

ON PARTITION OF THE SESAMOID BONES OF
THE LOWER EXTREMITIES

BY

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A.

PATELLA PARTITA

especially with regard to *histological* findings and the relation
to traumatism. Among others, six own cases examined
histologically.

A Contribution to the Pathology of the Patella.

“La patella bipartita ne présente
pas un simple intérêt de
curiosité; elle mérite d’être
connue en pratique.”

J. Fournier 1923.

I.

It was in the year 1883 that the patella partita made its first appearance in the medical literature of the world. That year the Russian anatomist *Wenzel Gruber* described a bilateral patella divided into two which he had encountered during a post-mortem examination in an Archangel peasant, aged 21. The histological examination of the specimen demonstrated that no fracture was present, as he had assumed, and that it was a case of an anomaly, unknown until then, in which the two fragments of the bone were united by *connective tissue*. A partition or division of the patella, therefore, appears to have occurred due to absent ossification. *Gruber* designated the anomaly *patella partita*.

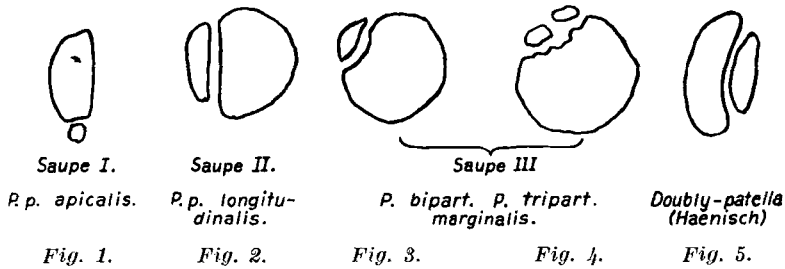
In 1902 *Joachimsthal* reported an anatomical specimen of

patella partita which he had unearthed in the Du Bois-Reymond collections.

In 1921 *T. W. Todd and W. C. McCally* in the Musée Hamann found some specimens of "scission rotulienne sans trace de traumatisme sans ébauche de cal."

Quite naturally it was the roentgen plate which was the first to reveal this patellar anomaly intra vitam. The very first case was demonstrated in 1901 by the Norwegian *Reinhardt Natvig*. *Natvig* has kindly informed me that it was a case of a peasant woman, 33 years of age, who was supposed to have suffered from a lesion of the spinal medulla at the age of three, and for the last ten years she had experienced pain in the knees, pain which particularly had increased during the last half-year. On examination the patient demonstrated flexion contraction of both hip and knee joint. No limitation was present, however, of the passive motion, and full extension was possible. Examination of the one knee—in which pain had been present or most pronounced, and in which a dry, crepitant synovitis existed—a deep transverse groove was palpated *across the patella* between the upper two-thirds and the lower one-third. *Natvig* at first supposed *a fracture* to be present. As the patient denied most firmly, however, having been the victim of any trauma, and as a perfectly identical, transverse furrow was palpated at the corresponding place of the opposite patella, the diagnosis of fracture had to be abandoned. *Natvig*, who realised that never before had he observed any similar occurrence, assumed that it was a species of sesamoid bone formed by an accessory centre of the inferior patellar ligament. The X-ray revealed a transverse partition of both patellae at the place indicated, in other words a *patella partita apicalis*. On a visit to Berlin *Natvig* reported the case to professor *G. Joachimsthal*, who asked for the loan of the roentgenogram. In his article "Ueber Struktur, Lage und Anomalien der menschlichen Kniescheibe" (*Arch. f. klin. Chir.*, Vol. 67, 1902) *Joachimsthal* published the roentgenogram together with the history of the case. He did not, however, regard the clinical symptoms of the knee as resulting from the anomaly of the patella.—*Natvig* has further stated that he has not subsequently observed any similar case during his 40 years practice.

II.



Erich Saupe (1921) distinguishes between the following three varieties of *patella partita*:

- Type I* The patella is divided by a horizontal fissure into a larger upper and a smaller lower fragment, which forms the patellar apex: The *apical* partition.
- Type II* The patella is divided by a vertical fissure into a smaller *lateral* fragment and a larger medial one at a ratio of approximately one-third to two-thirds (*Pytel*): The *frontal, longitudinal* partition.
- Type III* The *upper lateral corner* of the patella is divided from the remaining part of the patella by an *oblique fissure with a course medial from above, lateral downwards*: The *marginal* partition.

In the marginal type one may find two small fragments in the upper lateral corner—patella tripartita—or more—patella multi- or pluripartita. Also in the frontal type fragmentation has been observed of the smaller lateral fragment, which appears to have been the case with one of the patients of *Zwerg*.

Saupe states that in type I both fragments added together are longer than the patella normally, while in types II and III the fragments added together are not wider than a normal patella.

In addition to the three types of *Saupe* comes type IV, a form of fissure in *the sagittal plane*, described first by *Haenisch* in 1925, and later by *Paas* in 1931, in which the patella is divided into two fragments, not as in the other types located to the same

frontal plane—but *superimposed on each other*: “Kniescheiben-doppelung”—*double patella*. Of these four types II and particularly IV are very uncommon. The anatomical specimen mentioned previously, examined by *Joachimsthal*, demonstrated type II. Such cases have subsequently been recorded by *Grashey* (1923), *Hellmer* (1925), *Zwerg* (1928), *Siemens* (1931), *Erwin Paul* (1932), *Link* (1932), a total in all of *nine cases*. Cases of type IV—“double patella”—have been reported, besides by *Hae-nisch*, by *Silfverskiöld* and *Büttner*, both in 1925, *Pytel* (1930), *Paus* (1931), *Schwarz* (1932) and *Gorzowski* (1937), seven in all, most of which as a link in a general chondro-osteopathy.

The great majority of the cases, however, belong to type III—patella partita marginalis. Among 17 cases observed by *Siemens* were found 12 of this type—viz. 70 per cent, while *Pytel* states that 84 per cent of the cases are marginal. Among 81 cases of patella partita collected by him up to 1932, 12 were of type I, 5 of type II, and 64 of type III, that is to say that type III made up 79 per cent of the total. Among his own nine cases he had one of type II, and eight of type III. As the number of cases described in the literature increases, this great preponderance in the incidence of type III also increases. My own material of nine cases includes two of type I, six of type II, and one showing a transitory form between types II and III. Besides this preponderant incidence, the apparently *perfectly lawful localization and course* of the partition itself, make this type the *classical* form of patella partita. Transitional forms exist, however, between types I and II as well as between types II and III. With regard to the differential diagnosis between fracture and patella partita, it is of significance that practically without exception the medial patellar half is free from fragmentation. *Douarre* in one case found one fissure in the upper, outer quadrant and one in the lower end in the same patella.

In 1902 the Englishman *Kempson* recorded an anomaly of the upper lateral patellar corner, which he designated “*emargination of the patella*”, and which in his opinion was the result of defective ossification. The X-ray revealed this as a *semilunar*

defect of the bone, most frequently bilateral, in the above mentioned corner of the patella, such as occurs in a marginal partition, without any corresponding fragment, however. Subsequently a similar defect with the same localization has been reported by other investigators. *Todd* and *McCally* discovered this in three per cent of the skeleton specimens examined. *Fournier*, when examining anatomical specimens, on several occasions found an "emargination", partly in the form of a slight "encoche" and partly as a deep semilunar depression "avec bec osseux saillant au niveau de l'angle inférieur, disposition en tous points semblable à celles des images radiographiques habituelles de patella bipartita." Thus a kind of transition between an emargination and a patella partita marginalis. Similar cases have also been described by *Oetteking*.

Paas in 1931 reported two cases of unilateral defect of the contour of the upper lateral patellar corner, while a patella partita marginalis was present on the opposite side. On examination of 3000 roentgenograms of the patella *Paas* found a defect of the contour in two per cent of the cases, in approximately one-fourth of which bilateral. *Schaer* also maintains having come across this anomaly on several occasions. Numerous authors regard it as a variant of the marginal partition. In many cases *Fournier* has found a hypertrophy of the upper outer patellar corner, which has the appearance of a veritable apophysis. In two cases this had fused completely with the patellar body proper, while in two other cases a fissure was demonstrated between them. In one of these cases a thin bone lamella was discovered at the bottom of the fissure, uniting the apophysis with the patella, while in the other case the union was effected by a bony pedicle in the upper end.

III.

In 1921 *Odermatt* among 410 plates in his X-ray material found 15 cases of patella partita, *i.e.* 3.6 per cent, while *Paas* in 1931 after systematic search of his X-ray material of 15,000 patients found only 3—three—cases, *viz.* 0.2 per cent, in spite

of the fact that the greater part of the clientele was made up of individuals carrying insurance against accidents. As opposed to this *Blumensaat* in 1932 among 1378 knee-joint patients (Chir. Klinik, Münster) found 23 cases, *i.e.* 1.6 per cent.

While *Blencke* in 1922 was able to assemble from the literature 12 cases only of patella partita, *Siemens* in 1931 discovered 74 cases, even when including only those occurring in individuals above the age at which the ossification of the patella normally should be completed, in other words at the age of 14—15 years. In 1930 the Dane *Axel Rischel* among 270 individuals examined roentgenologically for various lesions of the knee joint at the Aarhus County Hospital in Denmark, found five cases of patella partita, *i.e.* 1.09 per cent. In 1933 *Pytel* collected 107 recorded cases. All cases described until the year 1921 were bilateral, when that year *Odermatt* reported the first unilateral case. As the number of publications gradually increased, however, the number of unilateral cases also increased accordingly.

In 1931 *Saupe*, in describing a unilateral case, maintains that this undoubtedly did not represent any rare occurrence. He mentioned the seven authors who had previously referred similar cases. In 1932 *Paas* estimates that approximately 30 per cent of the non-traumatic cases of patella partita were unilateral.

In 50 of the 74 cases reported by *Siemens* mention had been made as to whether it was a case of unilateral or bilateral patella partita, and of these 20 were unilateral, and 30 bilateral cases. In the 13 cases, among the 17 cases observed by himself, in which both knees had been examined, eight were unilateral and five bilateral.

Blumensaat has collected a considerable material. Of 20 cases in which this condition had been mentioned, 17 were unilateral and 3 bilateral. *Kalies* had 8 cases, 7 of which were unilateral, *Erwin Paul* among 9 cases found 7 to be unilateral and 2 bilateral. Of the 6 cases reported by *Rischel* 2 were unilateral and 4 bilateral. All of *Zwerg's* four cases were unilateral, and the same was the case with eight of the author's own nine cases. *Schaer* records that of the 10 cases, in which he had carried out pathologic-anatomical examination, 7 were unilateral and 3

bilateral. Among 140 cases which have been assembled by the author from the literature 80 cases were demonstrated to be unilateral and 60 bilateral, i.e. at a ratio of 4:3 (57.1 per cent and 42.9 per cent respectively). Not only are the unilateral cases thus in the majority, but in a substantial majority. All together a total of approximately 150 cases have been described in the literature up to the end of the year 1940.

In addition to the authors whose publications have been mentioned above, may be included the following, whose publications—with a few exceptions—comprise single cases: *Adams* and *Leonard*, *Beykirch*, *Botreau*, *Roussel et Mouchet*, *Climan*, *End-erle*, *Feinkorn*, *Hackenbrock*, *L'Heureux et Riche*, *Jancke*, *King*, *Køhler*, *Meisels*, *Noviaser*, *Paus*, *Potenza*, *Rocher et Guerin*, *Saupe*, *Schrøder*, *Thurston-Holland*, *Viuellet*, *Walls*, *Weil* and *Barthels*, *Wehner*, *Wright*.

In the great majority of cases the bilateral localization of the anomaly also means a *symmetrical* occurrence with regard to the *type*. There are exceptions, however; thus in the case of *L'Heureux et Riche* type I was found on one side and type III on the other, while in one of the cases of *Hellmer* and in the case of *Grashey*, type II is found on the one and type III on the other side. One may also find, as in the case of *Køhler*, type III bipartite on the one side and tripartite on the other.

The incidence of patella partita is preponderantly greater in males than in females, particularly in the marginal type. *Pytel* reports that 92 per cent of the cases occur in males. Among his 23 cases *Blumensaat* found 21 males and 2 females, i.e. 91 per cent males. In the above mentioned survey of the 44 cases of *Siemens*, in which the sex has been indicated, there are 40 males and 4 females, i.e. 90.9 per cent males. One of my eight patients was female. It may thus be stated that *the ratio between males and females with regard to the incidence of patella partita is roughly as 9 to 1*.

It is stated in the literature that in the unilateral cases the *right* patella is more frequently involved than the left. Thus in the 16 unilateral cases of *Siemens's* survey ten were right-sided and six left-sided, and in the 17 unilateral cases of *Blumensaat*

12 right-sided and 5 left-sided were found. The reverse relation is found, however, in the cases of *Kalies* and in the author's cases. In 6 of *Kalies*' unilateral cases, in which indication was given of the side involved, in two cases this was the right side and in four cases the left, while the figures in the cases of the author was two right-sided and four left-sided respectively. All told, it appears from this that a surplus for the right side is not constant, though the figures are too small to be of conclusive value.

IV.

Gruber was of the opinion that patella partita was due to an anomaly of the original patellar centre of ossification, in other words that it was a congenital anomaly. The point of time at which the ossification of the patella commences is indicated by the anatomists to occur within wide limits. While *Portal* (1803, cited from *Hellmer*) holds that the ossification starts already in fetal life, and *Kölliker* from the first year of life, *Munz* maintains (cited from *Gruber*) that it does not take place until the fifteenth year. In the literature one may encounter cases of "delayed" ossification—thus in the papers of *Siemens*, *Mau*, *zur Verth*. In this latter case the ossification of the patella was not completed until between the 17th and 20th year. The anatomist *Braus*, who holds that the ossification commences at the 3rd to the 4th year, also states that it is not completed until the twentieth year. The reason for these greatly varying statements must be looked for in several conditions, among others in the fact that small centres of ossification may evade the observation of the anatomist. The X-ray examination, therefore, is more reliable, although the reports of results differ also here, probably to some degree because the material in many cases has been too small, partly also because the point of time for the ossification is also in reality variable. Only some more comprehensive publications regarding the patella shall be mentioned here. In his paper from 1902 *Joachimsthal* states that one may observe a small patellar centre of ossification in the 4th to the 5th year. *Hasselwander*

maintains that the ossification commences in the 2nd to the 4th year. He refers from a serial examination carried out by *Noppe* in 300 children, that in all the females a patellar centre of ossification was present from the 4th year and in all males from the 6th year. *Flecker* among 55 children found that the centre of ossification appeared in the majority of girls in the 3rd year and in the boys not until the 5th year. *Rückenstein* fixes the time at the 3rd to the 6th year in girls and the 4th to the 6th year in boys. Of particular interest are the X-ray serial examinations of the patella in childhood carried out by *Pickhan* in 1930. He demonstrated that the first centre of ossification, in other words the ossification of the cartilaginous nucleus, commenced at the finish of the second year of life—at the time when a normally developed child has learnt how to stand and to walk. More centres of ossification were frequently added to this primary centre later. At first these were isolated from each other, but fused together as the evolution proceeded, and gave to the patella its final appearance. Of still greater importance are the exhaustive X-ray serial examinations of the conditions of ossification of the patella published by *Hellmer* in 1935. His material consisted of 400 healthy children (204 male and 196 female) at the age of 1—15 years. It appears from the diagram that the ossification of the patella in females commences in the 3rd year, in males in the 4th year, and that it has commenced in the 3rd year in approximately double the number of girls to that in the 4th year in boys. *It is further observed that the ossification takes place considerably more rapidly in females than in males.* In all the girls the commencement of ossification could be demonstrated in the 5th year, whereas in all of the boys not until the 7th year. *Hellmer* holds that in the roentgenogram one may distinguish between three different and characteristic phases of the ossification. In the last phase the patella has entirely or almost entirely adopted a cancellous character. While the patella is cancellous in a fairly great part of females already in the 4th year, this is the case in males in the 5th year in only about one-fourth of the corresponding figures for females. All females in the 9th year had reached the third phase of the ossification.

while this is not the case until in the 12th year in males. *In the 14th year the ossification is completed in females, in males in the 15th year.*

In the third phase of the ossification accessory centres appear, which contribute to the final shape of the patella. With predominating frequency one accessory centre is found in the *upper lateral corner of the patella*—thus a marginal centre of ossification— or in the *lateral* part. In the material of *Hellmer* this was found in 50 cases, *i.e.* in about one-fourth of the cases, and *with considerably greater incidence in males than in females*, viz. in 33 and 23 respectively. *In 38 cases the accessory centre was unilateral, in 18 bilateral.* In 30 of the cases of *Hellmer* an apical accessory centre was found, also this with greater incidence in males than in females, though the difference was considerably less here, viz. 16 and 14 respectively. *In 17 cases the accessory centre was unilateral in 13 bilateral.* Both forms occurred earlier in males than in females.

The histological examinations are also of particular interest. In two of the cases with marginal primary centre of ossification examined by *Hellmer* it was found that the narrow, continuous connection between the centres consisted of cartilage, here and there interspersed by vascular connective tissue. In the one case regressive changes were noticed in several places, and in the other typical degenerative changes were observed in the adjacent cartilaginous tissue. In a third case with primary centre cartilaginous cells with typical changes were discovered in the surrounding cartilaginous tissue, particularly in the bridge between the two primary centres of ossification, several more centres having been formed and indication of palisading having appeared.

It is obvious that these investigations of *Hellmer* to a great degree support the opinion that patella partita depends on congenital, and thus *endogeneous* factors. They provide a key, no doubt, to the explanation of the fact that the marginal type of partition of the patella has the preponderant incidence, and also that it involves males with predominating incidence.

In advocating a *traumatic* genesis of patella partita *Blumen-*

saat (1932) states that up to that year no case had been reported in the literature in which had been demonstrated in the same individual at a young age a patella with multiple centres of ossification, in which it has been possible to demonstrate a persisting partition after the period of growth had been completed under continual observation. *Schaer* (1934) remarks to this that systematical research with regard to this subject has not yet been carried out. As a result of follow-up examinations of his material—partly shortly afterwards (5—9 months) and partly after the lapse of a longer period (up to 8 years)—*Hellmer* reports that it is indicated that *the accessory centres of ossification usually fuse with the main centre of ossification*. In all cases the study of the conditions of ossification in the patella shows that *one may not talk about a partita as a permanent anomaly until after the completion of the ossification, as mentioned at the age of 15 for males and at the age of 14 for females*. Based on his own investigations on primary centres of ossification of the patella, and after mentioning the various theories regarding the pathogenesis of patella partita, *Hellmer* summarizes: "Obgleich die Frage der Aetiologie der Patella Partita nicht zur Gänze klargelegt ist, muss man daran festhalten, dass die immer vorhandene mehrkernige Anlage der primäre Bedingung für die Entstehung dieser Erscheinung ist."

The opinion of *Gruber*, that patella partita is a congenital anomaly, finds no inconsiderable support in the comparative anatomy, showing that patella partita may be found in certain predatory animals as for example the cat, and in certain rodents such as the mouse, the rat and the rabbit.—It was natural that this opinion of the pathogenesis was supported also by the fact of the markedly frequent bilateral localization of the anomaly. The fact that unilateral localization has now been demonstrated to be still more frequent, does not detract from the probability of a congenital genesis. Firstly, it is a known fact that partitions of definite congenital origin in other parts of the organism, as for example os acetabuli, though generally bilateral may also occur unilaterally. Secondly, from the author's own cases may be referred a case of *unilateral* patella partita marginalis as a

link in a general *congenital chondro-osteopathy*. The typical localizations and appearance of the partition also support the congenital theory. The objection lodged by *Blumensaat*, that there are also, as mentioned above, transitional forms between the different types, carries small or no weight in this connection. It is sufficient to bear in mind *that almost without exception the medial half of the patella avoids partition*.

The coincidence mentioned between patella partita and congenital chondro-osteopathy, which will be more closely dealt with later, turns the scale heavily in favour of the opinion of *Gruber*.

Previously it was generally supposed that the ossification of the patella took place from a single primary centre of ossification. In recent years, however, a couple of articles of high mark have shown that this is not the case. *Odermatt* (1931) by studying a great many cases—the number is not given—found *two or more primary centres of ossification in 15 per cent*, while *Hellmer* (1935) by systematical examination of 100 children from two and a half to three years of age, found in approximately 50 per cent of the cases *several primary centres of ossification, which must be regarded, therefore, as equally normal to one single centre*. A patellar partition persisting in an adult individual, therefore, must be looked upon as due to a developmental deficiency, which has *prevented the fusion of two or more centres*.—The possibility of a traumatic genesis of patella partita will be subsequently discussed in detail.

Just as little is known of the cause why one centre is present in one case, and several centres in another, as of the causal relation of the above mentioned deficiency of ossification in multiple primary centres of ossification. Endocrine disturbances have been suggested, rickets and so forth.

V.

For a long time the opinion of *Gruber* as to the pathogenesis of patella partita was the prevailing, and is undoubtedly the one which has had and still has, the greatest following. Thus *Hell-*

mer in 1925 maintains: "Wenn in der knorpeligen Patella mehrere Verknöcherungszentren vorhanden sind, und die so entstandenen Knochenfragmente durch eine Bildungshemmung nicht verschmelzen sondern isoliert bleiben, bekommen wir eine Patella partita." *Pickhan* states in 1936 that, after having carried out systematic X-ray examinations of the patella in evolution, similar to the investigations of *Hellmer*, he has arrived at the result "dass eine Patella partita als Endergebnis einer nicht zum Abschluss gelangten knöchernen Vereinigung einer aus mehreren Kernen bestehenden Kniescheibenanlage anzusehen ist und dass die kindliche Patella sehr häufig vielkernig angelegt ist."—Fairly early, however, a case occurred which might give room for another opinion. This was the case of *Natvig*—described by *Joachimsthal* in 1902—with bilateral apical patellar partition in a female, 33 years of age, with spastic flexion contraction of both knee and hip joints. The author had not connected this with the patellar partition, however. This coincidence, however, received quite another significance when compared with a case reported by *Enderle* in 1916, which also dealt with a bilateral apical patella partita, in which the patient, a male 47 years of age, had suffered pain in both knees from the age of ten without demonstrable cause. *Enderle* supposed that the cause of the patellar partition had to be traced back to *incomplete ossification* of two patellar centres, and that this again was due to a certain *distraction effect on the patella while still cartilaginous*—of the quadriceps in one direction and the inferior patellar ligament in the other. Such a pathogenesis appears all the more reasonable as the patella in both cases—particularly in that of *Natvig*—was drawn out longitudinally, at the same time having become narrower. In his paper of 1921/22 mentioned above, *Saupe* records a bilateral case of patella partita of type I, in a person, 38 years of age, suffering from Little's disease. A paraplegia of both lower limbs at the age of five had left a contraction of the knee joints of 140 and 110 degrees of the right and left knee respectively. In 1901 the patient had fallen on the right knee. X-ray examination disclosed a patella partita of type I, with a transverse partition—symmetrical on both

knees—of the elongated and anteriorly strongly convex patella. *Saupe* was of the opinion that on the basis of this, and the case observed by *Natvig*, in which also occurred an acquired diplegia, he could conclude that muscular spasm with contraction plays a pathogenetic rôle in type I of patella partita.

In 1924 *Hackenbrock* reported a case of a 15 year old boy with mongoloid features, who in addition to a number of other congenital deformities—among which were spina bifida and syndactyly of the feet, also presented bilateral contraction of the knee joints due to “Flughautbildung”. Roentgenologically was found that also here the patella of the one side was drawn out longitudinally and divided by a horizontal partition into two fragments, one greater upper and a smaller lower one. Simultaneously were found also a diastasis between the tibial tuberosity and the diaphysis. *Hackenbrock* was of the opinion that all this was arrested growth caused by a continual pressure of the patella on the femur. His case gives considerable cause for doubt, however, as to whether the patellar partition bears at all any causal relation to the contraction of the knee joint. Whereas this was bilateral, the patella was found to be divided on one side only, and that even on the side on which the flexion contraction was least. It is reasonable to suppose that multiple centres of ossification have been present bilaterally, and that for some reason or other the ossification has been delayed on one side, and was found to be completed here a couple of months after the flexion was relieved. Whether this is exclusively due to the result of an operation certainly gives cause for doubt. It should be recalled, namely, that when the ossification was completed the patient had not yet reached his fifteenth year, and was not, therefore, above the normal limit of ossification.

In 1920 *Walther Müller* referred a case of patella partita marginalis and maintained that this was a congenital anomaly which was always bilateral, and which could not be explained as having been produced by mechanical means similarly to the case of *Enderle* with transverse partition. Four years later (1924) *Müller* published some experimental investigations which serve to support to a not inconsiderable degree the above mentioned

observations made by *Joachimsthal*, *Enderle* and *Hackenbrock*. By keeping the one hind leg of young rats fixed in the hip and knee joints for three months, a simultaneous lengthening of the patella occurred and division into two fragments by a horizontal partition. This became manifest roentgenologically as a pale, transverse area, almost resembling an epiphyseal line. Histologically changes were found which corresponded to those present in a *pseudarthrosis* with separation and appearance of cartilaginous tissue, changes which were regarded by *Müller* as corresponding to those found in an "Umbauzone" according to *Looser*, in that no doubt normal bone tissue as a consequence of the mechanical strain represented by a flexion contraction of long duration has been changed into *inferior* bone tissue and finally into connective tissue.—*Müller* thus maintains that a *mechanical strain already in the intra-uterine existence* may be the cause of this anomaly and needs not necessarily depend on whether there are one or more primary centres of ossification, as appears from the explanation of *Müller*.

It will have been noticed that *Enderle*, *Saupe*, *Hackenbrock* and *Müller* supposed that a distraction of the patella between two forces pulling in opposite directions, was the cause of the partition found in the patella. In this direction undoubtedly also points the fact, which has not—at any rate up to now—received particular attention, that in the cases of the above mentioned authors, and least pronounced in that of *Enderle*, the patella has altered its shape, being drawn out longitudinally at the same time as it has decreased in width, which has not occurred in the other cases of patella partita of type I. Refer to the cases *Alv* and *Hjördis* in the present paper, and which represent typical examples of a patella partita apicalis. It should be noted also that the transverse partition in the cases in which the authors have reported that a flexion contraction has existed, is located higher up in the patellar body, though not so high up in the typical cases that one may actually speak of an apical partition in the prevailing sense of the designation. This appears particularly clearly from a case observed by the author—a female, 25 years of age, who had suffered for a number of years from

a major spondylitis with discharging sinuses, in whom a right-angled flexion contraction had gradually developed in one knee, having lasted for more than five years, and the crus simultaneously taking a subluxation position posteriorly, the patella thereby being squeezed against the articular surfaces of the femur. Clinically the patella was found to be considerably longer and wider than that on the opposite side—two and one and a half centimetres respectively. Further, the patella was in its entirety somewhat convex anteriorly, and also its frontal surfaces were considerably irregular, a fairly deep depression being palpated at the lateral margin, continuous as a definitely palpable furrow across the patellar frontal surface. These findings were verified roentgenologically, the sagittal view disclosing that the upper patellar pole was drawn out longitudinally and conically *pointed*. Similarly to the entire bony framework of the knee the patella was quite glassy, decalcified and structureless. Across the patella, however, is observed on the sagittal view a distinctly visible, though faint stripe with double contour, which must be interpreted as a transverse partition. The periosteum is thickened where it reaches the frontal surface, and this is also the case in a region further below. The partition forms a division between the upper and lower third. There is hardly any reason for doubt that this partition, like the change in shape of the patella, is caused by the *distraction* of this, which had been present for a number of years due to the contraction of the flexor muscles. This opinion receives substantial support from the fact that the patellar change was unilateral. *Hackenbrock* supposes that it is the *pressure action* of the patella against the femoral condyle which is the real cause of the partition in his case, and consequently also in other similar cases. It is quite natural to suppose that a *distraction as well as a pressure action* take place during the bending of the knee, and that both these factors are of importance. It is obvious that a distraction primarily may be held responsible when it is a question of a *transverse* partitioning, which always produces a separation of the patellar apex proper, and which furthermore

contrary to the upper part of the patella is not subjected to any pressure against the femoral condyle during flexion of the knee joint. It is reasonable, therefore, to suppose that the pressure action plays a greater rôle to the partitioning in the upper part of the patella. A special explanation is required, however, as to why this partitioning is found always in the upper lateral part of the patella. *Sommer* has furnished one, in that he has pointed out that the lateral femoral condyle, contrary to the medial one, is supplied with a *sharp bony edge* in its proximal part, which prevents the patella from slipping out to the side when it slides upwards during stretching of leg. As the quadriceps tendon always pulls the patella *outwards* and *upwards*, the upper, outer quadrant of the patella during this procedure will always collide with this protruding bony edge. It is exactly in this quadrant of the patella, however, that partitioning is most frequently discovered between two or more fragments and the patella proper.—Just as a factor with chronic action according to the investigations of *Müller* seem to be able to *produce* a partition of a normal patella, a similar influence according to *Sommer* should be able to *maintain a congenital partitioning*, as it prevents fusion of a patella with several primary centres of ossification. In both cases the result is an inferior patella with regard to physiological function, which is supposed to represent a locus minoris resistentia to traumatic insults within as well as outside the scope of the normal, and in the first instance to such as cause a distraction in longitudinal direction. The histological examination of a post-mortem specimen from a patella partita marginalis in a male, 33 years of age, mentioned by *Schaer* in his monograph published in 1934, and which will be referred in more detail later, appears to support the supposition of a degenerative process in the partition tissue. It shall only be mentioned now that the author, in referring to his case as an example of the typical construction of a patella partita, concludes as follows:—"Ich möchte das Bild in seiner Gesamtheit am ehesten als erhalten gebliebene Epiphysenfuge deuten, die von Fall zu Fall wechselnd die ver-

schiedene Grade der Knorpeldegeneration aufweisen kann."— Anyway, the cases recorded by *Joachimsthal*, *Enderle* and *Hackenbrock*, supported by the experimental researches of *W. Müller*, have introduced the *traumatic* factor into the question of the pathogenesis of the patellar partition, as the above mentioned flexion contraction in the knee joint of long duration must be supposed to have acted as a chronic trauma against the patella.

VI.

In 1920 *Walther Müller* described a case of Osgood-Schlatter disease in a boy, 13 years of age, in whom the lesion had occurred without antecedent trauma, and the roentgenogram disclosed that on the frontal side of the patellar apex of the one knee a small piece of bone was separated by a narrow fissure from the remaining part of the patella. Müller considers this to resemble the partitioning of the patella found in the case of *Enderle*. In my opinion this is not right, however. In the case referred by *Enderle* the apex proper of the patella was separated by a horizontal depression, while in the case of *Müller* it was the case of a thin lamella only of the anterior surface of the apex, which is separated from the patella by an oblique partition. On the other hand the roentgenogram of the case recorded by *Müller* is exactly similar to several of the cases which were described in 1922, independently of each other, by *Sven Johansson*, Sweden, and *Sinding-Larsen*, Norway. These authors considered it to be a separate disease, not before described, which has also subsequently carried the name of these authors. *W. Müller* as opposed to *Enderle* does not hold that this case depends on a congenital partition, but is a partial chip, though not on a purely traumatic basis, as no trauma existed and no clinical symptoms of such. On the contrary he regarded it as a *spontaneous infraction* caused by pull of the patellar ligament, as he regards this spontaneous tearing off of the bone as a parallel to the spontaneous *epiphyseal separation* in fractures. In this

case such "epiphyseal separation" was found also on both lesser trochanters. These symptoms give support to the opinion of the author that the Osgood-Schlatter disease is a systemic disease which manifests itself by an inclination to spontaneous infractions and epiphyseal separations—or on the whole to *spontaneous fractures*, and which in the opinion of the author are due to rachitis tarda. Anyway—this case of *Walther Müller's* is the first in which a partitioning of the patella has been connected with an Osgood-Schlatter disease.

Fleischner, in a case reported by him in 1924, arrived at a still more categorical conclusion than *Müller*, from the coincidence of a patella partita marginalis and an Osgood-Schlatter disease. It was a male, 28 years of age, who came in for X-ray examination on the clinical diagnosis of Osgood-Schlatter disease. Four months previously he had fallen and hurt his right knee, in which he had felt pain during the past two months. Recently the knee had become swollen, and there was tenderness over the tibial tuberosity. X-ray examination demonstrated an exostosis, the size of a pea, corresponding to the site of this tuberosity, with a more closely described, trunkshaped piece of bone protruding freely from the bone at this place. X-ray examination of the contralateral knee disclosed a marginal patella partita. Based on this coincidence *Fleischner* then advanced the opinion that patella partita should be regarded as a *juvenile osteopathy* similar to the cases of so-called apophysitis, the prototype of which is exactly an Osgood-Schlatter disease, and with the *aseptic necroses* related to it, though certainly not entirely identical, in epiphyses and the small spongy bones (Legg-Calvé-Perthes disease, the K $\ddot{o}$ hler diseases, and others).

Fleischner explains the partition of the patella as being the result of an osteochondritic process in the patella during the period of growth having caused decreased solidity of the cartilage and bones, so that the patella yields to strain also within normal limits. After the completion of the period of growth the same mechanical defect may delay the ossification and maintain the partition. The Norwegian *Nikolai Paus* who reported in 1927 a case of bilateral apical patella partita in a fisherman,

53 years of age, in whom were found roentgenologically "marked indications of a healed Schlatter disease", shares the supposition of *Fleischner*.

Some objections may be brought forward, however, against the conclusions drawn by the two authors from their cases. It

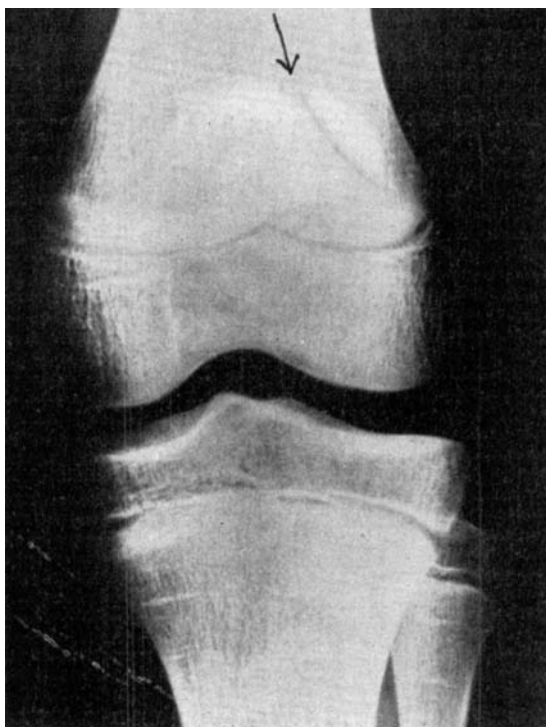


Fig. 6.
Case Torbjørn.

may be objected in the case of *Fleischner* that no conclusive proof has been procured that the large exostosis found on the tibial tuberosity on the side on which the patella was normal, was the result of an Osgood-Schlatter disease, and which in that case must have been dated back 10—15 years. It should also be recalled that this was the case of a patient who had sustained an injury to the same knee four months previously. As regards

the case of *Paus*, one has to agree with *Hellmer* when he asks for the roentgenogram which should have demonstrated that an Osgood-Schlatter disease actually had been present.

Besides these two cases, however, are also found a couple of others in the literature, and the author also may add one, all of

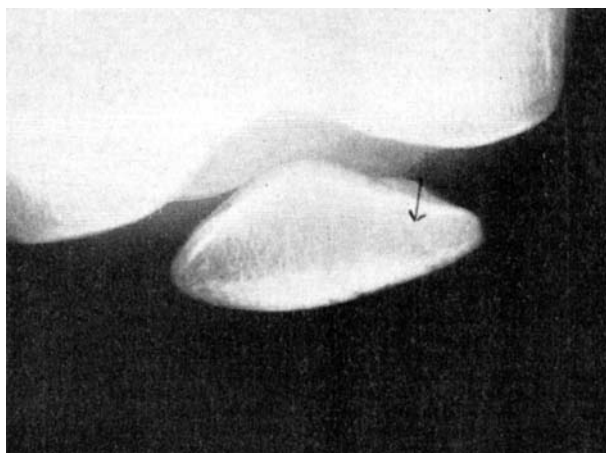


Fig. 7.

which makes it *highly probable that a simultaneous occurrence of two so rare lesions as patella partita and Osgood-Schlatter disease in the same individual is due to more than an accidental coincidence.* In the first instance, however, one shall have to disregard here the cases in which has been found a concurrence between Osgood-Schlatter disease on one side and Sven Johansson—Sinding-Larsen disease on the other as in the above mentioned case of *W. Müller*. Similar cases have also been reported, besides by *Sven Johansson*, by *Sinding-Larsen*, *van Neck*, *van Nes*, *Howley* and *Griswold*, and *Serfaty* and *Marottoly*. The Sven Johansson—Sinding-Larsen disease cannot be regarded as a patella partita in the usual sense, and at the time it is still under discussion whether it may be looked upon as a disease at all. More of this later.

On the other hand, patella partita associated with Osgood-Schlatter disease has been described by *King*. It was a case of

a boy, ten years of age, with typical clinical and roentgenological symptoms of a left-sided Osgood-Schlatter disease, the X-ray examination of the right knee revealing a marginal patella bipartita, while the left patella was normal.

Bilateral Osgood-Schlatter disease associated with marginal

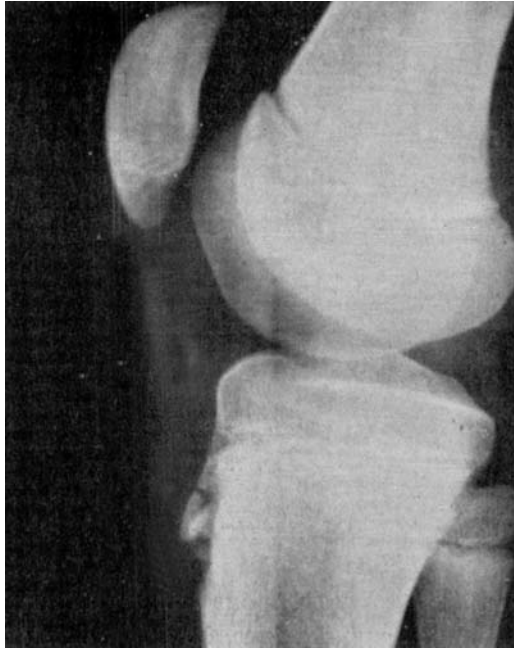


Fig. 8.
Right.

patella partita and bilateral "double patella" (*Hacnisch*), as a link in a general congenital chondro-osteopathy, is found in a case described by *Gorzowski*, which will be referred in more detail later.

The author recently has had the opportunity of observing a case perfectly identical to that of *King*, as follows:—*Case 1. Torbjørn*, 13 year old boy. Consultation March 12, 1940. A couple of weeks previously the patient had noticed a swelling close below the *right* patellar apex, with no antecedent trauma.

Half a year or one year ago the patient had just the same clinical symptoms, also in the *left* knee. These disappeared spontaneously in the course of a few months.

Local examination: Distinct swelling above the right tibial tuberosity with excessive tenderness to pressure about two fin-

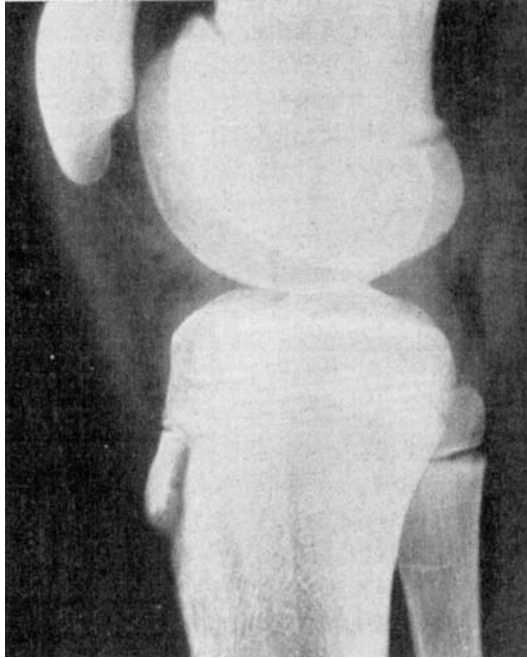


Fig. 9.
Left.

ger-breadths below the patellar apex. Pain on hyperflexion of the knee and when lying on the knee. Clinically no abnormal findings in the left knee. Never before experienced any pain in the knees. X-ray examination disclosed: Foto 6—9.

Right knee: Typical Osgood-Schlatter disease.

Left knee: Typical Osgood-Schlatter disease plus marginal patella partita¹⁾).

¹⁾ Addition during printing:

On control examination half a year later—on August 28th 1941—the

VII.

French authors (*Alb. Mouchet, Fournier*) suppose that a real *apophysitis patellae* actually occurs. In 1919 *Mouchet* reported a case of a boy, 14 years of age, in whom was present a non-traumatic hydrarthrosis of one knee localized to the superior recess. The roentgenograms showed normal conditions of the articular surfaces of the knee on both sides, but a bilateral marginal patella tripartita. *Mouchet* supposed that an "ostéite de croissance" was present, an "apophysite, développé au niveau du nodule accessoire de la rotule", quite analogous to that found in other cases of apophysitis (tibia, calcaneus) and with the changes one may find in the medial sesamoid under the great toe. In a subsequent paper *Mouchet* further emphasizes this, and says:—"Qu'il y a lieu de faire dans la pathologie infantile une place à des apophysites rotuliennes, tout comme aux apophysites bien connues du calcanéum ou de la tubérosité antérieure du tibia; elles ne sont peut-être pas aussi exceptionnelles qu'on le croit; elles expliqueraient certaines hydrarthroses curables de l'adolescence, qu'on a peut-être trop facilement attribuées à la tuberculose."

Among the specimens from the Musée Dupuytren described by *Fournier*, as above mentioned, where he had also encountered some cases of "emargination rotulien", he found four patellar specimens demonstrating "un renflement de l'angle supéro-externe, développé en une véritable apophyse."—In two of these the apophysis had entirely fused with the patella proper, while in the two others they were separated by a partition. In the one case the base of the partition was formed by a thin bone lamella;

roentgenogram demonstrated that the right tibial tuberosity had now been consolidated and presented the identical picture as the left side, which had also shown definite clinical symptoms of Osgood-Schlatter disease. Simultaneously, however, the partition in the patella had disappeared in the frontal as well as in the axial plane. There cannot, therefore, have been any question of congenital partition of the patella. This makes the case no less interesting, however, particularly when regarded in connection with the simultaneous affection of the tibial tuberosity.

in the other the apophysis was united with the patella by "une pédicule osseux siégant à son extrémité supérieure." None of these patellae showed evidence of trauma. According to these findings *Fournier* agrees with the supposition of *Mouchet* that an apophysitis patellae occurs during the period of growth. As the patellar partition is bilateral, while the symptoms are unilateral, it follows that the partition cannot have been the cause of these. An additional "something" must have occurred. That this is an apophysitis has not been proved neither in the case of *Mouchet* nor in the specimens of *Fournier*. Neither is this the case even if subsequently a consolidation has occurred of the assumed apophysis, as in other cases of apophysitis.

VIII.

Cases have been described also of patellar lesions, in which it has been assumed with more or less probability that it is a question of an "aseptic necrosis", an "osteochondritis". The first case of an osseous aseptic necrosis is found in *Alban K hler's* initial description of the lesion of the navicular bone of the foot, which has since carried his name, *Morbus K hler I*. The disease was bilateral in one of the three cases reported here—all were boys between five and nine years of age. Simultaneously, however, the patient complained of pain in both knees localized to the patella. X-ray examination showed a bilateral lesion with perfectly identical changes as those found in the navicular bones. It is stated with regard to the X-ray findings in these that the bones were visibly pathologic throughout, while the other bones of the skeleton of the foot were normal. "Das Navikulare war in vierfacher Beziehung ver ndert und zwar in seiner Gr sse, seiner Gestalt, seiner Architektur und seinem Kalkgehalt." Undoubtedly, however, some objections may be advanced against accepting without further ado the assumption of K hler based on the available information and the X-ray findings, that the bilateral patellar lesion was of the same nature as the navicular lesion. The roentgenogram discloses a patella, the development of which is greatly delayed when compared to the age of the patient. As

mentioned, however, the only indication of age was that the patients were between five and nine years. The roentgenogram shows that this patient must have been the oldest of the three. A roentgenogram of the patella of the twin brother of the patient is also illustrated, showing that while his patella measures 17×8 millimetres, the patella of the patient measures only 7×3 millimetres. The reproduction of the roentgenograms, which leaves much to be desired in the way of clearness of details, however, also shows as pointed out by the author—an irregular calcification. In his paper from 1936 *Hellmer* reports that the roentgenogram discloses two centres which are partly superimposed on each other, a fact which explains the irregular bony structure. I cannot accept this interpretation of the picture, whereas according to my opinion an objection might be raised that no fresh subsequent X-ray examination was carried out. Such would have given information as to whether increased irregular decalcification had occurred or subsequent consolidation of the bone respectively as in the aseptic necroses generally. We should then have been able to approach closer to the diagnosis. Even though such roentgenologic follow-up examination has not been carried out, however, it is not warranted to entirely reject the possibility that the ossification disturbance actually found in both patellae has an etiological interrelation to the changes observed in both the navicular bones of the feet, now admitted to be caused by an aseptic necrosis. At any rate such an assumption appears to be considerably more probable than that it is an accidental coincidence of two etilogically different lesions.

The combination of a unilateral K hler I with delayed ossification of the carpal bones and of both knee-caps, which demonstrated minor changes in a boy, seven and a half years of age, are described by *Behn*. Of more interest is a case of unilateral K hler disease I in a boy, nine years of age, recorded by *Korit-zinsky*, in which both patellae presented irregular, serrated contours with partially increased calcification and a bipartition of the left patellar centre, which also is observed to be considerably greater than the right.

In 1924 *H. Blencke* reported a case of a seven-year old boy

with symptoms from the one knee joint, suspected of tuberculosis (with pain i.a. over the patella and slight swelling of the joint). X-ray examination revealed wide epiphyseal areas in the skeleton of the knee, but no decalcification. Further, considerable changes were found in the patella, the upper two-thirds of which were made up of a crescent-shaped sclerotic "nucleus", while the remainder of the patella surrounding this nucleus demonstrated a marked mottled atrophy, particularly of the lower pole. It was also distinctly fuzzy, and separated from the other part of the patella by a narrow cleft of isolated bony islands about the size of mustard seeds. Further, the contours of the epiphyseal borders of the femur as well as of the tibia were serrated. No mention is made of the conditions of the opposite knee. Tentative diagnosis: Osteochondritis patellae, which appeared to be verified by the clinical course, as all symptoms receded spontaneously during rest. The patient reappeared, however, five months later as he again commenced limping. Examination established that a Legg-Calvé-Perthes disease was present on the same side, while the knee showed quite normal conditions. The author assumed the presence of a multiple epiphyseal lesion on constitutional basis. As the roentgenogram is not reproduced in the paper, one may only refer here to the description, according to which it appears that the changes in the epiphyses of the knee are not greater or other than normally observed in children during the period of growth. The patellar changes, which were considerably more pronounced, consisted in a strongly marked mottled atrophy, which seemed to have resulted in fragmentation—changes which tally perfectly, therefore, with those found in several of the cases described below (*Mau, Moffat*) under the diagnosis "osteopathia" or "osteochondritis patellae". The clinical symptoms attending these X-ray changes together with the coincidence of a definite osteochondritis of one hip joint, must be stated to make it probable, that the changes of the patella have also been osteochondritic.

In 1930 *Mau* under the designation "osteopathia patellae juvenilis" has described four cases, all in children between nine and thirteen years of age, among whom the one, a boy of nine,

is of particular interest. Without known reason the patient developed symptoms of a chronic synovitis of the right knee, which was interpreted as tuberculosis. X-ray examination disclosed marked structural change of the entire patella, particularly at the poles, with greatly irregular calcification, even to fragmentation. The patient was under observation for seven and a half years, during which time the bone had consolidated gradually, though very slowly, without attaining normal structure, at the same time as the patella increased in length as well as in width as compared to that on the sound side. *Mau* considered it to be greatly probable that an aseptic necrosis was present in all four cases, due to an abnormal pressure and pulling effect on the patella. As the case was not treated operatively, no opportunity offered of histological examination. Such was carried out, however, in two of four cases published by *Rostock* in 1929, also under the title of *osteopathia patellae*. Three of these cases concerned adult males, 26 to 41 years of age, and the fourth was a 16 year-old female. The three males had suffered a preceding trauma to the knee. Physical examination elicited pain in the knee joint, particularly on flexion, and also muscular atrophy. Roentgenogram in sagittal view demonstrated in all cases one or more rarefactions in the bone, the size of peas or beans, and surrounded by smooth walls. In the two cases operated on—both male—the rarefaction in the bone was disclosed to be a cavity sharply delimited by brittle bony tissue. The histological examination of this tissue in the first case gave a negative result, while the examination of the bone at the edge of the cavity demonstrated the presence of osteoid tissue proving that reparatory processes were at work in the bone. The histological examination in the other case showed distinctly necrotic bone besides adjacent osteoid seams. According to these findings the author assumed from the clinical and roentgenological findings, which corroborated each other in all cases, that it was a case of an aseptic necrosis of the patella. Considering the age of the patient, however, there can obviously be no question of a *juvenile osteopathy*. The X-ray finding also differed fundamentally from that in *Mau's* case.

Moffat, also in 1929, under the title "Køhler's disease of the patella" recorded a case in a child, seven years of age, who after a fall on the knee seven weeks previously had complained of pain here. The history of disease further reports that the same knee had become swollen consequent upon a trauma 13 months previously, when it had been incised and drained, subsequently remaining completely healthy until the above mentioned trauma occurred. Afterwards the knee had been slightly swollen with mild hydrops. Clinical diagnosis: Tuberculosis. While the X-ray picture of the sound knee showed a normal knee-cap corresponding to the age, the picture of the diseased knee disclosed a somewhat enlarged, but primarily strongly *fragmented* patella. Frontal view is absent. The case was treated operatively, a purse-string suture being affixed around the knee-cap to prevent further fragmentation. The operation revealed a chronic synovitis with hydrops, an elongated, extremely soft and almost cartilaginous patella. Microscopical examination showed: "... no evidence of osteitis. The bone was everywhere invaded by cartilage. The appearance corresponded to that described in microscopic examination of sections of the femoral head in Legg's disease." Subsequent X-ray examination showed very small changes with no augmented fragmentation. The author winds up by stating that an epiphysitis of the patella had arisen due to a clinically chronic infection, but that no inflammatory changes could be recognized. This epiphysitis had then caused a disturbance of the ossification with changes considered by the author to be identical to those found in Køhler's disease of the navicular bone, which softened the bone so that it yielded to axial pull.

In 1932 *Kremscr* referred, under the designation "eine seltene Lokalisation der Køhlersche Krankheit", two cases, both boys of 8 and 4½ years respectively. In the first case the patient showed a somewhat retarded development. Clinical examination disclosed slight swelling of the knee due to minor capsular thickening, and quite slight tenderness over the patella. Roentgenologically marked structural change of the patella was revealed, which showed "ein ausgesprochener scholliger Zerfall durch

den die Patella ein krümeliges Aussehen erhalten hat." Areas showing distinctly dense structure was also seen. Similar X-ray changes were seen also in the opposite patella, which showed perfectly normal clinical conditions. No roentgenological changes were found in the tarsal navicular bone and the head of the second metatarsal bone. Renewed X-ray examination half a year later disclosed increased calcification. In the sagittal view the left knee-cap was now distinctly divided into two by a transverse partition.

In the other case also quite slight clinical symptoms were present in the one knee (slight swelling of the soft parts with tenderness to pressure over the tibia). X-ray examination: Pronounced structural change of the left patella with irregular calcification—with two vacuolar rarefactions over the lower pole, otherwise with increased calcification and irregular contours. This case also showed normal conditions of the navicular bone of the foot and the head of the second metatarsal bone. No trauma was present in the past history of any of these cases. In both cases the patients were referred for X-ray examination because of a fear of incipient tuberculosis of the knee joint. The author states that his case does not tally in diagnostic respect with those of *Rostock*, described above, which according to his opinion concerned *localized* necrotic foci in the patella. In his two own cases on the contrary, he assumed that it was a case of *total necrosis* of the patella as in the aseptic osteocartilaginous necroses caused by mechanical strain in two individuals who presented disturbances of ossification. The first, a boy of 8 years of age, had reached the developmental stage of 6 years only. In both patients the development of the patella was considerably delayed according to the age.

In 1934 *Moses Gellman*, Baltimore, refers two cases of "osteochondritis of the patella". The one was a boy, 6 years of age, who appeared for examination on January 16, 1930, as he had complained of pain first in one and then in the other knee for some months. The clinical symptoms were limited to slight tenderness over the patella. The sagittal picture disclosed a distinctly mottled atrophy, "numerous areas of lessened density

and incomplete ossification and a tendency to fragmentation of the lower poles." The frontal picture showed slight, though definite fragmentation. During rest in bed for two to three weeks the tenderness over the patella vanished. Renewed X-ray examination two and one-third years later, during which time the child had had no symptoms from the knee, showed normal structure in both patellae which had, however, increased in length in proportion to the age. The second case is of particularly great interest in this connection. It was a boy, 12 years old, who had suffered pain in the right knee after having twisted it one year previously, feeling the pain particularly when mounting stairs. There was also some swelling over the patella, especially over the upper outer corner, without tenderness on pressure, however. The boy occasionally limped on this leg, and lately the symptoms had increased. The boy was well developed, though with some obesity, and rather under than over medium height. He also suffered from congenital ichthyosis. *Local examination: Right knee:* Free motion. Some swelling over the outer, upper corner of the patella, where considerable tenderness was elicited on pressure. *Left knee:* Normal patella. X-ray examination: Sagittal view of the right patella revealed a greatly changed structure. The upper pole was almost entirely separated from the remaining patella by a transverse furrow, and the entire frontal surface was also separated by a vertical furrow, the patella thus also being divided in a frontal and a distal part. The patellar structure itself showed extremely strongly marked mottled atrophy. The sagittal picture of the left knee showed that these changes were still more pronounced here than on the right side ("even more disorganized and moth-eaten"). On the frontal view the right patella is observed to be bipartite, the upper, outer corner, where the patient had shown tenderness to pressure, showing a small fragment separated by a fairly wide partition from the patella proper. Further, in the sagittal view the lower femoral epiphysis, particularly the anterior part, showed some irregularities especially on the left side. After immobilization for four and a half months all tenderness had vanished from the right knee, and there were still no symptoms from the left knee.

Renewed X-ray examination showed some improvement. In the right patella fusion had taken place between the two fragments, the structure, however, still remaining considerably mottled and disorganized. The left patella still showed partition, though on the whole the bone had become more solid and calcified. In September 1930 the patient presented himself for further consultation because of pain in both heels of some weeks' duration. There were distinct clinical symptoms of an apophysitis, roentgenologically on one side only, however. Three days later he reappeared due to pain in the left knee, in which were now demonstrated the typical symptoms of an *Osgood-Schlatter disease*, the typical roentgenologic changes also soon developing in the tibial apophysis. X-ray examination of the patella now demonstrated a considerably more dense and homogeneous, though not yet normal structure. On the last examination two and a half years after the first examination the patellae on both sides were perfectly symptomless. Both were, however, wider than normal, and the right also longer. While the left showed normal structure, mottled atrophy still persisted of the right patella. There was still tenderness over the tibial tuberosity.

It appears from this review that the roentgenological changes of the patella found in all of the patients referred, were interpreted as necroses. In the four patients of *Rostock* necrosis was observed, localized to certain circumscribed parts, while a *total necrosis* seems to have been present in the other cases. In a couple of cases (*Køhler*, *Koritzinsky*) the bilateral patellar changes which were associated with a *Køhler I disease*, also bilateral, only represented an incidental X-ray finding. In other cases clinical symptoms are met with in one knee (*Mau*, *Moffat*, *Kremser*, *Gellman*). In one of the cases of *Kremser* and one of *Gellman's* X-ray examination of the sound knee showed the identical roentgenological changes in the patella as in the other knee. Mostly the clinical symptoms were slightly marked, though sufficient to warrant a fear of incipient tuberculosis. In the case of *Moffat* it was so strong even that the knee joint was incised and drained. In this case a part of the patella was removed and examined histologically, with the result that the author meant

to be able to conclude that the identical process was present in the patella as in the upper femoral epiphysis in Legg-Calvé-Perthes disease. In my opinion, however, the description of these changes is too brief and contains too few details for such conclusion to be drawn with certainty. The fact that the clinical symptoms are so pronounced speaks rather against than for a primary patellar osteochondritis. On the other hand, however, the roentgenological findings—which demonstrated a fragmentation of great extent together with an elongated patella—concur with those found in aseptic epiphyseal necroses. No follow-up examination was carried out in this case, however, and it is not known, therefore, whether the patella was finally consolidated. This was the case, however, with *Mau's* patient, in whom fusion gradually occurred of the not inconsiderably elongated patella, in spite of strong fragmentation during the observation period of eight years, even though its structure had not yet become entirely normal. In the other cases the roentgenological changes were primarily limited to a *structural change* due to irregular calcification of the patella, which had shown irregular contour and in several cases were divided into two.

It is a factor of great importance in the evaluation of these cases that all the patients referred—except *Rostock's* four—were *children*, most of them in the medium age of childhood. One has to take into account, therefore, in all these cases that the ossification of the patella has not been entirely completed, all the more so as all the cases, with the exception of those of *Mau*, two of the four of which were female, and sisters, were boys in whom the ossification period is longer than in girls. The sex has not been indicated, however, in *Moffat's* case.

In a critical analysis of the cases I have mentioned above—those of *Blencke*, *Rostock* and *Gellman* excepted, however, *Hellmer* winds up by establishing that the X-ray picture, interpreted by the authors mentioned by him as a form of the Køhler disease localized to the patella, is a common occurrence in the normal ossification of the patella. And in a discussion with *Kremser* regarding the above mentioned case of this author, *Hellmer* maintains that the irregular form and disorganization of the

patella is due to "Ueberprojektion mehrere teilweise noch von einander getrennten, teilweise in Verschmelzung begriffener Ossifikationszentren." As mentioned above *Pickhan* has carried out similar X-ray examinations of the patella in childhood and has arrived at the same result as *Hellmer*. The frequent incidence of several primary centres of ossification in the patella may result "in der verschiedenartigsten Formen im Röntgenbild . . . (Auflockerung, scholligen Zerfall, Maulbeerform)", in other words the roentgenograms are interpreted by various authors as resembling the K hler disease or the Sven Johansson—Sinding-Larsen disease, *though they are perfectly normal*. This, of course, can be proved histologically only, which has also been done by *Hellmer* as well as *Pickhan*. Examination of patellae which presented the said X-ray changes, showed that the histological construction was quite *normal*. No necrosis was demonstrated neither of cartilage nor of bone.

After having studied the above mentioned cases of *Mau*, *Kremser*, *Moffat*, and *Gellman*, the Swede *v. Rosen*, in his recently published paper (1939) on infectious pathological processes in the patella, arrived at the result that the case of *Kremser* and the first of those of *Gellman* only represent normal stages of patellar ossification, while in the case of *Moffat*, *Mau* and the second of *Gellman*'s cases, a benign osteomyelitis of the patella was probably present. The author concludes by stating that it is doubtful in his opinion, whether an aseptic necrosis does occur at all in the patella as a separate disease.

Hellmer and *Pickhan* have demonstrated by their investigations on the ossification of the patella, that similar X-ray findings in the patella as those made in the cases of the above mentioned authors, may also occur *without simultaneous clinical symptoms*. It is quite another matter, however, whether this is any proof that the roentgen changes lie within the physiological limits. It is often very difficult to decide where these limits are. It is at any rate a well-known fact exactly in the aseptic epiphyseal necroses, that one may find marked X-ray changes with *entirely normal clinical findings*. In the presence of a clinically unilateral Legg-Calv -Perthes disease one may thus observe

equally marked roentgenological changes in the clinically sound hip, as in the clinically diseased hip.—As far as the patella is concerned both *Kremser's* cases and one of *Gellman's* show the same findings. In *Kremser's* cases the X-ray changes were bilateral and identical, while the clinical symptoms were present on one side only. In the second of *Gellman's* patients the same was the case with the only difference that the X-ray changes were even more marked in the clinically sound knee than in the morbid one. *The fact that the X-ray changes mentioned are not accompanied by clinical symptoms, may not thus be regarded as any criterium that they lie within the limits of the normal.* Therefore, when in a unilateral lesion of the knee joint no other X-ray changes are found in the patella than those mentioned, while the other knee is roentgenologically normal, it must be a logical assumption that this is a pathological patella with resultant clinical symptoms and not a chance coincidence only between these and a patella with disorganized, though normal structure, as *Hellmer* claims to have been the case with the two patients of *Kremser*. The same reasoning is equally natural when in a patient with a *Köhler* scaphoid lesion or with an apophysitis of the tuber tibiae or calcanei or a Legg-Calvé-Perthes disease, changes are encountered of the same nature as described here, in one or both patellae, even if they are not combined with clinical symptoms. Nobody would maintain, I take it, that in the case II of *Gellman* a chance coincidence was present between a bilateral apophysitis of the knee, a unilateral apophysitis of the tibial tuberosity, and the pronounced bilateral patellar changes—and that these should not be due to the same pathogenesis even if they gave clinical symptoms on the one side only. No doubt exists that all of these osseous changes have been of general constitutional nature in this patient, who also presented other constitutional abnormalities (ichthyosis, obesity, low stature).

In my opinion, therefore, it is quite incorrect to deny categorically that the patella may also be the seat of an aseptic total necrosis—a *juvenile osteopathy*. *On the contrary—several*

of the cases mentioned here makes such an assumption highly probable. It may be of interest, therefore, in this connection to cite the statement of *Alban K hler* in 1936, i.e. almost 30 years after he had reported in his above mentioned paper his patient with the scaphoid necrosis associated with changes in both knee-caps—in his well-known manual: "Grenzen des normalen und Anf nge des pathologischen im R ntgenbilde": "Eine isolierte Wachstumsst rung der Patella bestehend in Strukturzerst rung, Schrumpfung und Sklerosierung des Knochenkernes kommt vor in Combination mit dem gleichen Prozess in Os Naviculare Pedis. Der Prozess heilt in einigen Jahren mit Wiederherstellung der Struktur, der normalen Gr sse und Form wieder aus." Thus the experienced author is still of the opinion that the processes that may be observed in the patella in association with a K hler navicular disease of the same nature as this.

In 1908 *Wollenberg* refers the results of some experimental researches in support of his theory of vascularization. After having remade the patella in a dog, this was killed in half a year. Sagittal roentgenogram of the remade patella revealed that this had now increased doubly in length at the same time as it had been divided into three parts, separated from each other by a furrow of proliferative cartilaginous tissue. No necrosis of the bone could be demonstrated with certainty in the fragments; obviously the process of substitution had already proceeded too far (Mau 1. c.). Scattered osteoclasts were found, however, lying in lacunae "deren osteoklastischen T tigkeit sich deutlich in der Form dieser Lakunen  ussert." In other places new formation of bone was found "mit Osteoklasten Ketten ums umt und lassen zwischen sich ein fettzellenhaltiges, fibr ses Knochenmark" (*Wollenberg*). The cartilaginous tissue, on the contrary, was distinctly degenerated, changed into connective tissue rich in ossific centres. The author interpreted the entire picture as arthritis deformans. *Walkhoff*, *Ewald* and *Preiser* have copied *Wollenberg's* experimental researches in seven dogs and two rabbits, but in two cases only—one dog and one rabbit—was it possible to demonstrate pathological changes macroscopically.

pically. In this dog a partition had occurred of the patella, as in *Wollenberg's* case, a bipartition with a small apical fragment. Microscopically the partition was filled with fibro-cartilaginous elements. On the whole the great patellar fragment was normally built, with no necrosis of bone or cartilage. The marrow was pure fatty marrow. Here also one frequently encountered osteoclasts on the bone spicules. In the small fragment intense new formation of bone was taking place, characterizing the microscopical picture.

While *Wollenberg* was of the opinion that the patellar changes in his case had to be interpreted as an arthritis deformans of high degree due to nutritional disturbance of the patella, *Walkhoff*, *Ewald* and *Preiser* maintained that this was not present in their cases, but that the patellar changes in their one case had to be explained as *a trauma* to the patella during the actual operative intervention. This does not appear to have been proved, however, and does not explain away the fact that patellar changes have been successfully induced experimentally, which correspond *roentgenologically* to those found in the aseptic epiphyseal necrosis.

In the cases mentioned here, there has been no partition of the patella in the sense of the designation *patella partita*. *Meisler* has described in 1928, however, a case of a railwayman, 42 years old, who after an attack of influenza had suffered recurrent pain in the right knee, and which had now occurred again without demonstrable cause. The knee was considerably swollen with circumscribed considerable tenderness over the upper outer margin of the patella, where an irregular depression was felt on deep palpation. Similar depressions were felt also on the corresponding place of the left patella, though without tenderness on pressure. X-ray examination disclosed a *bilateral* patella bipartita marginalis. While the edges of the depression in the left patella, however, were smooth and with regular structure and sharp contours, they were irregular, serrated and fluffy on the right side. The partition also had an irregular course. Further, the small upper lateral fragment showed some mottled rarefactions and blurred contours. Similar rarefactions were

also observed in the large fragment in the patella proper. The pain and swelling of the knee disappeared during immobilization in the course of ten days. *Meisler* assumed that it was here a case of *recurring osteochondritis* in an abnormally developed patella brought about by an influenza infection, which had found a spot of minimum resistance in the right patella, being regarded as more exposed than the left patella to mechanical strain. Irrespective of the fact that this latter assumption appears entirely untenable, I consider it to be predominantly probable that the X-ray changes in the right patella, which corresponded substantially to those in the left patella, are not of primary nature, but *secondary* after a primary synovitis, possibly recurring after a previous influenza infection. As furthermore no histological examination is available, the diagnosis osteochondritis appears still more dubious. The age of the patient vouches for the fact that it is not a case of *juvenile osteochondritis patellae* at any rate.—The supposed osteochondritis, anyway, cannot be the cause of the patellar partition which was bilateral.

The fairly numerous cases of patella partita—unilateral or bilateral—in patients who present more or less marked symptoms of a *congenital general chondro-osteopathy* are of considerable importance to the question of the congenital genesis of the patella partita. This concerns primarily the patellar partition of type IV “double patella”. *Haenisch's* case (1925) referred to a female, aged 48, with changes in both hips which were definitely due to deforming arthrosis, though the author did not connect it with the patellar anomaly, which he considered to be of congenital character.

Büttner, also in 1925, described a patient, a girl aged 11, who in addition to bilateral Legg-Calvé-Perthes disease with subluxation of the hips, showed changes in the humeral head and the elbow joints with deformity and flattening of the distal metacarpal epiphyses. The lower femoral and tibial epiphyses also presented a patella tripartita of type IV. In addition to the skeletal changes mentioned the patient also presented a series of other conspicuous stigmata of degenerative nature such as scapulae scaphoidea, pedes excavati, multiple “Schlottergelenk”,

tonsillar hypertrophy, and so forth. Due to the regular structure of the patella the author assumed that the partition depended on the existence of three primary centres of ossification.—The mother of the patient also presented some skeletal changes, viz. cystic rarefactions, the size of peas, in the bones of the hand and palm.

In *Paas'* case (1931) concerning a tailor, 31 years of age, the X-ray picture demonstrated a bilateral Legg-Calvé-Perthes disease with luxatio coxae and coxae valga with deformity of the extremely shortened outer phalanges of all fingers and toes, deformity of high degree of both elbow joints with subluxation of the radial head, furthermore, scoliosis, spondylitis deformans, and platyspondyli. In his third year the patient had offered symptoms of rickets, which the author regarded as the cause of the skeletal deformities, a disproportion having arisen between the power of resistance of the diseased skeletal parts and the mechanical strain. In the opinion of the author, however, the primary cause of the partitioning of the patella had to be looked for in the several primary centres of ossification which had been prevented from fusing due to the static conditions being changed by post-rachitic deformities. Later, however, the author arrived at the result that the cause of these anomalies had to be looked for in deeper-lying factors than in the rickets, as he had an opportunity, namely, of closely studying the family history of the patient, from which it appeared that one of the sisters of the patient presented a general bone and joint lesion which corresponded in all details to that described above, thus also with regard to the patellar anomaly, and that another sister, deceased four years previously, in all probability had also suffered from the same disease. The three sisters were the remaining of a family of ten sisters and brothers from a remote village, where inbreeding was very common. *Paas* now regarded this lesion to be a new, heretofore undescribed systemic disease—probably of constitutional nature, in which hereditary disposition played a part. At any rate it must be assumed that degenerative factors are also of significance etiologically.

In 1932 *Schwarz* reported a case of "generalized bone and

joint disease" in a patient—no age given—in whom changes were present simulating Legg-Calvé-Perthes disease with coxa valga of both hips and coexisting changes in the elbow joints, in hands and feet, as also *patella duplex et bipartita*, the anterior fragment being bipartite. A sister of the patient was said to suffer from the same disease, though she had not been examined. Schwarz considered it to be "a systemic lesion of a new variety."

Finally Gorzowski (1937) has given a close description of a case of general congenital chondro-osteopathy in a girl, ten years of age, with changes throughout the skeleton, of which platyspondyli and bilateral changes in the hip joints similar to those observed in Legg-Calvé-Perthes disease. It should be noted particularly that these changes were also associated with a bilateral Osgood-Schlatter disease and bilateral marginal patella partita and "double patella". The author considers the causative relation of the disease to be a *constitutional anomaly*, which has caused the osseous tissue to become inferior, resulting in ossification disturbances. It must further be assumed that exogeneous factors, such as trauma, take part.

In Scandinavian literature the Swede Silfverskiöld in 1925 has described under the designation "A forme fruste of Chondrodystrophia" a very undersized boy, 11 years old, with considerable changes throughout the skeleton, i.e. platyspondyli, and in both hip joints similar changes to those found in high-grade forms of Legg-Calvé-Perthes disease with coxa vara and subluxation of the hip. It is said of both patellae: "Bone marking finely porous. The apex is separated by a non-calciferous band. This separate bone shadow is of irregular form and about the size of a grain of rice." This finding thus exactly corresponds to that presented by the Johansson—Sinding-Larsen disease and the cases referred above by W. Müller, and are no more than these to be regarded as patella partita in its usual sense. It is a different matter with the case recorded by Silfverskiöld the following year under the title *Achondroplasia atypica*. This also concerned a boy, nine years of age, who presented in addition to a number of skeletal changes, among which typical Legg-Calvé-Perthes disease in both hips, bilateral patellar changes.

While the development of the patella on the one side was greatly arrested, a *patella tripartita* of type IV was present on the opposite side.

It thus appears from this review that all these six cases of patella partita of type IV "double patella", have occurred as a link in a general chondro-osteopathy. In all cases the patellar anomaly was bilateral except in those of *Silfrerskiöld*, in which the development of the opposite patella, however, was considerably delayed.

The fact that a *patella duplex* may also occur in an otherwise perfectly healthy individual, and also contrary to those referred above. *unilaterally* only, is demonstrated by a case recorded by *Pytel* in 1933. This was a female, 29 years of age, who had suffered a contusion of the right knee joint ten years previously and had since periodically felt weakness of the knee with dull pain. Two years previously she had had a luxation of the same knee joint. X-ray examination disclosed a patella duplex on the right side, while the left patella was normal. *Pytel* maintains that the patellar anomaly is embryonic.— Of these eight cases of patella duplex reported in the literature—including the sister of the patient of *Paas*—three were male and five female, which is the reverse relation to that shown in other forms of patella partita. This is all the more remarkable as the congenital general chondro-osteopathy, which in the great majority of cases is associated with patella duplex, appears to attack males considerably more frequently than females. The two cases of *Silfrerskiöld* were male, and six of nine cases of chondro-osteopathy observed by me were male, so that eight out of eleven cases were male and three female. Three of my cases were from one family (brothers) and two from another (sisters). *Familial disposition*, therefore, is definitely evident besides *sex disposition*. All of my cases presented *platyspondyli*, with resultant dwarfism, which in one case however, was compensated by the abnormally long lower extremities. Further, an abnormal femoral skeleton was present bilaterally in all cases. In five cases the deformity consisted in typical, marked changes resembling those of the Legg-Calvé-

Perthes' disease, with dislocation of the hip. In the remaining four cases the femoral head was considerably flattened, though with regular structure and normal delimitation. In five of the nine cases the knees have been examined roentgenologically, in two of which the findings were normal. In one of the other three the sagittal view showed in the patella under the cartilage a formation which was interpreted as an osteochondritis dissecans. In the second case was observed that the upper lateral quadrant on both sides projected higher than the remaining part of the upper border of the patella. Parallel with this border a sclerotic stripe in the bone was noticed (cured osteochondritis? or marginal patella partita?) In the third case a boy, twelve and a half years old (case II Sundt) presented a unilateral patella partita marginalis. A pronounced platyspondyli was also present and extremely flattened femoral head on both sides attached to a conspicuously short and broad femoral neck.

Finally, a case shall be mentioned which was reported by *Beykirch* in 1929, of bilateral "sesamum cubiti"—"patella cubiti"—*Pfitzner*—in a 57 year old male who presented a simultaneous unilateral *patella tripartita* and arthrosis of knees and elbows.—Further a case described by *Rocher and Guérin* of bilateral coxa vara adolescentium in a male, 15 years of age, with marked adiposity, presenting synchronous bilateral marginal patella partita. It appears from this survey that patella partita may occur as a link in a general chondro-osteopathy of proved congenital origin, and that this particularly applies to type IV—double patella—but also to type III (*Sundt*), unilateral cases (*Pytel, Sundt*) as well as bilateral.

This coexistence in one and the same individual of patella partita and other changes in the osseous system, partly of general and partly of local nature, indicates quite conclusively that the causation of the patellar anomaly should be sought in factors of general—or rather constitutional congenital nature. This fully supports the opinion of *Gruber* of the patella partita being of endogeneous origin. As mentioned above, he found the causal relation of the patellar partition in the fact that the patella in these cases had developed from *two centres of ossification* in-

stead of from *one centre*, which at that time was regarded as normal. As a consequence of this developmental anomaly no fusion had occurred of the two centres of ossification. This was a case, therefore, of *suppressed development of a normal centre of ossification*. Even if the assumption of *Gruber* cannot be entirely upheld, as multiple primary centres of ossification cannot be regarded as an abnormality, the assumption of retarded ossification as genetic factor holds perfectly good. Between this opinion, however, and the one maintained by *Fleischner* of patella partita as a juvenile osteopathy—*no principal adverse relation* exists, as is generally assumed. On the contrary, in my opinion it is an easy matter to bridge the gap between these. I consider that the interrelation may be ascertained by observing the conditions in the Legg-Calvé-Perthes disease. It is a familiar fact that this is mostly a unilateral lesion which invades individuals—generally boys—with otherwise apparently entirely normal skeletal system. Not infrequently, however, it also occurs bilaterally, clinically as well as roentgenologically. When making it a routine practice—also in the clinically unilateral cases—to X-ray the clinically sound hip, it is not infrequently found in this also similar, quite conclusive, and occasionally even far advanced X-ray changes. In addition to this one may not rarely demonstrate roentgenologically a definite subluxation of the hip of proved congenital character in unilateral as well as bilateral cases of Legg-Calvé-Perthes disease. However, when *F. Calot* categorically asserts that: “La maladie de Perthes (ou de Legg) n'existe pas. Les centaines de cas cités sont autant de subluxations congénitales larvées et méconnues (après 150 observations personnelles)”, the first sentence is quite incorrect, the second considerably exaggerated. It must be regarded as indubitable that the Legg-Calvé-Perthes disease attacks individuals with apparently perfectly normal skeleton of the hips. On the other hand, however, it is also an indisputable fact, as above mentioned, that the said changes of the skeleton of the hip are found remarkably frequently in conjunction with more or less pronounced *congenital subluxation* of the hip, in unilateral as well as bilateral cases. In such cases numbers of

years may elapse before the X-ray changes consolidate. Furthermore, these patients may present sure, even if not prominent, signs of constitutional developmental anomalies.

No doubt these cases form a transition to the extreme X-ray changes of the femoral skeleton associated with subluxation, which is almost constantly observed as a link in a general chondro-osteopathy. Between these changes in the upper femoral end and the acetabulum, and those found in a unilateral Legg-Calvé-Perthes disease in an apparently perfectly healthy individual, there is hardly any essential difference pathogenetically. It is sure that in the Legg-Calvé-Perthes disease, as well as generally in the so-called aseptic chondro-osseous necroses, constitutional factors play a not inconsiderable rôle. The sex and age disposition is very marked, and there is also occasional familial disposition. This is also the case, as mentioned before, in patella partita, in which congenital and constitutional etiological factors are evident, also in the cases involving apparently perfectly healthy individuals. This is held out by the frequent bilateral cases, clinically quite dumb, which predominate in numbers as well as in sex disposition. These facts are still more accentuated in those cases in which patella partita is found in individuals who simultaneously present similar or definitely related changes somewhere or other in the skeleton (osteocondritis, apophysitis), and still more, of course, in those cases in which a patellar partition is found as a link in a general congenital chondro-osteopathy. The patellar division in these cases, of course, must be assumed to be of the same genesis as the other skeletal changes. *Also in cases of patella partita, therefore, it must be assumed that no essential difference exists between the cases in which a unilateral partition is found in an apparently healthy individual and that found in a general chondro-osteopathy.*

The fact that no fusion occurs in patella partita, therefore, cannot be assumed to be different to or more than that which is found in the varieties of the Legg-Calvé-Perthes disease in which the constitutional factor puts its mark on the patient in the form of a more or less pronounced chondro-osteopathy.

Summing up the above, it appears that the development of the patellar partition designated patella partita is *multiple centres of ossification*, though contrary to previous opinion this is such a frequent occurrence that it cannot be regarded as an abnormality. *The causal relation, therefore, of the partition has to be looked for in an entirely absent ossification in a normal patella with multiple centres of ossification. The cause of this suppressed ossification again has to be looked for in endogeneous constitutional conditions, that is to say in the same conditions in which, no doubt, the deeper causes of the juvenile osteopathy have to be looked for.* This furnishes an entirely natural and unconstrained explanation of the coincidence which may be observed between a patella partita and a juvenile osteopathy in one and the same individual.

The conclusive evidence in the question as to whether patella partita represents a juvenile osteopathy, in other words that it is due to an osseous aseptic necrosis, may naturally be furnished only by a histological examination. As patella partita, however, extremely rarely gives indication for operative intervention, such histological examinations are very scarce. Analogous comparisons have been made, therefore, with the results from histological examinations in similar division of other sesamoids of the lower extremities, which are of practical medical importance—viz. those of the great toe.

In 1925 *Adams* and *Leonard* drew attention to the similarity between the anatomical picture of the separation of the patella and that of the sesamoid bones of the head of the first metatarsal, particularly the medial one. This has subsequently been done also by a number of other authors (*W. Müller, Siemens, Mau*, etc.). This relation has been dealt with in detail in the second part of the present paper, inter alia based on two cases of partitioning of these sesamoids, which were operated on and examined histologically by myself. I shall only mention here that my own investigations as well as those of others, have given evidence that an *aseptic total necrosis* may develop in the sesamoids of the great toe, in those congenitally divided as well as in the apparently quite normal, in complete conformity with

that found in the head of the second metatarsal in the case of the K hler disease.

As far as the relation is concerned in this respect in the case of patella partita, this will be dealt with extensively in connection with the record of my own cases. It shall only be mentioned here that the histological examination of my own cases *broadly speaking directly supports the assumption that an osseous aseptic necrosis may be present in a patella partita*. They thus corroborate the findings of Weil and Barthels in a couple of cases, which they demonstrated in 1932 before the Breslau Surgical Society, and which are of particular interest in this connection. Histological examination of a divided sesamoid bone under the first metatarsal disclosed aseptic necrosis. At the same time a case of patella partita histologically proved was demonstrated, in which similar changes were present as those in the sesamoid bone. It will appear from this, and from the subsequent discussion around the histological findings in a patella partita, that they give extensive support to the assumption of a *consistency between this anomaly and the juvenile osteopathies* without in any way shaking the assumption that patella partita is of congenital origin.

With regard to the possible r le played by a trauma—whether chronic or a single acute trauma—in the pathogenesis, one would refer to the mention made to this subject in a later chapter.

In connection with the question as to the pathogenesis of patella partita and its possible relation to the juvenile cases of apophysitis and epiphysitis, it is necessary also to investigate its relation to the *Sven Johansson—Sinding-Larsen disease*. The two authors in 1921/22 published each two cases—all children of pre-puberty age, and thus within the period of ossification. The lesion may be bilateral as well as unilateral. In these latter cases X-ray changes in the patella may also be found on the clinically sound side, although less marked. The clinical symptoms are slight, pain on movements of the knee and slight swelling may be present. There is, however, persistent pain, generally considerable, on tapping the patella proper or above the apex. Roentgenologically irregularities or fluffing are found of the

apex and the lower part of the anterior surface. In single cases may be observed at the apex or the adjacent part of the anterior surface a small detached lamella separated from the remaining part of the patella by a narrow, though distinct partition—thus a picture recalling that of an apical partition. In all cases normal conditions, clinically as well as roentgenologically, have been restored in the patella in the course of a few months.

In one of the cases of *Johansson* and *Sinding-Larsen* X-ray changes were found in the tibial tuberosity corresponding to those in the Osgood-Schlatter disease, and *Sven Johansson* regarded the patellar changes to form an analogy to this disease, etiologically as well as clinically and roentgenologically. *Sinding-Larsen* expresses a similar opinion, in assuming that a simple periosteal or epiphyseal irritation was present, and refers to the Osgood-Schlatter disease. Both authors also agreed that the patellar changes described by them represented a lesion hitherto undescribed. *Hellmer* points out, however, in his paper on the ossification of the patella, that this is not correct. Similar cases have been described in Germany by *Sciffert* (1912) and in France by *Mayet* (1914) and *Mouchet*. It has been mentioned previously that *W. Müller* in 1920, before *Sven Johansson* and *Sinding-Larsen*, has recorded a similar case, associated also with the Osgood-Schlatter disease.

Subsequent to the appearance of *Johansson* and *Sinding-Larsen* several authors have supported their opinion, that it is a matter of a patellar lesion which is analogous to the Osgood-Schlatter disease of the tibial apophysis (*van Neck*, *Howley* and *Griswold*), while others maintain that it is a disturbance in the ossification (*Haglund*, *Kienbøck*).

In his previously mentioned paper *Mau* referred to the changes presented by one of the four cases described, as *resembling osteopathy of the patella*. Two of these four patients were sisters. *Mau* identifies three of them with the *Johansson—Sinding-Larsen* disease, with which they agreed perfectly, clinically as well as roentgenologically. The changes in the patella of the fourth case which concerned a boy, nine years of age, in

the author's opinion were identical to those of the Osgood-Schlatter disease and the Legg-Calvé-Perthes disease.

In "Røntgenpraxis", volume VI 1934, page 617, *Grashey* relates, as an example of a source of error, the case of a boy, 11 years old, who appeared for X-ray examination on the same day that he had sustained a blow to his right knee. The X-ray revealed a fluffy appearance of the patellar apex, but simultaneously the left patella showed similar, and even more pronounced changes, being obviously closely related to the Osgood-Schlatter disease, and which the author considered to be a disturbance of the ossification of the patella.

In opposition to the opinion of all these authors as to the character of these patellar changes, *Hellmer* claims that it is also here a matter of changes within the limits of normal ossification, as similar to those changes in the patella in which a lesion analogous to the Kjøhler lesion of the scaphoid has been supposed to be present. The identical objections may be lodged here, however, as against the above mentioned opinion of *Hellmer* of the changes present in the cases designated "osteochondritis of the patella". According to the comprehensive investigations of *Hellmer* and *Pickhan* this contention cannot be rejected in cases in which these changes are negligible and bilateral, and not associated with clinical symptoms. *In the presence of simultaneous clinical symptoms, however, particularly in unilateral cases, it is my opinion that the contention cannot be upheld.* Still more this holds good when simultaneous roentgenological changes are found in the tibial tuberosity corresponding to those of an Osgood-Schlatter disease. *In such cases the X-ray changes around both places of insertion of the patellar ligament must either both be normal or both pathological.* There is hardly any doubt, however, that an Osgood-Schlatter disease with its clinical symptoms is actually a disease.

Neither is the opinion of *Hellmer* supported by those cases which have occurred after a trauma, and which have been recorded by a number of French authors, *Stoltz*, *Meyer et Weiss* (Strasbourg), *Coureaud*, *Mouchet et Ardouin*, as a separate disease under the name of "patellite post-traumatique", which

is manifested clinically as an "ostéoporose passagère" due to post-traumatic "troubles osseux d'origine vasomotrice" (Leriche), "(vasodilatation, hyperémie et trouble métabolisme calcique local)." The author compared these X-ray changes arising some weeks after the trauma, and which take the form of "un état pommelé de la rotule", with the "alterations post-traumatique" seen in the osteochondritis and apophysitis of childhood. After rest and quiet for some time they disappear together with the clinical symptoms.

The case observed by *Mouchet* and *Ardouin* concerned a female, 20 years of age, who had fallen on the one knee six months previously. A subtotal resection of the patella was performed. Histological examination showed "pulverisation du tissu osseux, formation de microsequestres, destruction du revêtement cartilagineux".

Against this post-traumatic "patellite" which occurs in *adult* individuals, *Mouchet* sets up the *Johansson—Sinding-Larsen* patellar disease, which occurs in children and youths, which he terms "patellite de croissance des enfants et adolescents", the roentgenogram of which may show "état de fragmentation de la rotule surtout à son sommet, comparable à aspect de l'apophysite tibiale antérieure de l'ostéochondrite de la hanche... etc." The difference between these two varieties of "patellite" may be summarized such, that the one consists of an "ostéoporose post-traumatique d'adulte", the other in an "ostéochondrite de croissance: Dans le premier cas aspect radiologique *simplement* pommelé, dans le seconde cas, aspect pommelé avec pseudo-fragmentation". There is surely no doubt that both forms agree clinically as well as roentgenologically with the lesion referred by *Sven Johansson* and *Sinding-Larsen* as a "separate disease of the patella, not described previously", and which *Mouchet* claims to have described in July 1919.

Almost twenty years ago—or before I was acquainted with the publications of *Johansson* and *Sinding-Larsen*—I had an opportunity of observing a case which appears to me to be particularly interesting in this connection:

Case Olav, 12 years of age. He presented himself for consulta-

tion on February 11, 1922. The father at that time was lying in the Coast Hospital suffering from a tuberculous coxitis. The patient, a strong, well-developed lad, once in the preceding year had received a blow from an axe against the right knee, without having any trouble from this later. In the autumn of the same year, viz. about 2—3 months previous to the present visit, he fell on the ice and hurt the same knee. Between Christmas and the New Year he again fell on the ice, hurting again the same knee, which now became swollen. He did not limp, however. Four weeks later, *while running and playing with other children in a field, he suddenly felt pain in the knee.* He now consulted a physician, who was afraid that it was tuberculosis, why the patient was referred for special examination. The following were the findings: Normal configuration of the right knee. No effusion. *However, considerable tenderness over the patellar apex.* Normal motility of the knee. Two centimetres of muscular atrophy was found above the patella, and one centimetre over the thick of the calf. Immobilization for three weeks followed by cure. X-ray (foto 10) shows chipping of the patellar apex. The fragment torn off is affixed by its outer corner to the outer facet of the patella, under which considerable bony atrophy is present. The left knee shows normal clinical and roentgenological conditions. On March 3, X-ray examination of the right patella shows marked incipient fusion, though simultaneously a distinct zone of bony atrophy under the anterior surface of the patella and parallel to this. Clinically complete cure had been attained at this juncture. On March 27, X-ray examination demonstrated increased, though not yet complete fusion, over the patellar apex. Some atrophy was still present under the anterior surface of the patella.

When observing this case, I was not yet aware of the publications of *Sven Johansson* and *Sinding-Larsen*. Not for a moment, however, did it occur to me that this was something not previously observed or described. The pathogenesis appeared to me to be quite simply described in the following manner: The three consecutive traumata to the knee, i.e. against the patella—particularly the two falls on the ice—have caused an *osteoporotic*

process in the patellar apex, a *malacia*, with consequently reduced power of resistance against mechanical strain, even those within the physiological limit—in this case a hyperflexion when running—in a boy otherwise normally developed.—Clinically this case is perfectly identical to the “patellite post-traumatique”

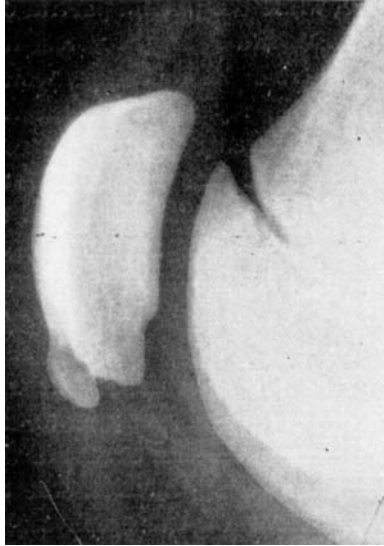


Fig. 10.
Case Olav.

of *Mouchet*, roentgenologically with the “patellite de croissance” of the same author, and with the one of *Sinding-Larsen’s* two cases.—In my opinion this is a pointer indicating in which direction one should look for the pathogenesis of the *Johansson* and *Sinding-Larsen* disease, at any rate in the cases which give clinical symptoms, particularly the unilateral ones, non-traumatic as well as traumatic. It is conceivable, even in cases where no trauma is demonstrable in the past history, that some factor has caused a disturbance in the ossification of the patellar apex in the same way as in the tibial tuberosity in the *Osgood-Schlatter* disease, thereby resulting in a morbid state with consequently reduced power of resistance to mechanical strain.

Whatever the case may be, however, it may be established that the X-ray changes in the patellar apex with the resulting partition in several cases, designated the Johansson—Sinding-Larsen disease, has nothing whatever to do with *patella partita* in its usual sense. The partition in a “patellite de croissance”, alias the Johansson—Sinding-Larsen disease, is acquired and is of transitory nature, while the patella partita on the other hand is congenital and persistent. It is of interest in this connection to mention two cases from the literature, which have so many features in common with my case, anamnestically as well as clinically, and in the one case partly also roentgenologically, that it is not improbable that the pathogenesis may be the same.

As mentioned above *Kuh* in 1932 described a case, under the diagnosis “osteopathia juvenilis patellae”, which as in my case concerned a boy aged 12—thus in the same age group as my patient. In this case also there was a preceding trauma, namely half a year before, and the patient had now for several months complained of pain in the right knee joint with swelling and tenderness to pressure over the lower part of the patella. X-ray examination revealed that the lower border of this was irregular and of an extremely jagged appearance. The anterior facet of the femoral condyle, just below the epiphyseal line, showed irregular markings, and in the axis plane the anterior border had irregular contours. Simultaneously, however, similar changes were also observed in the opposite patella. After one year had elapsed, the structure was perfectly normal, while an isolated centre of ossification, the size of a millet seed, was discovered under the patellar apex. The father of the patient, a physician, was afraid that it was a tuberculous lesion, while *Kuh* assumed it to be a disturbance of the ossification similar to the Osgood-Schlatter disease. At the completion of the period of growth the patella presented quite normal conditions. *Kuh* assumed that the probable disturbance of the ossification rendered the patella functionally *inferior*—“die zerrissene Knochenanlage bildet einen Locus minoris resistentia”—while the *trauma* has acted as a causative factor by injuring the nutritional veins.

When the author finds support for his assumption of a di-

sturbance of the ossification in the slight changes of the patellar structure and of the contours, the objection may be raised against this, that they appear in no manner to exceed the limits of the normal during the period of growth. Quite naturally the pathogenesis appears to me to be explainable in the same manner as in my case. A trauma is directed against a normal patella and leads to an osteomalacic process in its lower part. Some time later—some weeks or one or two months—the one case shows a more or less pronounced chip off the attachment around the patellar ligament with clinical symptoms, local tenderness to pressure, and finally after treatment for some time complete consolidation.

Clinically my case and also that of *Kuh*, are perfectly identical to the "patellite post-traumatique" of *Mouchet*, and roentgenologically to the "patellite de croissance" of the same author and the one of the *Sinding-Larsen* cases.

Feinkorn in 1931 described as patella partita a case which occurred in a boy, 13 years of age, who fell down off a bicycle with force on the left knee, which according to an eyewitness became dislocated and was reduced by him. When the patient came under medical supervision, not until four days had elapsed, clinical examination showed extensive effusion in the joint. Roentgenologically was found a small "shell-shaped" chip off the patellar apex. After conservative treatment for six weeks it was all over. About one and a half year later, however, a similar accident happened—fall from a bicycle and blow against the same knee. X-ray examination now disclosed that the patella was divided into two parts by a regular, broad partition with smooth borders—one upper larger and one lower smaller. In this partition an isolated piece of bone was observed, the size of a bean. Clinically there was tenderness over the patella, though no effusion was demonstrable in the joint. On the whole the symptoms this time were milder, and already after three weeks the patient was fully able to work. The author maintains that the regular width and the smooth borders of the patellar division, as also the shape of the separate parts of the bone—primarily of the two small parts in the upper outer quadrant—

speak definitely against the presence of a fracture. This is corroborated also by the fact of the clinical symptoms now being much less than on the former occasion, and too slightly pronounced to indicate the presence of a fresh fracture. On the other hand the author presumed that it was a case of a *patella multipartita* which had developed gradually after the first trauma. The X-ray findings also corroborated this. The author compared his case with one reported by the above mentioned French authors, *Stoltz, Meyer et Weiss*, under the designation "patellite (ou malacie de Sinding-Larsen)". It was here a case of a male, 20 years of age, in whom the patella immediately after a trauma demonstrated roentgenologically a mottled atrophic appearance, dark parties interchanging with lighter ones, so sharply delineated that the patella appeared to be in fragments. In the lower half a particularly light part was observed, while the patellar apex proper appeared almost detached. Three months afterwards the patella was observed to be of regular structure, though simultaneously longer and more flattened out. *Feinkorn* holds that the case designated *patellite* by the three said authors, in its extreme development resembles his own to such a great degree that it is tempting to assume that the pathogenesis is the same, viz. an *osteitis rep. osteo-chondropathia*. However, while the end result in the case of the three authors tallied with that observed in the other lesions designated osteochondropathy, consisting besides in a normal structure also in fusion and deformity of the diseased bone, no fusion of the fragments occurred in *Feinkorn's* case in the period of two and a half years that the patient was kept under observation. In the opinion of *Feinkorn*, therefore, an entirely different process of disease from osteochondritis must be involved. The author then assumes that it has been a case in support of the theory advanced by *Zwerg*, dealt with in detail in a later chapter, which is that originally multiple primary centres of ossification have existed, which have consolidated. The zone of fusion, however, will always remain a point of least resistance, being apt to yield to even a slight trauma, and again producing division. According to the author's opinion such division has gradually developed in this case after

the initial trauma. He finds support for the assumption of primary multiple centres of ossification in the fact that the opposite patella presents a singular pearshape, terminating downwards in a truncated process. Therefore, he also assumes primary multiple centres of ossification to be present in this patella. The X-ray picture reproduced does not, however, seem to differ obviously from that of a normal patella. In my opinion the explanation of the author as to the pathogenesis is unnecessarily artificial. If the patellar partition is not a fracture—which may seem probable—it has developed gradually after the initial trauma, as in the case of *Kuh* and in mine. While the division in these two cases, however, was located to the patellar apex proper, it was very close to the middle of the patella in *Feinkorn's* case. In my opinion this fact, and also the fact that the partition in his case had occasion to develop in the course of one and a half year, while the patient continued his daily work, may explain the non-appearance of fusion. It cannot be rejected either that the possibly pre-existing partition has been extended during the second, quite similar trauma against the knee. On the whole the absent fusion cannot in my opinion be advanced as final proof that a *post-traumatic osteomalacia* of the patella has not existed, as is assumed in my case Olav and probably also in *Kuh's* case—thus a lesion which must be assumed to approach closely to the “patellite traumatique” of the French authors. To a certain extent one may agree with *Feinkorn*, that at their extreme development they may show great similarity to a patella partita. As mentioned before, however, they are per se two totally different lesions.

X.

The fact that the diagnosis of a non-traumatic patellar partition is next to never made clinically—not even as a tentative diagnosis—but is almost always made as an *incidental X-ray finding* in an otherwise healthy knee, is proof that this anomaly, at any rate in the great majority of cases, has a perfectly mute course clinically. An example of this in my case histories is the

young boy with unilateral Osgood-Schlatter disease and patella partita on the opposite side, and also the female, 32 years of age, with traumatic arthritis in the one knee and patella partita in the other, perfectly healthy knee. In other cases patella partita may be an accidental X-ray in a diseased knee, in which the patellar anomaly has surely had nothing whatever to do with the lesion in the knee joint, such as in my case Arne, reported in a subsequent chapter, in which tuberculosis of the knee joint was present.

This was the general opinion until Odermatt's paper appeared in 1921. This author distributes the patella partita into three groups according to the relation to the clinical symptoms, viz.:

1. Patella partita gives no clinical symptoms and is merely an incidental X-ray finding.
2. The slight irregularities caused in the patella by the partition might act as a chronic irritant and consequently produce arthritic symptoms. My case histories are referred to here, showing that in those of the four cases of patella partita operated on, in which the joint was also opened, definite, partly very considerable signs of synovial irritation were found.
3. The soft parts tissue connecting the different fragments, and which has developed due to retarded ossification, may have become *extended and stretched*. Odermatt called this state *distortion of the patella*. In my opinion *distraction* is a more descriptive expression of the mode of action of the trauma.

The distraction may regress or it may result in recurring symptoms in the form of an arthritis. Later it has been maintained by other authors that patella partita *as such* may cause clinical symptoms, which opinion has been advocated by Sommer, Eichengrün, Siemens, and others, and in French literature by Mouchet, Fournier, L'Heureux et Riche. The two latter authors even maintain that patella partita in adolescence may manifest itself by a slight fever and pain, spontaneous as well as elicited by movements. In some cases a slight hydrops may occur, localized either to the superior recess or to the entire joint cavity. In other

cases, however, the clinical symptoms may be absent, thus in adult individuals. *Mouchet* states that the hydrops may be so prominent that the lesion may be taken to be tuberculosis. Other authors also, besides the French, as for example the Dane *Rischel*, mentions hydrops as a symptom in patella partita. This is denied by *Sommer*, who is of the opinion that the knee joint as such is never invaded. Hydrops and pain, and possibly also abnormal motion against each other of the fragments, and in extreme cases also a deficient function, according to *Odermatt* are the symptoms of a *distortion of the patella*, depending upon a preceding trauma. This may have been very slight, and according to *Odermatt* may have given no symptoms until after the lapse of a considerable period, even up to a couple of years. It must be admitted that after such a long time the causal relation may be very doubtful. The assumption that over-exertion in the joint may lead to these symptoms, is much better founded, as has been stated by *Sommer*, and apparently corroborated by one of my cases in which exaggerated sport was cited, and hardly without reason, as having caused the clinical symptoms, of which pain was the most prominent. The said symptoms of patella partita, therefore, must be assumed to have been released by an *accidental cause*. A priori, this also appears normal in a congenital anomaly. As the accidental cause in question here—a trauma—may be sustained at any age, no definite age may consequently be fixed for the clinical picture of disease of patella partita. Most of the cases, however, concern young individuals of between 20—40 years of age (*Siemens*). As even traumata of the slightest character appear able to produce a distraction of the patella, it must be regarded as reasonable that such lesion has been present also in the apparently non-traumatic cases of so slight character as to have been overlooked or forgotten.

It is therefore a result of the nature of the case that the symptoms of a distraction of the patella is the *slight post-traumatic arthritis*—of trivial nature: Slight swelling, with or without hydrops—and pain on motion. In addition to these symptoms, or without them, particularly *tenderness on pressure* over the patella—the upper, outer part over the apex—will

point in the direction of the diagnosis. To a still greater degree this is the case with another symptom in unilateral cases, namely when one discovers the upper half of the patella to be *wider* over the diseased knee than over the healthy one (*Sommer*). Other authors have had the same experience, *Paul*, *Dediée*, *Sundt* and also *Schaer*. This latter author, however, states that he has found the upper lateral quadrant of the patella to be wider than normally also without the presence of a partition, which may also be verified from my own observations. It should be added, however, that anatomical investigations have proved that the normal form of the patella may vary considerably. *Madlener* et *Paas* have considered this increase in width of the patella to be characteristic and of differential diagnostic importance as against paramedial fractures of the patella.

Another symptom which may give a direct clue to the diagnosis, and which was present in one of my cases—*Karl*—is a *palpable* partition (*Sommer*). Others agree with this opinion, and this was an exceedingly prominent symptom in *R. Natvig's* case. *Reinbold* holds that it is possible by palpation to establish that the fragment is detached. All this assumes a certain width of the partition, which is not always present. The roentgenograms of the different cases show that it may vary considerably in width, *Blumensaat* indicates between one half to three millimetres. This is evident also in my material—one compares for example the cases *Rolv* and *Torbjørn*, in which the partition is quite linear and very narrow. In another of my cases (*Frank*), in which a patella tripartita was present and tenderness had been demonstrated over the upper lateral corner, it was very difficult even during the operation, when the patella had been exposed, to palpate the partition which the roentgenogram showed to be of a width of 2—3 millimetres. Also in a third of my cases (*Karl*) this was quite impossible during the operation from the anterior as well as from the posterior surface of the patella, while during the operation in a fourth case the fragment was found to be easily mobile. In this case two trauma had preceded the operation (*Rolv*).

Proof that a congenital patella partita may cause clinical

symptoms are rightly observed in those cases in which operative removal of one or more small patellar fragments makes the symptoms disappear. A distinct case proving this is found in my material—Frank—where as mentioned a marginal patella tripartita was present, and conservative treatment had proved quite ineffectual. A closer analysis of this case makes it extremely probable that it was not the patellar partition—being a congenital anomaly—but a *chronic trauma in the form of exaggerated sport*, which was the cause of the clinical symptoms from a knee joint furnished with a *patella which was inferior when subjected to such strain*, while the opposite patella was normal. It is extremely probable that this relation was present also in my case Rolv, which was also a young male with unilateral partita. As mentioned before a trauma had occurred here on two occasions—dislocation of the patella—which appears to have played the same part as the sport in the first case. Neither do these two cases, therefore, appear to favour the contention that *patella partita on its own may give rise to clinical symptoms*. In my opinion these find their natural explanation in a *distraction of the patella*, as it must be assumed that a *stretching* has occurred of the division between the patellar fragments, loosening the connection between them. This *distraction* then brings about the *state of irritation* of the joint, which leads to the clinical symptoms.

It thus appears from the above statements that no *single symptom*, no more than any combination of *clinical symptoms ensures the diagnosis patella partita*. It is entirely an *X-ray diagnosis*.

XI

In the majority of cases one roentgenogram in the frontal and sagittal plane is sufficient to establish the diagnosis. In order to obtain better details, particularly of the partition, in a patella partita marginalis, one should push the patella outwards so that the upper outer corner is clear of the femoral condyle. The partition in marginal patella partita is seen between the fragments as an oblique line, downward convex, of varying

width, as mentioned before. Both fragments together seem to correspond to the normal size and form of the patella, though not always. As mentioned before, the partition may be so wide that the whole of the upper part of the patella is wider than normal (*Dediée*). The sagittal view in marginal patella partita is of definitely less value in the diagnosis than the frontal one. If the partition is narrow, it may be difficult to observe it, or even impossible, in the sagittal view as in my case Torbjörn. In other cases, however, the small fragment may be discovered enclosed in the patella "a joint mouse sitting in its bed" as *Sommer* very aptly expresses it, or as an "egg in an egg cup" (*Odermatt*), refer to my cases Karl, Frank, and particularly Arne. In such cases a roentgenological differential diagnosis between osteochondritis dissecans and patella partita is an impossibility. This is emphasized also by *Sommer*. He maintains that the small patellar fragment never occupies the whole of the thickness of the patella, as it reaches backwards to the cartilaginous cover and forwards is covered by the patellar surface. This will be dealt with further in a subsequent chapter. Here shall be added only, that if this was always the case it would undoubtedly be an important differential diagnostic factor as against an oblique fracture on a traumatic basis, as advocated by *Paas*. He is of the opinion, however, according to his X-ray examinations, also with sagittal and axial direction of the rays, that this does not apply to all cases. The greater the separated fragment the smaller the covering anterior bony shell. On the other hand, according to *Paas*, the reverse pressure from the before mentioned bony ridge on the femoral condyle might result in fracture of the posterior patellar wall. *Schaer* maintains that when the partition is observed on the entire transverse section of the patella, this is due to an erroneous interpretation of the sagittal film.

Among the five cases of marginal patella partita in my material, the sagittal view in the one case, Torbjörn—shows no partition whatever. In the case Arne the small fragment is observed to be interposed in the patella, however considerably nearer to the anterior than to the posterior facet, and upwards

reaches all the way to the anterior facet. In the case Frank—patella tripartita—the one fragment is seen on the sagittal film to be interposed in the patella, while the other, lying in a cavity, forms the upper apex of the patella. It is separated from the fragment lying below by a partition which runs right through the patella. A similar picture is presented by the case Rolf, in which the fragment also forms the upper apex of the patella, divided from this by a continuous transverse partition. In the case Karl the sagittal film shows that the fragment penetrates the posterior wall of the patella, forming almost the entire upper half of the backward limitation and joint surface of the patella. In all of these cases the roentgenograms in the sagittal plane show a picture which in all details corresponds to that found in an osteochondritis dissecans. At the same time, however, they disprove the contention of *Sommer* that the fragment is always covered by “die Auszenschicht der Scheibe wie ein Schild”. Particularly in more doubtful cases, or when it concerns details as to the appearance of the borders of the partition, exposures in the oblique or axial view, besides the frontal and sagittal view, would furnish very valuable information, especially as against a fracture. The partition in my case Torbjörn, not shown in the sagittal film, is easily visible in the oblique view, and was also seen in the axial plane. In order to obtain a clear view of these details *Albert Mouchet* has recommended X-ray examination with the patient in ventral decubitus with the knee slightly flexed and the patella rotated outwards with the aid of a wooden disc. Later *Paas* (1931) has recommended the direction of the rays laterally from behind and medially in front, with the patella rotated outwards. He states that only with a perfect X-ray examination in all directions compared with past history and clinical examination, had it been possible for him to overcome the differential diagnostic difficulties in important cases.

XII

To an essential degree the differential diagnosis will appear from the above as far as the clinical symptoms are concerned. To recapitulate, those of importance are: possible tenderness to pressure over the outer lateral quadrant, or over the apex of the patella, which is met with also in the Johansson—Sinding-Larsen disease, however, and further a possibly palpable partition of the patella. It is obvious that such a finding will be more important in a non-traumatic case than in a traumatic one.

Tenderness on pressure over the patella may be found, except after trauma, also in prepatellar bursitis and infectious processes. Patellar osteomyelitis, however, which is also very rare (*v. Rosen*) brings no differential diagnostic difficulties, not entirely excluded in an incipient tuberculosis of the patella (tenderness on pressure). It should be taken into consideration here that tuberculosis as well as osteomyelitis of the patella primarily belong to childhood (5—15 years) (*v. Rosen*), being the period of growth when a patella partita is still physiological. The differential diagnosis against chondromalacia (chondropathy) of the patella (*Büdingen, Aleman, Fründ*), are of quite another practical importance. When *Schaer* regards the patellite post-traumatique of the French as a chondromalacia, this is quite obviously incorrect. The "patellitis" depends on an *osteoporosis*—which appears also from the histological findings in the case of *Mouchet* and *Ardouin*, even though destruction of the cartilage was also found. In the chondromalacia *tenderness on pressure* on the patella is also found (*Fründ's* symptom, pain on tapping against the patella with the knee flexed). The symptom is not at all constant, and is of importance only when it is present. Further, it is found much more frequently, that the patient suffering from chondromalacia complains of pain in the knee when walking downhill and downstairs. Of much greater importance, however, in chondromalacia is the *retropatellar crepitation* on movements in the knee, as also—though less constant—scratching when the patella is pushed to the side against the anterior surface of the femoral condyle. It should

be remembered, however, that one must distinguish between *cracking* in the joint and retropatellar crepitation, which is not at all easy. Beforehand one should hold it possible that also in a marginal patella partita one might find a retropatellar crepitation in the joint—or cracking respectively. This is not the case, however, Perusal of the case histories referred in the literature shows that this symptom is mentioned remarkably rarely, and never as a prominent feature. Further, as the condition of the other knee is not mentioned, no diagnostic value may be attached to the symptom. It is thus characteristic that no mention is made of this in *Schaer's* comprehensive monograph on patella partita. The explanation of the fact that retropatellar crepitation is rarely or never present in patella partita must be looked for in the fact that the partition rarely or never involves the posterior surface of the patella—or at any rate not that portion which partakes in the articulation with the condyles of the femur. *Sommer* who has drawn particular attention to this, states that in the cases operated on by him the part of the patella connected with the knee joint was smooth and covered with cartilage. It is reasonable to assume that in case of distraction of the patella, with a supposed looser connection between the fragments, retropatellar crepitation will occur in the joint during motion.

A crepitation in the joint was present in two of my cases. In the one, *Frank*, it was so pronounced in the diseased knee that it could be heard at a distance of twelve metres, and none in the sound knee. After removal of the two small fragments, the crepitation disappeared. The not inconsiderable part of the patellar cartilage visualized during the operative intervention, was smooth and regular without fissures. In the other case also—*Rolv*—a lively crepitation was heard in the diseased—traumatized—knee, and not in the sound one. This crepitation was still present, and to a much greater extent, one year after the small and considerably loose fragment had been removed. As this intervention took place extra-articularly, the patellar cartilage could not be inspected. In this case *chondromalacia patellae as well as a patella partita* have obviously been present. The crepi-

tation at any rate has had nothing to do with the patellar partition. Such coincidence is found also in my case Arne, in which a *synovectomy* was carried out due to tuberculous synovitis. The histological examination of the patellar cartilage showed chondromalacia. This was the case also in a patient operated on by *Blumensaat*, in which a histologically proved chondromalacia was found independent of the centre of ossification of the patella.

A third case in my material of patients operated on for marginal patella partita, Karl, is of interest here because *no retropatellar crepitation was present*, in spite of good reason for such presence when the sagittal film of the patella is observed, demonstrating that *the partition involves almost the entire upper half of the posterior facet of the patella*. The posterior facet of the removed fragment also proved to be cracked, without crepitation, however.

When retropatellar crepitation is found in the presence of apical partition, this cannot in reason be due to the partition, as the part of the patella involved lies outside the articulation. The crepitation which was present in the case Alv, therefore, must probably have been due to a chondromalacia, all the more so because it was present on both sides.

As retropatellar crepitation may be absent in definite, histologically verified cases of patellar chondromalacia (*the author*), it will appear from this report that the presence of a retropatellar crepitation, no less than the absence of this symptom, possesses no conclusive differential diagnostic importance whatever. In this respect also the roentgenogram has the casting vote.

The greatest difficulty, differential diagnostically as against marginal patella partita is present by *osteochondritis dissecans patellae*. The differentiation here is a pure X-ray diagnosis, though this may also be extremely difficult, and in *unilateral* cases even quite impossible. This is corroborated to a great extent by several of my own cases. I quite agree, therefore, with *Sommer* when he writes: "Insbesondere die beiseitlicher Betrachtung deutliche Zuhörigkeit der Knochenstücken zur Knorpelschicht,

des Freibleiben der Auszenschicht der Scheibe die wie ein Schild über allem liegt, lässt auf den ersten Blick an Osteochondritis dissecans denken, da die Knochenstücken wie die Gelenkmaus in ihrem Bett sitzen". Sommer continues: "Schliesslich sind auch die klinischen Erscheinungen der Osteochondritis wie der Patella

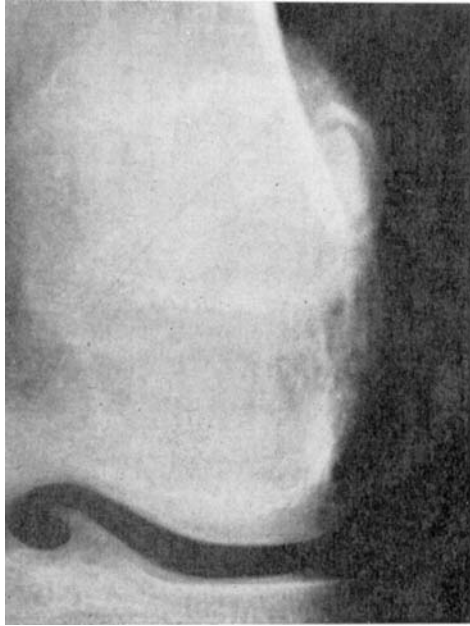


Fig. 11.

partita heimliche und langsam zutage tretende". Even a bilateral affection is not decisively in favour of patella partita, as it must be assumed that an osteochondritis dissecans can occur bilaterally in the patella as well as in other localizations. *Sommer* later writes as follows in his work on the differential diagnosis between osteochondritis dissecans and patella partita:—"Hier ist nochmals darauf hinzuweisen, dass bei Patella partita das kleinere Knochenstück niemals die ganze Dicke der Patella durchsetzt, sondern gelenknahe unmittelbar am Knorpelüberzuge sitzt, überdächt durch die ganze vordere Patellarfläche. Das Bild entspricht so sehr dem Bilde der Osteochondritis dissecans, dass

man immer wieder versucht ist, den gleichen Krankheitsprozess bei der Patella partita voraussetzen". In order to arrive at a definite diagnosis *Sommer* had resort to the histological examination in two cases. The result indicated a kind of *pseud-arthritis*, and *no dissecting process was present* at any rate.



Fig. 12.

When no complete separation has occurred of a free body, therefore, the roentgenological differential diagnosis falls short of effectivity.

In 1921 *Wehner* recorded a case of a "movable body inside the patella"—a movable body $2\frac{1}{2} \times 1\frac{1}{2} \times 2\frac{1}{2}$ centimetres having been removed from a cavity within the patella eight days after an accident. The cavity communicated with the joint cavities. The movable body consisted of spongy bone. Half of the surface was covered with cartilage. The bone as well as the cartilage was necrotic. The author assumed this to be an old process, which had nothing to do with the trauma, and that this process was an osteochondritis dissecans (*König*) without formation of a joint mouse. In connection with *Wehner's* demonstration *Ritter* referred a roentgenogram of a male patella in which a square piece of bone was being separated from the

upper border of the patella. This was assumed to be an *incipient* movable body. In my opinion, however, it is doubtful whether in the two cases mentioned here free bodies have actually been present due to a separating process in the patella. The roentgenograms are not reproduced.

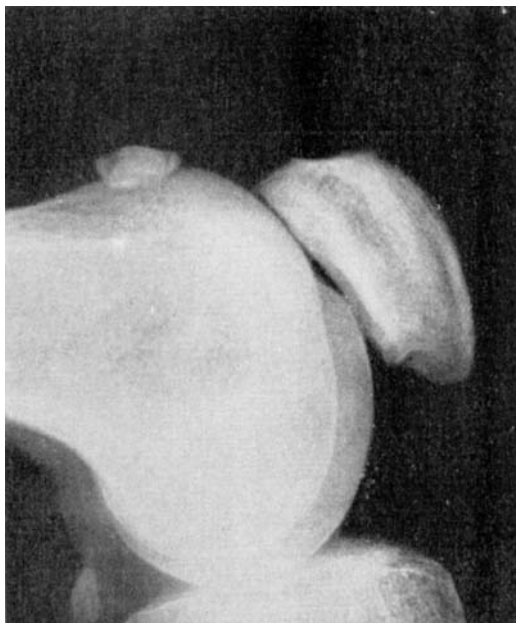


Fig. 13.

In this connection the above mentioned case demonstrated by *Mouchet* and *Ardouin* in 1932 is of considerably greater interest. The authors were of the opinion that it was a case of "patellite post-traumatique" associated with osteochondritis dissecans. The roentgenogram showed rarefaction of the bone as also a free body, originating from the lower part of the posterior facet of the patella. Foto 11—15 illustrates that a corpus librum genus, which has reached the superior recess, in certain combinations with the patella may simulate perfectly the picture of an osteochondritis dissecans. This was a sailor, 25 years of age, who in March 1937 had been the victim of a trauma against

both knees—the lateral part of the right, and the medial part of the left one. Although this latter knee has troubled him all the time since, he did not consult a physician until he came home to Norway one year after the accident, presenting himself for consultation on March 28, 1938. In the left superior recess an easily movable body was palpated, and removed from the bottom of the superior recess on the lateral side of the knee. Histological examination demonstrated the presence of a *joint mouse*. In this case it was impossible to demonstrate any formation of “mouse-

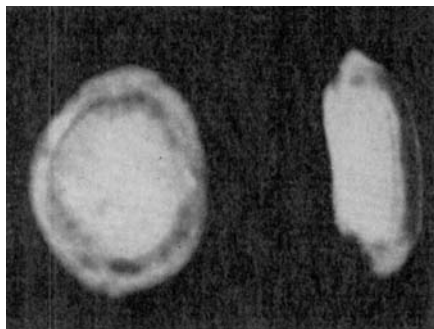


Fig. 14—15.

bed” roentgenologically. Apart from the fact that the so-called osteopathia patellae, “patellite post-traumatique”, occurs in the period of growth (“patellite de croissance”), a clinical differential diagnosis between this lesion and patella partita is hardly possible. As will be mentioned later, the histological diagnosis in one of my operative cases of marginal patella partita was “Osteitis fibrosa. Degenerative changes of the cartilage”, while in a second case “extremely limited osteitis fibrosa” was found besides “degenerative changes”. This undoubtedly brings forward for discussion osteitis fibrosa patellae, not with regard to the differential diagnosis only, but the pathogenesis as well. It is well known that a tumour in the patella is a rare lesion. In 1925 *Cole* (Minnesota) collected from the literature a total of 25 cases reported of tumours of the patella, benign as well as malignant, including one case that he had himself described as *osteitis fibrosa cystica*—the first in the literature, as far as can be ascertained. Among

the 25 cases, however, was not included one case of "giant cell tumour" of the patella described in 1924 by *Faltin*, Helsinki. In 1931 *Neurenbergk*, Freiburg, could assemble from the literature a total of 37 cases of patellar tumours, six of which were definite cases of osteitis fibrosa patellae. To these should be added two cases which he has referred as osteodystrophia fibrosa patellae. Subsequently *Rigney d'Annoy* and *John Connell* of Louisiana recorded a case of "osteitis fibrosa localisata patellae" and at the same time *Myron O. Henry* reported a case of "giant cell sarcoma" of the patella. Among 41 patellar tumours, therefore, ten cases were found of osteitis fibrosa patellae and giant cell tumours respectively, i.e. in 24.4 per cent. It is surprising, however, that the absolute figure is no larger, when it has been proved that 47 per cent of all osteitis fibrosa processes are localized to the lower end of the femur and the upper end of the tibia—thus to the remaining skeleton of the knee. When the osteitis fibrosa is clinically manifest as a *patellar tumour*, the differential diagnosis towards patella partita is connected with no difficulties, whereas it is different when the patella discloses no change in shape. It is the roentgenogram which decides the diagnosis in the latter case, as it demonstrates more or less cystic rarefactions in the bone in osteitis fibrosa, most frequently predominating in the lower pole. *The clinical as well as the X-ray picture presented by osteitis fibrosa thus excludes the possibility of osteitis fibrosa patellae in the general meaning of this designation, in my two above mentioned cases.* Quite naturally the explanation of the histological findings of osteitis fibrosa in the two above mentioned cases of patella partita, must be looked for in the fact that osteitis fibrosa is a designation used for a *principal and characteristic, though nonspecific* reaction on the part of the osseous tissue in a series of lesions, in which disturbance of the ossification prevails. In certain circumstances it may be so obvious that it entirely dominates the pathologic anatomic picture and creates the picture of disease termed "osteitis fibrosa localisata", "osteodystrophia fibrosa". This was not present, however, in my two above mentioned cases of patella partita.

When it is a case of patella partita apicalis, the processes of calcification occasionally found in bursa infrapatellaris subcutanea et profunda (*Rauber-Kopch*) may cause difficulties in diagnostic respect. Such cases of calcification have been reported by *Bähr*, *Sonntag* and *Blencke*. I have not been able to read in the original the paper of *Bähr* from 1914 on "a typical lesion of the patellar ligament". The case was unilateral, as also that of *Sonntag* (1918), which dealt with two cases, the X-ray examination of which showed an *ossification* of the upper part of the inferior patellar ligament, though in perfect continuity with the patella—thus without any partition whatever. Confusion with patella partita, therefore, is quite out of the question here. It is another matter with the case of *Blencke* (1922), which concerned a young girl, 16 years of age, who had always suffered pain in the left knee when kneeling. The roentgenogram shows a typical *apical patella partita*. When *Blencke* was of the opinion that no such lesion was present here, this was because of the fact that it was *unilateral*. On the other hand he assumed that a *calcareous bursitis* was present in the subcutaneous or deep infrapatellar bursa. An indication of this, in the opinion of the author, was the tenderness on pressure elicited at this point as also the slight thickening found over the prepatellar bursa, which appeared to indicate that this was also involved. When we are aware now that a marginal patella partita may not only occur unilaterally, but actually in a great many cases also does, the main argument of *Blencke's* diagnosis falls completely away. In this case it has surely been a matter of an apical patella partita.

Apart from some cases of "Johansson—Sinding-Larsen disease" the chief competitor to this diagnosis is represented by the traumatic chip fracture of the patellar apex, in which the past history is, of course, of great importance. A proved trauma against the patella immediately prior to the occurrence of the disease or some time later (refer to my case Olav), together with possible tenderness on pressure over the patellar apex, speaks for fracture, as also the X-ray finding if it demonstrates an irregular partition with irregular, jagged borders contrary

to the more regular partition with smooth—partly well-marked borders—found in the congenital partition of the apex. The following case is an illustration of how careful one has to be in making the diagnosis: *Hjørdis*, female, 36 years of age, entered the Coast Hospital suffering from a chronic synovitis of the



Fig. 16.
Case *Hjørdis*.

knee subsequent to a trauma, and suspected of tuberculosis. Explorative arthrotomy revealed that it was a case of synovitis chronica villosa nontuberculosa. The roentgenogram showed a normal patella on the diseased side, on the *healthy* side, however, *apical patella partita*. If this latter finding had been made on the traumatized side, it would hardly have been possible to have avoided the diagnosis of fracture. (Foto 16).

The most difficult differential diagnosis towards patella partita, and that which is at the same time the most important in practice, is towards *fracture of the patella*. This will be closely dealt with in a later chapter.

XIII

Patella partita per se needs no *treatment*—all are agreed about that. Indication of treatment is present only when there are clinical symptoms, and everyone also agrees that it should then be of a conservative nature (rest and quiet, possibly immobilization)—*Sommer, Schaer, Fournier, L'Heureux et Riche*—to mention a few names only. When in some quarters one has even gone as far as to *caution* against an operative intervention, i.e. extirpation of the separated fragment, this is quite erroneous according to my opinion. Thus *Siemens* categorically maintains that patella partita needs no surgical procedure, as the separated fragment is not necrotic. A series of authors also claim that some cases have to be treated operatively, viz. when a conservative treatment has not been successful, as in my case Frank. Thus, *Odermatt*, being the first one to extirpate such a fragment, claims that an operative intervention is warranted when a state of irritation of the joint does not subside after conservative treatment. The French authors mentioned also maintain that one should, though in exceptional cases only, perform the minor operative intervention of removing the fragment—that is to say in cases where symptoms are present of an “ostéite aiguë” (*L'Heureux et Riche*), or when the pain does not disappear after conservative treatment (*Fournier*). There is no doubt that a patella partita may dispose to recurring hydrops, arthritis deformans (*Siemens*). Just as indubitably, this also is an indication warranting an operative intervention. These are also the indications which have been present in those of many cases, in which operative interventions have been carried out. I will refer the case histories.

When *Schaer* states that in one exceptional circumstance only is there an indication for removal of a fragment in patella partita, viz. when a traumatic patella partita is present with dislocation of the separated fragment—he refers such a case—I would like to refer to my case Kjellaug, in which the removal of the necrotic, though not dislocated fragment, made all the symptoms disappear, which had lasted for almost two years.

XIV

SIX CASES OPERATED ON AND EXAMINED
HISTOLOGICALLY

Case 1, Frank, 17½ years of age, mechanic's apprentice.

Has always previously been healthy. 11½ to 2 years ago—when the patient was 15—16 years old—he noted tenderness *over the upper outer corner of the right patella*. When walking much the knee became swollen. Simultaneously with these symptoms he noted “clicking” and crepitation in the knee when walking. Gradually the knee felt *stiff*, especially in the morning. The knee was also occasionally swollen. After a strenuous march three weeks previous to the admission, the condition had become much worse. Particularly the tenderness over the patellar corner had been aggravated. Now he feels and hears clicking and cracking in the knee, when moving it lying down. He has noted also that he has less strength in the right than in the left leg. The physician, who referred the patient for examination to the Coast Hospital, also found hydrops of the joint. The patient is not able to suggest any definite cause of his knee trouble, as he had not been exposed to any trauma. He has been, and is still, however, an eminent performer in all branches of athletics, especially gymnastics and marching, however.

Physical examination June 15, 1937: The patient is not, and has not been, lame. The right knee has normal contours. No hydrops. Normal motion *with considerable palpable and audible clicking and cracking in the joint*. By pushing the patella from one side to the other a slight irregularity is palpated behind the patella on both knees. Both patellae also are strikingly easily movable to both sides. *The right patella* is distinctly wider than the left—6 and 5.3 centimetres respectively. Atrophy is present, two centimetres of the right thigh and one centimetre of the right calf. When the patient stands on the right leg, he barely manages to straighten up from a position with bent knees. It is accompanied by such cracking in the knee, however, that it may be heard at a distance of twelve metres. The left knee: Normal clinical conditions.

X-ray findings: Right knee—marginal patella tripartita.

Left knee—normal conditions.

During the last few weeks the patient has felt so troubled by the symptoms from the right knee, that he has desired an operation to be performed. He was advised to keep as quiet as possible for



Fig. 17 a.
Case Frank.

the time being and to spare the knee. Four weeks later—July 16th—he again presented himself for examination. He had been away on holiday, having among other things done mountain climbing, after which the knee had become considerably worse. Distinct swelling was present, 35 (34.5) centimetres—however without demonstrable hydrops. Considerable thickening was felt of the soft parts above the synovial fold of the suprapatellar

pouch. Mild tenderness on pressure over the upper outer patellar corner. There was also some tenderness on pressure of this corner against the underlying parts. When the patella is pulled downwards, pain is reported "within the upper lateral corner of the patella". No tenderness of the remainder of the patella.



Fig. 17 b.

Normal motion of the knee, during which a *clicking* is still felt in the joint, and heard at a distance of twelve metres, though with no retropatellar crepitation. When the patella is pushed towards the medial side, pain is reported in the lateral side of the patella. Distinct scratching is also felt against the underlying parts. The patient now insists on an operation. On July 19th, therefore, the two lateral patellar fragments were extirpated under local anesthesia. When the patella was exposed

a small indentation was palpated in the upper lateral corner, which appeared to be the groove between the patella and the upper fragment. When this was removed one entered the joint cavity. After removal of both these fragments a not inconsiderable part of the cartilaginous surface of the patella was visualized, and appeared to be normal, without any fissure. The visible part of the synovial membrane, however, was distinctly swollen and succulent. August 10th—Uneventful course. Unrestricted motion of the knee, *without cracking or clicking*. No pain, spontaneously or on motion. The patient is discharged. He subsequently presented himself for control on September 3, and November 29, 1937 and May 9, 1938. He had been working since four days after he left the hospital, and had long since resumed his sport in full. In other words, he feels perfectly well, has had no pain or other discomfort from the knee since the operation. No clicking in the knee on motion. *Histological diagnosis: Osteitis fibrosa. Degenerative changes of the cartilage.* (Professor Kreyberg). A detailed report of the histological findings in this case as well as in the following will be given in a subsequent chapter.

Case 2, Karl, 22 years of age, mechanic.

Previously he has always been healthy. Two weeks before Christmas 1938 he suddenly felt pain in the knee when stepping down on the left leg. This became swollen, he felt a stinging sensation inside the joint, and limped. He immediately consulted a physician, who ordered rest and massage, and in a week's time he improved and took up his work again. However, pain and swelling of the knee with hydrops recurred, and puncture produced about 30 c.c. of clear fluid. The knee was put in plaster of Paris for two weeks, after which it was again massaged. It did not help much, however. A starch bandage was applied for two weeks, and the knee was then punctured anew, when only a sparing quantity of fluid was evacuated. An elastic bandage was applied to the knee, and then renewed massage. He still suffered pain in the knee, however. Recently he has felt some improvement, but he has had to keep as quiet as possible, and

has used a walking stick. He has felt occasional *crepitation in the knee*, especially when trying full extension. Locking symptoms have never occurred. As the symptoms did not subside, he was referred by his physician to the Coast Hospital, where he was admitted on April 13, 1939. He states with regard to the

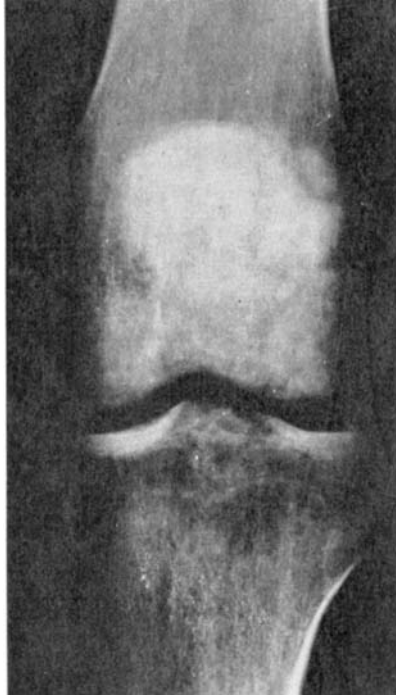


Fig. 18.
Case Karl.

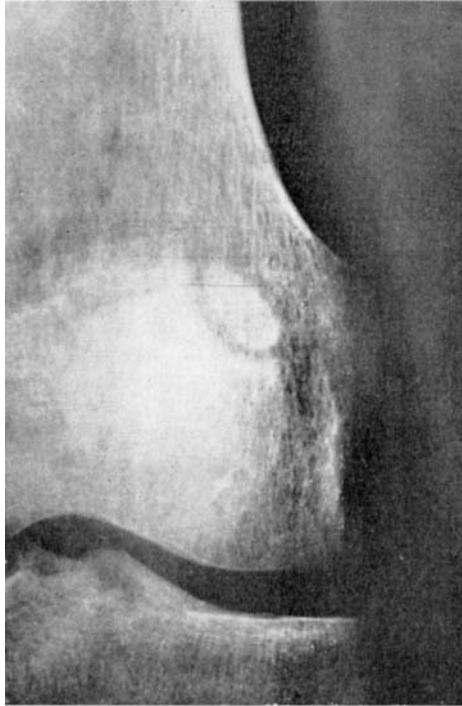
causation of his disease, that during military service in the summer of 1938 he felt tenderness of the knee on several occasions under extreme bending. Notwithstanding this, he took part in a marching competition. He is not aware of any definite trauma, but he states that his work includes having to *crawl on his knees* several times daily underneath the machine at which he works, and he is of the opinion that he may have struck his left knee. *Physical examination: Left knee*—Normal configura-

tion. No distinct capsular thickening. No hydrops. Patella somewhat wider than on the right side. Tenderness over the outer lateral corner, no other tenderness over the patella. Normal mobility of the knee *without crepitation or clicking*. The patella is freely movable. Equal circumference of both knees. No atrophy of thigh or calf. *Right knee*—Normal conditions. *X-ray findings: Left knee*—Considerable mottled atrophy of the entire skeleton of the knee including the patella at the upper outer corner of which a clearly defined fragment is observed. In the sagittal view this is seen lying posteriorly in the patella, *occupying almost the entire upper half. The partition dividing this from the remainder of the patella reaches as far as the articular surface.* The right patella is normal. April 17th—The small patellar fragment was resected in local anesthesia. It proved very difficult, even after the patella was exposed, to find the lower limitation of the fragment, and after it had been separated from above with knife, it had to be chiselled off the patella. After removal it appeared that a depression was left in the patellar border. The joint was not opened. The cartilage on the resected fragment was found to be cracked. May 15th: Uneventful course. The patient has been up for two weeks. Walks easily without pain. Slight effusion in the joint. Puncture: 50 grams strongly hemorrhagic fluid. June 13. The constantly recurring effusion in the knee has now disappeared. He bends the knee to an acute angle *with no crepitation in the joint*. No pain. November 23, 1939—Control: Two months after returning home the patient commenced working. He has had no pain in the knee the whole time. No effusion in the joint, free mobility with quite slight, soft crepitation. Distinct muscular atrophy of the thigh: over the patella half a centimetre, over the superior recess two and a quarter centimetres, and fifteen centimetres above the patella four centimetres. The patient states that the condition of the knee is considerably better than prior to the operation. October 5, 1940.—The patient has reported that he has fully recovered.

Histological diagnosis (Kreyberg): Degenerative changes. Extremely limited osteitis fibrosa.

Case 3, Arne, 29 years of age, works' manager.

Entered the Coast Hospital on June 6, 1939, on the diagnosis tuberculosis of the knee, the first symptoms of which had commenced in the autumn of 1938. The patient had never sustained any blow or other trauma against the knee. *Clinical examination*



Case 19.

Case Arne.

showed thickening of the capsule of the left knee and restricted motion. Tenderness on the medial side of the joint, but not of the patella, over the upper lateral corner of which a distinct furrow was palpated. The left patella is not wider than the right. It is freely movable. No crepitation is felt on motion. *X-ray examination:* Tuberculosis of the knee with marginal patella bipartita. The right knee normal. Normal clinical and

roentgenological conditions. On June 13th *synovectomy* of the knee was carried out under spinal anesthesia. The entire patellar cartilage was found to be considerably soft and attenuated. The lower part was separated from the upper part by a horizontal furrow. No other crack or defect was found. In the upper lateral corner of the patella a furrow was seen, which appeared to correspond to the partition between the patella and the fragment which was removed. Its facet against the patella was cartilaginous. Histological diagnosis: Tuberculosis synovialis et chondromalacia patellae. The histological examination of the fragment showed: *Osseous tissue with regressive changes (Kreyberg)*.

Case 4, Rolv, 17 years of age, sailor.

Presented himself for consultation on May 4, 1938. The father was a hypophyseal dwarf, height 135 centimetres. The patient states that on April 22, 1938, he slipped on the deck during his work on board, and fell on the right leg with the knee bent under him. He felt that the patella was dislocated together with the lower leg. He could feel the patella on the outside of the knee. The patella as well as the lower leg slipped back spontaneously. The knee became greatly swollen, and after a few hours of continued work, he had to stop this. On April 29th he came to port, and consulted a physician, who punctured the knee and evacuated the blood. Puncture again May 2nd. On May 5th he was admitted to the Coast Hospital. The knee then was still swollen with effusion. Puncture: Blood. *X-ray examination*: Right knee—Marginal patella bipartita (Fracture of the patella?). Left knee—Normal findings. Massage was instituted. May 12th: Again effusion in the knee. Puncture: Blood. May 27th: The knee still swollen, but without effusion. Normal mobility. August 20th: For a long time the patient has been up all day and cycles as previously with no other trouble but that the knee, as he insists, became swollen when he had cycled too much. Almost normal conditions of the right knee. On both sides, but particularly on the right, the patella is strikingly easily movable from one side to the other. Normal mobility in the knee accompanied by *lively retropatellar crepitation*, which is felt as

well as *heard*. No crepitation on the left side. Upwards towards the upper outer corner of the right patella an irregularity is palpated—the patellar partition. Measure across the patella 37.5 (37) centimetres, and fifteen centimetres above the patella three and a half centimetres atrophy. The subjective statements

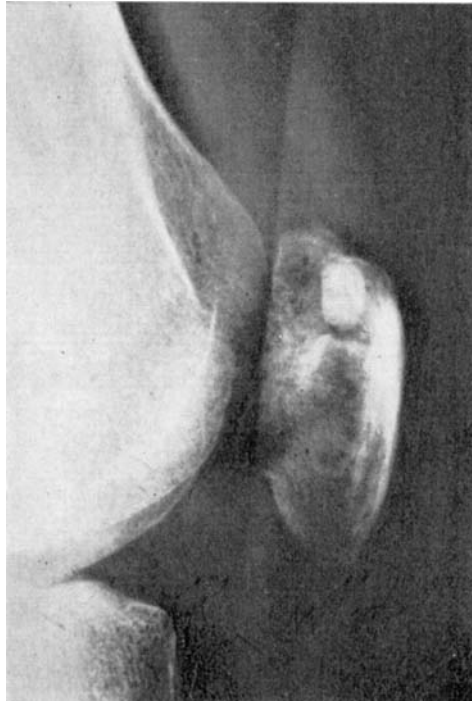


Fig. 20.

of the patient, among others, that his knee will not permit him to continue as a sailor, are regarded as considerably exaggerated. On July 27, 1938, the treatment was finished. The case was recognized by the Public Accident Insurance Board (R.T. V.). On May 9, 1939, the patient again went to sea after having been examined by another physician, who declared him to be fit. The knee had not been examined, however, as the patient had made no mention whatever to the physician of his previous knee

lesion. The whole of the autumn and winter of 1938/1939 he had had no trouble from his knee. On July 17, 1939 he again came in for consultation. He stated that about May 20th during a voyage across the Atlantic he had stumbled on the right leg, and noticed that the patella was again on the point of being luxated out-

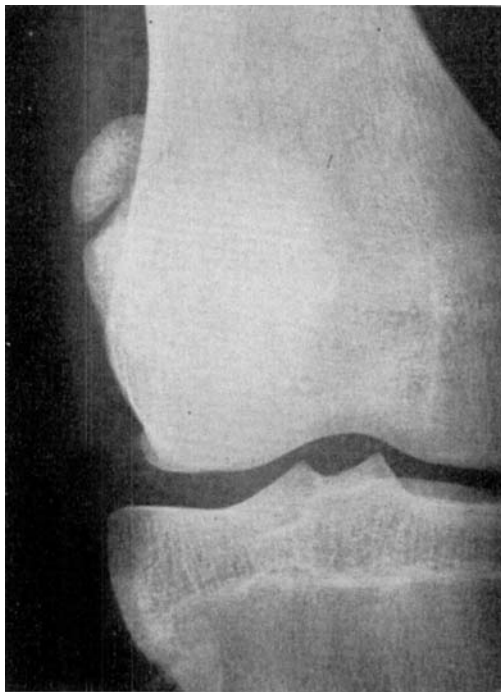


Fig. 21.
Case Roly.

wards. It did not do so entirely, however, and immediately receded spontaneously. The knee, however, in the course of a quarter of an hour became swollen, and is stated to have been swollen ever since. On July 13th he returned to Norway, and on the 17th again presented himself for consultation, when a mild effusion of the knee joint was found with slight capsular thickening, two and a half centimetres atrophy over the superior recess. On palpation of the patella the upper lateral corner was found to

be prominent, and there was also a distinct furrow parallel to the border. By pushing the patella outwards laterally, enabling one to palpate it between two fingers, the fragment visualized roentgenologically was distinctly felt as also that the muscular attachment was markedly hard, almost cartilaginously thickened. On bending and stretching of the knee—which was done to normal extent—considerable retropatellar crepitation was felt and heard as well as cracking against the underlying parts by pushing the patella from one side to the other. No pain on weight-bearing. X-ray examination now *discloses distinctly mottled atrophy of the fragment and the adjacent part of the patella*. The condition was regarded as a *traumatic exacerbation* of the previous post-traumatic lesion, and on this foundation the case was passed upon as being compensable under the compensation law. On September 28th the lateral fragment of the patella was removed under local anesthesia. It was discovered to be *easily movable corresponding to the patella* and was removed extra-articularly in its entirety. The fragment measured $1.5 \times 2.5 \times 1$ centimetres. The lower facet against the patella was distinctly irregular. The cartilage posteriorly was partly destroyed. *Histological diagnosis: Osseous tissue with regressive changes. Aseptic necrosis?* (Kreyberg). The course was uneventful, though a mild hydrops persisted in the joint for several months. February 6, 1940, on the latest follow-up examination for the Public Accident Insurance Board, the knee showed normal configurations. No capsular thickening, no effusion. Normal motion, with considerable audible as well as palpable retro-patellar crepitation and cracking. One centimetre of atrophy over the superior recess, and three centimetres of atrophy twenty centimetres above the patella. No subjective symptoms. On June 10, 1940, a luxation of the patella with hemarthrosis again occurred. After some weeks of rest the knee again was quite normal, however, with extreme crepitation during movements. The mobility of the patella outwards had now increased to a marked extent.

Case 5, Alv, 17 years of age, warehouseman.

Admitted August 29, 1938, suffering from a lesion of the knee joint. Two—three years before he had been in a sanatorium under treatment for pleurisy. Otherwise he has been quite healthy. He has, however, since he started school (at the age of

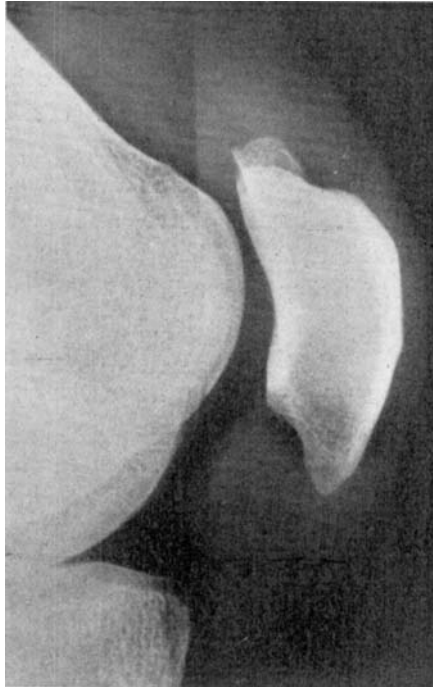


Fig. 22.

seven) been troubled by pain in both knees, and was consequently always exempt from gymnastics. His physician at that time was of the opinion that it was a case of Osgood-Schlatter disease. In February 1938 he commenced suffering gradually strong pain in the right knee. He assumed the cause of this to be that he had cycled much on a bicycle with so low handlebar that the knees kept on knocking against this. As swelling appeared in the knee after some weeks (in March), he consulted a physician who advised him to keep quiet. He had then already

had to give up working. When he had been sitting quietly for a long time with the knee in one position, he had difficulty in straightening it fully. Renewed examination after three weeks disclosed considerable *hydrops* of the knee. Puncture: No tuberculosis, neither by inoculation nor by cultivation of the punctate.

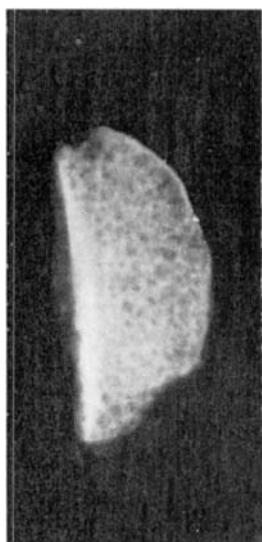


Fig. 23.



Fig. 24.

After immobilization of the knee for 6 weeks in plaster bandage the exudate was resorbed. When he consulted a physician one and a half month ago after having injured his left knee in an automobile accident, *hydrops* was demonstrated, but simultaneously also in the right knee. X-ray examination possibly showed a very mild capsular thickening, as also an apical patella partita of the right knee. (August 18, 1938). *Physical examination* August 24, 1938: *Right knee*—The contours somewhat blurred, no effusion in the joint. There seemed to be a slight swelling below the patellar apex. No tenderness over the knee. Normal motion *with retropatellar crepitation*. Normal conditions in the left knee, also here with marked retropatellar crepitation during movements. *X-ray examination*: Frontal picture demonstrates

normal conditions in both knees. The sagittal picture: The posterior part of the patellar apex on the right side shows a fairly well-defined, atrophic area, and particularly the lower border corresponding to the patellar apex is distinctly delimited. A fragment the size of a pea, is observed to be separated from

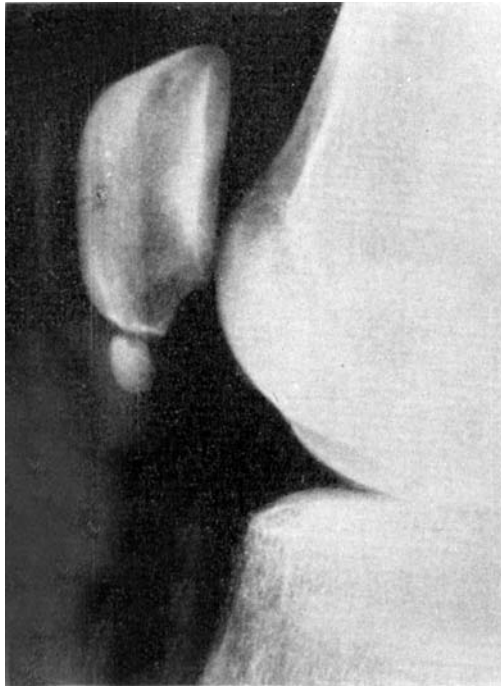


Fig. 25.
Case Alv.

the apex. During the first weeks of the hospitalization hydrops of the right knee again occurred, which receded after rest in bed. A considerable capsular thickening gradually developed, however, and an explorative arthrotomy was performed, therefore, whereby a thickening of the synovial membrane was discovered, particularly around the patella, with tumour-like hypertrophy behind the inferior patellar ligament. The patellar cartilage, which was perfectly smooth without fissures, in its lateral

part was covered by a fibular connective tissue. The apical fragment was removed. *Histological diagnosis*: "Bone and cartilage with degenerative changes. Fibrous marrow and irregular zone of ossification. Some pieces of bone showed normal condition." The explanation of this is given in the X-ray picture of the patella after the operation, showing that not only the fragment, but also some part of the apex of the patella proper has been chiselled off. On January 19, 1939, the patient was discharged with normal clinical conditions of the right knee and feeling that this was perfectly sound. *X-ray examination* demonstrates that there are still some chips of bone left under the patellar apex. Shortly after the discharge from the Coast Hospital the patient was admitted to a department of internal medicine suffering from duodenal ulcer, having had symptoms of this during the latter part of his stay at the Coast Hospital. When he was up again after completion of a diet cure, he again complained of the same symptoms in the right knee as previously. X-ray March 20, 1939, showed the same findings as when he left the Coast Hospital. He was now treated for two months with immobilizing bandage, and one month later again started working. Renewed examination on August 30, 1939, showed quite normal conditions in the right knee, and the patient was certified as chauffeur. (Kind information from his physician).

Case 6, Kjellaug, 15 years of age.

Has always been well. In February 1937 she fell when skiing. Throwing herself down in order to avoid running into a fence, she fell *with the left knee under herself in a greatly bent position*. She also struck the knee and received a small excoriation over the patella. It did not hurt much, although she felt some pain when she tried weight-bearing on the leg. She was driven home. After one-quarter of an hour the knee had become extremely swollen, and the following day great bruises had developed over the knee, which was considerably stiff. The patient now rested quietly for six weeks, the knee still remaining swollen. It could be flexed to 90 degrees, but she noticed cracking in the joint when she bent the knee, and has noticed this ever

since. Some swelling of the knee has persisted, and she has constantly limped somewhat, particularly when walking fast. No particular pain, however. When in the summer of 1937 she had been seated on the ground with the leg greatly flexed under herself, she could not straighten it out again—it was locked.



Fig. 26.
Case Kjellaug.

She has not since had similar experience, but she has felt the knee to be weak, particularly when she climbed hills and stairs. Once in the summer of 1937, after having been for a walk, she felt excessive pain in the knee as an unendurable sense of exhaustion—all the way up the hip, especially after she had gone to bed at night, and she had to put a pillow underneath the knee. In the morning she was quite all right again. She has subsequently had similar sensations on several occasions, and

has recovered again before morning. She has otherwise been up and about all the time, has been skiing, not jumping, however, as this caused pain, has cycled and skated. After cycling she became slightly more tired. She was sent to the Coast Hospital, therefore, for examination and was admitted on November 24,

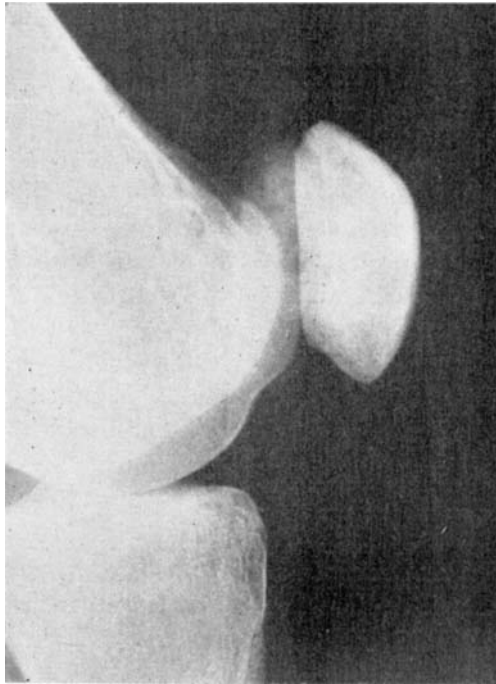


Fig. 27.

1938. *Physical examination:* The left patella is one centimetre wider than the right. No irregularities are felt over the patella. The knee is flexed and extended normally with pronounced audible as well as palpable cracking and retropatellar crepitation. The same, though somewhat less pronounced, findings in the right knee. By lateral motion no particular cracking is felt behind the patella. No hydrops. No abnormal motion in the joint. One centimetre atrophy of the thigh fifteen centimetres above the patella. No atrophy of the calf. One centimetre small cir-

cumference over the patella. *X-ray examination demonstrates a longitudinal partition of the patella into two fragments, one large laterally and a smaller one medially.* The partition which traverses the entire patella, gradually narrows from above downwards. This fragmentation is not visible on the sagittal view of the patella. On another picture taken more obliquely the contours of the small fragment are seen along the posterior surface of the patella. On December 1, 1938, the lateral patellar fragment was removed under narcosis. No visible or palpable irregularity of the anterior facet of the patella, and neither along the upper patellar border. The lateral fragment, *which was movable in relation to the remaining part of the patella,* was easily separated with a scalpel, except the upper fourth, which had to be chiselled off. The fragment removed measured $5 \times 3.2 \times 1$ centimetres. The facet against the patella proved to be osseous in the chiselled-off part only, otherwise it was fibrous. On the facet against the joint the fragment was irregular and apparently denuded of cartilage. The view obtained of the joint showed that the synovial layer was greatly hypertrophied, the femoral cartilage facing the patella appeared normal, while the patellar cartilage of the part lying close to the place of fracture was greatly frayed. The X-ray examination of the fragment removed showed that this was taken up by a considerable mottled atrophy. Pathologic-anatomic analysis of the fragment disclosed: *Osseous necrosis with some resorption and fibrosis. (Kreyberg).*

DISCUSSION

The first five of these six patients presented an indubitable congenital partition of the patella—the first four of marginal type and the fifth of apical type. All the patients were male. The age at which they came for treatment was for three of them 17—18 years, the two others 22 and 29 years respectively. In all the cases the lesion was *unilateral*. In three cases the right knee was involved, and in two cases the left knee. In the sixth case, which concerned a female, 15 years of age, a longitudinal partition was present (Saupe's type II) in such direct associa-

tion with a severe trauma against the patella that it must be assumed to have been clinically quite established that it was a case of *fracture of the patella*. The X-ray findings revealed necrosis of the fragment with no signs of callus formation. As mentioned patella partita was an incidental finding in one of these cases—Arne. In another—Karl—this has also most probably been the case. This concerned a patient who for four months had suffered recurring unilateral hydrops of the knee joint with pain and cracking in the joint, which had proved refractory to conservative treatment. The X-ray picture demonstrated a considerable mottled atrophy in the knee, as frequently seen in non-specific chronic cases of synovitis of the knee joint. The cartilage on the resected fragment had been cracked—fissured as in a chondromalacia. The simultaneous microscopic examination of the cartilage showed that it was considerably frayed and degenerated—thus findings corresponding to those made in this lesion. The joint was not opened, and no opportunity offered, therefore, of inspecting the remaining part of the patellar cartilage or the synovial layer. The above mentioned macro- and microscopical changes in the cartilage, however, demonstrated that a chondromalacia at any rate was present in the part of the cartilage which had been removed.—The patient could give no definite causal relation of the lesion in the knee, apart from the fact that the first symptoms, in the form of pain of entirely transitional character, had occurred on a couple of occasions during military service approximately half a year before one day when he again suddenly suffered pain in the same knee with hydrops. Further he stated that his work entailed that he had to crawl on his knees several times during the day. It is conceivable that this, or the unusual strain associated with military service, has brought about the clinical symptoms mentioned as a reaction on the part of the knee *the patella of which was bipartite*, and may thus have been less resistant than the other, the patella of which was normal. In the diseased joint a *patellar distraction* has developed, which has resulted in degenerative changes in the fragment. At the same time, or perhaps most probably *due to these an irritation has occurred of the synovial*

layer with hypertrophy of the tissue and resultant hydrops. The identical symptoms of a synovial irritation was present also in the other three cases, the joint cavities of which were opened during the operative interventions (*Frank, Alv, Kjellaug*). The case *Arne* is not taken into consideration here, in which a tuberculous synovitis was present.

In the case *Karl* the patellar partition must be looked upon as a predisposing cause of the clinical symptoms, which may be explained by a *distraction (distortion)* of the patella. This may also be taken to be the case with the patient *Frank*, in whom the tripartition of the patella must be assumed to have made it inferior towards strain to which the opposite patella did not react. In both cases the histological examination demonstrated that changes were present in the cartilage (degeneration) as well as in the bone, changes similar to those found in *osteitis fibrosa*. In the case *Frank* clinical cure took place very rapidly after removal of the two small fragments. This excellent result supplied indication of a similar intervention in the case *Karl*, in which cure was obtained although after some longer time—possibly because the symptoms had lasted longer.—Assumption of a patellar distraction as the cause of the symptoms in a patella partita, of course, is still more justified when a *definite trauma* is present in the past history. The problem presents itself here, however, with still greater insistence, whether *the partition per se is not the causal factor in the trauma*, in other words whether it is not a case of *fracture of the patella*. The nature and extent of the trauma, of course, will have to partake in the decision of this question: a direct trauma against the patella or a chip fracture due to a hyperflexion of the patella. Furthermore, the shape and location of the partition as also, according to the opinion of several investigators, the appearance of the border, are of diagnostic importance. A fragment, separated at the classical place of a marginal partition, and preceded by a definite trauma, is no conclusive evidence *against* a fracture on traumatic basis. Such is the case of *Rolv*, who had first suffered a trauma and then after the lapse of a year another, similar trauma, however less violent. The operative intervention showed that the frag-

ment was movably connected with the patella. Co-ordinated with the X-ray and histological findings this further strengthens the diagnosis of distraction of the patella and speaks against a fracture.

In the case *Alv* an apical partition is found. The X-ray picture revealed this with a smooth partition with regular borders as seen in congenital patella partita. The assumption of the patient that the symptoms were due to his continually striking his knee against the handle-bar of a bicycle too low for him, cannot be recognized as the primary causation. The opposite patella, which was naturally exposed to the same collision with the handle-bar, was normal. It may be imagined, however, that the chronic trauma represented by these knocks may have produced a bruise of the congenitally abnormal and therefore less resistant patella.

It will be observed that in the six cases taken up for discussion here, I have assumed that the clinical symptoms in four cases had causal relation to an acute or chronic trauma against the patella. In the two remaining cases, on the other hand, the partition was an incidental X-ray finding in a tuberculosis of the knee and a fracture of the patella respectively. In the first four cases the said trauma must be regarded as the *incidental cause* which has released the symptoms, while the partition as such must be assumed to depend on a congenital anomaly.

XV

The contribution that my six above cases give to the *histology* of the patellar partition, and consequently also to its pathogenesis, is of particular interest.

As an operative treatment of patella partita so rarely has been indicated and performed, the histological material for the evaluation of the pathogenesis of this anomaly, as mentioned above, has been very sparing. The first case treated operatively and examined histologically, is that of *Odermatt*, Basel (1931). It was a male, 58 years of age, who had eight days previously fallen on the right knee, which had become greatly swollen and

painful. The X-ray examination showed in the upper outer quadrant of the patella several small pieces of bone with quite smooth contact facets. The sagittal view disclosed on the upper pole of the patella a piece of bone, the size of an almond, and resembling a sequestrum, in a bulge on the patella as "an egg in an egg-cup". *Odermatt* first assumed that a deformity was present. As X-ray examination of the opposite patella showed normal conditions, however, he abandoned this. As the fragments of the right patella were strikingly mobile and also tender, they were extirpated, the joint thereby being opened, as the cartilage-coated facet of the extirpated fragment at this point formed the anterior delimitation of the knee joint. X-ray examination of the fragment showed it to consist of two larger and several smaller pieces. The two larger pieces presented smooth, almost polished, contact facets. X-ray examination of the small pieces showed *rarefactions* in the osseous tissue, which were histologically interpretable as "true medullary spaces". About the further histological findings is mentioned only that small bony islands were observed in the middle of the cartilage, the single pieces of bone being separated from each other by hyaline cartilage and connective tissue poor in cells. The author drew the conclusion from this, that it was a case of absent fusion of multiple centres—thus a deformity due to delayed or entirely absent ossification.

In one of the cases of *Sommer*, concerning a male, 17 years of age, who for a couple of years without known preceding trauma had felt occasional pain in the right knee, and the X-ray disclosing a marginal patella tripartita, the two small fragments were removed on the diagnosis osteochondritis dissecans. The patient was completely cured in two weeks. The histological examination of the removed patellar fragment showed that the tissue lying between and around this consisted of a *hyaline* cartilage, poor in ossific centres, penetrated by numerous clefts and large cavities. These changes were seen most amply in the partition between the fragments. On the other hand the osseous tissue—the bone struts as well as the marrow—at first glance appeared to be perfectly normal. Serial examinations, however,

revealed changes, particularly on the part of the fragment which according to the opinion of *Sommer* had been in collision with the bony crest on the external femoral condyle, as mentioned previously—in other words had been exposed to a chronic trauma. These changes were mainly located to the border of the fragment, and consisted in the osteo-cartilaginous limitation becoming gradually more blurred and finally disappearing, so that the bone struts projected freely into the hyaline cartilage. The fatty marrow in the thus open marrow spaces was replaced by connective tissue, poor in centres, of the appearance of scar tissue. Apart from these border zones of the fragments facing each other, in which the osteo-cartilaginous limitation had disappeared, the bone shows entirely *normal structure*. The bone spicules were of normal thickness and calcification. There were no signs, therefore, of necrosis, dissecting or inflammatory processes. It was remarkable, however, that also in the quite healthy areas the osseous centres could not be stained. As both pieces of bone otherwise had the appearance of being quite sound, the author assumed that this lack of staining of the centres did not signify dead bone. The author concludes “Festzuhalten ist jedenfalls die Tatsache dass an beiden Knochenstücken die in ihrer Struktur normalen Knochenstücke nur an den einander gegenüberliegenden Flächen, dort, wo sie das kernarme, hyaline Gewebe zwischen sich fassen, keine scharfe Grenze zeigen. Nur dort ist der Kerngehalt der Bälcken geringer, nur dort finden sich das Fettmark ersetzt durch derbes kern- und gefässreiches Bindegewebe. Zieht man Vergleiche an, so sieht diesen Gewebe am meisten einer *Pseudoarthrose* ähnlich Die dem Spalt zugekehrten Knochenränder, denen ja die scharfe Begrenzung fehlt, könnten keinen genügende Callus bilden” It thus appears that *Sommer* is of the opinion that patella partita is an abnormality, the primary cause of which must be sought in multiple centres, the ossification of which is suppressed or prevented thereby that the patella is subjected to a trauma in the period before the ossification is completed. *Sommer* maintains that such a trauma represents the collision between the upper outer corner and a small sharp bony crest as

found upwards laterally on the lateral femoral condyle, and which must occur when the patella during the movements of the knee glides over and is pressed against the femoral condyle. The fact that it is also exactly the outer upper corner of the patella which comes into contact with this bony crest, explains why it is this corner which is the site of the marginal partition. "Jeder Zug der Quadriceps lässt aufs neue den Spalt auseinander gehen". The ossification is prevented, and a pseudarthrosis occurs. The fragments removed in the case of *Sommer*—a patella tripartita was present—did not lie in a cavity in the patella, but in a bed, and neither did it communicate with the joint. They were not, therefore, as in the case of *Odermatt* covered with cartilage on the side facing the joint.

Siemens in 1931 performed an operation in the belief—just as *Sommer*—that it was a case of osteochondritis dissecans patellae, a unilateral, as he thought at that time, patella partita marginalis, in a chimney-sweep, 21 years of age, who had presented recurring hydrops genus subsequent to a trauma against the knee, three—four months previously. A subsequent X-ray examination showed, however, that the patellar partition was bilateral. The operation disclosed that except for a single, hardly visible irregularity, the patellar cartilage was macroscopically normal. No information is given of the osseous tissue. Based on this case together with that of *Odermatt* and *Sommer*, *Siemens* claims to be able to conclude that no macroscopical changes of the patellar cartilage are found in patella partita. It should be borne in mind here, however, that the cases are very few in which it has been possible to form any opinion as to this by autopsy, as it is only in very few cases of patella partita operated on that the operation has procured the necessary access to the posterior facet of the patella. In a later paper (1933) *Siemens* has referred the results of a histological study of a post-mortem specimen in a unilateral partition of the marginal as well as the vertical type. The patient was a male, 82 years of age, who had died from bronchopneumonia. The past history gave no information of knee symptoms. Macroscopically the patellar cartilage demonstrated distinct changes, the upper half

being extremely absorbed and destroyed. Thus the upper outer quadrant was almost entirely denuded of cartilage. Further an osteo-cartilaginous partition was observed on the transverse section of the medium and lower third of the patella, which reached all the way forwards to the anterior facet of the patella, where the connection between the two fragments is apparently formed by connective tissue. The destructive and absorbing processes in the cartilage mentioned naturally are "physiological wear and tear" and therefore have no pathogenetic connection with the patellar partition. Microscopical examinations of the patella showed normal osseous structure, and this also applied to the bone marrow. No more than in the case of *Sommer* could any necrosis or dissecting process or inflammatory changes be demonstrated. It appears from the detailed description of the histological build of the partition between the fragments, that it consisted partly of hyaline, partly of fibrous cartilage, and partly of connective tissue. It was striking that the bone facets facing each other, delimiting the partition spaces between the different fragments and the patella, were coated by fibrous cartilage, more or less rich in cells. The author considered this to be a sign that after the finish of resorptive processes a *pseud-arthrotic* end-result had developed, similar to the case of *Sommer*. On the basis of senile absorption of the cartilage this *pseud-arthrotic* articular space had become open against the joint cavity. In these microscopical changes the author sees an expression of a reaction against mechanical strain of purely functional nature in the form of pressure against the femoral condyle with stretching and pull on the patella during the movements of the knee, a strain to which exactly the upper outer corner of the patella is subjected: "Es ergibt eine starke Verlagerung der angelagerten Knochenstücke durch Zug nach dem Gelenk zu über den äusseren Femurcondylus als Hypomachleon sowie die teilweise Knorpelhyperplasie an der Patellargelenkfläche durch Druck." *Siemens* also holds the opinion that these changes are caused by original multiple centres of ossification prevented from fusing by mechanical functional factors. At the same time, however, he will not repudiate the fact that the histological

changes may be caused by a reaction released by the same mechanical functional factors, which in a *single centre of ossification* has resulted in "Umbauzonen" (Looser) or in the "Umbildungsprozessen" found by W. Müller in his experimental researches mentioned above, and which he found to correspond to those existing in a *pseudarthrosis*. Link, who has described, as mentioned before, one of the few cases of patella partita longitudinalis in its—as he terms it—"always law-directed, proper place" agrees with the opinion of Siemens. According to Link patella partita belongs to the large group of "insidious formations of partitions" in the bone, and regards them as expressions of "Reaktionen des lebenden Knochens auf statisch-mechanische Beanspruchung, die genetisch zusammengehörend, sich histologisch je nach dem Zeitpunkt der Untersuchung in verschiedener Weise darstellen" (Greifenstein).

Blumensaat (1932) maintains that it is not possible from the histological examination in the case of Odermatt to make any definite conclusions with regard to the pathogenesis. This is also his opinion of the case of Sommer, the histological picture of which according to Blumensaat may indicate that a usual patella partita was present as well as a pseudarthrosis or a traumatic separation. Neither does Blumensaat mean that the histological examination gives full clarity as to whether a fracture line was present (incipient pseudarthrosis) or an "Umbauzone" in the only case in his material in which a histological examination had been carried out. It was an insured patient, 31 years of age, who had hurt his knee by a fall. X-ray examination showed in the frontal view a vertical patella partita—in the sagittal view a fragment was seen behind the patella. The diagnosis after an operative intervention was: Unspecific synovitis. After another intervention five months later an incipient, histologically established chondromalacia patellae was found "independent of the ossification centre of the patella". By a third operation three weeks later the ossification centre, which was fibrously united with the patella, was removed. The microscopical examination showed: "Knochengewebe mit Fettmark erfüllt, quer durchlaufende ein Streifen von bindegewebig knorpe-

liger Beschaffenheit mit Übergang in osteoiden Knochen und Umbildung von Knochenbälcken". According to these findings the physician in attendance considered that a piece of bone had been chipped off the patella, while the accident insurance company on the other hand regarded it merely as a patella tripartita and the histological findings as "Umbauvorgang". The exacerbation was regarded as a consequence of the operation. While the patellar specimen examined by *Siemens* was the only one showing partition in 129 cadavers, *Schaer* also among 120 cadavers found nine cases of patella tripartita, two of which were unilateral. Macroscopically *Schaer* found changes in the cartilaginous covering in single cases only. In these cases it could be distinctly observed that the fragment in the marginal as well as the apical variety could be clearly distinguished from the remainder of the patellar cartilaginous facet. The fragment could be quite firmly contiguous with the patella, while in other cases—as in that of *Siemens* and also in one of mine—the connection was looser and mobile. *Microscopically the patellar fragment* proved to consist of regular spongy bone, in which the bone spicules showed a perfectly normal structure. Osteoid seams were absent, as a rule. The medullary spaces were filled with fatty marrow poor in cells. In the peripheral parts, particularly in connection with the remaining part of the patella, the fatty marrow disappeared more and more and was replaced by a *fibular connective tissue* (fibrous marrow) moderately rich in cells, frequently with abundant capillaries, the picture greatly resembling granulation tissue. The thin, but regular, corticalis was separated by the cartilaginous bridge or cartilaginous space in open communication with the medullary spaces of the fragments. The facet of the fragment facing the joint was coated with hyaline cartilage. The cartilage space showed variable structure, as the hyaline cartilage of which it consisted might show extremely strong degenerative changes, quite fuzzy and ragged. The cartilaginous cells might disappear completely in many places, and the cartilage become replaced by necrotic masses without any structure whatever. In the neighbourhood of these necrotic parts cystic degeneration of the tissue might occur partly, and partly

one might find lively regenerative growth of the cartilaginous cells. Very frequently the hyaline cartilaginous bridge was interspersed by transverse, vascular bands of connective tissue. It was in open communication, however, with the medullary spaces in the patella proper as well as in the fragments. Just on the transition to normal fatty marrow this connective tissue is richly vascularized. In the opinion of the author this coincidence of areas of inflammatory connective tissue with areas in which there is greatly marked degeneration of the cartilage, must be regarded as a reaction on the part of the adjacent osseous marrow. The author summarizes the result of the histological findings, that the picture as a whole must be virtually interpreted as "*gehalten gebliebene Epiphysenfuge*", which from one case to another may demonstrate different degrees of *cartilaginous degeneration*. The author considers the cause of this degeneration to be the fact that the epiphyseal space just above the bone has to be looked upon as a *spot of least resistance*, and which reacts more easily, therefore, to the strain of daily life, for example an increased strain on the stretching apparatus of the knee in a sprinter, which may bring about an extension of the cartilaginous space between the two patellar fragments. In this way *Schaer* explains that these degenerative changes increase with age.—The author rejects the presence of a healed fracture of connective tissue of cartilaginous nature, as also that data should be present on which to base the contention of a cured inflammatory process.

In 1926 *Skřivánek* (Brünn) operated on two cases of unilateral marginal patella bipartita. In both cases the anomaly was an incidental X-ray finding in patients who had sustained a slight trauma to the knee. Both fragments had sharp, smooth edges and were separated by a narrow cartilaginous space, the borders of which were also sharp and had an entirely parallel course. The small fragments were not dislocated. Histologically was found *normal connective tissue* with no indication of inflammation or degeneration, and neither of fracture. It has been mentioned previously that *Weil and Barthels*, who in 1932 made a resection in a case of patella partita owing to pain, by

the histological examination found necrotizing and proliferative changes in the border zone, resembling those found by the same authors by histological examination of a divided sesamoid bone under the great toe—viz. “fibrös überbrückter Fraktur und aseptische Nekrose einer Knochenhälfte. Ob Nekrose oder Fraktur das Primäre ist, bleibt offen.” This finding tallied perfectly with that made by W. Müller in histological examination of a separated sesamoid bone of the great toe. The authors concluded from this that patella partita does not always represent changes of congenital origin, but may also be due to “Schmerzen verursachende Vorgänge”. Schaer in his monograph refers a case, which will be dealt with more closely in the chapter on patella partita and traumatism, in which he had resected an apparently congenitally separated patellar fragment, which had been chipped off from the patella by an accident. The result of the histological examination is mentioned quite briefly, that it demonstrated “das nun bekante Bild der Patella partita: Isolierte Knochenkern mit Fettmark und dünner Corticalis die überall noch von einer ziemlich dicken Schicht von hyalinen Knorpel überzogen sei”.

XVI

These histological examinations of operatively treated cases are all I have been able to trace in the literature, totalling eight: Odermatt, Sommer, Siemens, Blumensaat, Skřivánek, Weil and Barthels, and Schaer, as also similar examinations of ten unprepared specimens of patella partita (Siemens, Schaer)—and to these may now be added the writer's six cases, operatively treated and histologically examined. Referring to the case histories given in detail in a previous chapter, the result of the histological examination for each case shall be dealt with more closely here.

Case 1, Frank, 17 years of age.

Marginal patella tripartita. The two small fragments were removed. The one fragment, of the size of a hazelnut, on one side

showed a 1.1 centrimetre long, polished, firmly elastic facet (probably cartilage). On one side this is delimited by a slightly walled border continuing in a soft tissue attached as a fold to one of the lateral facets. The four irregular remaining facets appear to consist of solid spongy bone. Microscopically the

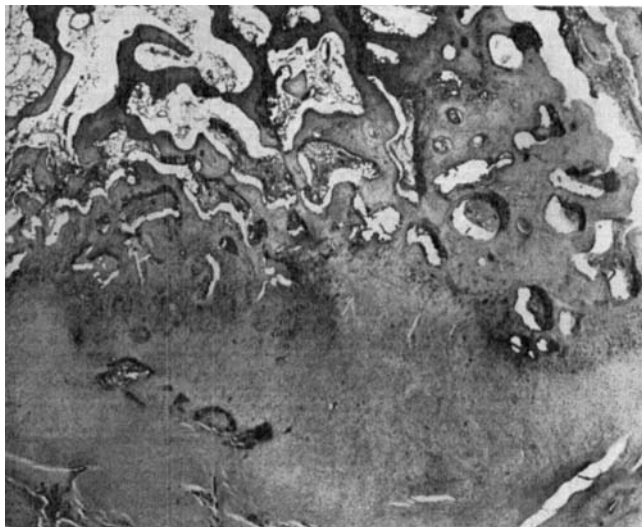


Fig. 28.
Case Frank.

articular cartilage is fuzzy and fibrous. The arrangement of the cartilaginous cells is irregular, as also the osteo- cartilaginous limitation. The bone contains, fibrous marrow.

Diagnosis: Osteitis fibrosa. Degenerative changes of the cartilage. (Kreyberg). The other fragment showed an irregular cartilaginous area, up to two millimetres in width. Microscopically normal osseous tissue and normal fatty marrow are seen in the greater part of the specimen. Against the thickest part of the cartilage the medullary spaces are changed into connective tissue rich in cells. Blood pigment is seen here, greatly fagocytized by cells, and further some large giant cells with the centres arranged in clusters surrounded by protoplasm. Sur-

rounding these medullary spaces are deposits of neoplastic osseous tissue beneath rows of osteoblasts. The part of the cartilage facing the osseous tissue is calcified here. A similar picture is presented by the osseous tissue and medullary space against the side where the cartilage is thinner. The cartilage in this area

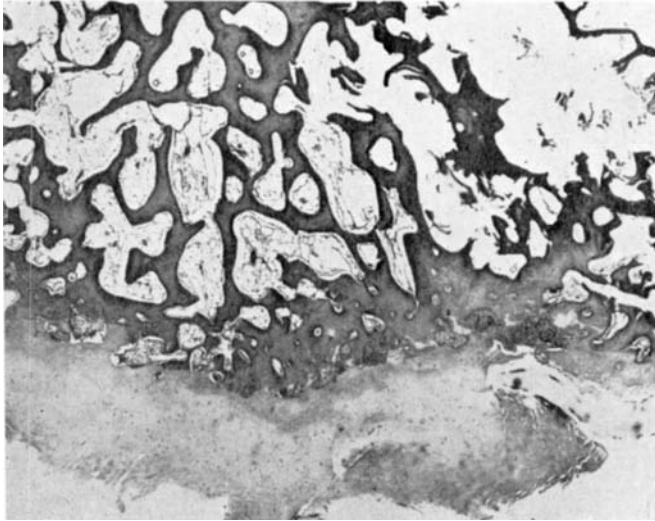


Fig. 29.
Case Karl.

is partly denuded, so that one gets a picture of thick fibres instead of the homogeneously hyaline one. No cysts, clefts or zones of demarcation are observed.

Diagnosis: The picture is interpreted as a reaction against an old trauma (*simulating osteitis fibrosa*) with no definite picture of osteochondritis dissecans. (*Harbitz.*)

Case 2, Karl, 22 years of age.

Marginal patella bipartita. Macroscopically a defect was seen in the cartilage. Microscopically *considerable fraying of the cartilage* superficially with mottled staining and partly gross defect downwards against the osseous tissue, which is *normally*

spongiuous, poor in cells and with a fatty marrow poor in cells. In a small limited space corresponding to a cartilage defect, there is some abundance of cells in the marrow with *development of fibular tissue*.

Diagnosis: Degenerative changes. Greatly limited osteitis fibrosa. (Kreyberg.)

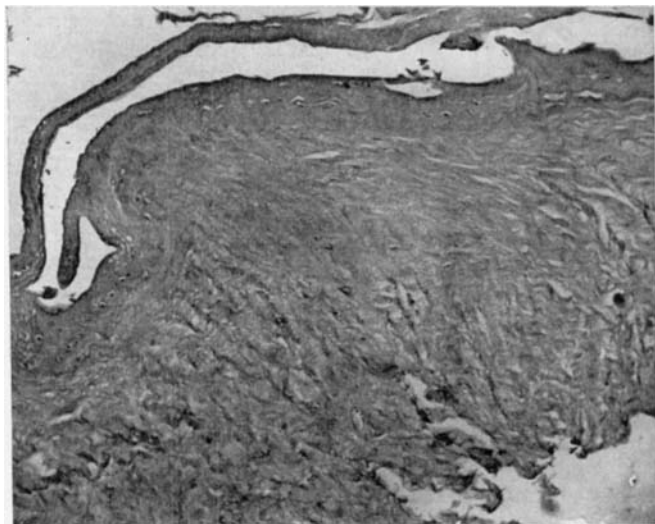


Fig. 30.
Case Arne.

Case 3, Arne, 29 years of age.

Synovitis genus tuberculosa + tuberculosis renum. Arthrotomy: Marginal patella bipartita. The entire patellar cartilage, which was surrounded by the hypertrophic synovial membrane as a wall, was considerably softened. The lower fourth was separated by a horizontal line from the remainder. The cartilage was considerably attenuated. No cracks or defects were noticed in the cartilage. The upper lateral corner, however, was delimited from the remaining part by a small furrow, which distinctly demarcated the boundary against the upper lateral fragment. *The facet against the patella*

was covered by cartilage. Microscopy of the fragment, of the size of a nut kernel, revealed *some necrosis of the osseous tissue*, and in some areas *degenerative changes*. *The greater part of the osseous tissue, however, is well preserved*, though with sparing osteoblastic seam. Further, fibrous tissue is seen, which is rather poor in cells and without inflammatory reaction.

Diagnosis: Osseous tissue with regressive changes. "Microscopy of the cartilage with appendant chips of bone, demonstrates a gradual transition from bone to cartilage. The cartilage has some few cartilaginous capsules with cells. The greater part of the cartilage itself is frayed, extremely fibular. The small pieces of bone attached to the cartilage show fairly normal structure.

Diagnosis: Chondromalacia of the patellar cartilage. Microscopy of the synovial membrane demonstrated tuberculosis." The chondromalacia of the patella discovered in this case has to be looked upon as a secondary result of the chronic synovitis present, which had no connection with the patellar partition. Compare with the case of *Blumensaat*. It is of interest, however, to establish the fact that this partition also involved the joint cartilage proper.

Case 4, Rolv, 17 years of age.

Marginal patella bipartita. The macroscopical examination of the removed fragment, the size of an almond, showed that it had "a slightly irregular, concave side, possibly cartilaginous, and a fairly straight side, irregular, ragged, the opposite side convex, irregular, and the fourth side flat, irregular. Microscopy: Longitudinal section reveals that the entire surface is covered by a consecutive layer of fibrous cartilage, which gradually turns into a vascular, fibrous perichondrium. The osteo-cartilaginous limitation is somewhat irregular. The centre is occupied by bone spicules which are more slender towards the centre than in the periphery. *Some of the bone spicules are undoubtedly necrotic.* There is no osteoblast seam, and neither is there any distinct signs of osteoclasts in the central areas. Only those regions which are in contact with the cartilage show indications of

growth of the osseous tissue. The space between the bone spicules is occupied by vascular fatty marrow, very poor in cells. Transverse section of the specimen.

Diagnosis: Osseous tissue with regressive changes. Aseptic necrosis. (Kreyberg).

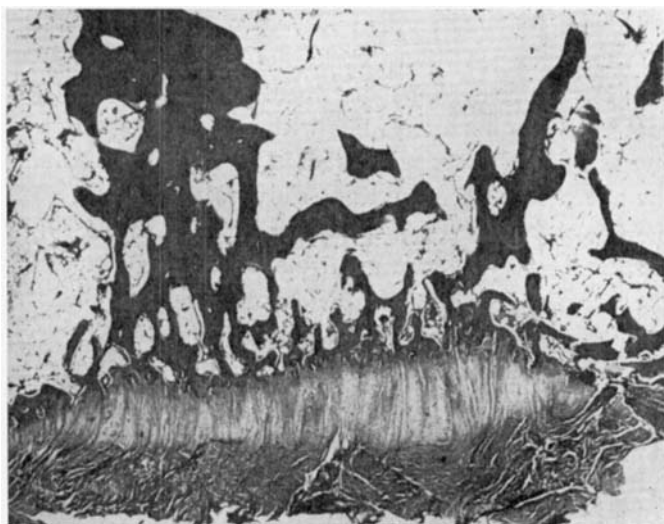


Fig. 31.
Case Rolv.

Case 5, Alv, 18 years of age.

Apical patella bipartita. Explorative arthrotomy on suspicion of tuberculosis of the synovial membrane. During the intervention the apical patellar fragment was also chiselled off. The histological examination excluded tuberculosis. The following was stated regarding the patella:—"Microscopically areas are found with gradual transition between fibrous connective tissue and fibrous cartilage, which again shows irregular ossification. Other pieces present irregular, partly degenerated hyaline cartilage and irregularly calcified bone with fibrous marrow. Other pieces of bone again show normal conditions.

Diagnosis: Bone and cartilage with degenerative changes. Fibrous marrow and irregular ossification.

Case 6, Kjellaug, 15½ years of age.

Patella bipartita propter fracturam. As the knee constantly troubled the patient, the lateral smaller fragment was removed after a lapse of one and three-quarter years. One long side appears to be coated with irregular cartilage, which rather abruptly



Fig. 32.
Case Alv.

gives room to irregular osseous tissue approximately in the middle part. This osseous tissue continues in a fracture surface on the one long side. Microscopically the transverse section of the patellar fragment demonstrates osseous tissue which is necrotic and partly atrophic in the central part. The medullary spaces are filled with fatty tissue and blood vessels. Otherwise the osseous tissue is extremely poor in cells. It is surrounded by irregular cartilage and fibrous connective tissue with no marked reactionary changes, and is poor in cells. Longitudinal section from the cartilage-coated border shows corresponding changes, irregular cartilage and bone necrosis. There are, however, some distended vessels in the border zone. In other regions the medullary spaces are fibrous. In some places regenerated cartilage

is found, and in these regions it appears as if a certain enchondrous ossification may occur. *No regular callus formation is observed*, and proliferative processes are very rare on the whole.

Diagnosis: Bone necrosis with some resorption and fibrosis. Loose portions of the fragment dislocated irregular cartilage with degenerative changes.

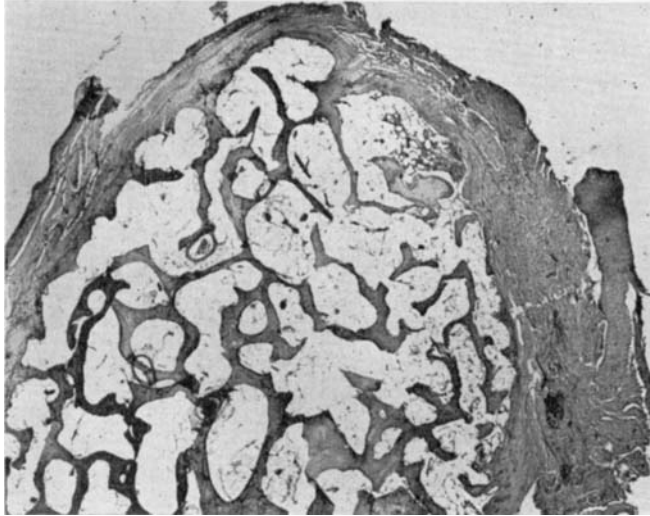


Fig. 33.
Case Kjellaug.

XVII

When evaluating the results referred here of the histological examinations in patella partita, one has to differentiate between those examinations which have been carried out in *post-mortem specimens* from individuals regarding whom no information is available that symptoms from the knees have ever occurred, and those examinations which have been made subsequent to operative removal of the patella in patients with clinical symptoms from the knee. Under the first category fall examinations of specimens from ten patients (*Siemens 1, Schaer 9*). In all of these cases it is stated that the histological examination of the frag-

ments showed normal osseous structure. This also applied to the marrow tissue. It was maintained with regard to *Schäfer's* cases, however, which were dealt with collectively, that it might be observed in the peripheral parts of the fragment, bordering on the partition between the fragments, that "the fatty marrow was changed gradually more and more into fibrous marrow". As particularly emphasized by *Siemens*, no indication was found of necrosis, dissecting processes or inflammatory changes in the bone. The histological examination of the partition between the fragments shows that a normal cartilage centre has been replaced by degenerated tissue—fibrous cartilage, connective tissue, partly cystically degenerated, partly with calcification deposits, in other words a *functionally inferior tissue*, which yields to the daily mechanical strain, and thus prevents the normal fusion of the multiple patellar centres of ossification.

The other category consists of the cases treated operatively, a total of fourteen, of *Odermatt*, *Sommer*, *Siemens*, *Blumensaat*, *Skřiváněk* (2 cases), *Weil and Barthels*, *Schäfer*, and the six cases of the writer. The histological findings in several of these cases have been sketched quite briefly (*Odermatt*, *Siemens*, *Blumensaat*, *Skřiváněk*, *Schäfer*). In the case of *Siemens* no mention is made of microscopy of the actual fragment removed, only that the patellar cartilage macroscopically was virtually normal. It is the partition which has been the subject of a searching investigation. *Odermatt* found osseous islands in the middle of the cartilage surrounded by hyaline cartilage and connective tissue poor in cells—a picture of absent ossification. In the case of *Blumensaat* the osseous tissue appears to have been normal except for one area, in which degenerative changes were found with transition into osteoid tissue and new formation of bone spicules. The description—also here quite brief—of the histological findings in the two cases of *Skřiváněk*, is to the effect that the osseous tissue was normal, while *Weil and Barthels* in their case found necrotizing and proliferative processes simulating those found in an *aseptic osseous necrosis*. Contrary to these authors *Sommer* in the case examined by him gives a detailed description of the histological findings. Also in his case the osseous tissue

in the major part of the specimen was found to be normal, though not in the areas bordering on the partition, in which degenerative changes were present. Summarizing the result of the histological examinations in the eight cases of these authors, it appears that it is primarily the changes in the tissue in the actual *partition* between the fragments which come into question. Apart from the case of Odermatt, in which the changes were interpreted as depending on absent ossification, the changes in the partition in the other cases, dealing with this question, were of degenerative, *regressive* nature. *Sommer* and *Siemens* interpreted them as *pseudarthrosis*, and *Schaer* as those changes found in the presence of an open epiphyseal line. The changes in the osseous tissue of the actual fragment receded in practically speaking all of the cases—partly the osseous tissue was normal, partly changes were present only in the area bordering on the partition. In these cases also the tissue changes were of degenerative and regressive nature. In one case (that of *Weil* and *Barthels*) necrosis of the bone was found, and in one case indications were found of new formation of bone spicules in the apparently normal osseous tissue (*Blumensaat*).

When looking at the histological examinations in the author's six cases, the same findings are made: degenerative, regressive changes, *of the osseous tissue as well as of the cartilage*. While this latter showed changes in all the cases, in some cases great parts of the osseous tissue might be normally structured. These degenerative changes most frequently had the character of a *fibrosis*. In some cases (Frank and Karl) this was so pronounced that the histological diagnosis was simply *osteitis fibrosa*—although in the latter case in a limited area only. In a couple of cases *necrosis* was found of the bone spicules (aseptic necrosis), partly more localized, partly more widespread (Kjellaug—*fractura patellae*). As mentioned before, the chondromatosis patellae found in the case, in which a tuberculous lesion of the knee joint was present, must primarily be regarded as a se-

condary process in causal relation to the tuberculous synovitis present. The fraying of the patellar cartilage found in the case Karl must also be interpreted as a chondromalacia, in this case caused by an unspecific synovitis. Refer to the recurring hydrops. —All of these changes—those of degenerative nature as well as those indicating the cellular activity of development of fibrous marrow—have to be regarded as *reactionary* processes by some harmful insult, such as an infection or a trauma, arteriosclerosis or the like. Infection may be safely counted out, as in no case have inflammatory changes been disclosed. In the specimens taken from individuals of senile age, as for example in the case of *Siemens*, an arteriosclerosis cannot be excluded. In all the cases, however, in which clinical symptoms have been present—and it is these which have formed the indications for the operative interventions—it is most natural to seek the cause in some traumatic insult. Perusing the case histories, it is observed that in all the cases—except that of *Sommer*—a trauma is present in the past history. This also applies to a couple of the cases of the author (Rolv, Kjellaug). In the remaining cases—the case Arne excepted, in which a tuberculous synovitis was present—the knee appears to have been exposed to *chronic traumatism*. It has to be considered perfectly possible that an *acute* such—one single trauma—may prevent a divided patella from fusing by causing a distraction of the fragment. In my opinion it cannot either be denied that this may happen also in a *chronic* trauma. And it can hardly be repudiated here, that the bony ridge on the anterior facet of the femur, as mentioned by *Sommer*, may cause *chronic traumatism* of the part of the patella lying immediately opposite. In the presence of a marginally divided patella this region must be regarded as particularly vulnerable, as a distraction may occur in the partition here. In the same manner an apically divided patella per se may be regarded as more vulnerable to a chronic as well as to an acute trauma—and reasonably not the least to those which may have a stretching effect on the partition between the two fragments, whether it may be a trauma with an acute effect such as hyperflexion, or a more chronic one, even within the limits of the

normal, such as sport. It is all the more reasonable to suppose that a trauma which must be assumed to have a stretching—"distracting"—effect on a patellar partition which is already present, might be likely to produce changes in the patellar tissue, when one bears in mind that during his experimental researches *W. Müller* succeeded in producing degenerative changes corresponding to those found in a pseudarthrosis in a beforehand entirely normal patella. The investigations of *Sommer* have demonstrated that the degenerative changes in the actual partition may directly invade the osseous tissue. By being exposed to a traumatic insult a beforehand functionally inferior patella may thus become still more inferior and may cause clinical symptoms from the knee, primarily due to irritation of the synovial membrane. On the other hand it is also conceivable in my opinion that just as a *primary* synovitis may produce *secondary* changes in the patellar cartilage in the form of chondromalacia, *it may also lead to purely degenerative changes in the patellar partition* with resultant clinical symptoms. *A traumatic insult, therefore, should not always be necessary in order to produce such degenerative changes in a patella partita.* This is also corroborated by the clinical experience. In the same way as it must be permitted to suppose that a patella partita may occasion a synovitis of the knee, one may thus also be justified in assuming that *a synovitis may be the cause of a patella partita giving clinical symptoms.* In this manner a trauma may also be imagined to produce symptoms *via a synovitis* in a latent patella partita. The fact of the identical histological picture not always being present from one case to the other, although always within the scope of the regressive changes, finds its perfectly natural explanation in a series of conditions no doubt appertaining with regard to the mode in which the organism reacts to the insult in question. In the first place the nature of the insult—traumatic or non-traumatic—has to be considered. Further, in the case of trauma its extent and nature, direct trauma against the patella or a distracting violence. Further, and not least, *individual* differentiation, not only such as the age and sex of the patient—thus it has been observed that males

are in preponderant majority as against females—but certainly also the individual difference with which humans react against traumatic insults (*Payr*). Neither in the pathogenesis and etiology of this lesion are we able to overlook the factors of constitutional nature, which play such an important rôle in the cases of aseptic osseous necrosis. In these also one has to regard the histological changes under the viewpoint of a *reaction on the part of the tissue* towards insults of different varieties, surely here also primarily of traumatic nature. Though the histological picture of these osseous necroses is much more synonymous and uniform than in patella partita, variations may also be found in these. It is of particular interest in this respect that several authors, *Gustav Riedel* and *Konjetzy*, when examining specimens from Legg-Calvé-Perthes disease apart from necrosis also found pronounced fibrous reformation of the medullary tissue, with abundant giant cells, a picture in perfect accord with that found in *osteitis fibrosa*, as was found also in two of my cases of marginal patella partita. In the aseptic osseous necroses, however, the normal procedure is that regeneration occurs of the necrotic bone by substitution from the surrounding periosteum. In patella partita, on the other hand, practically no signs exist of regenerative processes. The cause of this, no doubt, must be looked for in the fact that the nutritional conditions of the patella, as the sesamoid bone it is—and particularly in the fragment or fragments separated from the patella proper—are far more unfavourable than in the epiphyses and small spongy bones, which may be the seat of an aseptic necrosis. The completely absent formation of callus approximately two years after a fracture of the patella as found in the case *Kjellaug*, in which proliferating processes on the whole were very scarce, must surely be ascribed to absent regeneration due to poor nutrition. In my opinion this may have another causative factor in the case of the patella. We are aware that the aseptic necrosis in the first place involves epiphyses and spongy bone in the lower limbs. Excluding all other localizations the upper epiphysis of the femur is the site of predilection, thus osseous tissue which in its physiological activity has to be exposed to the pres-

sure of *weight-bearing*, and such only. It is another matter with the patella. As will be explained in detail subsequently, the patella during the movements in the knee is exposed not only to a compression against the femoral condyles, but simultaneously also to a *distraction* in longitudinal direction. In other words, the patella during the performance of its functional duties is exposed to double fire. It must be reasonable to assume, that this in an injured patella—whether the injury has been sustained traumatically or through a congenital anomaly—may be able to prevent regeneration of degenerated tissue, and in particular degree when it is a case of regeneration in a transverse partition.

Summing up the results of the histological examinations of the fragments in a patella partita, they are found to be of *degenerative nature*. Further it appears to be perfectly justified to assume that they are *secondary after similar changes in the actual partition, induced by insults of various kind, primarily by traumatic such*. While in the so-called juvenile osteopathy necrosis of the osseous tissue plays the leading part, this keeps more in the background in patella partita, and to a still greater degree this applies to the regenerative processes. This does not exclude, however, that the *primary*—the deepest cause of a partition of the patella—must be looked for in the same conditions in which the deepest cause of the juvenile osteopathy lies, viz. in factors of *endogeneous* nature. As mentioned previously a number of clinical symptoms speak for this, as also the X-ray findings. Similar to the conditions which no doubt exist in the cases of juvenile osteopathy depending on an aseptic necrosis, the endogeneous factors also in patella partita create the required *disposition* in order that some exogeneous factor, as incidental cause, may produce the histological changes and release the clinical symptoms.

XVIII

PATELLA PARTITA AND TRAUMATISM

The question of the rôle played by the trauma in the pathogenesis of the patellar partition, in the cases in which a distinct

separate trauma of the intensity required to cause a patellar fracture may be definitely *excluded*, is not only of theoretical, but also—and to a far greater degree—of practical importance. Its exogeneous factor did not appear in earnest in the discussion of the pathogenesis of patella until the above mentioned experimental researches of W. Müller, in which by a protracted trauma, having the effect of *distraction* and *pressure*, he induced the formation of a *transverse partition of the patella*.

A longitudinal partition arisen traumatically is more difficult to explain, as in the presence of a normal patella a very considerable *direct* trauma must then take place. When such does not exist, it must be assumed either that the patella has beforehand been functionally inferior, as for example due to the presence of a partition, manifest or not. Refer to *Zwerg's* hypothesis mentioned below. It is however still more difficult to explain a traumatic genesis in the marginal form of patella partita, in which there is an *oblique partition* in the upper outer quadrant with its entirely typical course from case to case. Such regular course in the identical localization may be possible only in the presence of increased functional strain in the period of ossification. (*Paas*). Assistance in the explanation of this relation is rendered by the investigations carried out by *Payr*, on "das Patellarspiel" and its importance to the pathology of the knee joint. He has demonstrated that the patella, when the knee is flexed and extended, does not only move in sagittal direction in its sliding course on the femoral condyle, but also outwards in a laterally convex arch because of the oblique course of the extensor tendons and the patellar ligaments. A certain physiological hindrance meets this movement, however, due to the steeply ascending facet of the lateral femoral condyle, which is considerably higher than the medial one. As mentioned previously *Sommer* has looked upon these anatomical conditions, and particularly the sharp edge which forms the upward and lateral limitation of the outer femoral condyle, and thus prevents the patella from slipping outwards, as genetically interrelated with marginal patella partita as it is just the outer upper quadrant which during the movements of the patella comes into

collision with the sharp edge. This virtually represents a traumatic insult, which may be imagined to prevent the ossification of a partition existing beforehand in the outer upper patellar quadrant.

In 1920 *Reinbold* (Switzerland) records two cases in young men, who both had been exposed to a direct trauma against the anterior facet of the one knee with resulting clinical symptoms (slight tenderness, pain, limitation of motion, swelling, and in the one case also slight hydrops). X-ray examination showed bilateral patella partita, which the author assumed to be a constitutional anomaly, interpreting the clinical symptoms as the consequence of a "fracture parcellaire". The connection between the fragments were supposed to represent a "spot of minor resistance" which predisposes to a separation or chip fracture—even when the traumatism is mild—similar to that observed in epiphyseal separation in young individuals. Reinbold has described here the symptoms which *Odermatt* (Switzerland) the following year (1921) on the basis of a single case gave the collective designation *distorsio patellae* due to traumatism. Previous authors, however with the exception of *Reinbold*, had definitely repudiated an interrelation between a patella partita and a lesser trauma. *Odermatt*, on the contrary, was of the opinion that in cases in which a definite accident had taken place, a *distorsio patellae* would have to be acknowledged and accepted by the Public Accident Insurance Board. The first investigator to have emphasized the traumatic genesis in patella partita, however, is *Zwerg*, who maintains, in his paper published in 1928 that in opposition to the opinion previously ruling, in *certain* cases a trauma may give rise to a patella bipartita. In the past history of four of the cases observed by him a direct trauma against the knee was present, although of inconsiderable strength. In the one case, in which the symptoms did not become manifest until after the lapse of two years, and then suddenly without outside inducement, my opinion is that it is justified to doubt whether the trauma has played any part etiologically. The clinical symptoms, except in one case (severe pain and considerable swelling of the joint), were negligible. As in none

of these cases the trauma was presumably of a sufficient intensity to have caused a fracture in a normal patella, *Zwerg* assumed that in these cases the patella was less resistant. The causal relation here would have to be looked for in an *ossification disturbance in multiple centres of ossification*. On the border between the two zones of ossification the bone does not possess the solidity as in the centre of ossification. This border zone, therefore, is a "spot of least resistance". When a slight trauma is sustained the osseous, non-resistant bridge between the centres becomes separated, thus presenting the picture of a patella bipartita without any direct fracture having occurred. Each fragment of bone in a patella bipartita, therefore, will have to be regarded as a centre of ossification.

Despite this fact, he was of the opinion that *based on the cases observed by him it was incorrect categorically to reject an interrelation between a trauma and patella partita*. If the possibility is acknowledged, that through a particular disposition this anomaly may be brought about by violence, *all the same there is an essential difference between this and a fracture, the partition in patella partita persisting and not fusing as in a fracture*. If further the possibility is assumed of a *traumatic patella partita*, a *unilateral* occurrence after a definite trauma according to *Zwerg*, will have to be *acknowledged and accepted* in certain cases by the Public Accident Insurance Board. In this respect, therefore, *Zwerg* concurs with *Odermatt*. In the opinion of *Zwerg*, however, the partition is not *manifest* on the roentgenogram, and is thus entirely hypothetical. It has not been possible, therefore, to procure X-ray proof of the correctness of the contention of *Zwerg*, and he is himself fully aware of this.

The opinion of *Odermatt* and *Zwerg* that in certain cases a patella partita subsequent to a trauma will have to be acknowledged and accepted by the Public Accident Insurance Board, is shared by *Eichengrün* on the basis of a case observed by him, a male, 51 years of age, who had for a couple of weeks had symptoms (swelling, hydrops, restricted motion with great tenderness of the outer upper patellar border) in the one knee, which he had injured fifteen months previously in an accident. X-ray

examination demonstrated patella bipartita. Clinical diagnosis: *Distorsio patellae*. X-ray examination of the other knee showed normal patella.

Sommer is not able to recognize the traumatic patella partita of *Zwerg*. He maintains that the typical patella partita is never the result of an accident, though such may be assumed, of course, to cause an *aggravation* of the lesion already present, and that such may be assumed when clinical symptoms occur directly or indirectly subsequent to a trauma against the patella.

Paas, who has paid particular attention to the question of traumatic genesis in patella partita, claims that in the presence of such lesion disturbances in the ossification depending on development and disposition are of less importance than *mechanical functional* causes, especially an increased *effect of pressure* of the lateral femoral condyle against the upper lateral patellar quadrant, acting as a chronic trauma. Contrary to *Zwerg*, however, *Paas* holds that *multiple primary centres of ossification are not unconditionally necessary to cause the "traumatic oblique partition"*. *Paas* intentionally avoids calling this a fracture. It may arise also in a single centre of ossification. He is of the opinion also that a single *mild* trauma against the knee, such as a blow or knock, is able to cause a complete continuous partition in the upper outer corner of the patella, just because this region is frequently the seat of irregular ossification also in healthy individuals. The osseous zone which glides over the sharp bony edge of the lateral femoral condyle during the movements in the knee shows a particularly *weak structure*. The one identical process thus is the origin of the partition, whether it is caused by delayed ossification of multiple centres of ossification or by a continuous partition in an apparently fused centre. Under all circumstances "Abbau und Umbau" will occur in the patellar tissue in the process of being or already having been ossified. Traumatic or non-traumatic patella partita according to *Paas*, therefore, is subjected to the same regular laws. The traumatic partition is always localized to the typical place for a congenital marginal partition (*Saupe III*) and with the same course.

Paas' own material comprised six cases, which he had sub-

jected to careful follow-up examination. In three of these cases he considered that a *non-traumatic patella partita* was present, while in the other three cases the identical marginal partition was regarded as an *oblique fracture* merely because a trauma was present in the past history, partly with and partly without clinical symptoms from the joint. The X-ray findings also—namely *extremely irregular borders of the partition*, which Paas looks upon as an important differential diagnostic factor in favour of a partition of traumatic origin. The fact that this idea cannot be maintained will be dealt with in more detail in a subsequent chapter.

Paas considers himself justified in registering *four different varieties of patella partita*, viz.:

1. *Patella partita vera* due to *endogeneous* factors (multiple centres), *exogeneous* factors (mechanical functional causes), or an interchange between these two factors.
2. *Distorsio patellae* (Odermatt). Primary partition associated with trauma. The primarily present genuine patella partita is attacked by a *mostly slight trauma* with consequent subjective and objective clinical symptoms in the knee.
3. *Traumatic separation or patella traumatica*. Cause: *A zone with weak structure in the patella associated with a trauma*. An osseous fusion primarily exists, although of weak structure, in which a generally moderate trauma causes complete partition, roentgenologically visible.
4. *Oblique fracture*. Cause: *Normal, solidly ossified patella associated with a severe trauma*. Exclusively for this causal relation a partition occurs of the lateral proximal quadrant.

It will thus be seen that a traumatic insult plays a part in all of the three latter forms. *The transition between all four forms, however, is entirely fluid*. With regard to the relation between a traumatic patella partita and the Public Accident Insurance Board Paas, with Zwerg, Eichengrün, Sommer and Siemens all agree that a distortion of the patella must be looked upon as *an exacerbation of a primary anomaly caused by a trauma* and will have to be acknowledged, therefore, by the Pub-

lic Accident Insurance Board. On the other hand, however, he is of the opinion, as opposed to that held by *Sommer* and *Siemens*—but in conformity with that of *Zwerg*—that a patella partita consequent upon a *single trauma* must be considered to be very possible. He is further agreeable with *Zwerg* that all roentgenologically obscure cases and the symptoms occurring in connection herewith, will have to be acknowledged when a definite trauma (hemarthrosis) can be traced in the past history.

Siemens entirely rejects as being the result of accident cases of patella partita of types II and III, which are discovered incidentally or subsequent to a slight trauma, and all the more decidedly when control examination shows that the partition is bilateral. *Siemens* contrary to *Paas*, regards all doubtful, uncertain cases, as for example those in which the lesion is unilateral, as varieties of patella partita which should not be accepted as the result of an accident, unless a *definite severe trauma* has been present. On the other hand *Siemens* would acknowledge a *traumatic exacerbation* of an existing partition, even when it is a question of less considerable traumatism. According to the opinion of *Siemens*, namely, the fact cannot be repudiated that a divided patella is considerably more vulnerable to trauma than a normal one. Muscular atrophy, restricted motion and recurring hydrops, are all symptoms of a post-traumatic exacerbation, symptoms which are not caused by the actual partition, but by a distortion (distraction) of the patella.—If the hypothesis of *Zwerg* is accepted, that the *traumatic partition* due to the division between the two centres of ossification represents a spot of minor resistance, such cases will have to be acknowledged.

According to the observations of *Siemens* patella partita also appears able to dispose to *arthrosis deformans*. On several occasions *Siemens*, when studying the sagittal X-ray view, has observed on the posterior facet of the patella small projecting parts which might be considered to be of traumatic origin and to be likely to lead to chronic conditions of irritation with resulting deforming processes.

With support in eight observed cases *Blumensaat* concurs with

Zwerg in his opinion that a traumatic patella partita exists, by which he means a partition which has been brought about after a single trauma, and pseudarthrosis in the patella, manifesting itself roentgenologically as a patella partita, from which it cannot be differentiated at all, or only with great difficulty, and then only by means of a special X-ray view. The clinical picture reported by *Blumensaat* as rather characteristic and corresponding to that described by *Zwerg*, takes the form of a brief circumscribed tenderness on pressure and painful motion, frequently of the duration of a few days only. Also in more pronounced cases a circumscribed swelling is found over the patella. Occasionally hydrops is also detected after hemarthrosis. In some cases pain may recur again after an interval free of pain from a few weeks up to two years, only after occurrence of a mild trauma. Usually no, or only quite negligible, restricted motion is present. As pointed out also by *Blumensaat*, the symptoms are the identical ones, therefore, found in *non*-traumatic cases of patella partita, when an incidental trauma causes stretching and separation of the fibrous bridge connection between the patella and the fragment or fragments—in other words a distraction of the patella. Differential diagnosis between such lesion and a traumatically divided patella is possible only when a patella partita is found in the opposite, non-injured knee. According to the opinion of *Blumensaat* the question as to whether a fracture occurs of the patella or a partition only, merely depends on the strength of the violent trauma. *Blumensaat* maintains that a traumatic patella partita occurs as an “insidious fracture” due to molecular changes in the partition, which leads to a “Knochenumbau” in the sense of *Looser*, caused by the previously mentioned collision between the upper outer quadrant of the patella and the steep outer femoral condyle with its sharply projecting bony ridge.—It is thus a matter of a combination between the pathogenetic hypotheses regarding patella partita advanced by *W. Müller* and *Sommer*. An effect of distraction on the patella is in the opinion of *Blumensaat* as opposed to that of *Müller*, not sufficient to cause a traumatic patella partita. The essential part is that *the direction of distraction* has been

changed to such an extent that an increased "Kreiselungsbewegung" occurs in the patella. This is still more augmented in cases of static anomalies, particularly genua valga, first pointed out by *Sommer*, later by *Paas*. *Blumensaat* claims that with reference to a great deal of the bilateral cases of patella partita the presence must still be maintained of multiple embryonal centres of ossification, more particularly because nothing has been proved to the contrary. Similarly to the findings in broad, persisting lines of ossification, for example os acetabulum, unilateral congenital cases must be assumed in patella partita also. He also emphasizes, however, that up to then no case had been recorded in which—when multiple centres of ossification had been observed in adolescence—a persisting and continuous line of partition had been found subsequent to the completion of the period of ossification.

The great similarity, even leading to confusion, between a congenital and a traumatic line of partition in the patella, justifies the assumption that a conformity exists between the procedures leading to the actual partition. Presupposing in the congenital as well as in the traumatic cases a formation of pseudarthrosis—refer to the histological findings—a *primary* pseudarthrosis is present in the congenital forms, and a *secondary* pseudarthrosis in the traumatic forms resulting from fracture. The causal relation in both cases must be looked for in the fact that the fragments are constantly moving against each other due to the movements of the patella.

If it is acknowledged that some cases of patella partita may be the result of a single trauma, the clinical picture obtains significance to the Public Accident Insurance Board. Definite lines of direction shall therefore have to be drawn up for the acknowledgment of a traumatic patella partita. *Blumensaat* makes the following claims to such:

- I. That the process is unilateral.
- II. Detailed proof that the trauma has involved the diseased place.
- III. A characteristic course of disease.

As the symptoms according to *Blumensaat* hardly last more than two weeks and do not entail essential consequences to the occupation, the question of compensation plays a less important rôle. Investigations must always be carried out as to whether a distraction of the patella is present in bilateral cases on non-traumatic basis with resulting clinical symptoms—always bearing in mind, however, that a trauma, no doubt, may cause an aggravation of the condition.

Schaer in his monograph on patella partita has also devoted special mention to the relation to the Public Accident Insurance Board. He has received the impression, just as *Siemens*, that a knee joint, the patella of which presents partition, reacts considerably stronger to a trauma than a normal knee joint, with regard to subjective symptoms as well as to the objective findings. This has also been advanced by others, thus already in 1921 by *Todd* and *McCally*, later by *Didié*, *Sommer*, and others. *Schaer* also has found, similar to *Siemens*, that a partition of the patella may occasion the development of *arthrosis deformans*, as in all cases of advanced age he discovered the changes typical to *arthrosis deformans* in the patellar cartilage. After the forties *chondromalacia*, *osteopathy*. "patellite", were found regularly in variable degree. In younger individuals also, however, with the patellar cartilage entirely intact, he has found traces of *arthrosis deformans* in the neighbourhood of the partition by the histological examinations. *Schaer* considers it reasonable, therefore, to assume that a patella thus traumatized beforehand, also reacts to slight traumatic insults with subjective complaints, as observed after major injuries to the osseous and ligamentous system. This correlation, therefore, must take an important part in the evaluation of the results of a possible trauma against the knee, even of a milder degree. The question then crops up to what extent the accident may be made responsible as "sogenannter Teilunfall für allfällige vorliegende Beschwerden, oder bleibende Nachteile." *Schaer* points out that the Swiss accident insurance law contains a paragraph stating that compensation for an injury entailing invalidity or death, becomes reduced when this is only *partly* due to an accident falling under the insurance. He

also holds that it be proposed that this paragraph should be taken into use in cases in which the conviction has been arrived at after close deliberation of all circumstances, that the results of a trauma against a knee joint has been aggravated or the cure been delayed because of the presence of a patella partita. *Siemens* maintains, from German quarters—where the accident insurance law makes no such provision—that “das Axiom der etwaigen Rentenentschädigung der Patella partita—natürlich nur im Sinne der Verschlimmerung und höchstens bis 30 % — möchten wir nach kritischen Beurteilung und Sichtung der Fälle für anwendungsmöglich halten.” *Schaer* mentions a case which claims particular attention in the correlation between patella partita and traumatism. It was a case of a male, 51 years of age, who during a jump across a wall more than one metre high, suffered intensive pain in the left knee, which had not previously presented any morbid symptoms. Clinically and roentgenologically it was revealed that a piece of the outer upper patellar quadrant had been separated and was seen on the X-ray picture outside the patellar shadow. It showed a fairly smooth surface, which according to *Schaer* indicated the presence of a “chip fracture”. After removal the chip appeared to be entirely covered by cartilage—also the surface of separation towards the patella. As mentioned before, the histological examination demonstrated the now well-known picture of patella partita. Therefore, it appeared that a traumatic separation had taken place in the partition between two patellar fragments, in all probability of congenital origin. It is all the more reasonable to assume this, as the X-ray examination disclosed a similar partition on the opposite side.

With regard to my own material a probable or definite trauma existed in three cases: Case *Frank*—Diagnosis: *Distraction of the patella*. Probable causation: Exaggerated sport. Case *Rolv*—Diagnosis: *Distraction of the patella*. Causation: Considerable single trauma (luxation of the patella, luxation of the knee?). Hemarthrosis. In both these cases a marginal patella partita was present in the injured knee, while the opposite knee was normal. Case *Kjellaug*—Diagnosis: Longitudinal fracture

of the patella subsequent to a considerable direct trauma against the patella. The opposite patella normal.

Only the second of these three cases was an *occupational accident*, and was accepted by the Public Accident Insurance Board.

Summing up the different opinions which have been advanced with reference to patella partita and traumatism, these may be distributed into two groups, broadly speaking: The one is *Odermatt's distortion of the patella*—*Sundt's distraction of the patella*. This presupposes the presence beforehand of a partition in the patella. A trauma, therefore, may here only play a part as a *factor of exacerbation*, in that a distortion or distraction takes place in the patellar division. That such may take place and may even result in entire *separation* of the one fragment, is demonstrated by the case of *Schaer's* mentioned just above. It is, of course, of no conclusive importance whether the partition is unilateral or bilateral, when the diagnosis is *distraction of the patella* after a traumatic insult on one side.

All the authors mentioned above concur in acknowledging a trauma as an *aggravating* factor in the presence of a pre-existing patellar partition.

The other group comprises those who hold the opinion of *Zwerg's*, who claims that a trauma, even of mild degree, may induce a patella partita in certain cases.

Looked upon from a correct angle, however, there is hardly any essential difference between these two points of view, as both presuppose the existence beforehand of a *less resistant patella* due to disturbance of the ossification in multiple centres of ossification. As *Zwerg* assumes, however, that this less resistance has no causal relation to any partition existing beforehand, and demonstrated roentgenologically, his assumption is considerably more hypothetical than that of *Odermatt*, and cannot be proved at all unless by a chance finding of a case of post-traumatic partition in a previously normal patella, demonstrated roentgenologically. Still more hypothetical than the *traumatic patella partita* of *Zwerg* is the "oblique fracture" ad-

vanced by *Paas*. In my opinion this is in reality based on a very weak foundation and hardly warrants his enumeration of four different types of patellar partition. One has to agree with *Schaer* when he remarks about the hypothesis of *Paas*, that it is only fit to confuse the ideas. *Paas* also stresses the fact that the boundaries between his different types are quite fluid. This also applies on the whole to the traumatic patella partita of *Zwerg*,—recognized by *Blumensaat* also, as well as by *Paas*. In my opinion the symptoms in *Odermatt's* distortion of the patella correspond perfectly with those in traumatic patella partita (*Zwerg*) and the "oblique fracture" (*Paas*) respectively. Either a picture of disease is present, as emphasized by *Schaer*, based on an anomaly—a variety—which has become exacerbated by a trauma which has induced clinical symptoms, or a fracture is present. In case of doubt, if the case is so vague as to exclude a decision one way or the other, this weakness—*Schaer* maintains—should be calmly admitted, and in case of a definite and sufficiently great trauma having taken place, one should plead for a fracture.

The conception "traumatic patella partita" should not be adhered to. From the point of view of medical jurisprudence, therefore, it is devoid of any importance in my opinion, whether the patella which has been involved in a trauma, was the seat beforehand of a *latent* or *manifest* partition. In both cases the trauma will have to be accepted as an *aggravating* factor in the presence of a patella which was previously not normal. As mentioned above, my case Rolv was accepted by the Public Accident Insurance Board on this basis. The great mobility of the patellar fragment in this case, as compared with the remainder of the patella, and verified by the operation, directly indicated that a distraction had taken place. In addition to this came the mottled atrophy gradually demonstrated on the X-ray picture, which had to be interpreted as a *post-traumatic osteoporosis* around the partition.

Therefore, I shall have to acquiesce in the opinion advocated by *Odermatt*, *Sommer*, *Siemens* and *Schaer* with regard to the correlation between patella partita and traumatism and the

evaluation of this problem from the point of view of *medical jurisprudence*.

As far as *the differential diagnosis* is concerned between patella partita and fracture of the patella, *Adams and Leonhard* (1925) have compiled the following schematic survey of the four chief points of importance in this respect:—

1. Bilateral occurrence.
2. The appearance of the borders of the partition.
3. The localization of the partition.
4. The clinical symptoms.

For a long time bilateral occurrence as opposed to unilateral, formed the criterium of the existence of *an anomaly*. *Pouzel* thus claims this as late as in 1930. It cannot be upheld, of course, after the *congenital unilateral occurrence*, and the frequency of its incidence has been long since established. It may still be claimed, however, that bilateral occurrence speaks *for*, unilateral occurrence *not against* an anomaly. In cases where one finds, after a trauma against the one knee, a partition with typical localization for a congenital origin, and of typical shape, and then on the other side makes the identical findings, the bilateral occurrence must be conclusive proof, no doubt, of the presence of an anomaly. Two such cases have recently been recorded by *Wolfgang Schröder*. When after a trauma, however, a partition is disclosed with atypical shape, and on the other, non-traumatized, knee a partition is found with the typical localization and shape indicating congenital origin, the bilateral occurrence is not, of course, of decisive importance. When a trauma has happened to a unilaterally partitioned patella, directly or indirectly, a decision will be considerably more difficult, of course. It should be emphasized that the fact of the unilateral occurrence is not at all conclusive in such cases. My case Roly is an example of this. Of essential importance in the separate case is the *nature* and *intensity* of the trauma together with the *clinical symptoms*. An extensive and considerable trauma has to occur in order to cause a fracture.

Fracture in all directions of the patella have been described. (*Adams and Leonard*.) Not all authors, however, demand the

same intensity from a trauma. The well-known stellate fracture, which is nearly always associated with rupture of the capsule, demands very great violence. This is also the case with the purely longitudinal and oblique fractures. For this is further required a quite unique trauma, constructable with difficulty, as rightly maintained by *Siemens*. This is not necessary, however, in a transverse fracture of the patellar apex proper, as will be explained later.

In addition to the intensity of the trauma, *the localization of the fracture and the age of the patient* are of diagnostic importance. With regard to the latter, fracture of the patella in *children* is very uncommon. *Diebold*, among a material of 1200 patellar fractures collected during fifteen years, found sixteen cases only in patients under fifteen years of age, i.e. 1.33 per cent. His own cases included two such only. *Ronget* in 1929 referred two cases of patellar fracture in children, doubtful in the one case. *Hellmer* maintains that particularly in the advanced stages of the ossification of the patella, roentgenograms taken may resemble so much those in fracture of the patella, that a decision may only be arrived at after lengthy observation. At any rate, a roentgenogram will have to be taken of the opposite knee for comparison, also because the ossification has not proceeded equally far in both knees.

Bähr (1895) and subsequently *Meyer* (1906) have demonstrated that border fractures of the patella indubitably exist. It is just as indubitable, however, that in many cases this has been a case of a *partition*. It is obvious that if subsequent to a traumatic insult to the patella—directly or indirectly—a partition is found in the upper outer quadrant, the actual *localization*—also because of the fact that a fracture here is on the whole rare (*Adams and Leonard*)—will weigh heavily in favour of an anomaly. The conditions are more difficult when it comes to the *longitudinal* partitions. Even though a patella partita of this type is rare, the same applies to the longitudinal, sagittal, vertical, and frontal fractures. In 1932 the radiologist *Jean Didiée* reports that only four cases had been described in the literature, not including one described in 1931 by *Dufour et Mouchet*. These latter authors emphasize that these sagittal

fractures, of which the paramedial show a greater incidence than the medial, have frequently been overlooked and misconceived, because the clinical symptoms are often very vague, as is also the case with the X-ray changes, the displacement being either slightly pronounced or entirely absent. Such a fracture may be perfectly invisible, therefore, in the sagittal view, as in my case Kjellaug. If one wishes to avoid overlooking such a fracture, projections will have to be made frequently in the axial and oblique plane. *Mouchet* recommends that the knee be photographed in the frontal view from behind with the patella against the film, the leg rotated slightly outwards, and the patella luxated outwards, while *Paas* in order to get a clear view of the border of the partition in addition to the three planes mentioned, also recommends the oblique view—direction of the rays from behind laterally—anteriorly medially, with the patella luxated outwards. The incidence of fracture is great, particularly in the *horizontal* partitions, especially the apical ones. *Didié* claims that an apical partition up to the age of 12—14 years should not be regarded as anything exceptional. In adults, on the other hand, he considers that *an apical fragmentation is always of traumatic nature*. In the opinion of *Didié* only one case has been described in the literature, in which an anomaly is dealt with, and that is the case observed by *Natvig*. The author adds to this another case observed by himself. It was a female, 40 years of age, with rheumatoid pain in the knees, the X-ray examination showing signs of chronic arthritis with exostoses and simultaneous changes in the patella on both sides, as the patellar apex—particularly on one side—is separated horizontally at right angles. On the other side, where this is less pronounced, a fragment is separated from the patellar apex proper by a thin, though distinct and clear, partition. This fragment has the appearance rather of a pendant to the patella, as the actual patellar body on both sides is of equal size. In this case the author finds an anomaly analogous to that of *Natvig*. The extreme opinion of the author is further stressed by his explanation of another case reported by him in a paper published the preceding year, dealing with a male, 20 years of age, who had injured his left knee by a fall down a flight of

stairs. X-ray examination demonstrated that the patellar apex was separated from the remainder of the patella by a horizontal, clear, quite regular partition, with slightly convex border upwards. At the same time the roentgenogram of the right knee, which had never been exposed to any trauma, revealed a *marginal patella partita*. The author supposes, in spite of this, that the apical partition of the left patella is a *traumatic fragmentation*, and no anomaly, most likely "un décollement épiphysaire" caused by rupture, also when complete fusion appeared to have taken place. The author looks for support of this assumption in the investigations of *Mayet*. He maintains that the lower fifth of the patella is the apophysis of the inferior patellar ligament, and that it is ossified several years later than the remaining part of the patella, viz. at about the age of 16 and 17—from one anterior and one posterior zone. Thus the apex of the patella according to *Didiée* forms "une région spéciale de l'os individualisée et plus ou moins séparée" at any rate during the period of ossification, when it must be assumed that a traumatic fragmentation is closer related to a "décollement au cartilage" than to a real fracture. This type of fracture is met with most frequently in young adults and females, and the line of partition is always regular with a slightly convex course. In more advanced age the horizontal fracture is always higher up in the patella. Considerable objections may be raised against *Didiée's* hypothesis, that all apical partitions in the patella with a very few exceptions are not *anomalies*, but are due to traumatic insult. The first one is that very often these partitions are quite incidental X-ray findings, also in late adult age, and further that the partition has this regular form and is delimited by regular, distinct borders, as seen in cases of bilateral, non-traumatic cases, so that it must be supposed to be caused by a congenital anomaly. Both my cases of apical partition recorded in the present paper, which were both unilateral, presented this picture. In the one case, *Hjördis*, the patient had been exposed to a trauma against the *other* knee. As a completely accidental X-ray finding the apical partition was found on the patella of the *non-traumatized* knee. In the other case (*Alv*), a chronic

trauma might possibly not be excluded, but certainly an acute single trauma. The histological examination of the fragment removed showed no changes speaking for a fracture being or having been present. *Both of these cases of mine thus speak very distinctly against a traumatic causation of the fragmentation.*

An essential objection against the hypothesis of *Didié* is also that these partitions, which in his opinion occur traumatically, *become permanent. They do not become fused*, and no callus is formed.

It seems possible to maintain the diagnosis in one of the two cases of fracture of the patella reported by *Ronget*, and not in the other. It was a case of a boy, 14 years of age, who had been exposed to a mild trauma against the knee five months previously, which had left slight lameness and slight muscular atrophy. X-ray examination demonstrated a typical regular apical partitioning with well-defined, not "jagged" borders. After the lapse of a further four months, according to the description of the author, no new roentgenogram being reproduced in the article, no fusion had yet taken place. The partition still persisted. It is probable that a *bipartite distraction of the patella* has been present, an opinion held also by *Schaer* in his reference to this case.

In differential diagnostic respect great significance is attached to the appearance of the line of partition and the borders. It has been claimed always that a regular course of the line of partition with smooth borders speak for an anomaly and against a fracture. The importance of this differential diagnostic factor has been emphasized, among others by *Fournier* in his papers from 1922 and 1923. He maintains that the fragment in a patella partita is sometimes smaller, sometimes larger, than the corresponding indentation in the patellar border, and the extent never corresponds to that of a fragment caused by a fracture. The sharp line of partition (*séche et nette*), which characterizes the fracture line, is not seen in a patella partita. The line of partition in patella partita is "*comme estompée, sans que les surfaces en présence aient l'air d'avoir jamais été en contact plus intime*". This appears to me to be a very apt expression.

"*Le bord interne du fragment osseux est régulier, et non dentelé comme pour les fractures.*" The author does not, however, attach any absolute value to these differences. It is of conclusive importance to him whether the partition is bilateral or not.

As mentioned previously *Adams and Leonard* also attach great differential diagnostic significance to the appearance of the borders of the partition. They claim that while the borders in patella partita are smooth and consist of cortical tissue, they are more or less irregular and jagged in fractures, composed of porous, spongy tissue. *Sommer*, who holds that patella partita is never caused by traumatism, states that the partition in patella partita is narrow and sharply defined. In fissures, however, it is "ausgezogen, länger, sich verjüngt". In spite of this, however, a decision may be impossible in the presence of a separation of the upper outer quadrant, if the fracture shows irregular, jagged contour. *Siemens* is of the opinion that the irregular, jagged line of separation in fractures constantly mentioned in the literature, is no conclusive evidence. In none of his cases was anything found to prove a traumatic genesis. *Paas* on the contrary attaches certain diagnostic importance to the appearance of the borders of the partition. In his differential diagnostic, schematic compilation of four varieties of patellar partition the appearance of the borders of the patellar partition plays a part. In patella partita vera he finds relatively smooth borders of the partition and minor or no displacement. In "distortion of the patella"—*Odermatt*—also relatively smooth borders and small to moderate displacement. In traumatic patella partita greatly irregular borders, possibly greater displacement, and in the "oblique fracture" greatly irregular borders ("Zackenbildung event. Aussprengung kleiner Fragmente"). *Blumensaat* belongs to those, however, who take a more sceptical view towards the differential diagnostic value of the borders of the partition. He declares that their shape and course frequently are of no importance as to whether the partition is of congenital or traumatic origin. The fact of the matter, namely, is that a closer inspection of the partition, as permitted by the X-ray views of recent times, very frequently reveals an irregular and variable

width—it is stated by *Blumensaat* to vary between one half to three millimetres. The borders do not present the identical thickness and markings of the bone, but irregular rarefactions and fine structural changes. It is not always possible, even when the line of partition has a presumably smooth course, to decide from the roentgenogram whether this has occurred through a congenital deformity, or by an acquired, non-traumatic partitioning of two osseous centres present beforehand, or by a pseudarthrosis, and neither whether it has been caused by a dissecting process. The explanation of this must be looked for in the fact that it is generally here a matter of a *final state*, in which a flattening of the borders has occurred gradually after “*Umbau*” and adjustment. *Blumensaat*, therefore, holds that *no absolutely definite, differential diagnostic value can be attributed to the shape and course of the line of partition*.

Several authors have mentioned *the absence of callus* as a factor of differential diagnostic importance. In a great deal of patellar fractures, however, having caused pseudarthrosis, callus is not present—which fact has been pointed out by several authors, as for example *Puas* and *Blumensaat*. In other cases formation of callus may be found, however. Thus *Pouzet* has made the diagnosis fracture of the patella exactly due to this in a boy, 15 years of age, in spite of the occurrence of the partition at a place typical for patella partita. *A positive finding of callus formation only is of importance in differential diagnostic respect, never a negative one.*

When making a perusal of my own cases with regard to the question of the roentgenological differential diagnosis between patella partita and fracture of the patella, the following findings are made:—

In the two cases of apical patella partita, in the one of which a fracture could be definitely excluded, and in the other with overwhelming probability, X-ray examination in both cases demonstrated *perfectly regular, well-defined borders of the partition*.

In five cases of marginal patella partita and in one case in

which the partition was a transitional variety between Saupe III and II (case Torbjørn), the following findings were made: Regular borders on the whole were found in this latter case as well as in three others. In these four cases the patella partita was an incidental finding: in one, case Ole, associated with general chondro-osteopathy, in one, case Torbjørn, associated with bilateral Osgood-Schlatter disease, and in one, case Arne, associated with tuberculosis of the knee, while in the fourth, case Rolv, a *traumatic distraction of the patella* was undoubtedly present. In the remaining two cases, however, Frank—with indubitable presence of a traumatic distraction of the patella—as also in the case Karl, in which the same was probably the case, the borders were somewhat irregular and jagged, particularly in the latter case. In the first of the two cases a *typical patella tripartita with two regularly delimited fragments* was present. In the latter case the fragment was distinctly smaller than the corresponding defect in the patella. Both of these circumstances speak strongly against a fracture.

In the four marginal cases, as also in the one apical one, in which histological examination was carried out of the removed fragment, *no sign was disclosed of callus formation having taken place*. In the case Kjellaug, in which clinical examination definitely indicated *fracture*, the diagnosis was entirely verified by the X-ray findings, the frontal view revealing a gaping, wedge-shaped longitudinal partition, tapering downwards, the greatest diastasis between the fragments being eight millimetres. The borders of the partition here were considerably irregular, partly torn. In spite of the fact that three-quarters of a year had elapsed since the trauma, neither in this case was there any indication of formation of callus, *roentgenologically or by the histological examination*.

The borders in one of my cases appeared more irregular in oblique view. As this was a non-traumatic case, however, no differential diagnostic significance may be attached to it. In four of the marginal cases, more particularly in three of them, the sagittal view provided a picture which bore a perfect resemblance to that found in an osteochondritis dissecans.

It is of particular importance from a differential diagnostic point of view that in two of my cases the marginal fragment was considerably smaller than the corresponding defect in the patellar borders. As mentioned before, in a third case a patella tripartita was present with two—the one oval, the other spherical—fragments.

Direct traumatic violence against the patella had not occurred in any of my cases whether of marginal or apical partition.

Apart from one of the two marginal cases (case Karl), in which the border of the partition must be stated to be considerably irregular, almost lacerated, despite the fact that no *direct* trauma had occurred, no more than any probable *indirect* one, against the patella, it may be said that, broadly speaking, my cases prove the saying of *Grashey* (1928): “Die Trennungslinien (bei p.p.) sind für Bruchspalten zu schön, zu ebenmässig.”

The study of my own cases as well as those described in the literature, has convinced me that *Schaer* is right, when he maintains—in opposition to *Paas*—that the X-ray diagnosis between patella partita on the one hand and fracture of the patella on the other, is in reality fairly easy. Some cases may remain, however, in which a detailed history of disease, the clinical course, and subsequent follow-up examination, are required to elucidate the matter. When marked clinical symptoms are found consequent upon a severe direct trauma: intensive pain and tenderness, extreme swelling with hemarthrosis, restricted motion, disorganization of the patella due to displacement of the fragment, possibly also crepitation, the X-ray findings will only serve to verify the clinically established diagnosis of fracture. The situation is considerably more vague, when it is a matter of an *indirect* trauma, such as hyperflexion or luxation of the patella, or a less important trauma with consequently much less marked clinical symptoms. If in such cases the X-ray examination should reveal a patellar partition with the localization and course typical to a congenital patella partita, a fracture is so far from being definite that, on the contrary, a distraction (distortion) of the patella must be regarded as probable, even if a

hemarthrosis is present, as in my case Roly, or the borders of the partition would be irregular as in my case Karl. In my opinion a distraction would be quite definitely established in such cases if the patellar fragment appears to be decidedly smaller than the corresponding defect in the borders of the patella. This also applies to the cases in which a patella tripartita or multipartita is present with well-marked limitation, and a severe direct trauma against the patella may be excluded.

SUMMARY

Patella partita was first described by the Russian anatomist *Gruber* (1883). The first roentgenological case was observed by the Norwegian orthopedist *Reinhardt Natvig* (1901). Up to 1940 approximately 150 cases were found to be mentioned in the literature. Of the three different types of patella partita distributed into groups by *Saupe* in 1921, type III—the marginal partition—in the upper lateral patellar quadrant, has predominating incidence. Next comes type I—the apical transverse partition. Only nine cases have been recorded of type II—the longitudinal partition, and only five cases in all of type IV—the sagittal partition, double patella—referred by *Haenisch* in 1925. The incidence of the anomaly, which is given with greatly varying figures by the investigators, is sure to be considerably greater than generally supposed. While it was previously assumed that the incidence of the bilateral cases was predominatingly the greatest, my investigations demonstrate that the *unilateral* cases are the most frequent—at an approximate ratio to the bilateral cases of 4:3. The anomaly attacks males with considerably greater incidence than females, according to my investigations at a ratio of approximately 9:1. The right side appears somewhat more frequently involved than the left.

The deeper cause of the patella partita must be sought in *endogeneous* factors. *Gruber* supposed the anomaly to be of *congenital* nature, being due to abnormal multiple patellar centres of ossification. *Hellmer* in his X-ray studies (1935), however, has demonstrated that in half the cases the patella has

several primary centres of ossification. According to this, therefore, it is reasonable to suppose that the anomaly is caused by *the absence of fusion* in a *normal* patella with multiple primary centres of ossification, in other words a *disturbance in the ossification*. The great majority of writers agree with this assumption. *Fleischner* (1923) has maintained, however, that patella partita must be looked upon as a *juvenile osteopathy* resembling the Osgood-Schlatter disease and similar lesions appertaining to adolescence, and he finds support for his opinion in the coincidence between patella partita and the Osgood-Schlatter disease which he discovered in one and the same patient. It must be considered highly doubtful, however, whether an Osgood-Schlatter disease was actually present in this case. Several other authors, however, have established such coincidence with certainty, among others the writer in a case of unilateral patella partita marginalis and bilateral Osgood-Schlatter. These cases, as also the fact that in some cases—thus also in one reported by the author—the patella partita appears as a link in a general congenital chondro-osteopathy support the opinion advocated by *Fleischner*. The author, however, considers no principal opposition to exist between the opinion of *Gruber* of patella partita as a disturbance in ossification in a patella with multiple primary centres of ossification, and the contention of *Fleischner* that the patella partita is related to the juvenile osteopathies. A series of clinical symptoms speak definitely against the deeper cause of patella partita as well as of the juvenile osteopathy having to be looked for in endogeneous factors of constitutional nature. Broadly speaking, the *histological* examinations carried out in the author's cases *support the assumption of the possible presence of an aseptic necrosis in patella partita*. For this refer to the text.—In the literature some patellar lesions are described, partly designated as “Osteopathia patellae”—“Osteochondritis patellae”—“Apophysitis patellae”—or as “Köhler's disease of the patella”—and finally as “patellite post-traumatique” or “patellite de croissance”. *Pickhan* and *Hellmer* have claimed that these are X-ray changes within the limit of the normal ossification. The author has demonstrated that this may

be the case by histological examination in two—three cases. This does not signify, however, that it is always the case. After a critical analysis of the cases recorded in the literature under the said designations, the author has arrived at the conclusion that it is not justified categorically to deny the presence of an *infantile patellar osteopathy*. On the contrary he rather considers it to be highly probable, namely in cases where *clinical* symptoms exist, and particularly when the changes—and therefore the lesion—are *unilateral*. This also applies at any rate to some of the cases designated as the Sven Johansson—Sinding-Larsen disease. The author reports a case which he had the opportunity of observing before he was aware of the works of these two authors, in which the X-ray changes tallied perfectly with those seen in the Johansson—Sinding-Larsen disease, which, however, were undoubtedly caused by a post-traumatic malacia of the patellar apex. The X-ray changes in a patellar osteopathy or in the Johansson—Sinding-Larsen disease, however, have nothing whatever to do with those found in a patella partita.

The anomaly patella partita as such, *produces no clinical symptoms*. If such are present, they depend either on a chance coincidence with some *lesion of the knee*—such as a chronic synovitis, chondromalacia patellae, or tuberculosis—of which the author has referred examples—or they are due to a *distortion of the patella* (Odermatt) or a *distraction of the patella* (the author) brought about by an acute or chronic trauma.

At most the clinical diagnosis may be a tentative one (possible marked tenderness over the upper lateral patellar quadrant or apex—possibly palpable partition over the patella.) To all intents and purposes the diagnosis is a pure *X-ray diagnosis*. Frequently oblique and axial views have to be made in addition to the frontal and sagittal views.

The differential diagnostic factor of predominating importance is *osteochondritis dissecans patellae*, towards which, however, the X-ray diagnosis may also fail entirely. (Refer to several of the cases of the author).

In the first instance the treatment is always *conservative*.

When this has not succeeded, the author has removed one (or more) small patellar fragments, with excellent result.

The author refers and discusses in detail five cases of patella partita on definitely congenital basis, which he has had occasion himself to observe, operate upon and examine histologically, four of which marginal patella partita, and one apical patella partita. In addition to these comes one case of patella partita on purely traumatic basis (inveterate patellar fracture), which has also been examined histologically. In this connection a review is made of all cases of patella partita, operated on and examined histologically, which have previously been recorded in the literature, a number of no more than 7—seven—cases, however. In addition come ten unprepared specimens examined histologically. In the entire literature thus are found twelve cases only of operatively treated and histologically examined cases of congenital patella partita, five of which are found in my material. In several of the remaining cases, however, only a very brief description is given of the histological findings. It appears from the far more detailed report of this finding in my cases, that it is *degenerative* processes which primarily characterize the histological picture, usually in the form of a *fibrosis*, in some cases so pronounced that the histological diagnosis actually was *osteitis fibrosa*. In a couple of cases necrosis was demonstrated of the bone struts (aseptic necrosis), partly more localized, partly more scattered.

On the other hand practically no indications exist of regenerative processes in patella partita, as opposed to that which is the case in the aseptic necroses. In the opinion of the author, however, this does not exclude that the primary, deeper cause of patella partita shall have to be looked for in the identical relations as the primary cause of the aseptic osseous necroses, viz. factors of endogeneous nature. Otherwise reference is made to the text.

In conclusion a problem of practical importance is closely discussed, i.e. that of the correlation between patella partita and traumatism. A survey is given of the history of the question, and thereupon mention is made of the differential diagno-

sis, particularly the roentgenological one, between congenital patella partita and fracture of the patella. Based on studies of the cases in the literature as well as of his own cases, the author maintains, in agreement with the other writers who have discussed this question, that in certain cases of congenital patella partita a trauma may produce *clinical symptoms* which must be assumed to depend on a *distraction of the patella* (Sundt) or *distortion of the patella* (Odermatt). From the medico-legal point of view, therefore, a trauma in a specified case must be regarded as an *exacerbating* factor in an anomaly existing beforehand.

ZUSAMMENFASSUNG

Die Patella partita ist zuerst (1883) von dem russischen Anatomen *Gruber* beschrieben worden. Der erste röntgenologische Fall wurde von dem norwegischen Orthopäden *Reinhardt Natvig* (1901) beobachtet. Bis zum Jahre 1940 liessen sich im Schriftum annähernd 150 Fälle nachweisen. Von den drei verschiedenen Typen, in die *Saupe* 1921 die Patella partita eingeteilt hat, kommt Typus III — die marginale Spaltung — im oberen lateralen Patellarquadranten am häufigsten vor. An nächster Stelle kommt Typus I — die apikale Querspaltung. Von Typus II — der Längsspaltung — sind nur 9 Fälle beschrieben worden, und vom Typus IV — der sagittalen Spaltung, der von *Haenisch* 1925 beschriebenen doppelten Patella — im ganzen nur fünf Fälle. Die Häufigkeit dieser Anomalie, die von den verschiedenen Forschern mit stark schwankenden Ziffern angegeben wird, ist sicherlich bedeutend grösser, als man gewöhnlich vermutet. Während früher angenommen wurde, dass die bilateralen Fälle weitaus am meisten vorherrschten, zeigen meine Untersuchungen, dass die *unilateralen* Fälle am häufigsten sind; ihr Verhältnis zu den bilateralen Fällen beträgt annähernd 4:3. Männer werden von der Anomalie bedeutend häufiger angegriffen als Frauen, nach meinen Untersuchungen in einem Verhältnis von annähernd 9:1. Die rechte Seite scheint etwas häufiger angegriffen zu werden als die linke.

Die tiefere Ursache der Patella partita ist in *endogenen* Faktoren zu suchen. *Gruber* hielt die Anomalie für *kongenital* und wollte sie auf abnormale multiple Ossifikationskerne der Knie-scheibe zurückführen. *Hellmer* hat jedoch in seinen Röntgen-Untersuchungen (1935) nachgewiesen, dass die Patella in der Hälfte der Fälle mehrere Ossifikationskerne aufweist. Hiernach läge daher die Annahme nahe, dass die Anomalie durch *man-gelnde Verwachsung* einer *normalen* Patella mit multiplen primären Ossifikationskernen verursacht sei, m. a. W. eine *Ossi-fikationsstörung* darstelle. Die grosse Mehrzahl der Autoren stimmt dieser Annahme zu. *Fleischner* (1923) hat dagegen die Behauptung aufgestellt, die Patella partita sei als eine *juvenile Osteopathie* anzusehen, ähnlich der Osgood-Schlatter'schen Krankheit und ähnlichen Läsionen, die dem jugendlichen Alter angehören, und er findet eine Stütze für seine Ansicht in dem Zusammentreffen von Patella partita und Osgood-Schlatter'scher Krankheit, das er bei ein und demselben Patienten entdeckt hat. Es muss jedoch als höchst zweifelhaft angesehen werden, ob in diesem Falle wirklich ein Osgood-Schlatter vorgelegen hat. Es haben indessen mehrere andere Autoren ein solches Zusammen-treffen mit Sicherheit feststellen können, u. a. Verfasser dieses in einem Falle von unilateraler Patella partita marginalis und bilateralem Osgood-Schlatter. Diese Fälle wie auch die Tat-sache, dass die Patella partita in einigen Fällen — von denen Verfasser ebenfalls einen mitgeteilt hat — als Glied einer all-gemeinen kongenitalen Chondro-Osteopathie auftritt, stützen die von *Fleischner* vertretene Ansicht. Verfasser ist jedoch der Meinung, dass zwischen der Ansicht von *Gruber*, der die Patella partita als eine Ossifikationsstörung bei einer Patella mit mul-tiplen primären Ossifikationskernen auffasst, und der Behaup-tung *Fleischner's*, die Patella partita sei den juvenilen Osteo-pathien verwandt, kein grundsätzlicher Unterschied besteht. Eine Reihe von klinischen Symptomen spricht deutlich dagegen, dass man die tiefere Ursache sowohl der Patella partita wie der juvenilen Osteopathie in endogenen Faktoren konstitutionel-ler Art zu suchen habe. Kurz gesagt, die *histologischen* Unter-suchungen, die bei den Fällen des Verfassers durchgeführt wur-

den, stützen die Annahme des möglichen Vorhandenseins einer aseptischen Nekrose bei der *Patella partita*. Diesbezüglich sei auf den Text der Arbeit verwiesen. — Im Schrifttum werden einige Läsionen der Patella beschrieben, die im einzelnen als "Osteopathia patellae", "Osteochondritis patellae", "Apophysitis patellae" oder als "Köhler'sche Krankheit der Patella" und schliesslich als "patellite post-traumatique" oder "patellite de croissance" bezeichnet werden. *Pickhan* und *Hellmer* haben behauptet, dies seien röntgenologische Veränderungen innerhalb des Rahmens der normalen Ossifikation. Verfasser hat gezeigt, dass dies nach der histologischen Untersuchung in 2—3 Fällen der Fall sein kann. Dies besagt jedoch nicht, dass es immer der Fall ist. Nach einer kritischen Analyse der im Schrifttum unter den genannten Bezeichnungen wiedergegebenen Fälle ist Verfasser zu dem Ergebnis gelangt, dass man nicht berechtigt ist, das Vorhandensein einer *infantilen Osteopathie der Knie-scheibe* kategorisch abzuweisen. Er hält diese im Gegenteil eher für höchst wahrscheinlich, namentlich in Fällen, wo *klinische* Symptome vorhanden sind, und insbesondere dann, wenn die Veränderungen — und daher die Läsion — *unilateral* auftreten. Dies gilt jedenfalls auch für einige der als *Sven Johansson-Sinding-Larsen'sche Krankheit* bezeichneten Fälle. Verfasser berichtet über einen Fall, den er zu beobachten Gelegenheit hatte, bevor er die Arbeiten dieser beiden Autoren kannte, und bei dem die röntgenologischen Veränderungen vollständig mit den bei der *Johansson-Sinding-Larsen'schen Krankheit* beobachteten übereinstimmten, und der trotzdem unzweifelhaft durch eine posttraumatische Malazie des Apex patellae verursacht war. Gleichwohl haben die röntgenologischen Veränderungen bei einer Osteopathie der Patella oder bei der *Johansson-Sinding-Larsen'schen Krankheit* absolut nichts mit denen zu schaffen, die man bei einer *Patella partita* findet.

Die Anomalie patella partita als solche *zeitigt keine klinischen Symptome*. Wenn solche vorhanden sind, sind sie entweder auf ein zufälliges Zusammentreffen mit einer *Läsion des Knies* zurückzuführen — wie z. B. einer chronischen Synovitis, einer Chondromalacia patellae oder einer Tuberkulose, wovon Verfas-

ser Beispiele mitgeteilt hat —, oder sie stammen von einer *Distorsion der Patella* (Odermatt) oder von einer *Distraktion der Patella* (Verfasser), die durch ein akutes oder chronisches Trauma zustandegekommen ist.

Die klinische Diagnose wird zumeist tentativ sein (eventuell umschriebene schmerzhafte Empfindlichkeit über dem oberen lateralen Quadranten der Patella oder über dem Apex, eventuell palpable Spaltung über der Patella). Für alle etwa beabsichtigten Massnahmen ist die Diagnose eine reine *Röntgendiagnose*. Oft sind ausser der Frontal- und Sagittalaufnahme auch noch Schräg- und Axialaufnahmen zu machen.

Der differentialdiagnostische Faktor von entscheidender Bedeutung ist eine *Osteochondritis dissecans patellae*; die Röntgendiagnose auf dieses Leiden kann jedoch auch völlig versagen. (Siehe einzelne der Fälle des Verfassers.)

Das erste Mal ist die Behandlung stets *konservativ*. Wo diese Behandlung keinen Erfolg hatte, hat Verfasser ein (oder mehrere) kleine Fragmente der Patella entfernt, mit ausgezeichnetem Erfolge.

Verfasser beschreibt und erörtert ausführlich fünf Fälle von Patella partita auf sicher kongenitaler Basis, die er selbst Gelegenheit gehabt hat zu beobachten, zu operieren und histologisch zu untersuchen. Vier davon waren marginale und einer eine apikale Patella partita. Hierzu kommt noch ein Fall von Patella partita auf rein traumatischer Basis (inveterierte Patellarfraktur), der ebenfalls histologisch untersucht wurde. In diesem Zusammenhang wird ein Überblick gegeben über alle operierten und histologisch untersuchten Fälle von Patella partita, die früher im Schrifttum beschrieben worden sind, deren Anzahl allerdings nicht mehr als 7 — sieben — beträgt. Dazu kommen zehn unpräparierte, histologisch untersuchte Proben. Im gesamten Schrifttum finden sich also nur zwölf Fälle von operativ behandelter und histologisch untersuchter kongenitaler Patella partita, von denen fünf aus meinem Material stammen. In einigen der übrigen Fälle ist jedoch eine ganz kurze Beschreibung des histologischen Befundes gegeben. Aus dem bedeutend ausführlicheren Bericht über diesen Befund in meinen Fällen geht

hervor, dass das histologische Bild in erster Linie durch *degenerative* Prozesse gekennzeichnet ist, gewöhnlich in Form einer *Fibrosis*, die in einigen Fällen so ausgesprochen war, dass die histologische Diagnose wirklich *Ostitis fibrosa* lautete. In ein paar Fällen konnte eine Nekrose des Knochengewebes (eine aseptische Nekrose) nachgewiesen werden, die teilweise mehr lokalisiert, teilweise mehr diffus war.

Andererseits liegen aber bei der Patella partita praktisch keine Anzeichen für regenerative Prozesse vor, wie man sie bei der aseptischen Nekrose findet. Nach Ansicht des Verfassers schliesst dies aber nicht aus, dass die primäre, tiefere Ursache der Patella partita in ganz denselben Verhältnissen zu suchen ist wie die primäre Ursache der aseptischen ossösen Nekrosen, nämlich in Faktoren endogener Natur. Im übrigen sei auf den Text verwiesen.

Am Schluss wird noch kurz ein Problem von praktischer Bedeutung erörtert, das Verhältnis nämlich zwischen Patella partita und traumatischen Veränderungen. Es wird ein Überblick über die Geschichte dieser Frage gegeben, und hierauf wird die Differentialdiagnose, insbesondere die röntgenologische, zwischen kongenitaler Patella partita und Fraktur der Patella erwähnt. Gestützt auf das Studium der im Schrifttum angeführten und seiner eigenen Fälle behauptet der Verfasser in Übereinstimmung mit den anderen Autoren, welche diese Frage erörtert haben, dass in gewissen Fällen von kongenitaler Patella partita ein Trauma *klinische Symptome* zeitigen kann, die auf eine *Distraction der Patella* (Sundt) oder eine *Distorsion der Patella* (Odermatt) zurückgeführt werden müssen. Vom rechtsmedizinischen Standpunkt aus muss daher ein Trauma im gegebenen Einzelfall als ein *exazerbierender* Faktor bei einer im voraus vorhandenen Anomalie angesehen werden.

RÉSUMÉ

La patella partita a été décrite pour la première fois par l'anatomiste russe Gruber (1883). Le premier cas radiographique a été observé par l'orthopédiste norvégien Reinhardt Natvig

(1901). Jusqu'à 1940, environ 150 cas ont été mentionnés dans la littérature publiée. Parmi les trois différents types de patella partita répartis en groupes par *Saupe* en 1921, c'est le type III — la partition marginale — dans le quadrant patellaire latéral supérieur, qui est le plus fréquent. Vient ensuite le type I — la partition transverse apicale. On a seulement enregistré neuf cas du type II — la partition longitudinale — et seulement cinq cas en tout du type IV — la partition sagittale, patelle double — décrit par *Haenisch* en 1925. L'incidence de ces anomalies indiquée par des chiffres très variables par les différents investigateurs, est certainement beaucoup plus considérable qu'on ne l'avait généralement supposé. Alors qu'on estimait autrefois que les cas bilatéraux étaient prédominants, mes recherches démontrent que les cas *unilatéraux* sont les plus fréquents, dans la proportion approximative de 4 contre 3. Les hommes sont plus souvent atteints de cette anomalie que les femmes, selon mes recherches dans une proportion approximative de 9 contre 1. D'autre part, il semble que le côté droit soit plus fréquemment atteint que le côté gauche.

La cause profonde de la patella partita doit être cherchée dans des facteurs *endogènes*. *Gruber* supposait que cette anomalie était de nature *congénitale*, due à un nombre multiple anormal de cellules osseuses dans la patelle. *Hellmer*, dans ses études aux rayons X (1935), a démontré cependant qu'il existait dans la moitié des cas un nombre plus élevé de cellules osseuses dans la patelle. Dans ces conditions, on est donc fondé à supposer que cette anomalie est causée par une *croissance défectueuse* dans une patelle *normale* comptant des cellules osseuses primaires multiples, en d'autres mots provient d'une *perturbation d'ossification*. La grande majorité des auteurs sont d'accord quant à cette conception. *Fleischner* (1923) a maintenu cependant que la patella partita doit être considérée comme une *ostéopathie juvénile* ressemblant à la maladie d'Osgood-Schlatter et à des lésions similaires appartenant à l'adolescence et son opinion se trouve appuyée par le fait qu'il découvrit chez un même patient simultanément de la patella partita et de la maladie d'Osgood-Schlatter. Il est toutefois extrêmement dou-

teurs qu'il se soit réellement agi de maladie d'Osgood-Schlatter dans ce cas. Plusieurs autres auteurs ont, cependant, établi cette simultanéité avec certitude, entre autres l'auteur, dans un cas de patella partita marginale unilatérale et d'Osgood-Schlatter bilatérale. Ces cas, de même qu'un certain nombre d'autres — dont un rapporté par l'auteur — chez lesquels la patella partita apparaît comme faisant partie d'une chondro-ostéopathie congénitale générale appuient l'opinion soutenue par *Fleischner*. L'auteur, toutefois, considère qu'il n'existe aucune opposition fondamentale entre l'opinion de *Gruber* suivant laquelle la patella partita est un trouble d'ossification dans une patelle ayant des cellules osseuses primaires multiples et l'assertion de *Fleischner* mettant la patella partita en relation avec les ostéopathies juvéniles. Une série de symptômes cliniques montrent définitivement que la cause profonde aussi bien de la patella partita que de l'ostéopathie juvénile doit être cherchée dans des facteurs endogènes de nature constitutionnelle. En résumé, les examens *histologiques* effectués dans les cas de l'auteur appuient la supposition de la présence possible d'une *nécrose aseptique* dans la patella partita. A cet égard on est prié de se reporter au texte. Dans la littérature, quelques lésions patellaires ont été décrites, désignées soit comme "osteopathia patellae", "osteochondritis patellae", "apophysitis patella", ou "maladie de Köhler de la patelle", soit enfin comme "patellite post-traumatique" ou "patellite de croissance". *Pickhan* et *Hellmer* prétendent qu'il s'agit là d'altérations radiographiques dans la limite de l'ossification normale. L'auteur a démontré en effet que l'examen histologique peut conduire à ce résultat dans deux ou trois cas, mais que ceci ne signifie cependant pas qu'il en soit toujours ainsi. Après une analyse critique des cas enregistrés dans la littérature sous les désignations précitées, l'auteur en arrive à la conclusion qu'il n'est pas justifié de nier catégoriquement la présence d'une *ostéopathie patellaire infantile*. Au contraire, il considère plutôt que c'est extrêmement probable, notamment dans les cas présentant des symptômes *cliniques* et particulièrement lorsque les altérations — et conséquemment les lésions — sont *unilatérales*. Ceci s'applique aussi à quelques-

uns des cas désignés comme maladie de Sven Johansson-Sinding-Larsen. L'auteur rapporte un cas qu'il a eu l'occasion d'observer avant de connaître l'ouvrage de ces deux auteurs, chez lequel les modifications radiographiques correspondaient parfaitement à celles observées dans la maladie de Johansson-Sinding-Larsen mais, qui, cependant étaient causées sans aucun doute par une malacie post-traumatique de l'apex patellaire. Les altérations radiographiques dans l'ostéopathie patellaire ou la maladie de Johansson-Sinding-Larsen n'ont cependant rien à voir avec celles constatées dans la patella partita.

L'anomalie de la patella partita comme telle *ne produit aucun symptôme clinique*. Si ceux-ci existent, c'est qu'ils sont dus au hasard de la simultanéité d'une *lésion du genou*, telle que synovite chronique, chondromalacie de la patelle ou tuberculose, dont l'auteur a rapporté quelques exemples — ou bien à une *distorsion de la patelle* (Odermatt) ou à une *distraction de la patelle* (l'auteur) causées par un trauma aigu ou chronique.

La plupart du temps le diagnostic clinique doit être tentatif (éventuellement sensibilité marquée dans le quadrant patellaire latéral supérieur ou l'apex, ou partition palpable de la patelle). De toute manière le diagnostic est un *diagnostic purement radiographique*. Il faut souvent prendre des épreuves obliques et axiales en plus des épreuves frontales et sagittales.

Le facteur d'importance prédominante dans le diagnostic différentiel est *Poosteochondritis dissecans patellae*, maladie pour laquelle, cependant, le diagnostic radiographique peut faire entièrement défaut. (Se référer à plusieurs des cas de l'auteur).

Le traitement doit être en première instance *conservatif*. Lorsque celui-ci n'a pas donné d'heureux résultats, l'auteur a enlevé un (ou plusieurs) petits fragments patellaires avec d'excellents résultats.

L'auteur rapporte et discute en détail cinq cas de patella partita sur base congénitale certaine qu'il a eu l'occasion d'observer lui-même, d'opérer et d'examiner histologiquement, dont quatre de patella partita marginale et un de patella partita apicale. A ceux-ci s'ajoute un cas de patella partita de nature purement traumatique (fracture patellaire invétérée) qu'il a

aussi examiné histologiquement. Par ailleurs tous les cas de patella partita opérés et examinés histologiquement qui ont été antérieurement mentionnés dans la littérature — il ne s'agit que de 7 cas — sont passés sous revue. En plus viennent s'ajouter dix spécimens non préparés, examinés histologiquement. Dans toute la littérature on n'a trouvé que douze cas de patella partita congénitale traités opérativement et examinés histologiquement, dont cinq font partie de mon matériel d'observation. Dans plusieurs des autres cas, toutefois, il n'a été donné qu'une brève description des trouvailles histologiques. Il ressort du rapport beaucoup plus détaillé de ces trouvailles dans mes cas que c'est le processus *dégénératif* qui caractérise en premier lieu le tableau histologique, en général sous la forme d'une *fibrose*, dans certains cas si prononcée que le diagnostic histologique devient alors *osteitis fibrosa*. On a constaté des nécroses osseuses (nécrose aseptique) parfois plus localisées, parfois plus diffuses dans quelques cas.

Par ailleurs, il n'existe pratiquement aucune indication de processus régénératif de la patella partita, contrairement à ce qui est le cas dans les nécroses aseptiques. Dans l'opinion de l'auteur, cependant, cela n'exclut pas que la cause primaire, profonde, de la patella partita, tout comme celle des nécroses aseptiques osseuses, réside dans des facteurs de nature endogène. Par ailleurs, se référer au texte.

Pour terminer, un problème d'importance pratique, la corrélation entre la patella partita et le traumatisme est sommairement discuté. Une vue d'ensemble est donnée de l'histoire de la question, après quoi il est fait mention du diagnostic différentiel, particulièrement du diagnostic radiographique entre la patella partita congénitale et la fracture de la patelle. Se basant sur des études de cas de la littérature ainsi que sur ses propres cas, l'auteur maintient, d'accord avec les autres auteurs qui ont discuté la question, que dans certains cas de patella partita congénitale un trauma peut parfois produire des *symptômes cliniques* qui doivent être attribués à une *distraktion de la patelle* (Sundt) ou à une *dorsion de la patelle* (Odermatt). C'est pourquoi, au point de vue médico-légal, dans un cas spécifié, un

trauma doit être considéré comme un facteur *exacerbant* d'une anomalie existant antérieurement.

REFERENCES

- Adams and Leonard*: Surgery and Gynecology etc. *41*, 601, 1925.
D'Annoy and Connel: J. Bone and Joint Surg. *16*, 689, 1934.
Bähr: Zbl. Chir. *1895* — 385.
 —: D. med. W.schr. *1913*, 1402.
 —: Zbl. Chir. u. mechan. Orthop. *1914* — 360.
Behn: Fortsch. Röntgenstr. *14*, 202, 1909—10.
Bey-Kirch: Chirurg, *1929* — 1013.
Blencke: Z. Orthop. Chir. *42*, 291.
Blumensaat: Arch. Orthop. u. Unfallschir. *32*, 263, 1932.
Botreau-Roussel et Mouchet: Revue d'Orthop. *1929* — 511.
Braus: Lehrbuch d. Anatomie *1920*.
Businco: Radiol. med. *12*, 812, 1925.
Büttner: Arch. klin. Chir. *136*, 793, 705.
Calot: Journal des practines *1921*, 51.
Climan: Med. Journ. a. Rec. *131*, 558, 1930. Ref. J. organ Chir. *51*, 349, 1930.
Cole: J. Bone and Joint Surgery, *7*, 637, 1925.
Coureaud: Bull. et Mem. Soc. Nationale de Chir. no. *20*, *18*, 1931.
Didié: Acta Chir. Scand. *68*, 278, 1931.
 —: Acta Radiol. Scand. *13*, 144, 1932.
Diebold: Arch. klin. Chir. *147*, 664, 1927.
Douarre: Bull. et Mem. Nation. Chir. *1921*, *10*.
Dufour et Mouchet: Revue d'Orthop. *1931*, *340*.
Eichengrün: Beitr. klin. Chir. *148*, 311, 1930.
Enderle: Med. Klinik, *12*, 979, 1916.
Faltin: Acta chir. Scand. *58*, 36, 1924.
Feinkorn: Röntgenpraxis, *3*, 945, 1931.
Flecker: J. of Anatomy, *67*, 118, 1932—33.
Fleischner: Fortsch. Röntgenstr., *31*, 209, 1923.
Fournier: Anomalie rotulienne. La "Patella partita". Thèse Paris *1922*.
 —: Revue d'Orthop. *1923*, 393.
Gellman: J. of Bone and Joint Surgery, *16*, 95, 1934.
Gorzoyski: Arch. klin. Chir. *188*, 538, 1937.
Grashey: Atlas typischer Röntgenbild, München *1928*.
 —: Röntgenpraxis, *4*, 617, 1934.
Gruber: Kirchows Arch., *1894*, 375.
Hackenbrock: Z. Orthop. Chir., *43*, 568, 1924.
Haenisch: Fortsch. Röntgenstr., *33*, 676.
Haglund: Prinzipien d. Orthopädie, *1923*.

- Hasselwander*: Die Röntgenstr. in der Anatomie, Leipzig 1924.
- Haxley and Greiswold*: Surgery, Gynecology etc. 47, 68, 1928.
- Hellmer*: Acta Radiol. Scand., 4, 137, 1925.
- : Bemerkungen zu Carl Kremser etc., Röntgenpraxis, 4, 928, 1932.
- : Acta Radiol. Scand. Supplement. 27.
- Henry, Myron*: J. Bone and Joint Surgery, 16, 964, 1934.
- L'Heureux et Riche*: Revue d'Orthoped. 1926, 35.
- Holland, Thurstand*: J. of Anatomy, 55, 235, 1921.
- Joachimsthal*: Arch. klin. Chir., 67, 342, 1902.
- : Berlin. klin. W.schr., 1912, 424.
- Johansson, S.*: Z. Orthop. Chir., 43, 82, 1922.
- Kallies*: Patella bipartita. Diss. Tübingen, 1930.
- Kempon*: J. Anatomy and Physial, 36, 419, 1902.
- King*: J. Bone and Joint Surgery, 17, 88, 1925.
- Kolliker*: Entwicklungsgeschichte d. Menschen etc., Leipzig 1861.
- Konjetzy*: Arch. klin. Chir., 142, 33, 1926.
- Koritzinsky*: Norsk mag. f. Lægevid., 1919, 1332.
- Kremser*: Röntgenpraxis, 4, 394, 1932.
- : Erwiderung auf Hans Hellmers Bemerkungen, Ibidem, 4, 931, 1932.
- Kuh*: Z. Orth. Chir., 57, 604, 1932.
- Köhler*: Grenzen d. Normalen u. Anfang d. Pathologischen im Röntgenbild, 6. Auflage 1931.
- : M. med. W.schr., 1908, p. 1923.
- Link*: D. Z. Chir., 237, 768, 1932.
- Looser*: D. Z. Chir., 152, 210, 1920.
- Madlener u. Paas*: Fortschr. Röntgenstr., 41, 38, 1930.
- Mau*: D. Z. Chir., 228, 221, 1930.
- : Verhandl. deutsch. Orthop. Gesellsch. 1931, p. 334.
- Mayet*: Paris Chirurgical. 6, 591, 1914.
- Meisels*: Fortschr. Röntgenstr., 37, 42, 1928.
- Moffat*: J. Bone and Joint Surgery, 11, 579, 1929.
- Moreau*: Presse médicale, 28, 374, 20/6—1920.
- : Bull. et Mem. Soc. Nation. Chir., 45, 1273, 1919.
- Mouchet*: Bull. et Mem. Soc. Nation. Chir., 12/1—1921.
- : Bull. et Mem. Soc. Nation. Chir., Avril, Mai, Oct. 1921.
- Mouchet et Ardouin*: Bull. et Mem. Soc. Nation. Chir., 9/11—1932, 1354.
- Müller, W.*: M. med. W.schr., 1924, 854.
- : Beitr. klin. Chir., 120, 599, 1920.
- : Beitr. klin. Chir., 120, 389, 1920.
- : Beitr. klin. Chir., 130, 459, 1924.
- Van Neck*: Arch. franco-belges, 1926, 119.
- Van Nes*: Arch. franco-belges, 1930, 664.
- Neurenbergk*: Beitr. klin. Chir., 153, 406, 1931.
- Noviazzer*: Annals Surgery etc., 94, 150, 1931, Ref.: Zbl. Chir., 1932, 2006.

- Odermatt*: Schweitzer. medic. W.schr., 11, 1263, 1921.
- Oetteking*: Annal. Rec., 23, 269, 1922, Ref.: Schaer and Siemens and Z. Org. Chir. 18, 499, 1922.
- Paas*: Arch. klin. Chir., 165, 322, 1931.
- : D. Z. Chir., 230, 261, 1931.
- : Zbl. Chir., 1932 no. 45.
- : Arch. klin. Chir., 71, 606, 1932.
- Paul*: D. Zeitschr. Chir., 237, 626, 1932.
- Paus*: Acta Chirurg. Scand. 61, 44, 1927.
- Payr*: Beitr. klin. Chir., 136, 260, 1926.
- : Chirurg I, 7 and 68, 1929.
- Pickhan*: Röntgenpraxis, 2, 969, 1930.
- Potensa*: Radiol. med. 17, 289, 1930.
- Pouzel*: Lyon méd., 145, 19, 1930.
- Pytel*: Zbl. Chir., 1930, 1727.
- : Arch. klin. Chir., 172, 718, 1933.
- Reinbold*: Revue Médicale de la suisse romand, 37, 653, 1917.
- : Revue Suisse des accidentés du travail, 14, 385.
- Riedel*: Zbl. Chir., 1922 no. 39, 1930.
- Rischel*: Hospitalstidende, 73, 1068, 1930.
- Ritter*: Zbl. Chir., 1921, no. 33, p. 1204.
- Rocher et Guérin*: J. de Médecine d. Bordeaux No. 12, 1929. Ref. Revue d'Orthop. 1929, 466.
- Ronget*: Revue d'Orthop. 1929, 249.
- v. Rosen*: Die infektiösen Krankheiten d. Kniescheibe. Acta Orthop. Scand. Supplement III.
- Rostock*: D. Z. Chir., 217, 406, 1932.
- Rückensteiner*: Die normale Entwicklung d. Knochensystems im Röntgenbild, Leipzig 1931.
- Saupe*: Fortschr. Röntgenstr., 28, 37, 1921—22.
- : Röntgenpraxis, 4, 439, 1932.
- Schaer*: Ergebn. d. Chir. u. Orthop., 27, 1, 1934.
- Schröder*: Röntgenpraxis, 11, 230, 1939.
- Schwarz*: Zbl. Chir. 1932 no. 24, 1488.
- Serfatty and Maróttoli*: Prensa Méd. Argentina, 15, 1030, 1929. Ref.: King, and Z. org. Chir. 48, 126, 1930.
- Siemens*: D. Z. Chir., 233, 727, 1931.
- : D. Z. Chir., 239, 715, 1933.
- Silfverskiöld*: Acta Radiol. Scand. V, 223, 1925.
- : Acta Radiol. Scand. IV, 44, 1925.
- Sinding-Larsen*: Acta Radiol. Scand. I, 171, 1922.
- : Norsk Magazin f. Lægevidensk., 1921, 856.
- Skřivánek*: Ref. Zbl. Chir., 1927 no. 8, 487.
- Sommer*: Beitr. klin. Chir., 148, 1, 1930.

Sonntag: M. med. W.schr., 1918, 372.

Stolz, Meyer et Weiss: Bull. et Mem. de Soc. Nationale de Chir., 1927, 847.

Sundt: Acta Chir. Scand., 60, 523, 1926.

Thurston: J. of Anatomy, juli 1921. Ref.: L'Heureux et Riche.

Todd and Mc. Cally: Annals Surgery, 74, 775, 1921.

Valls: Revue d'Orthop., 1932, 762.

z. Verth.: Beitr. Z. Orth. Chir., 53, 281, 1931.

Viuillet: Revue medicale Suisse romand., 37, 1917.

Walkhoff, Ewald u. Preiser: Z. Orth. Chir., 28.

Wollenberg: Arch. f. Orthop. Mechanothorapi u. Unfallschir., 7, 226, 1909.

Wehner: Zbl. Chir. 1921, no. 33, 1203.

Weil u. Barthels: Klin. W.schr., 1932, 657.

Zwerg: D. Chir., 212, 362, 1928.