FROM THE COAST HOSPITAL AT STAVERN, NORWAY
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ON PARTITION OF THE SESAMOID BONES OF THE LOWER EXTREMITIES

BY

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B.[1]

PARTITION OF THE SESAMOID BONES OF THE GREAT TOE

I.

It is a very natural thing to assume that the identical conditions existing in the partition of the sesamoid bone of the quadriceps femoris—i.e. of the patella—are present also in the partition of the remaining sesamoid bones of the lower extremities, that is practically only the two sesamoid bones in the flexor hallucis brevis, or those lying on the plantar surface of the metatarso-phalangeal articulation of the great toe.

These sesamoid bones (o. s.) are ossified very late—all investigators agree on this point. *Hasselwander* (1924) found that in females it takes place between the age of 9-12 years, in males between 12-13 years, while *Rückensteiner* (1931) found that it happened on an average in the tenth year in females, and in the twelfth year in males. *Kewenter* (1936) as the result of an investigation of 239 females and 226 males between 5-16 years of age, found that the average age of ossification was 9.1 years in females and 11.1 years in males. Thus the ossification occurs approximately two years earlier in females than in males. In

[1] The first part of this paper: A. Patella Partita, has been published in this magazine, Vol. XIII, Fasc. I.

this respect the conditions correspond entirely to those found in the patella, but while the ossification here is completed already during or at the finish of the infant age period, this is not the case for o. s. until several years into school age. Further, *Kewenter* was able to verify that the ossification took place from one or more osseous centres, as observed already in 1907 by *Momburg*. *Kewenter* by studying a number of roentgenograms, namely, had found partition of the o. s. in 9 cases, 5 of which in two parts, 3 in three parts, and 1 in four parts. *Kewenter* also found that several ossific centres were present mostly in the medial (tibial) o. s., and finally that the ossification was completed in the course of 1-2 years.

The first investigator to have observed a *partition* of these o. s. is the anatomist *W. Pfitzner* (1892), who had found, not so rarely, a bipartition of the medial o.s. and—more rarely and less pronounced—also of the lateral (fibular) one. In an anatomical study of the sesamoid bones of the hand and foot *Stieda* (1904) demonstrated an anomaly of the o.s. of the great toe, a partition which he pointed out could be mistaken for a fracture. The first *roentgenological* observations also met with in the literature were regarded as fractures (*Schunke* (1901), *Marx* (1904), *Muskat* (1906)). It was *Momburg* who first advanced the opinion, in his above mentioned paper from 1907, that a partition of the o.s. was not always of traumatic origin, not even when a trauma was present in the past history. He referred two cases—both soldiers—who had felt great pain under the ball of the great toe during jumping, roentgenological examination disclosing partition of the medial o.s. As similar partition was found also of the corresponding o.s. of the other foot, the author assumed that the partition had to be of *congenital* nature. With predominating frequency the partition strikes the medial o.s. and was generally transverse. He held that the tenderness found under the metatarsal head in these cases was due to an *inflammatory reaction* from the metatarsophalangeal joint. *Igelstein* in 1908 recorded as case in an undergraduate, 22 years of age, who after a fall when skating, had felt tenderness in the region around the sesamoid bone of the

great toe with pain on dorsal flexion of the toe. Roentgenologically transverse partition was found of the lateral sesamoid bone, and as an identical partition was found simultaneously of the medial sesamoid bone of the other foot, he also assumed that the clinical symptoms were due to neuralgia brought about by the partly dislocated sesamoid bone pressing on the plantar nervous branches.

Painter in 1910 referred a case of partitioning of *both* sesamoid bones in a 66 year old man, and which he assumed to be of congenital origin. The symptoms disappeared after treatment with plaster bandage.

P. Müller, Philadelphia, in 1912 gave an account of a woman, 35 years of age, who two years previously, when dancing, had felt pain and tenderness under the ball of the great toe, and the tenderness and pain often persisted during walking, after the acute symptoms had vanished. Roentgenological examination demonstrated transverse partition of the medial sesamoid bone, which was removed, upon which all symptoms disappeared. No mention is made of the conditions in the contralateral foot. The case was regarded as a fracture, which must be considered to be quite uncertain according to the information available.

Speed (1914) records—without giving any details—that he has operated upon five cases of fracture of the o.s. with good result. As he makes no mention of the possibility of the presence of a congenital anomaly, however, doubt may be harboured of the diagnosis *fracture*.

In 1915 *Boardman*, San Francisco, under the title "Pseudofracture of the sesamoid Bones of the big Toe", gives a detailed account of a case of a 25 year old female, who had consulted him for pain, tenderness and swelling of the ball of the right great toe during walking—symptoms which vanished after a few weeks' rest. When playing tennis seven years subsequently she suddenly felt intensive pain accompanied by tenderness and swelling under the great toe of the right foot. Also this time the pain disappeared after one week's rest. A few weeks later, however, she complained of dull pain in the foot after dancing, with

tenderness over the distal end of the first metatarsal. Pain and tenderness forced her to walk on the lateral part of the sole of the foot. Roentgenologically was demonstrated a "definite separation of the tibial sesamoid in two portions by a lateral line of cleavage". The diagnosis was *fracture*. As neither in this case mention was made whether the partition was bilateral or not, the diagnosis may be doubtful also here. *Boardman* reports that he has subsequently seen four other cases of partition of the o.s., two of which in females and two in males. In the two latter cases it was an incidental finding, and the partition, therefore, was considered to be of congenital nature. In the two women clinical symptoms were present after trauma. In the one case the partitioned medial o.s. was extirpated. No fracture was found. The partition was unilateral. In the second case, in which also the medial o.s. was affected, the partition was bilateral. The author assumed that also in both these cases a congenital partition was present.

These papers concentrate upon the question as to whether the cause of the partition is a fracture of the o.s. or whether it is a partition of purely congenital nature.—In the immediately following years *some* papers appear in American and Italian literature, recording cases in which the above mentioned clinical symptoms are found of an affection of the o.s. (pain and tenderness on the plantar side of the head of the first metatarsal) and the roentgenogram demonstrating *a partition* of an o.s., at the same time as a *fracture* may be definitely excluded (absence of a separate trauma in the past history). The various authors assume the presence, partly of a congenital partition, partly of a *sesamoiditis*. In the following I shall report briefly from the papers of these authors with which, unfortunately, I have been able to make acquaintance only in quite short abstracts.

In 1920 *Freiberg* referred 14 cases, in which the patients had complained of tenderness on the plantar side of the first metatarsal, the tenderness persisting, and the roentgenogram showing a transverse partition of the medial o.s. Demonstration of any definite trauma was never possible in the past history.

In the same year *Serafini* recorded similar cases—also without preceding traumatism. The lesion was held to be an inflammation or metatarsal neuralgia, not a fracture. In 1921 *Brugman* refers some cases af "fracture of sesamoid bones", among which one case of *congenital partition* with excessive pain during walking. In 1924 *Uuzzi* described a "presumably often *misjudged sesamoiditis* under the great toe", which manifested itself in pain localized to the sesamoid bones and presumably caused by the pressure of these on the plantar nerves, and with deformity of the sesamoid bone. The symptoms vanished upon extirpation of the diseased bone.

Hernaman-Johnson (1920) regarded this lesion of the seamoid bones as a fracture arisen in the same way as the so-called "Fussgeschwulst".

There is certainly no doubt but that these traumatic cases of an affection of the o.s. (the sesamoiditis of *Nuzzi*), find their explanation in the two cases published in 1924 by the Swede *Axel Renander* under the designation "Typical Osteochondropathy of the medial sesamoid-bone of the first metatarsal", which he represents as a "hitherto not described lesion" of this bone. *Renander* opined that an *aseptic necrosis* of the sesamoid bone was present, similar to the two Köhler diseases of the skeleton of the foot, the Legg-Calvé-Perthes' disease of the hip, the Kienböck disease of the skeleton of the hand, and so forth, and supported this opinion on the histologic examination carried out in the one of his two cases. In 1925 *Walther Müller* reported four clinical observations of partition of the sesamoid bones of the great toe, in which he designates the lesion a *malacia* and the morbid picture as *typical,* on the basis of the clinical and roentgenological findings. Subsequently several authors, thus *W. Müller* in a new paper from 1927, *Meffert* (1929), *Kimmelstiel, Kremser* and *Richter* (1933), and others, the works of whom are dealt with more closely later on, have endeavoured further to trace the pathogenesis of the disease—by histological examinations, partly of sections, partly of operative specimens. Among these papers, that by the Swede *Yngve Kewenter* entitled "Die Sesambeine des I. Metatarsophalangealgelenks des Men-

schen" published in 1936 in this magazine occupies a prominent position.

II.

In the clinical picture of the affection of the o.s. recorded here—whatever its nature may be—*pain and tenderness* over the plantar side of the head of the first metatarsal—i.e. over the ball of the great toe—play the domineering part. The pain may occur gradually, but also *suddenly* and apparently quite spontaneously, at any rate not associated with any separate trauma, as in my two cases reported just below and in one case mentioned by *Kimmelstiel, Kremser* and *Richter*, in which the pain occurred suddenly in bed at night. The pain may be very intensive. It stands to reason that the pain is most pronounced when the patient walks and stands. Together with *tenderness to pressure* over the affected place they may be so intense that the patient has to walk on the outer part of the foot. The pain may also radiate over the entire foot and up into the thigh (*W. Müller*). In addition to the pain and tenderness may come *swelling* of the ball of the great toe. A fourth and particularly important symptom is *pain on dorsoflexion* of the great toe with simultaneously normal conditions in the metatarso-phalangeal joint. *W. Müller* holds this symptom to be *pathognomonic*. He further states that the rotation movement of the dorsoflexed great toe may provoke pain around the sesamoid bones, and he had found also in some of his patients an intermittent edema on the dorsal side of the head of the first and second metatarsal. Recently I have had occasion to observe the following couple of cases, which must be regarded as entirely characteristic of the morbid picture represented by *Renander* and *Müller* as typical of osteopathy of the o.s.:

Case I. 35 year old female factory worker. For 14 years she has worked in a match factory, having had to stand all the day during work. Never before has she had any disease of the feet, and has never been ill at all. On Sunday, September 29. 1940—she had been free also the preceding day as at the time no work was done at the factory on Saturdays—she got pain under the ball of the great toe of the left foot

without any inducive trauma or overexertion or any other demonstrable cause. The pain persisted during the night, at the same time as the foot became tender at the place mentioned. In spite of the fact that the condition had not improved, she went to work the next day and has worked since. During this the foot has become considerably swollen, and on the morning of October 2nd she consulted a physician.

Physical examination: A considerably corpulent woman of quite healthy appearance. Bilateral hallux valgus, most pronounced on the left foot, as also some degree of transverse flat-foot. Over the ball of

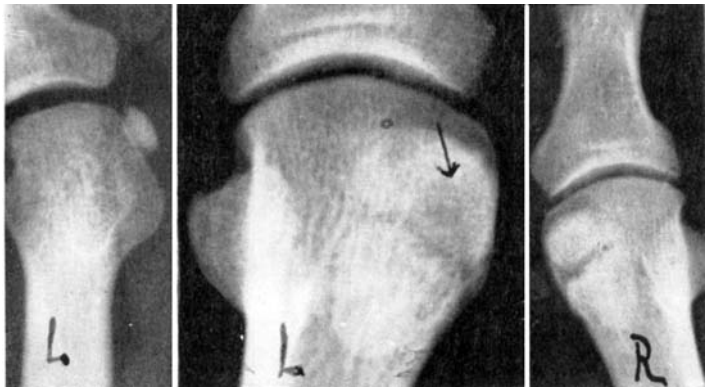

Fig. 1.

the great toe and adjacent parts, thus the anterior part of the medial edge of the foot, the left foot is *considerably swollen with excessive tenderness* under the ball proper of the great toe, particularly the region corresponding to the *medial sesamoid bone.* Due to this tenderness she cannot wear a shoe and on account of the pain under the ball of the great toe she has to walk on the outer edge of the foot. Dorsoflexion of the great toe increases this pain to a considerable degree. The clinical conditions over the right foot are normal. Rest and application of lead lotion compress was instituted. *October 3rd:* The symptoms considerably improved, the swelling greatly decreased. Still tenderness of the ball of the great toe, particularly over the medial o.s., which is palpated. *October 9th:* The patient now feels so well that she can go to work, though there is still some swelling of the ball of the great toe and pain on dorsoflexion of the great toe. *Roentgenologic finding:* Bilateral transverse partition of the medial sesamoid bone. On the left side this sesamoid bone shows distinct spotted rarefaction of both fragments, particularly the distal one. In the axial plane also the lateral o.s. of the left foot is observed to be partitioned, as also on the same foot a small medial sesamoid bone under the head of the second phalanx. Roentgenogram

of the knees demonstrate distinct emargination of the upper outer patellar quadrant.

Control examination, November 6, 1940: The patient has been at work as previously since October 10. Notices some pain under the first metatarso-phalangeal joint when she has walked much, as also on dorsoflexion of the great toe. No swelling around the joint mentioned or tenderness on pressure over the o.s. Roentgenological examination demonstrated fairly unchanged conditions.

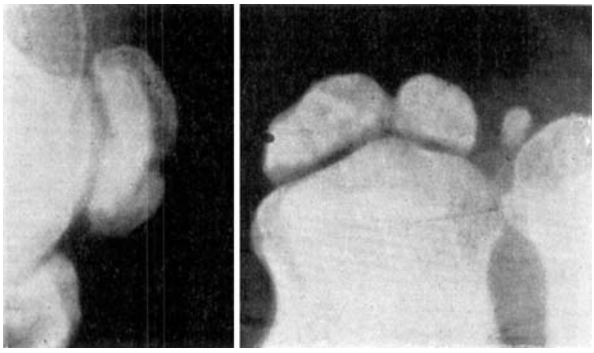

Fig. 2.

Follow-up examination on October 25, 1941: The patient has been—and is still—at full work during the 13 months since the previous examination. During this period she has never felt pain in the foot, and does not now either, even after long walks. Clinical examination shows entirely normal conditions, particularly no pain on dorsoflexion or abduction of the great toe. Roentgenological examination demonstrates normal structure of the diseased sesamoid bone. The focus as mentioned in the distal fragment, however, is barely visible. The partition is as before.

Case II. Male medical student, 25 years of age. The patient has had the usual children's diseases. Otherwise has always been healthy. Especially no disease of bones or joints. He has no complaints from his feet. He has been an active athlete for several years, and he has i.a. ten county championships of athletics, and four distance badges in silver. In 1937 he hit the right knee violently during a long jump. He was in bed for 3 weeks, since when he has noticed nothing amiss. Neither have the feet failed in any way in endurance tests, as for example for the military marching badge. Occasionally, however, after great exertions he has noticed greater fatigue and tenderness of the right foot than of the left. On January 30, 1941 he went for a walk of approximately one mile

and a half. Already the same evening he got severe pain of the ball of the right great toe corresponding to the first metatarso-phalangeal joint. He was almost unable to tread down on the foot due to pain. There was extreme swelling over the basal joint of the great toe and great tenderness to touch. *Physical examination:* Very moderate hallux valgus of

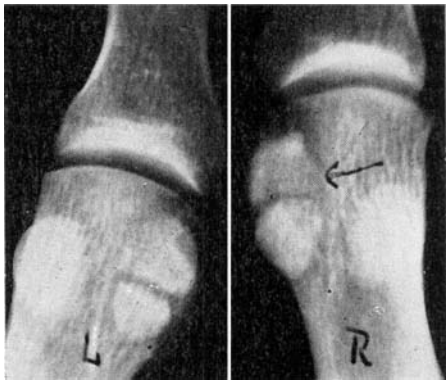

Fig. 3.

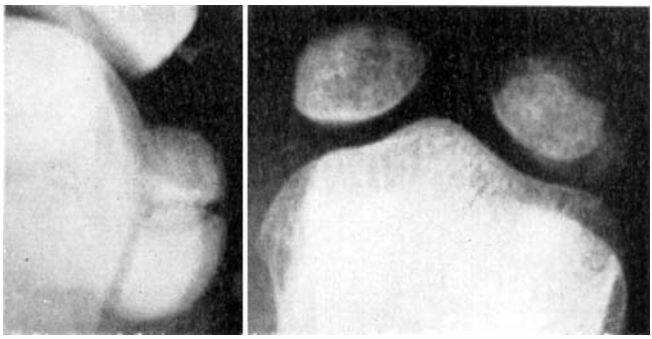

Fig. 4.

the right foot. Great swelling over the first metatarso-phalangeal joint and the ball of the great toe. The swelling extends over the entire anterior part of the foot. The skin covering the joint mentioned is red and warm. Great pain on traction of the great toe and on pressure against the ball of the great toe, as also on attempts at movement in the joint mentioned, particularly on *dorsoflexion* and *abduction* of the toe, however not on compression in the joint. Extreme tenderness on palpation of the medial o.s. The patient is greatly lame, and due to pain

has to walk on the outer margin of the foot. He would not keep quiet, however, and continued his work. In the course of the first few days the condition grew worse, thereupon improving gradually without treatment. When approximately two weeks had elapsed the lameness had disappeared, though there was still some tenderness over the ball of the great toe for some weeks. Also the pain and tenderness had vanished after the lapse of one month, and later the patient has not been troubled by his lesion.

Roentgenologic examination January 24, 1941: Bilateral transverse partition of the medial o.s. of the great toe with spotted rarefaction, particularly of the distal fragment, which demonstrates distinctly spotted and linear rarefactions in transverse as well as longitudinal direction, this fragment appearing almost fragmented. Roentgenogram March 22nd shows the fragment to be of more even structure, and on October 25th 1941 the structures are practically quite normal. A definite tapering is seen now, however, an incipient exostosis on the lateral corner of the metatarsal head on both sides. The partition is unchanged. *Diagnosis:* Mild arthrosis of the joint of the great toe.

Discussion: In both the above cases the symptoms occurred quite suddenly, in the first case entirely without any demonstrable external cause. In the second case it cannot be regarded as probable at all that the one and a half mile walk of a sportsman in training can have been a releasing factor of the suddenly occurring symptoms. In the first case bilateral hallux valgus was present, more marked on the diseased than on the healthy side. In the second case hallux valgus—though very moderate—is present on the diseased side, and not on the healthy side. On the whole clinic and roentgenology, as also the fact that no clinical symptoms existed of any interarticular lesion, (no pain on pressure of the articular surfaces against each other), speak definitely for the presence of an "osteopathia" of the o.s. (*Renander*).

With regard to the cause of the acute clinical symptoms with pain, tenderness and redness—thus inflammatory—it is most natural to imagine a secondary infection. The fact that these symptoms may vanish in the course of a short time, as in my case II, even without the patient having kept quiet or having been subjected to any treatment whatever, should speak against such assumption. On the other hand, however, a case has

been referred (*Lange* and *Bennet*), which, demonstrates that in such an acute case it has been a genuine osteomyelitic infection which has resulted in destruction of the sesamoid bone through the formation of abscesses and fistulae. It may be perceived, therefore, that in cases similar to the two of mine, similar infection has been present, which has terminated, however, before suppuration has set in. It must be supposed, at any rate, that the possible infection has attacked an o.s. which was partitioned already beforehand, and that it has no causal relation, therefore, to the pathogenesis of the partition. This question is discussed in more detail in connection with the cases of *Lange* and *Bennet*.

In the predominating number of cases, however, the symptoms have an *insidious* onset. Pain and tenderness on pressure may have troubled the patient in variable degree and with intervals—of years even, as in my cases III and IV. In the chronic cases the sole clinical symptom may be pain on dorsoflexion of the great toe (*Kimmelstiel-Kremser-Richter*). Simultaneously the patient not rarely presents some anomaly or other of the skeleton of the foot—though frequently slight only—such as pes excavatus, pes plano-transversus, hallux valgus, as in all of my cases, or the like. Thus the clinical picture in the chronic cases is composed exclusively of quite commonplace symptoms, and cannot, therefore, be described as typical.—*Kimmelstiel*, *Kremser* and *Richter* also reject absolutely, due to the clinical symptoms as well as for other reasons which will be referred later, that a typical lesion exists of the sesamoid bones of the foot.

In 1931 *Wiedhopf* and *Griefenstein* in a paper on the histological changes in the so-called typical disease of the sesamoid bones of the first metatarsal, referred a case of arthritis urica in these sesamoid bones. The diagnosis was established definitely through histological examination of the extirpated affected medial o.s. The symptoms which set in suddenly, corresponded in all details to those recorded above in "the typical lesion of o.s.", and the authors deny definitely, therefore, that such lesion exists. They refer to their case as unique—and to a certain

extent they are right—as was proved by the histological examination. Otherwise it is not unique, however, as coincidence between arthritis urica and affection of the o.s. with the above mentioned clinical symptoms occurs in a case observed by me, which will be described more closely subsequently.—

When the disease makes its début with an acute attack, this lasts a very few weeks only, two-three, or even less than that, while the further course seems to be able to extend over years. As will be mentioned later, it does not seem unreasonable to assume that the acute stage may represent only *an acute exacerbation of a lesion with chronically latent course.*

The cases published hitherto of os sesamoideum partitum (o.s.p.) with clinical symptoms demonstrate that these have a *considerably greater incidence in females than in males,* thus quite the reverse condition to that of patella partita. Of the 59 cases which I have assembled from the literature, including my 5 cases, 17 were males and 42 females, that is 28.8 per cent males and 71.2 per cent females, approximately as *1: 2.5.* The same surplus of females is still more evident in childhood. Among 34 clinical cases referred by *Kimmelstiel-Kremser-Richter,* in which the sex was indicated, 14 were under 15 years of age, 2 of which were males and 12 females. This does not necessarily mean that the actual o.s.p. as congenital, primary anomaly—if such exists—has a greater incidence in females than in males. Of three cases of o.s.p., which were incidental findings, two—in which the sex was indicated—were females both, 32 and 40 years of age respectively (*W. Müller*), while conversely 5 cases of o.s.p., discovered as chance section findings, were men all, between the ages of 56-86 years. In two of these cases the histological examination indicated a healed fracture, in the remaining three cases *necrosis* was present of the partitioned sesamoid bone (*Meffert*). These figures, however, are too few, of course, so that no definite importance may be attached to them. It is reasonable to assume, according to the above remarks, that o.s.p. has a greater incidence in females than in males. Two of my five cases were males and three females.

With regard to *the age* of the patients, the symptoms occur

most frequently between 18 and 20 years of age. In the 34 cases of *Kimmelstiel-Kremser-Richter* the earliest appearance of the clinical symptoms was towards the end of the first decade, thus corresponding to the commencement of the ossification in females. Twelve were attacked between 10 and 15 years of age, the majority of the operated cases belonging to this group. Seven patients were between 15 and 20 years of age. Thus a total of 19 patients in the prepuberty or puberty years, or those

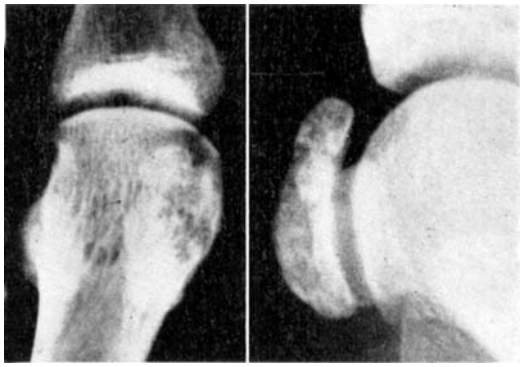

Fig. 5.

immediately following. 6 of the 7 patients of *Meis* were between 12 and 15 years of age, one was 22. My three female patients were 35, 31 and 21 years old respectively. The males were 25 and 75 years old.

Virtually all of the females in the materials of previous authors are self-supporting, among which 4 hospital nurses, a couple of factory girls, and so forth.

As far as *the incidence* of o.s.p. is concerned, some figures are available from earlier as well as more recent authors. It has been mentioned that *Momburg* (1907) on studying the roentgenological material for two years found 9 cases of o.s.p. *Wolf* (1912) for the 11 year-period 1902-12 found in the military hospital at Leipzig, among 900 normal feet, a partition of the o.s. in 54 cases, i.e. in 5.9 per cent. In 1915 *Geist* made an incidental finding of 10 per cent o.s.p. among 100 normal feet. In 1927 *W. Müller* in a series of roentgenological examinations

of 333 normal feet found o.s.p. in 27 cases, i.e. in 8.1 per cent. In 1929 *Meffert* examined specimens of sesamoid bones—chiefly derived from sections, partly also from operations—in 70 individuals between the ages of 4 and 80, and found transverse partition of o.s. on 7 occasions (10 per cent). Four of these patients were between 30 and 40 years of age, two of the age of 40-50 years, and one between 60-70 years. Six of these seven patients were female. Recently *Inge* and *Fergusson* (1933) have found by roentgenological examination of 1025 healthy individuals o.s.p. in 10.7 per cent. It was in 1933 also that *Kimmelstiel-Kremser-Richter* referred their examinations—also roentgenological—of o.s. Partition was found in 24 of the 35 clinical cases—approximately 70 per cent. *Kewenter* in his handsome paper from 1936 also accorded a more searching study to this question. Among 800 individuals between 14 and 65 years of age he found o.s.p. in 35.5 per cent.—As a matter of course only those of the above mentioned statistics may be compared, in which the material is uniform, that is to say the statistics based on serial examinations of *foot-healthy* individuals. In the five statistics in which this was the case and in which the number of individuals examined was one hundred or more (*Wolf, Geist, Müller, Inge and Fergusson,* and *Kewenter*) the number of partitioned o.s. varied between 5.9 and 35.9 per cent, the latter percentage in *Kewenter*'s material, while the number in the remaining four statistics did not exceed 10.7 per cent. In my opinion the cause of this great divergency, no doubt, shall have to be looked for in the fact that *Kewenter*'s material is examined not only in the dorso-plantar and the sagittal plane, but in the axial plane as well, as reported by *W. Müller*. The patient lies in prone position with maximal dorsoflexion of the great toe towards the cassette.

When, as mentioned in the material of *Kimmelstiel-Kremser-Richter,* in which the examination was carried out also in the axial plane—though not systematically—70 per cent of partitioned o.s. were found, which is double the number of that found in *Kewenter*'s material, in my opinion this must be ascribed to the fact that *Kimmelstiel-Kremser-Richter's* material

dealt exclusively with *clinical* cases. It plays no decisive part in this connection, that this material was so small compared to that of *Kewenter*.

As mentioned before, the partition in the great majority of cases involves the *medial* o.s. A number of authors (*Momburg, Stieda, Morian, Wolf* a. o.), however, have found partition also of the lateral o.s. Thus *Wolf* found partition of the lateral o.s. in 5.6 per cent, of the *medial* in 94.4 per cent of his 54 cases. *W. Müller* found partition of the lateral in 11.1 per cent, of the medial in 88.9 per cent of his 27 cases. *Kimmelstiel-Kremser-Richter* found the lateral o.s. to be partitioned in one case only of 35, and *Kewenter* in 10 cases only the lateral o.s. partitioned, i. e. in 1.3 per cent, while the medial o.s. was found to be partitioned in 30.6 per cent. In *Meffert*'s 7 cases the medial o.s. was partitioned in three cases, the lateral in two cases. In 10 of 54 cases *Wolf* found the partition to be *bilateral*, viz. in 18.3 per cent. *Inge* and *Fergusson* found 25 per cent bilateral among 83 cases, while *K. Koch* (1924) maintains that in the great majority of cases the anomaly is bilateral. *Kimmelstiel-Kremser-Richter* report that among their 35 clinical cases bilateral partition was found in 16 cases—all of the medial o.s.—i.e. 45.8 per cent. On three occasions they found unilateral partition on the left foot, and three times on the left. Once they found multipartition, also of the medial o.s. in 13.5 per cent, and of the lateral in one case (0.1 per cent). In the unilateral cases *Kewenter* found the partitions to be evenly distributed over both feet, and this applies to both sesamoid bones. 3 of my 5 cases were bilateral, and 2 unilateral. On that side in the one bilateral case where clinical symptoms were present, also the lateral sesamoid bone was found to be partitioned, although not a transverse partition. As mentioned previously, a small medial sesamoid bone was found at the same time *under* the head of the second metatarsal.

III.

The roentgenological picture of o.s.p. met with as an incidental finding—whether or not it represents a congenital

anomaly—demonstrates an o.s. of normal structure and with regular margins, which in the majority of cases is divided into two practically equal parts by a transverse partition as in my case I. Frequently the partition is of even width, but it may also be wedge-shaped on one foot, as in my case I. While it is quite narrow in some cases, in others it may measure 2-3 mm. in width. Besides transverse direction the partition may also have a more or less oblique course. Besides bipartition one may occasionally find multipartition. According to the direction of the course of the partition and the number of partitions, several types of partition may be registered. *Kewenter* has set up no less than eleven partitions, numbered according to their incidence. The most frequently occurring are the three forms of bipartition with transverse groove, of which the one dividing the bone in two equal parts, as mentioned previously, is the most frequent.

The margins of the patition are distinctly regular and well defined, though they may be also more irregular. If one wishes to study more closely the partition and its delimitation, it should not be done in the dorso-plantar and the sagittal plane only, but in the axial plane as well. The above mentioned method, recommended by *W. Müller,* is most suitable for this purpose, as one may ascertain in this way partitions which do not reveal themselves in the two other planes.

The X-ray findings described here give the distinct general impression that one is faced by a *primary anomaly,* as opposed to the X-ray findings in lesions of the sesamoid bones in which *clinical symptoms* obtain. Then it is not the partition which comes to the fore. A distinct, regular partition may be absent, as in my case IV, in which such could not be recognized even on the extirpated o.s. On the contrary an irregular partition was observed which had to be regarded as the product of the spotted atrophy, decalcified parts interchanging with more calcified or even abnormally calcified parts. The decalcified parts may lead to *fragmentation* by more or less regular partition.

With regard to the interrelation between the morbid picture,

designated by him as the "typical" one in a lesion of the o.s. with transverse partition, *W. Müller* emphasizes "*dass in keinem Falle wo die genannten Krankheitserscheinungen da waren, auch die Querspaltung fehlt, so dass also die Querspaltung gewissermassen mit der Ausdruck des pathologischen Zustandes ist, es gibt aber nicht das umgekehrte, denn es gibt zweifellos häufiger die Querteilung ohne irgendwelche Krankheitserschei-*

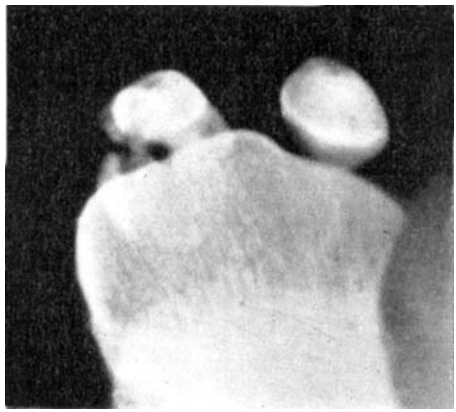

Fig. 6.

nungen." No doubt the last sentence is correct, though not the first one, however. My cases III, IV and V are proof of this. *Meis* maintains that the X-ray findings in his seven cases did not differ materially from those of the other authorities. Simultaneously he brings forth the quite remarkable information, however, that in none of his cases—which were all clinical—had he found the "von *Müller* so hervorgehobene fleckige Entartung in den Fragmenten selbst ... Im Röntgenbild ist dieser Sesambeinerkrankung gekennzeichnet durch eine Zwei- oder auch mehrfache Teilung in gleich grosse bzw. ungleich grosse Fragmenten."

Kremser in the above mentioned paper of *Kimmelstiel-Kremser-Richter* has described the X-ray picture in the lesion designated by these authors as *Osteochondrosis necroticans findens* in the o.s. of the first metatarsal, and which corresponds to the

"typical lesion" of sesamoid bones of *Renander* and *W. Müller*. 25 pairs of sesamoid bones were examined in individuals, all of whom presented pronounced clinical symptoms. In all of the cases, with the exception of two, X-ray changes were demonstrated deviating from the normal. Besides blurred structure these changes consisted of "scholligen Zerfall, Formveränderungen, vakuolige Aufhellungen in Verdichtungsbezirken sowie Zertrümmerungen der Sesambein". Further ragged contours were observed with proboscidiform projections. It is observed in several of the pictures reproduced in the text, all of which have been taken in the axial plane, that besides structural changes the affected bone also shows partly pronounced partition. Some pictures resembled a central sequestration. The authors wind up by stating that often the picture showed a far-reaching similarity to that found in necrosis of the os lunatum (Kienböck), Köhler's disease and Legg-Calvé-Perthes disease, adding that some of these pictures—particularly in children—call to mind the changes in *the patella* similar to Köhler's diseases recently described by the authors. Refer to part A of the present paper (patella partita) regarding this subject.

In 8 of the 25 cases examined by X-ray histologic examination was carried out of the extirpated sesamoid bone. It appeared that in all of these 8 cases discrepancy existed between the X-ray and histologic findings, no explanation of this fact being possible at all. In cases demonstrating severe structural changes quite normal histologic conditions might be found.

In the large material of *Kewenter* of 710 individuals, none of them—neither adults nor children—had presented or did present clinical symptoms of a lesion of the sesamoid bone—neither objectively nor subjectively. In four cases, however—adults all—the X-ray examination revealed distinct changes which had to be interpreted as pathological, consisting of blurred contours with structural changes, particularly in the form of spotted atrophy. In two other cases outside the material of this author, both of whom had consulted a physician due to clinical symptoms of a lesion of the sesamoid bone, identical findings were made. In the one case, a 50 year old male, the

symptoms set in suddenly apparently without external cause, with intensive pain under the left first metatarso-phalangeal joint, great tenderness as also swelling and redness over the first and second metatarsals. X-ray examination after 6-7 weeks had elapsed disclosed a lateral o.s. of the left foot, divided into two fragments with blurred structure due to spotted atrophy. The medial, non-fragmented o.s. of the same foot showed similar structural changes. The o.s. of the right foot were normal. No signs of arthritis urica, which was the clinical diagnosis made when the attack set in. A moderate hallux valgus of both feet. X-ray examination showed a slight arthrosis deformans of both metatarso-phalangeal joints. The second patient, a 39 year old female—had suffered from pain in the anterior part of the right foot for several months. No trauma. The pain was most pronounced under the medial part of the ball of the great toe with some tenderness. X-ray examination of the right medial o.s. demonstrated structural changes with fragmentation. Also here the metatarso-phalangeal joint showed arthrotic changes. *Kewenter* holds that the etiology of the lesion of sesamoid bones as present in these six cases, must be looked for in an arthrosis deformans. Particular interest attaches in this connection to my case V, which subsequently will be referred in detail, and in which definite arthrotic changes existed of the first metatarso-phalangeal joint. It shall be mentioned here only that this was probably also a case of arthritis urica, though certainly also of arthrosis deformans of *both* first metatarso-phalangeal joints with excessive tenderness over the ball of the great toe. X-ray examination demonstrated blurred contours with irregular plurifragmentary division of both medial o.s. *Thus the constant X-ray finding* in the clinical cases, the acute as well as the chronic, is the *spotted atrophy.* A distinct transverse partition, therefore, or on the whole a regular distinct partition as observed in cases with the partition as incidental finding, regarded—rightly or wrongly—as being of congenital nature, is not constant as shown by my last case. It appeared as if the irregular partition found in this last case, could be explained perfectly as being due to the particularly pronounced spotted atrophy of this case.

My cases, therefore, seem to corroborate entirely that *the clinical symptoms are dependent upon the structural changes or vice versa, and not upon the co-existing transverse partition of the bone in the majority of the cases.* My two cases with acute onset—more especially the first one—are of particular interest in this respect, as they demonstrate that *after the clinical symptoms have disappeared the structure of the bone became gradually perfectly normal.*

The first of these cases is of interest also because it shows marked structural changes of the diseased sesamoid bone already on X-ray examination five days after the clinical symptoms had commenced acutely and were already on the wane. It cannot be decided from my X-ray picture whether this indicated that these changes had actually developed in this short time in a beforehand normal sesamoid bone, or whether it means an exacerbation only in an already beforehand diseased bone and is due, therefore, to an acute exacerbation. The clinical symptoms, however, speak strongly against such assumption, and for the acute stage being the onset of the lesion of the sesamoid bone, which was revealed also on the X-ray film.

As mentioned previously the X-ray picture in the first of my two acute cases demonstrated a bilateral transverse partition of the medial o.s. Both fragments on the clinically diseased side showed structural changes in the form of spotted atrophy, especially the distal one, in which is observed a greater focus-like rarefaction. The spotted atrophy is particularly evident in the axial plane. In both planes is observed also that the lateral o.s. on the clinically diseased side is slightly, but irregularly partitioned. In the same foot is seen also a sesamoid bone, the size of a shot, on the medial side of the head of the second metatarsal. Both of the sesamoid bones of the sound foot, the medial one of which was transversely partitioned by a broader furrow than on the other side, appeared to have normal structure. Another X-ray examination seven weeks later demonstrates definitely less pronounced spotted atrophy of the diseased o.s. Follow-up examination thirteen months after the onset of the disease, proved the partition to be unchanged, *but*

the spotted atrophy having disappeared in both fragments, in other words a sesamoid bone with normal structure.

The X-ray examination showed also in my second acute case bilateral partition of the medial o.s., with normal structure, however, of both fragments on the clinically sound foot. In the fragments of the diseased foot, however, *considerable structural*

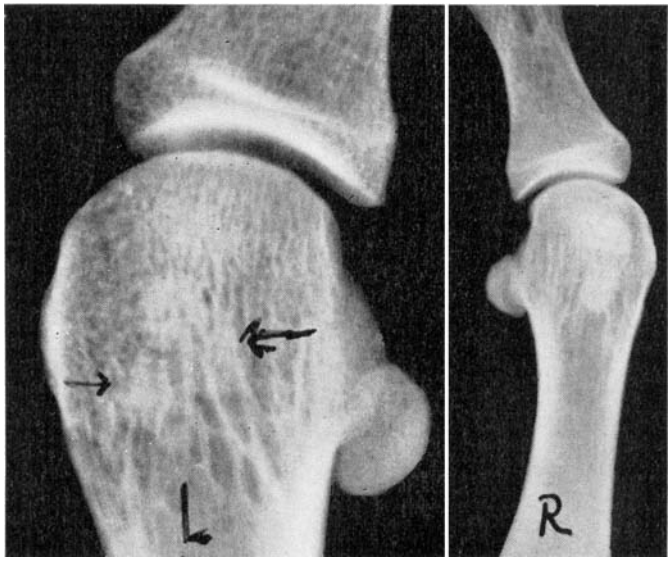

Fig. 7.

changes were seen in the form of spotted atrophy, particularly in the distal one. In the distal end of this was seen a distinctly delimited, abnormally profusely calcified part, the size of shot. Subsequent X-ray examinations, two and nine months later respectively, demonstrate that the partition is unchanged, but the fragments have a regular structure. This small, greatly calcified part is quite unchanged, though fragmented.

In my two cases with a chronic course (III and IV), which shall be referred in more detail later, and in which the diseased o.s. was extirpated, X-ray examination in the first case showed bilateral transverse partition of the medial o.s. with exceedingly pronounced spotted atrophy of both fragments on the diseased

side. In the axial plane also the medial o.s. on the sound side showed spotted atrophy.

In the second chronic case (IV) X-ray examination of the right, sound foot demonstrated a distinct transverse partition of the medial o.s. into two equal fragments with normal structure. X-ray examination of the left, diseased foot showed no transverse partition, but a marked spotted atrophy with an irregular partition of the bone.

IV.

If one is desirous of elucidating the pathogenesis of the partition of the sesamoid bones, the histologic examinations of extirpated sesamoid bones will be able to furnish more valuable contributions than the clinical and roentgenological examinations. The histological examinations performed have been directed against the actual partition as well as the fragments. Particularly the examination of the partitions must be of importance with regard to the question of congenital or acquired lesions, while the question of the histology will be of special significance a. o. to the question of the cause of the spotted atrophy in partitioned as well as in non-partitioned o.s., and consequently to an interrelation between o.s. and the aseptic osseous necroses.

The first histological examination of a sesamoid bone removed from under the head of the first metatarsal on the strength of clinical symptoms, was carried out in one of Renander's two cases. It was a 36 year old female, who had suffered pain for 3-4 years in the medial part of the anterior right foot —pain which had occurred gradually without any preceding trauma. X-ray examination demonstrated that the medial sesamoid bone on both feet was divided into two partitions—one greater and one smaller. It was flattened on both sides. While the structure on the left one did not differ definitely from the normal, on the right one—where the clinical symptoms were present—it showed marked *spotted* atrophy, profusely calcified parts interchanging with decalcified parts. Histologically the largest part of the great fragment disclosed *necrosis of marrow*

tissue as well as of osseous tissue, while the small part showed small necrotic areas, in which *the marrow cells* at any rate partly had been stainable. Further was observed in the greatest fragment a small number of *giant cells,* deposited partly in lacunae on the bone struts, partly in the osseous marrow, partly in the connective tissue uniting the two fragments. In the smallest fragment no changes were found of the cartilaginous tissue. It is said of the actual partition that the connecting line, half a millimetre wide, between the two fragments consisted of *connective tissue.*

Because of the correspondence that *Renander* meant to have found between both his cases with regard to the clinical and roentgenological, and in one case also the histological findings, and the Köhler, Legg-Calvé-Perthes, Osgood-Schlatter diseases etcetera, this author considered that both his cases had to be included in this group of chondro-osteopathies.

In his paper of 1925 *W. Müller,* as already mentioned, gave his support, based on the clinical and roentgenological findings in four cases, to the opinion of *Renander,* that the affection of the sesamoid bone was caused by a local malacia similar to that of the os lunatum or of the head of the second (third) metatarsal (Köhler). The author holds that *continuous,* mechanical irritaments in conjunction with *predisposing conditions of the osseous system* give rise to the strange, isolated necrosing process.

In his paper of 1927 *Müller* recorded a further three cases of lesion of the sesamoid bone. He also referred the result of the histological examination of one of the four cases reported in his preceding paper, in which an extirpation of the diseased lateral o.s. had been necessitated—that of a 29 year old dancing instructress, who in November 1924 rather suddenly, and without any preceding trauma whatever, had got intensive pain in the right foot, located to the plantar side of the first metatarsophalangeal joint. The pain was described as similar to violent tooth-ache. X-ray examination disclosed a peculiar spotted structore of the lateral sesamoid bone due to irregular calcification. *Another X-ray examination one year later revealed that the*

spotted atrophy had resulted in fragmentation of the bone. The X-ray picture of the medial sesamoid bone demonstrated that this was transversely partitioned into one great and one small fragment. No mention is made of the conditions on the other foot. Both sesamoid bones were removed. The histological examination of the medial o.s. showed normal conditions of the smallest fragment. The greatest, on the other hand, as well as the lateral o.s. demonstrated a *necrosis* of the osseous tissue, but not of the *marrow tissue.* This necrosis, however, was no *total necrosis,* the marginal lamellar system still generally containing cells. Thus *Müller* found that a *partial* necrosis was present of part of the medial o.s. and of the whole of the lateral. While the X-ray picture of this presented a fissured, irregular partition, it was smooth and transverse on the medial o.s.

With reference to the actual partition the author found that the marrow cavities in he fragments were open towards the partition as also that the bone strut projected freely towards this. The margins of the partition, therefore, were not regular. The actual partition space was filled by lumps of substance without centres, or a mass simulating the fundamental substance of hyaline cartilage, in which was observed irregular heaps of cartilaginous cells, while in other parts were seen fibrillary connective tissue, rich in cells, and "nekrotische Knochengewebstrümmer und Schollen". In three more cases regarding section material from patients, with reference to whom no information of possible clinical symptoms existed, the identical finding was made, broadly speaking. Also here the marrow cavities were open towards the partition space, which was filled partly by fibrillary or hyaline masses, while the marrow cavities were filled by fibrillary connective tissue, rich in cells. *Müller* maintains that his findings entitles him to conclude that it is not a question here of two primary *osseous centres.* One gets the absolute impression, however, that an original *single primary centre* is present, in which for some reason or other a partition has taken place—possibly during the period of ossification. The author assumes that the cause of this must be looked for in the fact that a "regional zone of resorption" must have

originated in the bone as a manifestation of a reaction on the part of the tissue to *mechanical* factors at work here. In other words, the author ranges the transverse partition on a line with the so-called "Umbauzonen—eine regionäre Knochenabbau" caused by mechanical strain. The histological picture resembles the one found in a *pseudarthrosis*. It speaks definitely against fracture, however. In addition to the four cases mentioned, *Müller* has examined histologically 50 sesamoid bones from sec-

Fig. 8.

tions. *The great majority of these demonstrated perfectly normal histological findings.* In a few cases only changes were found—*changes which corresponded perfectly to those above mentioned.*

According to this *Müller* assumed that the *partial* necrosis described by him was *characteristic of necrosis of the sesamoid bones of the foot,* and that it could not, therefore, as also assumed previously by *Renander* and himself, be ranged in a line with the aseptic epiphyseal necroses, in which the necrosis is *total,* that is to say, attacks *the marrow as well as the osseous tissue.* As opposed to the findings made in these "total necroses" *Müller* furthermore found that the partial necrosis was associated with markedly *slightly prominent, reactive, regenerative processes*—which he held to be a characteristic feature of the necrosis in these sesamoid bones.

Griep later in the same year as *Müller* referred a case of

"osteitis fibrosa der Sesambeine", a 29 year old domestic servant who had suffered pain for 5 weeks with no demonstrable cause, under the head of the first metatarsal of the right foot with excessive tenderness over the medial sesamoid bone. In the palms of both hands and the soles of both feet she had keratoma, a lesion which had been hereditary in the family of her father for several generations. X-ray showed a transverse partition of the sesamoid bone mentioned, which presented *characteristic spotted markings, had a spongy appearance, and was penetrated by small fissures.* As the clinical symptoms did not recede with conservative treatment, the sesamoid bone was extirpated. Macroscopically the cartilaginous coat demonstrated fine indentations which were suspiciously similar to cartilaginous degeneration. Microscopically *the marrow tissue showed a reorganization into fibrillary connective tissue* containing several blood vessels and giant cells. The periosteum demonstrated proliferation and bone formation. Professor *Schminckel*, who had carried out the histological examination, summarizes the result of this as follows: "Es handelt sich um einen Prozess der in seiner Gesamtheit in das Gebiete der Ostitis fibrosa hineingehört und offenbar durch ein Traume das zu einer Desintegration des Knochengewebes geführt hat, bedingt ist". Such trauma, however, was not demonstrable in the past history. A chronic-mechanic factor seems sure to have played a rôle, on the other hand. Also a portion of the cicatricial articular capsule was examined. No sign of inflammatory process was demonstrated.

W. Jaroschy, also in 1928, described two cases of "die typische Erkrankung der Sesambeine der Grosszehe", in a 33 year old housewife and a 15 year old girl respectively. While the clinical symptoms in the last-named case disappeared after conservative treatment for some weeks, in the first-named, in whom the symptoms had commenced one year previously without any trauma, the diseased medial sesamoid bone was extirpated. The roentgenogram of this showed a *spotted structure* with a distinct thickening of the proximal part, as also a *bipartition* of the bone with a transverse zone of rarefaction. Further the thickness of the sesamoid bone was reduced. Both

sesamoid bones of the diseased side was removed. No mention is made of the conditions on the other foot. The concave articular surface of the removed medial o.s. showed macroscopically a quite small defect of the cartilage. The histological examination (professor *Kraus*) demonstrated that the transverse furrow was filled partly by red corpuscles, partly by strongly eosinophile, homogenous masses. Subchondrally the partition was filled by scattered proliferative cartilage, connected with the cartilaginous cover of the surface. The walls of the partition were formed by proliferative cartilaginous tissue with few cells, calcified in scattered spots, the basic substance of which appeared to be mainly acidophile. In this connection the author states with regard to the result of the histological examination of the fragments as follows: "Anschliessend an diese unregelmässig gewucherten Knorpelmassen findet sich spongiöser Knochen mit stark verdickten Bälckchen, zwischen denen teils Fettmark, teils ein stellenweise sehr gefäss- und kernreiches Fasermark, stellenweise auch Knorpelgewebe vorhanden ist. Osteoide Säume sind nirgends zu sehen. Die präkapillaren Gefässe innerhalb des Fasermarks zeigen vielfach deutlich verdickte Wand. Der Gelenkknorpel ist etwas gewuchert und stellenweise gegen die Spongiosa in einer unregelmässig verlaufenden Grenzlinie abgesetzt". The author makes the following summary of his findings: "*In unserem Falle waren Knochennekrosen mit Sicherheit nicht nachweisbar.*[1] Wir sehen eine Kontinuitetstrennung des Knochens, wobei es sich, wie aus *den reichlichen reparatorischen und regeneratorischen Vorgängen am Knochen und Knorpel hervorgeht,*[1] zweifellos um einen Prozess älteren Datums handelt". No histological data existed, namely, on which to base the assumption that any inflammatory process was present, or any process due to circulatory disturbance. Whether the partition had involved an originally intact bone morphologically, or whether a necrotic focus had been present at the place of partition provoking a fracture, could not be decided from the histological findings. The bone had already been too

[1] Emphasized here.

greatly reorganized to enable such decision. The profuse cartilaginous tissue in the partition, which might be regarded somehow as a "luxuriant" cartilaginous callus, seems to indicate that the two fragments were in constant friction against each other, so that no consolidation could take place of the obviously well-nourished sesamoid bone. The author considers it reasonable to assume that this lesion of the sesamoid bone under the head of the first metatarsal is analogous to the Köhler disease of the head of the second metatarsal, as the sesamoid bone saves the head of the first metatarsal from the direct pressure during walk. The histological examination of the lateral sesamoid bone showed *normal conditions.*

In 1928 *Meis* recorded 7 clinical cases of *"osteochondropathia o.s."*. In one of these—a 21 year old male—extirpation had to be performed of the diseased medial o.s. of the left foot, which was divided into two unequal parts by an oblique partition. The bone was divided into three parts by perpendicular incisions in the frontal plane. In all incisions, outside the partition, *no pathological changes whatever* were found, neither with regard to cartilaginous nor osseous tissue. The result of the histological examination of the middle incision, containing the partition, corresponded materially to the picture found in an old fracture, and thus resembling the one found in a *pseudarthrosis.* The author holds that his finding on the whole corresponds to the findings of *Renander* and *Müller,* with the exception of the small peculiar, *necrotic* parts, demonstrated in the bone struts only, as described by *Müller,* and which *absolutely not could be found in the author's cases.* The author maintained that it was quite unjustified to assume—as *Müller* did on the basis of these small necrotic parts—that a morbus sui generis was present of the sesamoid bones. On the other hand, however, he held that undoubtedly these necroses fell within the scope of this lesion of the sesamoid bones. For this speaks *Renander's* finding of necrosis also of the bone marrow, a necrosis which meant no more, however, than a continuation of the process of fragmentation. With reference to the histological findings in the partition, the author claims that they are in

perfect conformity with those of *Müller*. "Bei allen Fällen ist auf dem Wege über primäre, subchondrale Zertrümmerung und Nekrotisierung der Knochenlamellen und der Markräume mit nachfolgende Reaktion seitens des Binde-Knorpel- und Knochengewebes ein an eine Pseudoarthrose erinnernder Zustand geschaffen worden. Die die Gelenkfläche bildende hyaline Knochenschicht ist in allen Fällen tadellos erhalten". The author agrees, therefore, with the opinion of *Renander* of this lesion

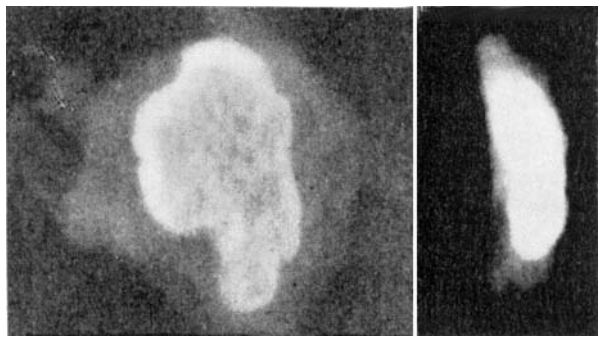

Fig. 9.

of the sesamoid bones as an osteopathy, and states in conclusion that his finding entirely corresponds to the histological findings in the first stages of the Köhler and Perthes diseases, which fact is confirmed also by the X-ray findings. The author assumes that in all probability the morbid process occurs in the way that during the ossification of the sesamoid bone, or shortly after, one or more *necrotic* foci occur *primarily*, gradually growing and spreading over the surroundings in one direction or other, and then confluing, thereby causing a partition. The author finds support for this assumption primarily in the irregular, curving shape of the partition with offshoots in different directions, and further in the gradual difference in strength of the reaction present in the surrounding osseous tissue at the different places.—According to the histological findings described here the author joins *Müller* in disassociating himself from the conception that the partition in o.s. depends upon a *congenital* division, as also that it is caused by a

genuine fracture. According to the opinion of the author many of the fragmentations of the sesamoid bones previously described as genuine or pseudo-fractures, or as congenital partitions, are sure to be identical with the morbid picture described here, granted that no really major trauma has occurred, as referred by *K. Koch* and *E. Müller.* The author excludes also circulatory disturbances of embolic nature as etiologic factor, as also syphilis, tuberculosis, and rickets. The author finds, however, the primary cause to be in the first instance a *congenitally reduced power of reaction* of the juvenile bone as against mechanical lesions, a disturbance of the ossification leading to a disproportion between the functional capacity of the osseous tissue and the strain to which it is subjected. Thus the same condition which is presumably present in the majority of the above mentioned osteochondritic processes.

The same year that the paper of *Meis* was published *Max Lange* referred a case of "the typical lesion of sesamoid bone (*Müller*)" with resulting suppuration. A 26 year old male, a keen sportsman (high jump and football), suddenly—and without any definite trauma—had felt pain in the left foot corresponding to the ball of the great toe. The pain was so great, that the patient was forced to keep in bed. Temperature up to 39° C. with severe swelling of the part mentioned. Incision produced pus. The wound closed in the course of three weeks, but five months after the onset of the disease it recurred, and the lateral sesamoid bone, therefore, was curetted and partly removed. After four years had elapsed another recurrence took place, and this also happened repeatedly in the course of the following two years. On examination November 1, 1927 was found variable pain over the ball of the great toe of the left foot, immediately the foot was subjected to weight-bearing, and this forced the patient to walk more on the outer edge of the foot. Never pain in the right foot. X-ray examination: Medial right o.s. normal. Medial left o.s. not bipartite. The structure is irregular to a slight degree only. Approximately one-third of the lateral sesamoid bone is missing. Both o.s. of the left foot are removed. The histological examination showed—apart from

a couple of small, well defined necrotic foci in the lateral o.s. —*a wide correspondence to the histological findings in W. Müller's cases:* partial, central bone necrosis with preserved marginal lamellae and without marrow necrosis, as also without reactive changes on the part of the bone. These changes were found in both sesamoid bones. The author agrees, therefore, with *Müller* in his opinion that the partition of the o.s. is not of congenital nature, but depends on *regional* reactions of tissue on mechanical basis, taking as a support of this the fact that the medial o.s. of the right foot was partitioned transversely, while the corresponding one of the left foot was not partitioned. The author held that this must depend on the fact that the histological changes in this bone had not yet developed so far that a roentgenological partition was recognizable. It will appear from the subsequent closer report of my case III, in which similar conditions existed, that this conception may hardly be maintained.

With regard to *Lange*'s case, this demonstrates that a spotted atrophy in a non-partitioned o.s. may be due to a partial necrosis of the bone, and that such a necrosis of the sesamoid bone may be caused by a pyogenous infection, which has become manifest clinically in this case as an osteomyelitis with acute onset, but chronic course. *Lange* explains the infection as a secondary complication which has originated in a beforehand changed osseous tissue, which for this reason has become a spot of minor resistance to a hematogenous infection.

Lange regards the infection as a secondary complication in an osseous tissue changed beforehand. The same explanation no doubt applies also to the three cases recorded by *Bennet* in 1935 under the title "Septic osteomyelitis as cause of the so-called typical lesion of the sesamoid bones of the first metatarsophalangeal joint." In the first case, a 12 year old boy, the disease started with attacks of shivering chill, high temperature and pain in the one hip and the one foot, which became swollen. The increase in temperature and the pain receded, and the patient got up, while the swelling of the foot persisted. The patient went to school again, however, and a fistula opened on the inside

of the foot, the X-ray examination disclosing two small pieces of bone along the medial border of the first metatarsal, as also "a deformed medial sesamoid bone with a lateral defect". The second case was a 15 year old boy, who had gradually developed pain in the anterior part of the medial left border of the foot. The foot was greatly swollen and tender around the first metatarso-phalangeal joint, with slight increase in temperature, to 38.4° C. X-ray examination disclosed one larger and one smaller piece of bone on the medial side of the first tarso-metatarsal joint, the medial sesamoid bone being regularly and horizontally bipartitioned. The third case was a female, 22-23 years of age, who in the course of a septic abortion had developed pyemia with swelling and pain of the inner articulation of the foot. X-ray examination demonstrated a regular oblique partition of the medial sesamoid bone, with no sequestrum, however. All of these three patients were treated surgically, and the tissue curetted from the fistular wall was examined microscopically with the result that unspecific granulations were found. In the two cases, in which osseous sequestra were present, however, these were *not* examined. Thus these cases cannot contribute towards the elucidation of the pathogenesis of the partition of o.s., in the two cases in which such partition was demonstrated roentgenologically. Neither is information available of the condition of the other foot.

The cases of *Bennet* give no other or further information than that the sesamoid bones—partitioned or non-partitioned—may also be attacked by an acute osteomyelitic infection. It cannot be refuted, therefore, as assumed by *Lange,* that it was a case of an inflammation of the bone in one of *Müller*'s cases, in which moderate swelling had occurred over the ball of the great toe with slight redness and increased temperature of the skin. —Suppurative inflammation of these sesamoid bones has been described furthermore by *Hernaman-Johnson* (1920).

In 1929 *Meffert* published a pathologic-anatomical paper on diseases of the sesamoid bones of the great toe. His material consisted of more than 70 specimens—chiefly fetched from the dissecting room, but also from the operating table—of o.s. from

patients of ages from 4 to 80. In addition to both first metatarso-phalangeal joints also the second metatarso-phalangeal joint and the hip joint on both sides were examined. Bipartition of the o.s. was found seven times, five of which of the medial and two of the lateral o.s. In five cases the patients were between 30-40 years of age, in two cases between 40-50 years, and in one case between 60-70 years. In six cases females were in-

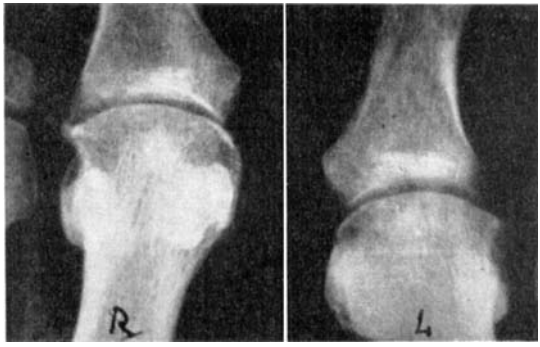

Fig. 10.

volved. It could not be decided whether the partition depended upon a congenital double rudiment, or whether it was due to pressure against the sesamoid bone of a frequently present osseous projection on the head of the metatarsal. By microscopical serial examinations *Meffert* found that *the transverse partition* was formed by a defect in the cartilage only, which was replaced by firm connective tissue, while the subjacent osseous tissue was perfectly intact. Opposed to this, however, the roentgenogram of another case showed that while the cover of the cartilage was quite intact and gave no data whatever for the presence of a partition, the underlying bone was divided into three fragments, the two smallest of which showed a poorer calcium content. The partition between them consisted histologically of *connective tissue* which had penetrated from the sides. In the material of *Meffert* are found also 3 cases—it was section specimens from individuals between 60-70 years of age—the histological examination of which showed necrosis of a sesamoid bone. In none

of the three cases was information available that clinical symptoms were present. In the one case, a 63 year old male, who had died from cancer of the stomach, the medial sesamoid bone showed a *bluish* partition corresponding to a bone projection on the head of the metatarsal lying opposite. There was no transverse division of the bone. The lateral sesamoid bone was intact. Histological examination demonstrated *necrosis of the osseous tissue, but not of the marrow tissue.* Not all of the osseous tissue was necrotic, however. The marginal lamellae also here showed staining of the centres, namely. *The case showed full conformity, therefore, with the finding of Müller of a partial necrosis. Meffert* was unable to find any causal relation of this. No signs were present of *hardening of the arteries* and no obliteration of the vessels, and neither any signs of fracture. *Meffert* contents himself with stating, that as only *a partial necrosis and no total necrosis* was present, the case could not be ranged on a par with *the Köhler diseases, the Legg-Calvé-Perthes a. o.,* and is looked upon as a step in the direction of a total necrosis. Such a *total* necrosis, on the other hand, was found in the other two cases. In the one—a 77 year old individual, who had had his leg amputated due to an arteriosclerotic gangrene—the medial sesamoid bone showed definite changes macroscopically, being i. a. divided transversely into two unequal parts. The second case concerned a 70 year old individual, who had died from nephrosclerosis. No mention is made as to whether the lateral sesamoid bone, being the diseased one here, was partitioned. In both these cases, however, the histological examination demonstrated *total necrosis in complete conformity with that found in the Köhler-Perthes diseases.* Neither in these cases, however, was the necrosis total, so that *all* osseous and marrow tissue was necrotic. Further, the author reports regarding these two cases, that the histological picture is in entire conformity with that referred by *Köhler* for necrosis of the head of the second metatarsal, in which is found: hypertrophy of the articular cartilage, the necrotic tissue delimited by a narrow band, and *total necrosis of the osseous and marrow system.* The only feature missing was the wedge-shaped necrotic

focus so strongly emphasized by *Axhausen* in his papers, as also the crumbling of the necrotic bone struts. *Axhausen* is of the opinion that the preservation of the cartilaginous disc is due to the fact that it is flushed by the synovial fluid.

Simultaneously with the paper of *Meffert* appears a report by *Schütz* of a case of *necrosis* of o.s. in a 22 year old operating room nurse, who had complained for 3 weeks of intensive pain around the first metatarso-phalangeal joint of the right foot, and conservative treatment not having procured any improvement worth mentioning. The roentgenogram showed a transverse partition of the proximal part of the medial sesamoid bone as also irregular, spotted atrophy of the bone. Roentgenogram of the lateral sesamoid bone of the left foot revealed a rather sharply defined transverse partition. The right medial o.s. was extirpated. Histological examination showed that the greater part of the bone was *necrotic*. Also here as in Müller's cases—spots were found in which the marginal lamellae still contained centres. In contrast with the cases of *Müller*, however, Schütz found that also *great portions of the marrow tissue was necrotic*. In other parts of the marrow cavities a marrow fibrosis was found. Of particular interest, however, was the *granulation tissue*, exceedingly rich in cells, apparently originating in the periosteum and consisting of spindle-shaped cells, which extended far into the marrow cavities. In the partition proper connective tissue and fibrous cartilage were observed. *Schütz* holds that this histological finding warrants *the ranging of the case among the juvenile, necrotizing osteopathies. Schütz* regards chronic traumata as cause of the disease, possibly on the basis of certain predisposing factors.

In 1931 *W. Wisbrun* gave a contribution to the pathology and therapy of the lesions of the sesamoid bones "based on 4 clinical cases, three male and one female, between the ages 36-42 years. The one of these patients—a 36 year old labourer—had suffered pain for a number of years under the ball of the great toe on both feet when walking long distances, which was supposed to be due to the existing bilateral hallux valgus, and for this reason bilateral operation was performed for this lesion.

As the pain did not disappear, extirpation was carried out of both the greatly tender and easily palpable medial o.s. Roentgenologically they presented only a certain irregular structure, but *no partition.* Subsequently the pain disappeared. A total of 9 sesamoid bones were removed and examined histologically from these 4 patients. This examination showed that the clinical symptoms, which have been described in exactly the same way by all authors, may be due to *entirely different processes etiologically.* The histological finding in one of these 4 cases demonstrated the presence of a fracture of the sesamoid bone in a stage of repair. In the one case only was there an indication of transverse partition, not in the three remaining cases. The histological finding in these cases disclosed that the bone covered by periosteum was the seat of an *osteoarthritic* process, originated from changes in the periosteum. The author is of the opinion that a *"primary osseous form" of the so-called arthritis deformans* is present. It was possible to distinguish between 3 different phases: 1. Penetration of fibrous tissue from cartilage and periosteum. 2. Dissolution of the structure of the spongious bone. 3. Reparatory structural changes aimed at adaptation.—The course of the disease depends upon whether the reparatory structural changes of the spongious bone are capable or not of stopping the proliferation of the connective tissue. The author could find no traces whatever of the changes of the osseous tissue described by *W. Müller,* and designated by him "Nekrose der Zwischenlamellen", and neither could professor *Hübschmann,* who had examined the specimens. The author disassociates himself definitely, therefore, from the opinion of *Müller* that there exists any "typical" lesion of the sesamoid bones. In the opinion of the author all lesions of sesamoid bones given such designation, or termed osteopathy or osteitis fibrosa, are of *traumatic* origin. They might occur without the patients being aware of having been exposed to any particular trauma. The author maintained that in all cases the nature of the disease would have to be traced back to some inferiority of the osseous substance, which was unequal to the functional strain. The author suggests, therefore, that the lesion be designated *insufficiency of the sesamoid bones.*

In a paper from 1931 *Wiedhopf and Greifenstein* survey the papers mentioned here (*Renander, W. Müller, Meis, Jaroschy, Lange, Meffert, Griep, Wisbrun*), which in their opinion may be classified in various groups, which will be described later in more detail. It should be mentioned here only that the authors maintain being able to establish that all microscopically examined cases heretofore described—also those without available history of disease—may be ascribed to the following three causes of the histological changes:

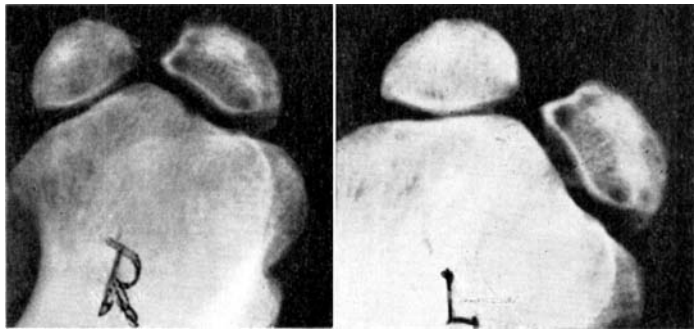

Fig. 11.

1. Subchondral necrosis of the o.s. corresponding to the identical processes in the lunate bone, Legg-Calvé-Perthes, and so forth.
2. Genuine fracture.
3. The so-called "insidious partition".

No typical lesion of the sesamoid bones exist. It cannot be definitely decided whether any *congenital* partition exists. They are certainly much less frequent, at any rate, than assumed.

The case of arthritis urica o.s. described by the authors in their paper showed clinically as well as roentgenologically the identical picture to that found in the so-called typical lesion of the o.s. The histological examination of the removed medial sesamoid bone of the diseased foot, demonstrated by the roentgenogram to be greatly spotted, atrophic, and which had been exceedingly tender on palpation, demonstrated profuse deposits

of urates in the substance of the bone, partly also in the cartilage. These deposits of urates had induced no necrosis of the surrounding tissue, neither of cartilage nor of bone. Around scattered heaps of urates, however, reactive changes had occurred in the tissue, so that it had become encircled by a granulation wall. Some giant cells also were observed here. In the parts of the cartilage, spongious bone and marrow which were free from urates, no signs were present of changes in the tissue.

In 1932 *Weil* and *Barthels* demonstrated to the Breslau Society of Surgeons the operated and histologically examined case of o.s.p. mentioned by me in the first part of this paper dealing with patella partita, in which *a fibrous, healed fracture and aseptic necrosis* were found in the one half of the bone. It was not possible to decide, however, whether it was this latter or the fracture which was the primary factor. The authors report that their investigation verified the investigations of *Walter Müller* regarding the cause of the o.s.p.

In 1933 *Walter Wisbrun* published a fresh contribution to os sesamoideum partitum, in which he recorded the result of the histological examination of 7 partitioned o.s. from 5 patients between the ages of 19-26 years, two of which were male and three female. In all of the cases the medial o.s. was involved. In two cases the lesion was bilateral, the roentgenogram in the one of which demonstrated a unilateral healed Köhler II disease. The patient never had experienced any clinical discomfort from this. In the other two cases the patient had bilateral hallux valgus. In the three unilateral cases also the o.s. were found to be partitioned on the sound side as well. In two of the cases a trauma might be assumed to be a reasonable cause, such being denied in the remaining three cases. In all cases X-ray examination demonstrated a transverse partition bordered by partly smooth, partly uneven margins. The histological examination showed that this partition consisted of connective tissue, the fibres of which showed the identical structure and course as those of the periosteum, with which it was immediately connected. The histological examination of the two halves of the sesamoid bones showed signs, almost to their entire extent, of a still active, or

possibly more correctly, a still *not completed ossification.*—At the places at which the two margins of the spongious bone are in contact, or at which they are separated from each other by a narrow layer of fibrous cartilage, the author in all his cases found small rifts in the tissue, which had to be regarded as causative of the pain. The substance of the bone showed a weak spot here, and must be assumed to be particularly exposed to traumatic and mechanical strain. The author finds an analogy in this with the findings of *Lange* in his investigations on osteochondritis coxae juvenilis. Neither here does one find such "Zersplitterungen und Zerreibungen" at any point of ossification or calcification, but on the places only which seem to be particularly exposed to such traumatic strain. Thus the author also finds a number of corresponding features between o.s.p. and the Osgood-Schlatter disease, apophysitis calcanei, Köhler II, after investigations made by *Zaaijer*, *v. Dietrich* and *Haas* respectively, all of whom have found that functional and mechanical lesions play a part in the partitions in the osseous tissue, which are dealt with here. In the presence of an abnormal ossific centre, this will play a determining rôle, while the trauma will be of no further significance than any other "trauma" occurring in daily life. In *Wisbrun*'s opinion, therefore, a conclusive factor in the etiology of the osteochondritis is *the pathological ossification*, which produces the spot of minor resistance which due to "örtlicher Gegensätzlichkeit in bezug auf Elastizität und Widerstand bei etwaige Stözen und Erschütterungen, ungleichmässigen Schwingungen und damit einhergehenden Druck- und Zerrungswirkungen ausgesetzt sind, die dort, wo besonders ungleicher und sogar gegensätzliche Konsistenzverhältnisse bestanden sich um so stärker bemerkbar machen müssen". (*Lange*). According to this *Wisbrun* considers being able to conclude that *such extensive conformity exists between the above mentioned skeletal diseases and o.s.p., that one is entitled to range this among the so-called juvenile osteopathies.* The only difference is that all the patients of the author had far exceeded the age when the ossification was completed. The author is unable from his observations to find a

reply to the question as to how this retarded ossification comes about. The explanation must suffice that the intensity of the ossification is not great enough to compensate the fibrous elements with normal spongious tissue. It is a matter here of a process taking place between the osseous and the connective tissue, while the cartilaginous tissue is attacked secondarily only. The author holds the opinion, therefore, that in the place of the designation *osteochondropathia*, or still better, *osteochondrosis* (*Haas*), one should use *osteofibropathia*, or still better, *osteofibrosis*. The juvenile malacia, therefore, should have to be termed *osteofibrosis juvenilis*.

In the opinion of the author there is no doubt at all that the continuous partition in these lesions of the o.s. are due to mechanical strain, and no less that continued mechanical strain leads to further partition, even to disintegration of the bone, whereby finally the picture of a pseudarthrosis occurs as described by several authors (*Müller, Jaroschy, Meis*). This must be the explanation also of freshly arisen partitions.

In the great paper—repeatedly mentioned above—published in 1934 by *Kimmelstiel-Kremser-Richter* (from Eppendorf, Hamburg) under the title "*Osteochondrosis necroticans findens der Sesambeine des I Metatarsals*" = o.s.p., the histological findings have been subjected to particular attention. Firstly, the paper is based on a systematical examination of 80 sesamoid bones assembled from a section material which has been selected irregardless of age or occupation of the individuals. Most of them, however, were between 60 and 70 years of age. The changes found in 20 per cent of this material were partly extremely great and demonstrated a variegated histological picture. They were found partly in the cartilage in different depth (= *chondrosis necroticans findens—Kimmelstiel*), and partly—and this was in the great majority of the cases—on the border between cartilage and bone, more precisely between "the growth cartilage" and the bone (= *osteochondrosis necroticans findens—Kimmelstiel*). As indicated by the designation, therefore, one is confronted here by a *necrotizing* process leading to *partition* of the tissue (findo = partition), or more precisely, *a dissociation*

either within the cartilage only or between the above mentioned cartilaginous layer and the bone.—The histological changes are partly of *degenerative nature*, partly of *reactive nature*. Due to necrosis of the growth cartilage in the chondrosis, infractions may occur in this with partition spaces filled by crumbling masses, while the osseous tissue is quite intact, or the articular cartilage may be the object of a necrosis which may become *total*, the cartilage deteriorating over the osseous tissue, which also now may be perfectly intact. The generative changes may lead also to degeneration of the surface of the cartilage, as in *Meffert's* case, and with the identical incidence, which is estimated to be in one half.

In the preponderant number of cases, however, *an osteochondrosis* is present, a necrosis, as mentioned, originating on the border between the growth cartilage and the bone, and which results in a separation of the cartilage from the bone. Frequently this separation is of small extent only while *the necrosis is predominant.* Apart from these degenerative changes, as mentioned before, reactive changes also occur of regenerative and reparatory character with formation of fresh connective tissue which penetrates into the marrow cavities, where it is deposited on the outside of the necrotic bone struts, partly also on those still preserved, and as osteoblasts form a zone of osteoid tissue simultaneously with fresh cartilage being formed —partly from the fresh connective tissue.

These processes are present in the most different phases within one sesamoid bone—thus in one part, generally on the plantar side, an osteochondrosis necroticans—while in another place only a chondrosis necroticans is found—while the entire remaining part of the bone may be perfectly intact. Most frequently one sesamoid bone only is affected, very rarely two, never all four.

The authors trace the cause of these histological changes to *the mechanical lesion* represented by the enormous weight-bearing to which the sesamoid bones are subjected, finding proof of this in the great incidence and in their different localizations, as the necrosis and the partition are found partly

within the limits of the cartilage, partly in the border between cartilage and bone. The authors emphasize strongly that these lesions—fissures and partitions, disruptions and other changes in the border between cartilage and bone—*have nothing whatever to do with an arthrosis deformans*, but should be regarded solely as degenerative and disassociating changes having taken place via mechanical-traumatic route.

In addition to these systematical studies of section material, the material of the author also consists of 34 *clinically* observed cases of o.s. lesions, histological examination having taken place in 8 of these. The results of these confirm as well as supplement the findings in this respect on examination of the section material. In the clinical cases also—fractures, subchondral necroses, pictures simulating pseudarthrosis, osteoarthritic processes—structural changes are found which speak for "Umbau" processes. Briefly, such a multitude of changes are present, that according to the author, it is out of the question that it is a uniform morbid picture. The difference between the histological findings in the section specimens and in the clinical cases is a matter of *grade* only, and may be charged merely to the account of the age of the individual. In the opinion of the author the fact is common to all these changes that due to the constant "traumata" against the less resistant sesamoid bones, the cartilaginous callus tissue becomes fractured persistently, with hemorrhage. *In this the authors find the explanation of the acute commencement and the acute exacerbation with swelling and redness of the soft parts, as known from the clinic.* In connection with this the slight tendency to healing becomes easily explainable thereby that the small "traumata" in the shape of the daily strain, lead to constantly fresh infractions. An indication of this are the cartilaginous callus formations frequently found—despite the slight other changes—in the systematically examined cases, and which are a sign of small power of resistance in the once injured sesamoid bone.

In one of the 8 cases treated clinically and operatively—it was a 15 year old schoolgirl, who had suffered a distortion of the foot two weeks previously (*Kimmelstiel-Kremser-Richter,*

case 31)—and in which the medial o.s. was found to be transversely partitioned, the histological examination demonstrated in the one centre some fibrous marrow as also extremely profuse "Umbau" processes on the bone strut, the activity of the osteoclasts being distinctly overshadowed by that of the osteoblasts, even if also giant cells were observed in the Howship lacunae. The second centre, separated from the first by a necrotic cartilage space, showed extreme *necrosis of the bone struts, partly also of the marrow.* In addition to the necrotic bone struts, however, one could also see some which were perfectly intact. The authors emphasize, however, that this in no way warrants the assumption of such process being characteristic, and see in it an analogy to that found in the Köhler and Legg-Calvé-Perthes diseases. In the aseptic necroses, namely, is not found the characteristic *wedge-shape* of the necrotic tissue, which according to *Axhausen* justifies the assumption of an embolic process. The lesion in the o.s. cannot either be compared with Kienböck's necrosis of the lunate bone, because in the opinion of the author the peculiarity of the lunatum necrosis is that a trauma is entirely lacking in the past history. The cause of this necrosis, therefore, must be looked for in the fact that the bone has been subjected to some sort of injury. Indeed the static conditions in os lunatum carpi differ widely from those in the o.s. of the foot, in which according to the author the trauma plays a prominent rôle etiologically.

In the case mentioned of *Kimmelstiel-Kremser-Richter*'s an incipient cyst formation was observed also in the necrotic area just under the cartilaginous border—a regressive change frequently noticed in arthropathia deformans. As mentioned previously, however, the authors disassociate themselves from the contention that the histological changes in the lesion in the o.s. have anything to do with arthrosis deformans.

With regard to the sesamoid bones the authors suppose that a traumatic separation with the resultant circulatory disturbances is entirely sufficient to explain the necrosis demonstrated. Such separation, however, does not need a definite one-time trauma in the opinion of the author. The daily mechanical stress

is sufficient, to which these small bones are exposed. The difference between these separations and a genuine fracture which may be traced back clinically to a single violent trauma, is not of essential nature, as it depends on the strength of the violence only. When this is quite slight, it results in an insidious, progressive infraction. The authors draw the conclusion from their researches, that the not infrequently occurring partitions of o.s., made as incidental finding on roentgenological examination of the feet, may possibly represent the final result of a pathological process (*Richter*). It could not be decided from the material of the authors (*Kimmelstiel*) whether congenital partitions of the o.s. also exist.

Kimmelstiel-Kremser-Richter summarize the result of their investigations in the way that the cause of the partition of the o.s. must be looked for in the following facts:

1. Slight traumata, and the possibility of sufficient reparatory processes.

   In these cases one meets the histological picture of "Umbau" in the structure of the sesamoid bones (*Wisbrun*).
2. Slight traumata without sufficient reparatory processes, for example due to persisting mechanical lesions.

   The most characteristic picture of this lesion of the sesamoid bone is met with here—the changes leading to a transverse division of the bone by *a connective tissue-cartilaginous callus.*
3. Severe acute traumata, leading to *fracture* of the sesamoid bones with no visible reparatory changes.

Kewenter has examined histologically 520 autopsy specimens of o.s. from 120 bodies of all age groups from 1-100 years, among which 16 in the group 1-20 years, 7 in the ossification age. Some of these showed partition. No more than in the non-partitioned cases, however, did these demonstrate any histological changes whatever. *Kewenter* is able to add to this post-mortem material one case treated operatively, which was examined histologically. It was a case of a 30 year old hospital nurse, who had struck

the ball of the left foot against the doorsill. X-ray examination seven to eight weeks afterward demonstrated transverse partition of the medial o.s., which was extirpated two weeks later. The histological examination showed perfectly normal structure of the one half of the o.s. which was divided into two equal parts, while the bone struts in the other half were lacerated and destroyed. The interspaces between them were filled by a vascular tissue. Giant cells were also demonstrated and in several places formation of new bone. Corresponding to the partition the cartilage had collapsed, being replaced by fibrous tissue, poor in cells. The partition is composed of a homogenous, collagenous substance. According to this the authors suppose that a fracture had taken place in the actual partition with destruction of the bone struts in the one (the proximal) fragment with incipient callus formation.

The normal histological build of these sesamoid bones demonstrates that the bone strut has a course vertically to these and forms the so-called *pressure*—or more correctly—*weight-bearing layer*. In the plantar part of the sesamoid bone, on the other hand, the bone strut has a course parallel to the *sole* of the foot, forming the socalled *sliding layer*.

The result of *Kewenter*'s histological examination of the autopsy specimens is that, whereas the *non-partitioned* sesamoid bones demonstrated this characteristic osseous structure, it was *missing* in the partitioned ones, in which no abnormal findings were made. Approximately 15 per cent of the present material consisted of partitioned o.s. The partition was transverse, generally—thoughnotalways—dividing the cartilage also, which often had collapsed over the partition and had become fibrously degenerated, while the partition proper was filled by vascular connective tissue, poor in centres, or fibrous, firm connective tissue with few vessels, in which were found also cartilage cells. In some rare cases the histological findings demonstrated the presence of a healed fracture, while in approximately 10 per cent of the cases signs were found of arthrosis deformans.—*Kewenter* summarizes the results of his clinical, X-ray and histological examinations, stating that

cases are found with morbid changes in the o.s. of the foot, although they are comparatively rare, and do not always give symptoms. *Further that no typical lesion of the sesamoid bones exists,* and finally that in his autopsy material was found—as causative factor of the morbid changes in the o.s.—fracture of non-partitioned as well as partitioned bones, as also arthrosis deformans.

V.

The cases referred here are all the *histologically* examined o.s. with partitioning that I have been able to find in the literature. In addition come the following two cases which I have observed myself: *Case I. Louise E.,* housewife, 31 years of age. Came in for consultation August 17, 1934. Presumably has always been healthy. As far as she is aware she has never had rickets. In May 1923 she was treated by me for a fracture of the lower tibial epiphysis of the right leg, which she had incurred one month previously by jumping down from a motor truck, thereby getting a squeeze on the foot. The tibial fracture healed without defect. She married three years later, and now has two children. In May 1934 she noticed pain under the ball of the great toe of the right foot. She states that just previously she had been digging a great deal in the garden, using the right foot on the spade. Ske knows of no other cause of her lesion. The pain which was intensive and persisted also when she kept quiet, night as well as day, radiated along the dorsum of the foot up into the leg. The ball of the great toe was tender and swollen, so that she had to walk on the outer edge of the foot, and was unable to wear a shoe. *Physical examination—right foot:* Slight hallux valgus. No distinct swelling of the first metatarso-phalangeal joint, which is stated to be very tender to pressure on the plantar side, particularly medially corresponding to the medial sesamoid bone, which is distinctly felt. Normal mobility in the joint mentioned, as also in the ankle joint. *Left foot:* Considerable hallux valgus. Normal clinical conditions otherwise. *Roentgenological examination:* The right medial o.s. *shows a severe spotted atrophy with ir-*

regular partition of the bone. In the sagittal plane the bone is partitioned transversely, in the axial plane the partitioning is more irregular. In the left o.s. is seen in the frontal plane severe regular atrophy *without partition.* Neither is such observed in the sagittal or axial plane.

On August 23. the total medial sesamoid bone was ex-

Fig. 12.

tirpated. Uneventful course. Histological examination (professor *Harbitz*): "..... The specimen consisted of two pieces of bone, the one well over the size of a bean, the other approximately the size of a pea. No definite fracture is seen macroscopically. Microscopically are observed in a great part of the specimen bone struts of normal appearance and structure, separated by normal fibrous bone marrow. In the other part the structure is indistinct. The bone merges into a cartilaginous, fibrous tissue with degenerated structure. A great many amorphous

pieces of brownish colour are seen. These probably consist of *necrotic pieces of cartilage embedded in fibrous tissue, and which are being resorbed.* In one part some small *necrotic* pieces, probably of *bone,* were observed encapsuled in *a granulation tissue. This was regarded as a partial necrosis. One has here a necrosis of bone and cartilage.* There is no sign of inflammation, however. Nothing speaking for a tumour. No actual fracture may be seen microscopically. *Diagnosis: Sesamoid bone with partial necrosis, particularly of the cartilage. No sign of inflammation.*"

October 12, 1934. The patient who presents herself for control examination, states that she feels much better, and is very satisfied with the operation. She now walks on the entire sole of the foot, wearing shoe as before. No pain on walking. No tenderness. Does her work as before.

Case II. Else H., domestic servant, 21 years of age. At the age of 10-12 years she consulted a physician because of bilateral considerable hallux valgus, most pronounced on the left foot. Conservative treatment for one month. Afterwards no treatment. Since she has had pain in both feet. While the pain in the right foot, however, was localized to the dorsal and medial side of the metatarso-phalangeal joint only, *in the left foot it was localized also—and even particularly so—to the plantar side of the joint, to the ball of the great toe, which was tender.* This has never been the case with regard to the right foot. The pain was greatest when she was walking or standing. In the autumn of 1939 this foot pain grew worse, so that the patient again consulted a physician in October. On October 25th bilateral hallux valgus operation was performed with disposal of the tendon for the extensor hallucis longus. Subsequently the pain in the right foot vanished, but not that in the left one, in which tenderness and pain under the ball of the great toe still persisted.

On February 28, 1940 the patient was exposed to a trauma, getting a distortion of the left *knee,* which was immobilized in plaster bandage. Examination of the feet disclosed persisting considerable tenderness of the ball of the great toe on the left foot.

X-ray examination of both feet on October 26, 1939 had demonstrated the following: *Right foot.* Distinct transverse partition of the medial sesamoid bone into two approximately equal parts with normal structure. *Left foot.* Medial sesamoid bone shows severe decalcification, which makes the contours as well as the structure blurred. The bone is observed distinctly,

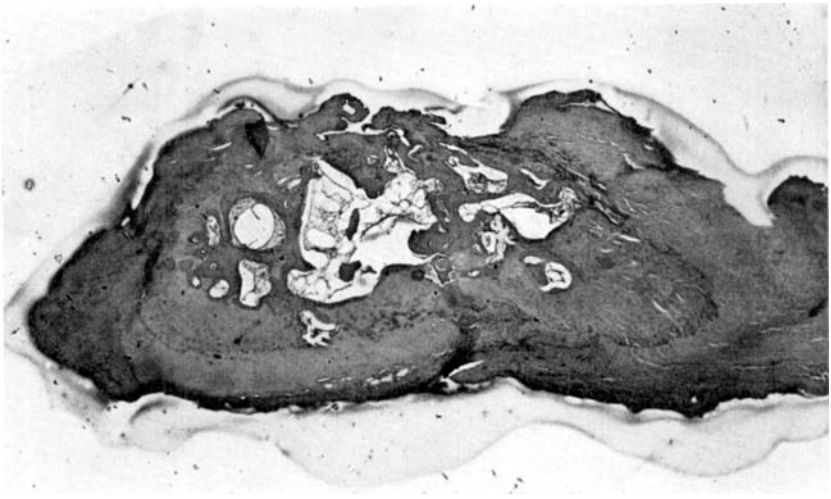

Fig. 13.

however, to be divided into three fragments. *No regular, distinct, wide transverse partition exists, however, as on the right foot, neither in the frontal, sagittal nor axial plane.*

March 2, 1940 the left medial sesamoid bone was extirpated in local anesthesia. The greatly flattened bone measured 11 × 10 × 3 mm. The upper surface, covered by cartilage, was greatly irregular. Uneventful course. Neither did the X-ray examination of the extirpated o.s. demonstrate *any distinct partition.* The pathologic-anatomical examination (professor *Harbitz*) had the following result: "Received a small flat piece of bone; it is triangular, the upper margin measuring 7 mm. and approximately 10-12 mm. along the two remaining margins. The one surface is plane and smooth, the second surface being slightly convex, and *a very small superficial furrow* is noticed here.

Microscopy: The inner part demonstrates the structure of *osseous tissue* with fairly great compact bone struts as also a bone marrow, very poor in cells, (no "fibrous bone marrow", however, as in osteitis fibrosa). In the periphery this osseous tissue is continuous with a cartilaginous region, which is again continuous with a *fibrous* tissue, rather poor in cells and tendinous, *which almost completely encircles the centrally placed osseous and cartilaginous nucleus.* A small part inside the piece of bone, in the one of the two specimens, has a *necrotic* appearance; this is very insignificant, however. No crushing of the tissue was observable in this region, and no cartilaginous furrow. The macroscopically visible furrow on the one edge is *a depressed area in the tendinous tissue.*

Diagnosis: Sesamoid bone consisting of osseous tissue and some cartilage in the inner centre, surrounded by fibrous, rather tendinous, peripheral tissue. In the inner part a very small necrotic piece of tissue." (Fig. 13.)

Follow-up examination November 10, 1941: After the operation for hallux valgus in October 1939, the patient has had no discomfort from her right foot. Subsequent to the removal of the diseased o.s. in March 1940 the patient was free from pain in this foot also, and this lasted into the summer, when she again commenced having pain in the first metatarso-phalangeal joint, at the same time as the great toe gradually adopted a more dorsal flexion. This has afterwards, and in increasing degree, troubled her, as she has had pain in this joint when walking. This pain she locates to the dorsal side of the capitulum, where she reports considerable tenderness on palpation. No tenderness, however, on palpation over the plantar side of the joint on the ball of the great toe, and neither over the anterior surface of the capitulum, which is palpated in its entirety, as the great toe is dorsoflexed to 90 degrees and luxated up on the dorsal surface of the capitulum, with the tendon of the extensor hallucis longus greatly tensed. From this position the toe cannot be plantar-flexed to the horizontal position. When attempting this the patient reports pain on the dorsal side of the joint. The great toe is in 30 degrees abduction

position. *Right foot:* Also here the great toe is greatly dorsoflexed. The great toe is easily plantar-flexed to the horizontal position. It is in 30 degrees abduction position. Quite slight tenderness on pressure over the ball of the great toe. *X-ray examination, left foot:* The great toe is in 90 degrees dorsoflexion and luxated up on the dorsal surface of the capitulum. *Right foot:* The medial o.s. partitioned as before.

VI.

Discussion: In the first case X-ray examination revealed a distinct bilateral partition of the medial o.s., presumably of congenital nature. Further was found also a spotted atrophy of the bone on the side on which clinical symptoms were present, symptoms which had lasted for approximately four months. The extirpation of the diseased bone resulted in cure. A definite exertion of this foot particularly was supposed to be causal of this lesion. Histological examination of the removed sesamoid bone showed a partial necrosis of bone as well as—and particularly—of cartilage. The necrotic parts were embedded in fibrous tissue or granulation tissue respectively. Thus *a necrosis was present in an undoubtedly congenitally partitioned sesamoid bone,* at the same time, however, as processes also existed which must be regarded as being of *reactive, reparatory* nature.

The second case concerned a female domestic servant, 22 years old, of asthenic type, who had since childhood had a bilateral hallux valgus, and who had also all the time been troubled by pain and tenderness under *the ball of the great toe* of the left foot, while this has never occurred on the right side. The operative treatment of hallux valgus did not do away with this pain. While the X-ray examination demonstrated a distinct, probably congenital, transverse partition of *the right medial o.s.* in two normally structured fragments, the left *medial sesamoid bone* showed an irregular partition of the greatly decalcified bone. Necrosis was demonstrated histologically in a small area, also this, however, with apparently reactive, reparatory processes. No signs demonstrable of osteitis fibrosa.

The first question that one is desirous of getting solved by the histological examinations, is whether partition of a sesamoid bone, when clinical symptoms have not been or are not present, must be assumed to be of *congenital nature.* Examinations, particularly of the actual partition, of course, are of importance in the autopsy material. Such examinations have been carried out by *W. Müller, Meffert, Kimmelstiel-Kremser-Richter* and *Kewenter.* In *Müller's* case partitioned sesamoid bone was found. The result of the histological examination was that *Müller* assumed that it was not a matter of a preformation with two centres, but of partition of one with one centre. *Kimmelstiel-Kremser-Richter,* who found obvious, partly even major, histological changes in 20 per cent of the 80 autopsy specimens examined by them, held that they could safely conclude that these had been acquired traumatically, thus excluding entirely the possibility of a partition of o.s. being of congenital nature. No mention is made, however, how many of the 20 per cent of the 80 specimens mentioned presented partition. *Meffert* does this, on the other hand, who found 7 partitioned ones among 70 specimens fetched chiefly from the section table, though also from the operating table. The result of the histological examination, however, was that the author was not able to decide whether the partition was congenital or acquired.—Neither does the great autopsy material of *Kewenter* pay any contribution towards the solution of the question. In one case only it is suggested as a possibility that the partition may be caused by "a primary division" and thus not belonging to the picture of disease. The fact of the partition being only histologically visible, not roentgenologically, speaks against such an assumption.

While the histological examinations have not been able to bring any definite decision in this question, therefore, a number of clinical observations provides a proof of the probability that the often clinically latent partition is of congenital origin, making it perfectly natural to place it among the primary, congenital partitions throughout the skeleton, in the first instance besides a patella partita, which also keeps quite silent clinically. It is sufficient here to call to mind the markedly great in-

cidence and regularity of the latent partition, the relatively frequent multiplicity and particularly its *symmetrical* bilateral occurrence. Further, that this partition of the o.s. not so rarely is associated with other manifest abnormities of the skeleton of the foot, especially hallux valgus, but also others. In addition to this a *familial* (*Müller*), and seemingly also an *individual* (*Meis*) disposition to these partitions has been ascertained on constitutional basis, as remarkably many of these patients at any rate are stated to present partly an asthenic, partly a puffy appearance. Among the seven patients of *Meis* this latter was the case with four, while it is stated of one of the remaining three that the patient was a tall, slim and nervous girl. Two of my patients belonged, no doubt, to the puffy type, and a third equally surely to the asthenic type. Above all other considerations, however, the distinct *disposition of sex* weighs heavily in favour of an *endogenous*—a *congenital* pathogenesis. *Müller*, who denies this fact, as mentioned previously, advocates the opinion that an augmented chronic mechanical strain on the foot, as represented in reality by a daily active professional over-exertion, is sure to be of importance. This strain is still further accentuated by the inadequate footwear of women (high heels, thin soles—*Jaroschy*). In my opinion, however, importance may be attached to this only as a *releasing* factor. If it had been the real cause, the lesion would have had a far greater incidence than it has actually. For the great majority of women sin greatly every day against the hygiene of the foot.—*Kimmelstiel-Kremser-Richter* attempt to explain the great surplus of women, which they found also in their material, 19 among 35 of whom were in the prepuberty or the puberty age respectively and the years following immediately, by the greatly increased sport of these years with consequent traumatic injuries. If this explanation was correct, however, one should have expected rather a surplus of men. The *disposition of age* also, as mentioned above, and which is distinctly demonstrable in the clinical cases in favour of the adolescent years, by itself as also together with the disposition of sex, speaks plainly in favour of an endogenous factor as the fundamental cause of the lesion.

The question as to the nature of the histological changes

found in the clinical cases has caused greater discussion than the question of whether the partition is of congenital nature or not. In lesions of the sesamoid bones they are on the whole decidedly more *synonymous* than in patella partita, as with a couple of exceptions *necrosis of the bone* has always been found in cases of o.s.p. In *Kimmelstiel-Kremser-Richter*'s material it was so marked that the authors declared the disease to be a *necrotizing* lesion, in spite of the motley picture presented by the histological examinations.

The question is of particular interest here, therefore, of the relation of the lesion of the sesamoid bones to the *aseptic,* osseous necroses, in which *a total necrosis* is present, i.e. a necrosis of the osseous tissue as well as of the marrow tissue, irrespective of whether the necrosis involves the entire bone in question or whether it is *partial* only. In six of the cases examined (*Renander* 1, *Schütz* 1, *Meffert* 2, *Kimmelstiel-Kremser-Richter* 1, and *Sundt* 2), *total necrosis* of the bones was found. In practically all the cases it involved certain parts of the bone only, for example in my second case in a small area only, in *Kimmelstiel-Kremser-Richter*'s case in part of one of the two fragments, not in the other. Histological examination of some—a few only— o.s. fetched from the section table gave the same result, and *Meffert* made an exactly similar finding, as he found *total necrosis* in two of his cases, and in the third partial necrosis, of the osseous tissue, namely, and not of the marrow tissue. In this case, however, not the entire osseous tissue was invaded by the necrosis.

As opposed to these findings of total necrosis, *W. Müller* drew the conclusion from his investigations that a *partial* necrosis—of the actual osseous tissue only, not of the marrow tissue—was *characteristic of the necrosis of the sesamoid bones,* and that this could not be compared with that found in the juvenile osteopathies as maintained by *Renander* and *Schütz,* as also by *Meffert* regarding two of his cases. Both my operative cases must be counted to this category of "*total necrosis*". In *Jaroschy*'s case, on the other hand, no signs of bone necrosis were demonstrable, and finally the histological findings in

Griep's case showed a picture corresponding entirely to that found in an *osteitis fibrosa*. The difference in the histological findings thus found between the two last-named cases on the one side and the others, in which a necrosis of the bone was present, is *sure to be more seeming than real* on closer study. It should be remarked, firstly, that it appears from the description of *Renander*'s as well as *Schütz*'s and of one of *Meffert's* cases, that the necrosis of the sesamoid bone demonstrated was not total in the true sense of the word, as there were parts in the osseous tissue as well as in the marrow tissue which took on the colour of the nucleus. Thus only a *partial* necrosis existed, *of bone as well as of marrow, however.* In the case of *Müller* also—in which the necrosis involved the osseous tissue only—it was not total, as coloured centres were found in some parts of the marginal lamellar system. This was the case also in the cases of *Renander, Schütz* and *Meffert.* Several reasons seem to make it entirely impossible to assume that the difference between the case of *Meffert* and the others should be of *qualitative* nature, according to the opinion of *Müller.*

It should be kept in mind, firstly that it is easily understandable that *the point of time* in the development of the disease at which the histological examination was carried out must play a rôle. The fact that in *Griep*'s case the patient was operated upon 5 weeks, in *Schütz*'s 3 weeks, in *Müller*'s and *Jaroschy*'s about one year, in *Renander*'s 3-4 years, in my first case 4-5 months and in my second case perhaps not until 10 years, after the symptoms had occurred, must be assumed in reason to be of importance to the histological findings. It is all the more reasonable to assume this if one sees in the histological changes—and this is no doubt correct—a reaction on the part of the tissue to some injury or other of whatever nature it may have been—a reaction which is certainly also *individually* different—refer to the individual disposition which is definitely present also in the onset of the disease. *Griep*'s case—in which the histological findings were interpreted primarily as an *osteitis fibrosa*—constitutes a perfectly parallel case to the case of *Riedel* and *Konjetzny* of Legg-Calvé-Perthes and

two of my cases of *patella partita,* in which the existing histological changes also primarily were interpreted as *osteitis fibrosa.* While *Müller,* however, found no regenerative processes in his specimens, *Griep* on the other hand in his specimen found marked such (proliferation of periosteum and connective tissue, bone formation). *Griep* found the marrow tissue, in which *Müller* found no changes, reformed into *fibrillary connective tissue,* and considered his case to resemble much more that of *Renander,* which was designated by him *osteopathia o.s.* Professor *Schmincke* states with regard to the case of *Griep:* "Der in den Sesambein erhobene Befund ist prinzipiell der gleiche wie bei der Köhler'schen Erkrankung. Auch hier halten wir die Nekrosen für das Primäre, die übrigen Veränderungen für reaktive, resorptive Natur". As mentioned previously giant cells were discovered in the case of *Renander* in the bone as well as in the marrow tissue and the tissue uniting the two bone fragments. Particularly should be noted here, however, the tissue consisting of spindle cells which he found in the marrow cavities as well as in the periosteum, and which he interpreted as *granulation tissue,* which had arisen as a reaction brought about by the necrotic process of the bone, and probably originated in the periosteum. These strongly reactive processes—as in the case of *Griep*—are in great contrast to that found by *Müller* in his cases, in which the necrosis had given so markedly slight occasion for reactive processes.

In a class of their own stand the case of *Jaroschy* and my two cases. In the two latter cases reactive processes were found, partly very marked. In *Jaroschy*'s case it was strongly emphasized that no necrosis of the bone could be definitely ascertained, whereas ample reparatory and regenerative processes were present in the osseous tissue as well as in the cartilage—processes which were undoubtedly of older date. It was not possible to decide whether a necrotic focus had existed once, which had resulted in fracture, or whether a partition had taken place in a morphologically sound bone. In his opinion the difference found in the cases of *Renander, Müller, Griep* and *Jaroschy* must depend only on a difference in the extent of the distribu-

tion of the pathological changes (possibly a primary bone necrosis) on which the lesion is based, and next on the fact that the different cases have come for examination in different stages. The degree of the reparatory processes, namely, depended to a great degree on the age of the process of disease. According to this *Jaroschy* concludes with advancing the supposition that this lesion of the sesamoid bones of the great toe corresponds to the Köhler disease of the head of the second metatarsal. While a similar lesion has been described occasionally also in the head of the third metatarsal, it has been described once only in the head of the first metatarsal (*Konjetzny*).

Against the assumption of an analogy between o.s.p. and the aseptic necroses has been advanced—as a very weighty argument—*the missing consolidation of the fragment.* Such consolidation together with a more or less pronounced deformity of the diseased epiphysis is typical and highly characteristic of the necroses as mentioned. The fact that a consolidation seems not to take place in o.s.p. corresponds to the fact that *Müller* found so remarkably small reactive processes by his histological examinations. It has been mentioned already that *Kimmelstiel-Kremser-Richter* traced the cause of the lacking consolidation to a constantly fresh traumatism, also represented by the daily strain. In my opinion, however, the fact that consolidation occurs in the aseptic necrosis of the head of the second metatarsal (Köhler II) despite the fact that the capitulum mentioned must be assumed to be equally exposed to mechanical injury as the sesamoid bones, speaks definitely against such assumption. Neither can in my opinion, however, the actual argumentation per se with the lacking consolidation be maintained. It has been mentioned previously that the histological examinations were not entirely consistent with regard to whether the smooth, regular, mostly bilateral and clinically quiescent partition in o.s. is of congenital nature or acquired. It is certain, however, that clinical and roentgenological facts with preponderant probability speak for this partition being of congenital nature, and thus of a different genesis from that of the spotted atrophy of the fragments found in the clinical cases, an atrophy which

recedes together with the clinical symptoms, and consequently leading to normal structure of the fragments. *In my opinion this must be regarded as an analogy to the consolidation in the aseptic necroses.*

Seemingly the disease attacks the fragments, while the partition remains untouched. This appears fully from the cases presenting a bilateral, symmetrical partition, with *unilateral* clinical symptoms, however. The partition is uniform on both sides. Furthermore the frequent symmetry in the partition per se speaks strongly for its being congenital. I am of the opinion that this is accentuated still further by the fact that, as far as I know, a bilateral necrosis of o.s. has not been observed.

In my two first cases with an *acute* onset a consolidated structure appeared of the fragments with spotted atrophy. In the two other cases (III and IV) the conditions seem to be undoubtedly more complicated—less in the first of these, however, than in the second. In this case also the lesion seemed to have commenced with rather acute symptoms, of which tenderness over the ball of the great toe with pain and calor still persisted after three months, making the patient consult a physician. To a much greater degree the roentgenogram of the diseased, irregular, not very distinct, multipartitioned o.s. carries the mark of being an acquired lesion rather than a congenital one —a conception which is still further strengthened thereby that the corresponding o.s. on the other foot was non-partitioned. When in this case consolidation of the fragments had not occurred, this may be ascribed quite naturally to the fact that the process, due to the patient being entirely untreated, had not yet had occasion to complete the reactive and therefore also the reparatory changes demonstrated by the histological picture to be in activity. My first case proves that these processes take their time. In spite of the patient having been under treatment and with only the one fragment involved, the roentgenogram after the lapse of one and a half month showed practically unchanged conditions. One year afterwards traces are still visible —though barely only—of a spotted rarefaction in the diseased fragment. It cannot be excluded, therefore, that in the above

case also consolidation would have occurred of the partitioned o.s., if the patient had been treated conservatively for a sufficiently long time.

The second of these two cases has been particularly complicated by the considerable hallux valgus which was present bilaterally, though most pronounced on the diseased foot, and which had troubled the patient since school age, at least for the last ten years. One is not aware, however, whether symptoms from a possibly partitioned sesamoid bone had already been manifest at that point of time, or when these first commenced. It is a certain fact, at any rate, that the pain in the right foot, but not in the left, disappeared after the performance of a hallux valgus operation in the autumn of 1939. Tenderness under the ball of the great toe of the left foot still persisted. Following the removal of the diseased o.s. the pain disappeared, coming on again, however, after the lapse of half a year due to a contraction of flexor halluxes longus with subluxation of the great toe.

On perusing the case histories in the publications of the different authors, the great incidence of hallux valgus in the clinical cases of o.s.p. is remarkable—an incidence which makes it difficult to assume that it is an accidental coincidence only. It seems natural to suppose that a change in the direction of the toe in the first metatarso-phalangeal joint cannot be without significance to the musculature governing the movements of the toe in this joint, and then to the tendon also in which the two sesamoid bones are embedded—tendo flexor hallucis brevis. In cases in which one or both sesamoid bones are partitioned, it could be imagined that the increased strain which an abnormal abduction must be assumed to represent, would be able to cause *a stretching* in the partition, particularly when it is divided transversely. This stretching would be able to produce clinical symptoms similar to those described in patella partita as a *distorsio patellae* (*Odermatt*) or *distractio patellae* (the author). It need not be any conclusive proof against such assumption that the roentgenogram demonstrates no change in the partition, for example in relation to a corresponding one on the other

foot. Even minor changes in the partition may be assumed to be sufficient for provoking circulatory changes in the fragments, which may find expression in a spotted structure of the bone. It is natural to assume at any rate, that a pathological abduction position of the great toe in the metatarso-phalangeal joint in the first instance will mean an increased strain on the *medial* sesamoid bone. This may be perhaps at least one of the causes that this sesamoid bone is found to be *clinically diseased* considerably more often than the lateral one. The cause mentioned may explain also the much greater incidence of the actual partition in the medial than in the lateral o.s. It will be understood that this conception lies very close to the one advocated by *Kimmelstiel, Kremser* and *Richter,* as they maintain that the traumatism of the o. s. which the daily stress is supposed to be, is sufficient to induce the circulatory disturbances of the bone which result in the necrotic processes leading to partition and to spotted atrophy of the fragments. Thus the partition is *acquired.* In my opinion, on the contrary, it is present beforehand as a congenital anomaly, and as such represents a spot of minor resistance to a trauma, particularly to such that causes *distraction* of the sesamoid bone and thereby also of the partition, thus a stretching of this resulting in circulatory disturbances in the fragments, and consequently to a spotted atrophy. This explanation applies to all cases in which a sesamoid bone is divided—mostly transversely—by an even, regular, well defined partition, unilateral or bilateral. This does not by far mean, however, that it is denied that a spotted atrophy in a non-partitioned sesamoid bone due to a traumatization of this, cannot become so marked that it leads to a partition. In such case this is irregular and indistinctly defined, as in my cases IV and V, in which cases it seems reasonable to explain the pathogenesis in this manner.

If one regards the even, clinically silent, transverse partition of o. s. as *an anomaly,* however, it must be considered a parallel to a possibly present hallux valgus, particularly, of course, in cases in which both anomalies are bilateral.

In all of my 4 cases as also in the subsequently referred case

V, hallux valgus was present, though only in the case referred above in a particularly prominent degree. The lesion was bilateral in all cases with the exception of case III, in which it was unilateral, being present—and even to a marked degree—not on the diseased, but only on the *sound* foot, the medial o. s. of which presented a considerably regular atrophy, but *no partition*. This case is an illustration of the fact that, even if it cannot by far be rejected that a certain causal relation may exist between a clinical lesion in the sesamoid bones and hallux valgus, such is *by no means any conditio sine qua non* for the lesion of the sesamoid bone dealt with here. If it is supposed that the pronounced hallux valgus, especially on the diseased foot in case IV had been produced by or has contributed to the production of the lesion of the sesamoid bone on this foot, it is obvious that it has not been curable as long as the patient had not been cured of his hallux valgus. *In this case, therefore, it is possible to explain in this way the fact that consolidation of the fragments had not occurred.*

On the whole it must be permitted to maintain that a missing consolidation of a clinically diseased sesamoid bone cannot be given as proof—at any rate not conclusive such—that the lesion of the sesamoid bones which has been dealt with here, cannot be included in the aseptic osseous necroses and, therefore, in the juvenile osteopathies.

In favour of such an assumption may further be included a number of clinical conditions, i.e. those which have been reckoned to be in favour of the regular, clinically silent partitions being of congenital nature (bilateral occurrence, age and sex disposition, a.o.). It should be emphasized here particularly that this lesion of the sesamoid bone, as well as the aseptic necrosis in the head of the second (third) metatarsal (Köhler), primarily occurs in the puberty and with the decidedly greatest incidence in females.

VII.

If one takes it for granted that the histological changes mentioned fall within the scope of the aseptic necroses, it is a matter

of course that *the etiology* of the above mentioned lesion of the sesamoid bones also corresponds to that of the juvenile osteopathies. The trauma plays a rôle here primarily. In the clinic of the lesion of the sesamoid bones, however, one rarely finds the acute trauma—such would probably in the majority of cases have resulted in a fracture or an infraction of the bone. Attention has been directed more towards the chronic trauma that the strain of daily life seems to be on the sesamoid bones of the foot. When all the same a lesion of the sesamoid bone is so rarely established, it must be assumed that a certain *disposition* must exist to make it occur, as claimed by several of the authors mentioned (*Renander, Meis, Schütz, Wisbrun*). Such disposition must be assumed to be both *local* and *general.* In my opinion it cannot be disregarded that a partition existing already beforehand, perhaps primarily a transverse partition—whether this is congenital or acquired—must cause the sesamoid bones to become *functionally* inferior. It must be conceivable that some trauma, even quite slight and entirely overlooked, against the great toe or the metatarso-phalangeal joint of the ball of the great toe as before mentioned, would be able to induce *a stretching*—a distraction—of the partition tissue with resultant nutritional changes in the bone tissue. In this way it may be explained that my case I, who had to carry out her work standing for 14 years, contracts an affection of the o.s. on a day when she had not been at work and neither had been exposed to any special trauma. The same applies to case II, the young sportsman.

It appears from the fact of the disease *occurring unilaterally* in bilaterally partitioned o.s., that the partition per se is not the cause of the disease, and that an additional factor is required.

Straight at a *general* disposition point the previously mentioned clinical data, age disposition and sex disposition, both of which are so prominent in the aseptic necroses, an endogenous disposition which must be regarded as common to *the partition as well as the necrosis.* It seems just as natural and justified to perceive the *real* cause of the disease in endogenous factors

which call forth a general disposition, and in the exogenous factors, as for example a trauma, to perceive a *releasing* factor, as in the aseptic necroses on the whole.

Other factors also, besides traumata, may no doubt be applicable. An indication of this are all the cases in which no cause whatever is demonstrable. In the etiology of the aseptic necroses, at any rate, an infection also seems to be able to play a part. The fact that suppuration never occurs, as also that inflammatory changes are entirely absent from the histological picture, speaks against such etiology. It is in this connection that *Axhausen* maintains that the necrosis is due to embolism caused by "mykotische Bröckel ... *wobei die wenig virulenten Bakterien nicht angehen oder rasch von den Schutzkräften des Körpers überwunden werden.* Es wären danach die epiphysären Ernährungsunterbrechungen als *blande embolische Nekrosen* aufzufassen". The assumption, however, of an infection being the cause of these necroses receives support in a number of clinical symptoms, as for example that a juvenile osteopathy may be associated with an acute infective disease. Among the cases of lesions of the sesamoid bones recorded in the literature an infection of o.s. was present in cases of *Lange* and *Bennet*. No *aseptic* necrosis is present here, however, but a *septic* one—an osteomyelitis. In the other clinical cases which have been examined histologically, the sesamoid bones appear to have reacted to the different injuries, whatever their nature may have been, with histological changes falling within the scope of the findings in the juvenile osteopathies. This applies also to the cases in which the reactive changes discovered are indicative of an osteitis fibrosa (*Griep*). It must be assumed here that either the point of time at which the examination was carried out, or possibly individual relations, or both, have played a rôle. It is evident that other causes than traumata and possible infection may also induce pathological changes in the sesamoid bones with clinical symptoms, when one studies the case of arthritis urica in the sesamoid bones of a 24 year old male previously referred by *Wiedhopf* and *Greifenstein,* in which the histological examination of the medial sesamoid bone, which

had been sensitive to pressure, demonstrated that ample deposits of urates were present in the sesamoid bones. In this connection the following case is of interest, which I had the opportunity of observing about one year ago, viz.:

Case V, 75 year old male, former sea captain. Approximately 30 years ago he had to give up life at sea because of "gout of the back". It soon disappeared, however, but still he remained ashore. About 20 years ago he got pain in the first metatarsophalangeal joint. It commenced suddenly. The physician consulted made the diagnosis of podagra. Subsequently he also had a couple of similar attacks, but this is several years ago now. In association with this he also had right-sided sciatica, which troubled him for several years, so that he was bedridden for a month or so each summer and winter. This pain has been gone now for many years, and the patient has felt well. In the beginning of April 1940 he developed pyelitis, slight attacks of which he also had had previously, and coincident with this he *commenced feeling pain in the above mentioned articulation of the great toe of the right foot. No febrile periods. The pain occurred continuously,* gradually increasing so much, however, that he had to keep to bed. It troubled him night and day, with extreme tenderness of the entire joint, *but particularly under the ball of the great toe*, with increased pain on attempt at movement. Not the joint only, but the entire great toe became swollen and tender. The skin above was warm and red, and as it started turning bluish-red the physician feared that an incipient senile gangrene was present. The patient gradually had developed similar symptoms also in the corresponding joint of the *left* foot: pain, tenderness and swelling, but considerably less pronounced than on the right side. When the patient was able to get up after approximately two to three months in bed, he had to walk on the outer edge of the foot because of pain and tenderness, particularly under the ball of the great toe. Well into the summer the patient was troubled also by protracted universal urticaria. As the symptoms still persisted in and around the articulation of the great toe, medication with *atophan* was instituted with marked beneficial effect. On October 18.

1940 he came in for X-ray examination. The clinical symptoms had disappeared. The X-ray examination demonstrated: I. *Bilaterally:* Arthrotic changes in the first metatarso-phalangeal joint with exostosis formation on the inner lateral corner. *II.:* Narrowed articular joint on the right side. *III. Right foot:* Medial o.s. shows considerably irregular decalcification, with a calcified centre surrounded by a decalcified area. The centre is observed to be slightly, but distinctly, transversely partitioned. *Left foot:* Medial o.s. shows extremely irregular decalcification, no visible partition. Axial plane: Irregular decalcification, no partition. Bilaterally is seen also deformity of both metatarsal heads, without cystic rarefactions, however. Normal clinical conditions were found bilaterally. No tophi. Follow-up examination on October 25. 1941: In the past year the patient has had no symptoms from his feet. Normal clinical conditions. X-ray findings: Right foot. The calcified centre has disappeared, and the calcium content is considerably more regular, while the structure is still considerably spotted, *without definite partition, however.* Left foot: Mainly unchanged, also bilaterally in the axial plane.

Discussion: It is indubitably justified to doubt the correctness of the diagnosis of podagra in this case. Against this speaks the successive onset, the protracted course, as also the absence of cystic rarefactions in the osseous parts of the joint. This may be ascribed to the circumstance, however, that no chronic arthritis urica has been present. Neither were such rarefactions observed in the case of *Wiedhopf* and *Greifenstein.* The fact that atophan seems to have brought improvement of the pain undoubtedly speaks for a gout, which was the final clinical probability diagnosis. The entire course, however, speaks for the likelihood of an affection of the medial sesamoid bones also having existed *in association with* the actual articular lesion. This is indicated also by the extreme tenderness over the ball of the great toe persisting for weeks and months and forcing the patient to walk on the outer edge of the foot. The roentgenograms, however, are the primary facts speaking for this conception, showing distinct structural changes in the shape of marked

spotted decalcification, most pronounced on the right foot, on which it also at one place occurred in the shape of a transverse partition, and the clinical conditions were most pronounced here. Whether this is something else and more than a coincidence between two lesions, however, cannot be decided without a histological examination, as carried out in the case of *Wiedhopf* and *Greifenstein*. No opportunity for this has been found in my case. In the case also of these authors the roentgenogram of the diseased right medial o.s. revealed spotted rarefaction. As mentioned above the histological examination showed profuse deposits of urates in the bone. It is not of conclusive importance that the roentgenogram did not demonstrate the cystic rarefactions in the metatarso-phalangeal joint or the metatarsal head of the great toe which—even though they are not characteristic—are typical of arthritis urica, for the reason that as a rule they occur only in severe cases of old date. Thus they were not present in the case of *Wiedhopf* and *Greifenstein*. On the other hand the roentgenogram of the metatarso-phalangeal joints of the great toe of *both* feet demonstrated definite signs of *an arthrosis* —of whatever nature this may have been—viz. exostosis formation of both capituli and narrowed articular joint on the right side, on which the symptoms had been most pronounced. According to this it is conceivable that an acute exacerbation has been present of a chronic articular lesion. After the lapse of one year, however, the X-ray examination showed no exacerbation of these arthrotic changes—complete status quo. Similar changes, exostosis formation of slight degree, though definite, were demonstrated also by the roentgenogram of the young undergraduate taken nine months after the acute course of the disease. These findings bring forward the question as to whether this lesion of the sesamoid bones in some instances may be due to similar changes to those found in a chronic arthrosis. *Wisbrun* has maintained this, holding that his histological changes in four cases had to be interpreted as a "*primary osseous process* in the so-called arthritis deformans". Other investigators (*Kimmelstiel-Kremser-Richter*) on the other hand, definitely reject the possibility of the histological processes characterizing

their osteochondrosis necroticans findens being in any way connected with arthritis deformans.—Also with regard to this, therefore, opinions are in opposition.

VIII.

The acutely commencing, non-traumatic cases, such as *osteomyelitis* and an acute infection of the joint will have to be considered from differential diagnostic points of view. The absence of temperature and in the latter case missing articular symptoms, speak against these lesions, while tenderness to direct pressure on the ball of the great toe or on a sesamoid bone, with swelling of the adjacent soft parts, will plead directly for a lesion of the sesamoid bones. Increasing inflammatory symptoms, of course, speak for pyogenous infection. At this stage, however, a roentgenogram would in all probability have elucidated the question.

In *traumatic* cases the question of fracture or non-fracture will constitute greater diagnostic difficulties. It is easily explainable that a fracture may occur as a result of direct violence against the anterior part of the foot, particularly against the metatarsals, and thus being a complication in a fracture of the metatarsal. It is another matter with an *isolated* fracture of a sesamoid bone. That such fracture may occur by *indirect* as well as *direct* trauma has been proved experimentally by *Stumme* (1907), and later by *Morian* (1909). It was proved possible to cause direct *fracture* of o.s. by blows of a hammer on the head of the metatarsal on the dorsal as well as the plantar side, and also to cause an *indirect* fracture, a chip fracture, by hyperflexion of the great toe with fixed sole of the foot. This experiment was successful in 7 of 18 cases for *Stumme* and in 2 of 8 cases for *Morian*. In the literature 17 cases are found in which presumably fracture has been present of an o.s.—The diagnosis is no definite clinical diagnosis. Tenderness on pressure over the ball of the great toe is a constant finding in non-traumatic lesions of the o.s., as also in distortions and contusions of the articulation of the great toe. This applies also to hypertrophy and swelling around the joint, and restricted mobility. Extreme-

ly rarely is crepitation recorded in the fractured sesamoid bone, and may be ascribed also to fracture of the metatarsal bone. Pain on movement in the joint, particularly on adduction and abduction, is frequently absent, thus in all of the five cases reported by *Morian*. The diagnosis, therefore, is a *roentgenological* one. It should be emphasized, however, in this connection that a bilateral partition of the o.s. no more than a bilateral partition of the patella, excludes the presence of a fracture, as unilateral congenital partitions also occur. In cases in which the diagnosis is doubtful beforehand, however, a partition also on the other side, as a matter of course, will increase the doubt considerably.

The appearance and shape of the partition is of importance. Contrary to the finding in congenital partitions—viz. regular groove with smooth, rounded edges—in a fracture are found irregular, serrated edges. Further, while the corticalis is distinctly visible in the congenital partitions, this is not the case around a genuine fracture line. Also the congenital partition is most frequently a transverse partition and forms regular, round or oblong fragments, while the fragments in a fracture are extremely variable in shape and size, and frequently with *great diastasis*. In some cases, however, only a quite small diastasis is present, or such may be entirely absent, because the fragments cover each other. *Conclusive* differential diagnostic importance may hardly be ascribed to these conditions, however.

Absolute proof of fracture is constituted by the following factors: 1) demonstration by roentgenogram of callus formation or complete osseous consolidation, when previous roentgenograms have demonstrated post-traumatic partition, and 2) operative removal of fragments disclosing the above mentioned properties. It is a matter of course, that of these two changes the first one—the X-ray demonstration of a consolidated partition—is the one of greatest value, as it is most easily effected.

A critical evaluation of the cases of reported fractures in the literature results in its being possible to establish in a number of cases, that it has not been a question of fracture, but

of a congenital partition. This applies to the cases published by *Schunke, Freiberg, Marx, Momburg* (two cases), and *Igelstein*—six cases in all, while in the cases published by *Muskat, Stumme* (two cases), *Morian* (four cases), *Müller* and *Koch* (l.c.) (two cases)—ten cases in all—a fracture of the o.s. has been present, no doubt. In the first of the five cases of *Morian,* however, in which the past history as well as the X-ray findings makes a fracture extremely probable, no follow-up examination had been carried out, so that this case must be regarded as uncertain, and it is not included in this survey, therefore.

It is in the nature of the case that in the fractures caused by *direct* violence complications are found also with fracture of one or more metatarsal bones. It should be pointed out, however, that not every partition of o.s. found in connection with a fracture of a metatarsal, necessarily means a fracture also of the o.s. An individual having a partition of an o.s., bilateral or unilateral, may contract a metatarsal fracture also. *W. Müller* thus records that in 3 cases of metatarsal fracture he has found one transverse partition of o.s. which was definitely no fracture.

In 6 of the 10 above mentioned cases of fracture of o.s., this was found complicated with fracture of one or more metatarsals. In four of these cases only, however, fracture was present of the first metatarsal, and in one of these cases the second to fourth metatarsals were also fractured. In the remaining two of these six cases the fracture of o.s. was complicated with fracture of the second to fourth metatarsals and of the second metatarsal respectively, but not of the first.

Entirely isolated fracture of an o.s.—i.e. without any complication—*was found in the remaining four of the ten cases* (*Muskat* 1, *Stumme* 1, *Koch* 2 cases). If the two fractures, in which the first metatarsal was intact, are also included among these isolated fractures, *a total of six isolated fractures* is obtained. The traumata which have caused these fractures have been considerably severe and direct—viz. in two cases running over by carriage or motorcar wheels, in one case crushing by a heavy slab of marble, in one by a large stone, in one by a heavy piece of iron, and in one by an iron door weighing 200 kilogram-

mes.—The nature of the trauma is of particular interest in the entirely *isolated cases* of fracture of an o.s. In *Muskat*'s case one finds that a 50 year old man rushed with the foot down into a depression in the road, the tip of the foot becoming lodged there. When pulling it out he experienced a stabbing pain in the foot. X-ray examination demonstrated a T-shaped fissure in the lateral o.s., which had vanished from the roentgenogram two years later. In *Stumme*'s case I a soldier running at full speed struck the tip of the foot against a tramcar mast. The roentgenogram revealed a fracture of the medial o.s. with the one fragment dislocated, lying under the metatarso-phalangeal joint. This was removed operatively. The fragment showed a serrated, irregular fracture line. In *Koch*'s case I, a 44 year old workman had been struck across the dorsum of the foot by a beam, while in *Koch*'s case II, a fireman had had the wheel of a motorcar running over the dorsum of the foot. The two cases of *Koch,* therefore, demonstrated that a *direct,* violent trauma across the dorsum of the foot *may cause an entirely isolated fracture of an o.s.,* a condition which is of forensic interest. In the two remaining cases of isolated fracture, this must be assumed to be caused by *a disruption,* probably due to *hyperflexion* of the toe.

In these ten cases the right foot was involved four times, the left foot six times. In six cases it was the medial and in four cases the lateral o.s. which was injured. In no case were *both sesamoid* bones fractured. In one of these cases hallux valgus was present of the injured foot, which is held by *Koch* to be a predisposing factor for a fracture of an o.s.

IX.

The treatment of the lesion of sesamoid bones dealt with here, is conservative in the acute stage—rest, possibly compresses.

The symptoms vanish in the course of two to three weeks. My case II illustrates the fact also that they may disappear in the course of a few weeks *without any treatment whatsoever.* In cases like mine III and IV—in which the symptoms have

lasted for months and perhaps for years—the same conservative treatment may be instituted, when no treatment had been applied previously. If the symptoms do not disappear in the course of a few weeks, extirpation may be carried out of the small bone, with excellent result as in my two cases mentioned above. In the cases in which the symptoms appear to be caused by hallux valgus, the sesamoid bone should be extirpated when it is found to be tender to pressure and X-ray changes are present (case IV).

The treatment of a fracture of o.s. is conducted along the same lines. When conservative treatment—bandaging is unnecessary—does not lead to the goal in the course of a few weeks, or if consolidation is not obtained because of great dislocation of the fragments, or for other reasons, the fragments should be extirpated, and the symptoms will then vanish just as surely as after the identical intervention in a non-fractured o.s.

The prognosis is perfectly good, therefore. Invalidity with consequential compensation claim, therefore, will not come into question in an *isolated* fracture of a sesamoid bone. It may be another matter when it is complicated by metatarsal fracture.

X.

The one of these lesions of the sesamoid bones of the great toe which is of practical importance, is the one resulting in a seemingly aseptic necrosis. The congenital partition is an anomaly which hardly ever gives rise to clinical symptoms except when the bone is attacked by *necrosis*. It belongs to the nature of the case that the fracture is forewarned by a definite trauma. The necrosis, on the other hand, comes gradually and with symptoms, which as a rule are probably misconceived, as they are taken to indicate another foot lesion of some kind, such as pes excavatus or planus, or hallux valgus. *It is of quite considerable practical significance that attention is drawn to the fact that this pain may be caused by a necrosis of a sesamoid bone, and this only.* My case II is particularly instructive, a bilateral *hallux valgus* being present. Despite operation for this lesion the pain persisted in the one foot, not to disappear until

a necrotic sesamoid bone was removed. In this respect the case is similar to that of *Wisbrun,* whose patient was operated upon for bilateral hallux valgus, and the pain not desisting until after the partitioned medial o.s. of both feet were removed.

XI.

SUMMARY

1. A review is made of the cases of partitioning of the sesamoid bones of the great toe described in the literature.
2. A review is made of the clinical symptoms in a lesion of the sesamoid bones of the foot, in which the X-ray findings are characterized by *a spotted decalcification (atrophy) with or without distinct partition.* In this connection two cases are referred, which have been observed by the author.
3. A review is made with detailed reference of the histological findings in all of the cases recorded in the literature, in which such examination had been carried out.
4. The author sides with those investigators who suppose that the regular, mostly bilateral and transverse, clinically entirely silent, partition of the sesamoid bone, is *a congenital anomaly,* and thus not, as assumed by *W. Müller,* acquired and representing a "typical lesion" of o.s. The clinical cases are characterized roentgenologically by a more or less spotted atrophy of the bone, in one or both fragments, in which partition is present.
5. In the great majority of cases the histological examination demonstrates more or less extensive *necrosis* of the osseous as of the marrow tissue, or changes which lie within the scope of those found in *the osseous, aseptic necroses.* This conception is supported also by the histological examinations of the author's two cases in which such had been carried out. The author associates himself, therefore, with those investigators who assign this lesion of the sesamoid bone room among the juvenile osteopathies, as for example Köhler II disease of the head of the second (third) metatarsal. The finding of *W. Müller* of partial necrosis only,

the marrow tissue not being necrotized, does not warrant the conclusion that such partial necrosis is specific to the sesamoid bones.

6. As cause of the necrosis of the sesamoid bones one must primarily assume a trauma with *chronic* effect, such as the daily strain on a *disposed* bone must be assumed to represent. One must look upon a partition of the bone, present beforehand,—particularly a transverse one—as being such local disposition. As in patella partita, a frequently quite slight and overlooked trauma may be conceived to cause a stretching—distraction (the author)—in the partition with resultant nutritional changes in the fragments leading to an aseptic necrosis.—In cases of o.s.p. with suddenly occurring, acute clinical symptoms (local pain, tenderness, redness with or without increase in temperature), it must be assumed that these symptoms are due to a secondary cause (infection? slight trauma?), and have nothing to do with the actual partition apart from the fact that perhaps an o.s.p. has to be looked upon as a place of minor resistance. Furthermore, one must assume that a *general* disposition plays a part—refer to the definitely existing *age* and particularly *sex disposition*. This must be characteristic of the juvenile osteopathies.
7. The author further refers one case in which it is a question of an acute lesion of a sesamoid bone associated with an acute affection of the metatarso-phalangeal joint, probably an attack of arthritis urica, similar to a case previously described in the literature (*Wiedhopf* and *Greifenstein*).
8. From differential diagnostic point of view *a fracture* of o.s. plays the greatest part. It has been proved by experiments that an *isolated* fracture of a sesamoid bone may occur. A number of fractures have been referred in the literature, only four of which, however, are able to face closer criticism as *isolated*. A violent direct trauma against the dorsum of the foot may cause an isolated fracture of a sesamoid bone.
9. The treatment is conservative. If it fails, extirpation has to be performed of the diseased bone.

10. The practical importance of the knowledge of the necrosis of sesamoid bones lies in the fact that its clinical symptoms are frequently mistaken for a foot lesion of some other kind, particularly hallux valgus, when this is present, and as far as the latter is concerned it has such great incidence that it is natural to assume that such lesion *disposes to a necrosis of sesamoid bones.* In cases which are troubled by a *hallux valgus, therefore, attention should be directed towards a possible affection of the sesamoid bones.*

XII.

ZUSAMMENFASSUNG

1. Es wird eine Uebersicht über die in der Literatur beschriebenen Fälle von Trennung der Sesambeine der Grosszehe erteilt.
2. Ferner eine Uebersicht über die klinischen Symptome bei einer Läsion der Sesambeine des Fusses, wobei der X-Strahlen-Befund *fleckenweise Entkalkung (Atrophie) mit oder ohne deutliche Trennung zeigt.* In diesem Zusammenhang wird über zwei von dem Verfasser beobachtete Fälle berichtet.
3. Es wird eine Uebersicht gegeben mit detaillierten Mitteilungen über die histologischen Befunde in sämtlichen in der Literatur angeführten Fällen, in welchen eine Untersuchung vorgenommen wurde.
4. Verfasser teilt die Ansicht derjenigen Forscher, welche in der regelrechten, meist doppelseitigen und schrägen Trennung des Sesambeines, die sich klinisch durchaus nicht bemerkbar macht, eine *angeborene Anomalie* sehen, — also nicht, wie von *W. Müller* angenommen, eine erworbene Schwäche, die als »typische Läsion« des o.s. aufzufassen wäre. Bei den klinischen Fällen zeigt das Roentgenbild eine mehr oder weniger fleckenweise auftretende Atrophie des Knochens in dem einen oder in beiden von der Trennung betroffenen Bruchstücken.
5. In der Mehrzahl der Fälle liefert die histologische Unter-

suchung Belege für eine mehr oder weniger umfassende *Nekrose* des Knochen- und des Markgewebes oder Veränderungen, die innerhalb des Spielraums derjenigen liegen, die man bei *aseptischen Nekrosen im Knochengewebe* findet. Diese Auffassung wird auch von den histologischen Untersuchungen, die an den zwei Fällen des Verfassers vorgenommen wurde, gestützt. Verfasser tritt daher der Meinung derjenigen Forscher bei, welche diese Beschädigung des Sesambeinraumes zu den jugendlichen Osteopathien, wie z. B. die Koehler II Krankheit am Kopf des zweiten (dritten) Metatarsal, rechnen. Der Befund von *W. Müller*, laut welchem nur partielle Nekrose vorlag, indem das Markgewebe nicht nekrotisiert war, gewährleistet nicht den Schluss, dass eine solche partielle Nekrose für die Sesambeine eigentümlich wäre.

6. Als Ursache der Nekrose der Sesambeine muss in erster Linie ein Trauma mit *chronischer* Wirkung angenommen werden, wie man es in der täglichen Belastung eines *disponierten* Knochens zu sehen hat. Eine bereits vorhandene Trennung des Beines (besonders eine schräge Teilung) ist als derartige lokale Disposition anzusehen. Wie bei patella partita darf man annehmen, dass ein oft ganz geringes und unbeachtetes Traume eine Dehnung — Spreizung (Verfasser) — des Zwischenraums mit daraus folgenden Veränderungen in der Nahrungszufuhr zu den Teilstücken verursachen und damit zu einer aseptischen Nekrose führen kann. In Fällen von o.s.p. mit plötzlich auftretenden, akuten klinischen Symptomen (lokale Schmerzen, Weichheit, Röte mit oder ohne Temperatursteigerung) ist anzunehmen, dass diese Symptome auf eine sekundäre Ursache (Infektion? leichtes Trauma?) zurückzuführen sind und nichts mit der eigentlichen Trennung zu tun haben, abgesehen davon, dass man vielleicht in einem o.s.p. eine Stelle geringerer Widerstandsfähigkeit zu sehen hat.

   Ferner ist anzunehmen, dass eine *allgemeine* Veranlagung eine Rolle spielt — vergl. die entschieden bestehende *Alters-* und *Geschlechtsveranlagung*. Dies trifft bei den jugendlichen Osteopathien zu.

7. Verfasser berichtet ferner über einen Fall von akuter Läsion eines Sesambeines in Verbindung mit einem akuten Leiden des Metatarso-phalangeal-Gelenkes, wahrscheinlich ein Anfall von arthritis urica, der einem früher in der Literatur beschriebenen Fälle ähnlich war (*Wiedhopf* und *Greifenstein*).
8. Von differentialdiagnostischen Gesichtspunkt aus spielt eine *Fraktur* der o.s. die grösste Rolle. Durch Versuche wurde bewiesen, dass ein *isolierter* Bruch eines Sesambeines stattfinden kann. In der Literatur sind mehrere Frakturen beschrieben, von denen aber nur vier bei näherer Untersuchung als *isoliert* bezeichnet werden können. Ein starkes, direktes Trauma gegen den Fussrücken kann eine isolierte Sesambeinfraktur verursachen.
9. Die Behandlung ist konservativ. Versagt sie, so muss das erkrankte Bein entfernt werden.
10. Die Kenntnis der Sesambein-Nekrose ist insofern von grosser praktischer Bedeutung, als die klinischen Symptome derselben häufig irrtümlicherweise einem Fussleiden anderer Art zugeschrieben werden, besonders dem Hallux Valgus, wo dieser vorliegt; letzteres ist so häufig der Fall, dass es natürlich ist anzunehmen, dass dieses Leiden *zu einer Nekrose der Sesambeine disponiert.* In Fällen, die an einem *Hallux Valgus leiden, empfiehlt es sich daher, auf eine mögliche Erkrankung der Sesambeine aufmerksam zu sein.*

XIII.

RÉSUMÉ

1. Il est donné un aperçu général des cas de division des os sésamoïdes du gros orteil décrits dans la littérature.
2. Il est donné d'autre part un aperçu des symptômes cliniques provoqués par une lésion des os sésamoïdes du pied qui se caractérisent à la radiographie *par une décalcification partielle* (*atrophie*) *avec ou sans division distincte.* Sous ce rapport, il est rendu compte de deux cas observés par l'auteur.

3. Il est donné un aperçu, avec référence détaillée, des trouvailles histologiques faites dans tous les cas publiés dans lesquels un examen de ce genre a été effectué.
4. L'auteur partage l'avis des investigateurs qui supposent que la division régulière, la plupart du temps bilatérale et transversale de l'os sésamoïde, qui ne provoque aucun symptôme clinique, est une *anomalie congénitale* et non pas, comme le suppose M. *W. Müller,* une maladie acquise et représentant une »lésion typique« de l'os sésamoïde. Au point de vue radiographique, les cas cliniques se caractérisent par une atrophie plus ou moins disséminée de l'os, dans l'un ou dans les deux fragments de l'os divisé.
5. Dans la grande majorité des cas l'examen histologique fait constater une *nécrose* plus ou moins étendue de l'os ou de la moelle ou des modifications qui rentrent dans le cadre de celles que l'on trouve dans les cas de *nécrose osseuse aseptique.* Cette conception est appuyée aussi par les examens histologiques des deux cas de l'auteur dans lesquels de telles recherches ont été effectuées. C'est pourquoi l'auteur se rallie aux investigateurs qui estiment que cette lésion de l'os sésamoïde se range parmi les ostéopathies juvéniles, comme par exemple la maladie de Köhler II de la tête du deuxième (ou troisième) métatarse. La trouvaille d'une nécrose partielle faite par M. *W. Müller,* la moelle n'étant pas nécrotisée, ne fournit pas la preuve de la conclusion selon laquelle cette nécrose partielle est propre aux os sésamoïdes.
6. Comme cause de la nécrose de l'os sésamoïde, il faut admettre en première ligne un trauma avec effets *chroniques,* comme on peut l'observer sur un os *prédisposé* ayant chaque jour à subir un effort. Il faut considérer la division déjà existante d'un os — particulièrement si elle est transversale — comme constituant une prédisposition locale de ce genre. Tout comme dans la division patellaire, un trauma souvent très léger et dont il n'a pas été tenu compte, peut avoir causé une extension — un écart (l'auteur) — de la partie divisée, avec le résultat que des modifications dans la nutri-

tion des fragments entraînent une nécrose aseptique. — Dans les cas de division de l'os sésamoïde, avec manifestation subite et aigue de symptômes cliniques (douleurs locales, mollesse, rougeur avec ou sans élévation de la température), il faut considérer que ces symptômes sont dus à une cause secondaire (infection? léger trauma?) et n'ont rien à voir avec la division existant, sauf le fait qu'un os sésamoïde divisé offre probablement une résistance plus faible.

Il faut considérer par ailleurs qu'une prédisposition *générale* joue aussi un rôle — voir à cet égard *l'âge* particulièrement critique et notamment la *prédisposition sexuelle.* Ce sont ceux de l'ostéopathie juvénile.

7. L'auteur rend compte, d'autre part, d'un cas dans lequel il est question d'une lésion aigue d'un os sésamoïde se joignant à une affection aigue de l'articulation métatarso-phalangienne, probablement une crise d'arthrite urique, similaire à un cas décrit antérieurement dans la littérature (*Wiedhopf* et *Greifenstein*).
8. Du point de vue du diagnostic différentiel, une *fracture* de l'os sésamoïde joue le plus grand rôle, des expériences ayant prouvé qu'il est possible de provoquer une fracture *isolée* d'un os sésamoïde. Il a été rendu compte d'un certain nombre de fractures dans la littérature. Toutefois, examinées de plus près, quatre seulement peuvent être considérées comme étant *isolées.* Un violent trauma direct sur le dos du pied peut causer une fracture isolée d'un os sésamoïde.
9. Le traitement est conservateur. Si celui-ci donne un résultat négatif, il faut procéder à l'extirpation de l'os malade.
10. L'importance pratique de la connaissance de la nécrose des os sésamoïdes réside dans le fait que ces symptômes cliniques sont souvent pris pour ceux d'une autre sorte de lésion du pied, particulièrement de l'hallux valgus, lorsque celui-ci existe et, en ce qui concerne ce dernier, c'est si souvent le cas qu'il est évidemment tout naturel d'estimer qu'une lésion de ce genre *prédispose à une nécrose des os sésamoïdes.* C'est

pourquoi, dans les cas qui souffrent de *l'hallux valgus, il faut envisager la possibilité d'une maladie des os sésamoïdes.*

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