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SPONDYLOLISTHESIS AND CONDITIONS RESEMBLING IT

BY
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Of late years, the condition generally termed spondylolisthesis is becoming an object of more and more interest both to orthopedists and to roentgenologists. The lesion was observed by *Herbinaux* already in 1842, but was described in greater detail and given its name, in 1854, by *Kilian*, whose first observations of it dated back more than twenty years earlier. The completest description of it was given by *Neugebauer*, who devoted several monographs to the subject. In the beginning, only the obstetricians paid some attention to it, however, on account of the displacement which it caused of the pelvis. It was supposed to occur only in persons of the female sex, and to be so comparatively rare that each new case became the subject of minute description, and was often labelled with the name of the patho-anatomical museum possessing the prepared specimen. *Neugebauer* was able to make a list of more than two hundred cases. Only later did the condition become the object of more general attention, specially after roentgen diagnostics had begun to be applied also to the lumbosacral region, when it was realised that it was by no means confined to the female sex, and that various degrees of the lesion are far more common than hitherto supposed, so that its discovery is often the result of incidental finding; clinical symptoms having either been totally absent or extremely slight (*Schmorl* and *Jungmanns*). The terms spondylolysis, spondyloclisis, spondyloptosis and spondylolisthesis were first suggested by *Lambl*, to express the various degrees of

dislocation of the vertebra. Only the first and last seem to be in use now: spondylolysis to denote the characteristic fissure formation in the interarticular part of the vertebra (of which later), spondylolisthesis usually—though in fact possessing a somewhat wider meaning, and yet not fully adequate to the sense in which it is used—to express the *forward* dislocation of the vertebra in relation to the one below it, irrespectively of the degree of that displacement. In most cases, the vertebra thus displaced is the fifth, more seldom the fourth lumbar or, very rarely, some other vertebra higher up (*Turner*). The entire portion of the spine above the dislocated vertebra follows the forward movement of the latter, and it is generally held to be characteristic also that the dislocation should take place slowly and gradually. Thus, a luxation fracture would not generally be spoken of as spondylolisthesis (see below). It will be seen from the following that the latter term is practically reserved for an absolutely definite form of forward dislocation of the bone.

I shall not enter here into any detailed description of the clinical symptoms of the condition. They have been described conformably and at length by a number of authors (*Meyer-Burgdorff*, *W. Mueller*, *Turner*, and others), a list of whose writings will be found in the bibliography appended to the present paper.

It has been stated that not only roentgenologically, but also on the pathoanatomical specimen, the displacement of the vertebra is best observed at the dorsal margin of the vertebral body, where no exostosis formations at the angles render the observation difficult (*Schmorl*, *Junghanns*, *W. Mueller*).

Ever since *Neugebauer*, the first and essential condition for the development of true spondylolisthesis—the form for which that term should be exclusively reserved—has been held to be a certain change in the posterior part of the vertebra, in the so-called interarticular part of the latter, resulting in a forward, or forward and downward, movement of the portion of the bone anterior from the part which has undergone this change; while the posterior parts do not follow the forward movement, but

perform a rotating movement around a transversal axis through the interarticular part. This change in the posterior part is usually described as the formation of a cleft in the bone, and was already by *Neugebauer* called spondyloschisis, or spondylolysis. That it occurs in all cases of true spondylolisthesis—as that term was defined by *Neugebauer*—is probably now agreed by all. Not all authors adhere strictly to that definition, however. By many, the term spondylolisthesis is made to cover all sorts of different conditions characterised merely by the displacement, whether forwards, backwards or sideways in relation to the next one, of any vertebra, either of the lumbar or any other region, irrespectively of whether the dislocation is due to purely traumatic, or destructive, or any other causes. *Schmorl* and *Junghans* rightly complain about this loosening of the definition, and stress the desirability of the term spondylolisthesis (in German: »Wirbelgleiten« or »Wirbelrutsch«) being reserved for the forward dislocation, due to spondylolysis, in the lower part of the lumbar spine, as described by *Neugebauer*; while for all other vertebral displacements they suggest (in German) the term: »Wirbelverschiebung«.

While the occurrence of spondylolysis is thus commonly agreed on, opinion is largely divided with regard to the causes responsible for the condition. It cannot be denied, of course, that a trauma may cause a fracture of that part of the arch, which then, for some reason or other, fails to heal, but gives rise to pseudarthrosis. It is agreed on all hands, however, that such an origin, if we accept it at all, is at least extremely rare. Two of the most weighty objections are the improbability of a bilateral, symmetrical fracture in the interarticular part, and the fact that spondylolysis may occur without any demonstrable trauma in the anamnesis.

Among the older theories may be mentioned the one advanced by *Lambl*, who would explain the posterior elongation as the result of congenital hydrorrhachis and the existence of supernumerary vertebræ. Since *Lambl's* time, spondylolisthesis has been the object of much attention and study on the part of Polish and Russian authors, as evidenced most notably in the work of his pupil, *Neugebauer*.

Neugebauer gradually came to the conclusion that the spondylolysis was of congenital origin, though developed in a different manner from the one supposed by *Lambl*. He suggested that it was due to the failure of two osseous centres on either side of the forming arch to fuse—in other words, to a kind of persisting gap in the epiphysis. He found support for this opinion in the result of some investigations by other authors, notably *Rimbaud* and *Renault*, who had found two centres on either side of the developing vertebral arch of the fifth lumbar vertebra. *Neugebauer's* views are still generally accepted. Failure of fusion between the two osseous centres is stated to be found in about 5 per cent. of all vertebrae examined.

As an argument against this whole theory it is contended by some authors, for instance by *Hayek* (quoted by *W. Mueller* and others) that *Neugebauer's* supposition of two centres in each side of the fetal arch is wrong. To this, the adherents of the congenital theory reply that any such contention must be based on faulty methods of investigation. Some of them maintain that there are *always*, in the younger embryonal stage, two centres, which very early fuse into one, however. Among those who have found this to be the case may be cited *Novak*, *Willis*, *Faraboeuf*, *Poirier* and *Charpie*. Others, like *Hellner* and *Schaer*, while admitting that a single centre in each half of the arch is the normal, assert that *occasionally* there are two, which sometimes fail eventually to unite, with the result that spondylolysis occurs.

Sharply opposed to the congenital theory stands another, according to which the spondylolysis should develop during the post-natal existence. This has lately been brought forward specially by *Meyer-Burgdorff*, but had already been advanced before, more tentatively, by other authors, for instance by *Arbuthnot Lane*, *Turner*, *Mouchet* and *Roederer*. *Meyer-Burgdorff* believes that the spondylolysis is due to the development, in the interarticular part, of a zone of transformation (»Umbauzone«), through the action of static and mechanical forces; and beside static conditions in the lumbar spine, involving increased pressure on the arcual part of the latter, he claims as a con-

tributary cause that precisely the interarticular part of the vertebra would be caught, as in the jaws of a nail-puller, between the articular processes of the vertebræ above and below it. Also to *Burckhardt* an explanation of this kind seems credible,—under the presumption, at least, that the strength of the arcual portion thus caught be in some way or other below the average normal.

I shall not attempt to judge between those different theories. It is to be noted, however, that against the views expressed by *Meyer-Burgdorff* very weighty arguments have been raised by several writers, who call in question his ideas both as regards the altered conditions of pressure on the arch and about the »pinching«, which—as pointed out by *Schaer*, for instance—probably cannot occur at all, on account of the position of the articular processes. *Schaer* also disagrees with *Meyer-Burgdorff* when the latter, in support of his theory, speaks of an increased thoracic kyphosis, with compensatory, increased lumbar lordosis, such as he has observed after compression fractures in the lower thoracic region, as one of the statical factors causing the development of a »zone of transformation« in the interarticular part. According to *Meyer-Burgdorff*, the increased lumbar lordosis should be what primarily brought the mechanical forces into play; while, according to *Schaer* and others, this increased lordosis, if it exists at all (see *Schmorl* and *Jung-hanns*), is a result of the spondylolisthesis—being nature's reaction against the altered statical condition brought about by the latter. If *Meyer-Burgdorff* were right in his contention, it should be expected that spondylolisthesis would be provoked as well by an increase of the lordosis proceeding from other causes, such as a gibbus of the lower thoracic region due to something else than a vertebral fracture, a hip contracture or the like; but observations to that effect do not seem to have been made in any number comparing to the relatively common occurrence of such increased lordosis. According to *Schmorl* and *Jung-hanns*, not even *Magnus*, in an examination of a very large number of vertebral fractures, found any such frequency of spondylolisthesis.

Junghanns, who is an adherent of the congenital theory, specially, as it seems, on account of the pathoanatomical likeness of the spondylolysis to an epiphyseal fissure, describes a case in which there was distinct spondylolysis on one side, while the interarticular portion of the other side of the arch presented a structure which could hardly be interpreted as anything but an originally existing spondylolysis that had become healed osteogenetically. It is evidently possible that a persisting epiphyseal cleft may become bridged over with bone under the influence of traumatic or other conditions; but no attempt is made by *Junghanns* to explain what, in this case, led to such a bridging over on one side of the arch. Experience with the so-called arch fractures after an Albee's operation shows that there sometimes develops in the arch a zone of greater thinness, which very much resembles the cleft in the interarticular portion, and which sometimes eventually becomes replaced by an osseous tissue similar in appearance to the one described by *Junghanns* in the case just referred to. At any rate, the whole question of whether spondylolysis is congenital or acquired cannot yet be regarded as finally settled.

With reference to the above case of *Junghanns's* it must not be forgotten that sometimes the cleft in the interarticular portion is not altogether unilateral. In such case, the resulting spondylolisthesis will be less pronounced, and is accompanied at the same time by a rotation of the sliding vertebra, as will also be the case when the lack of resistance in the interarticular portion is greater in one side than in the other. A case of spondylolysis simultaneously in the fourth and fifth lumbar vertebræ, with typical listhesis of the fifth one, has been observed by *Schmorl* and *Junghanns*.

As spondylolysis does not always necessarily result in dislocation of the vertebræ, it is evident that the occurrence of spondylolisthesis requires the intervention of yet another factor—a trauma, the increased pull of a body overweighted for instance by gravity or a large, pendent abdomen, or some other circumstance. I shall not go into the details of this; only about the rôle of the trauma I must say a few words, particularly in view of a case which I shall describe in the following.

By many authors, the trauma is considered as a necessary part of the mechanical mechanism determining spondylolisthesis, and, as a matter of fact, it frequently appears in the anamnesis of these cases. Descriptions are not lacking, however, of cases in which no trauma could be ascertained. According to *Schaer*, such cases are reported by *Schulz*, *Brandenberg*, *Mouchet* and *Roederer*, *Wynen*, *Nicolaysen*, and several others. In many cases it may, from the information elicited, be deduced that certain pathological conditions existed in the spine already before the trauma was sustained. *Huber* denies the rôle of the trauma as unique cause, on the ground that no description exists of any case in which roentgenological changes were positively absent before the trauma. The prevalent opinion nowadays is probably that the trauma, where any such is ascertained, has been, at most, the releasing factor which started the sliding in a vertebral column where spondylolysis already had created a disposition to spondylolisthesis, or which caused a pain to be felt in an already anatomically changed, but hitherto pain-free spine. On the other hand, it cannot be denied that *Reinbold*, for instance, distinguishes between traumatic spondylolisthesis and the spondylolisthesis developed on the basis of a congenital disposition,—which he, with a not very happy expression, terms »acquired« spondylolisthesis.

In this connexion, as well as on account of the age at which the spondylolisthesis first made its appearance, the following case may be of interest.

Case I. — Journal no. 930/32. Male. — The patient, who was born in 1882, was run over, at the age of about eleven, by a waggon, one of whose hind wheels passed over the small of his back. He was able to get up, and managed, though with difficulty, to walk the rather long way to his home unaided, in spite of pain in the lower part of his back and in the legs. He dared not say anything about his accident at home, and was not compelled to take to his bed, but went about, the pain in his back growing less little by little. Two or three weeks after, his parents accidentally noticed an apparent deformity of the lower part of his back. According to the patient's positive state-

ment, this deformity has not undergone any noticeable alteration since, but is to-day of about the same extent as when it was first observed. In the course of two years, all painful sensations gradually disappeared, and at the end of that time

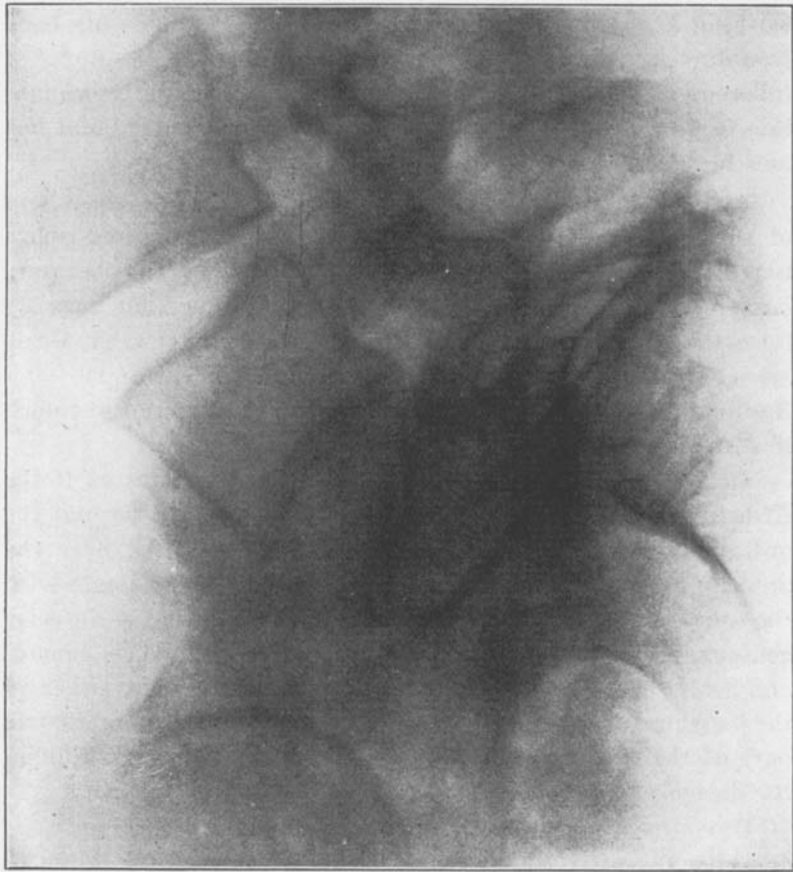


Fig. 1.

he was again completely fit and able to do his usual work. During the first time after his accident, however, he felt a pain in his back if he, for instance, happened to step accidentally into a hole or had to lift anything heavy, or if any of his play-fellows grasped him around the waist trying to wrestle with

him; and it was not until after those two years that he again felt really strong in his back. At the age of twenty-one he went through his term of military service, being assigned to the »train«; the deformity of his back having been noticed by the board of examination. Since then, he has until recent years been working at stone cutting and rock blasting, without his back troubling him in any way. In 1929, he developed symptoms of tuberculosis in one of his knee-joints, which eventually brought him to the coastal sanatorium at Apelviken, where the joint has now been resected on that account.

As regards his back, there is now noticed in the lower part of the latter an outward curve of the sacral bone, and above that increased lordosis, where one on palpation feels the upper part of the sacrum forming a projection below and dorsally from the fifth lumbar vertebra, which has slid forward. He is »short in the trunk«; the distance between the lowest ribs and the iliac crest is very small. The skin of his back and abdomen lies in transversal folds.

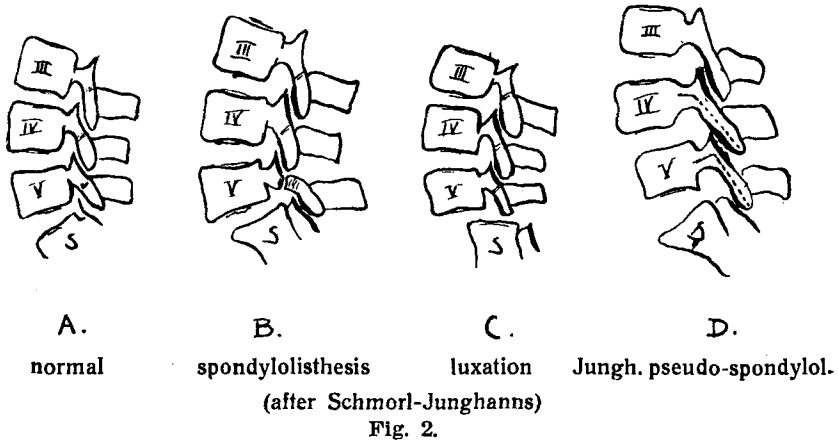
In the lateral roentgen picture (Fig. 1), it seems as if the fifth lumbar vertebra has slid about 3 cm. forward beyond the anterior line of the sacrum, and has become tilted over the anterior upper edge of the latter, so as to form an angle with the sacrum. The fifth lumbar vertebra is cuneiform; its inferior contour, as well as the superior one of the sacrum, is smooth and somewhat sclerotic. There is no sign of fracture, either in the body or any other part of the vertebræ. In the interarticular part of the fifth lumbar, there seems to be an interruption in the design of the bone (spondylolysis?).

Of course, the trauma in the anamnesis of this case impresses one strongly, at first, as being of the kind precisely liable to cause such a lesion as might result in a forward dislocation of the vertebra. Still, it may be questioned whether it would really have been possible for this patient to remain up and about with a vertebral fracture of such a character, and if it has not merely been a question of the trauma's starting the sliding of a vertebra inclined to dislocation beforehand as the result of already existing spondylolysis. Both the clinical and the roent-

genological picture speak for the case being one of ordinary, true spondylolisthesis. Assuming that the spondylolysis existed already previously to the trauma, it seems unreasonable to suppose, in a boy only eleven years old, a condition of physical statics such as would give rise to acquired spondylolysis in the sense which *Meyer-Burgdorff* attaches to that term, and the only possible supposition left is thus that the spondylolysis has been congenital. The two facts that the deformity declared itself already soon after the accident, and that its appearance has remained unchanged ever since, both speak for the dislocation having actually taken place then, and not having noticeably progressed afterwards. The case would thus be one of spondylolisthesis occurred in a subject at the age of eleven. *Meyer-Burgdorff* himself says that »spondylolisthesis occurs at the earliest at the age of puberty«. *Neugebauer* states that he has found spondylolysis in the fifth lumbar vertebra of a six year-old child, and *Reisner* has made positive roentgenologic observations of spondylolysis in children aged six and eight.

A pathological picture resembling spondylolisthesis may be found, however, also in cases where there has been no spondylolysis. Such a picture is the one resulting from a luxation fracture. Already *Neugebauer* gave to that violently traumatic change the name of »pseudo-spondylolisthesis«. *Junghanns* uses the same name in describing a sliding process of one vertebra in relation to another, which in many respects resembled spondylolisthesis, but where there was neither spondylolysis nor any such preceding trauma as might have caused a luxation fracture. Instead, there was on both sides an increase of the angle between the arch and the articular process of the vertebra underneath, and the interarticular line of the minor articulations between the displaced vertebra and the one below it was directed considerably more horizontally than normal. Besides, there were in these articulations, but not in the ones adjoining them, pronounced deforming changes in the shape of unconnecting surfaces and thickened margins. *Junghanns* thinks it probable that the abnormal position of the articular process may have helped to cause a subluxation of these articulations, but he does not

express himself as to whether the localised intervertebral arthritis should be considered as cause of the subluxation, or as a result of it. Before *Junghanns*, such arthritic changes had been observed by *Chiari*, and had by him been connected with the origin of spondylolisthesis. It may perhaps cause some confusion that *Junghanns* for these conditions uses the same designation which *Neugebauer* had already appropriated to a different purpose. There is, of course, in both cases a question of luxation, or subluxation, in the intervertebral articulations; still, the



origin is essentially different in the two, and, besides, *Junghanns's* pseudo-spondylolisthesis often has a different location, the dislocation being only in 2 of his 11 cases between the fifth lumbar and first sacral vertebræ, while in 7 it is between the fourth and fifth, in 2 between the third and fourth lumbar vertebræ. In Fig. 2 I have attempted to illustrate the difference between spondylolisthesis, luxation and *Junghanns's* pseudo-spondylolisthesis.

W. Mueller calls attention to the bearing which degeneration of the intervertebral fibro-cartilage has on the occurrence of dislocation between the vertebræ, and would see therein one of the reasons why the disposition to such dislocation is greater in subjects of advanced age. He even thinks that the state of the intervertebral disc has more to do than the intervertebral articulations with bringing about the condition, and he finds

confirmation of this in an observation which he made of a man aged 36, in whom the inferior articular process of the second lumbar vertebra was entirely absent—probably a congenital anomaly—without this having the slightest influence on either the functioning or the position of the spine.

Treub has described, in a very complete paper, published in Liège in 1889, a case of dislocation between the fifth lumbar and first sacral vertebrae, which, from the occurrence of certain destructive processes simultaneously with the displacement, he considered to be of the same kind as a case described, in 1861, by *Olshausen*. For this case, *Treub* uses the designation of pseudo-spondylolisthesis. *Olshausen* does not, so far as I have been able to ascertain, use this term, but he speaks of his case as »an actual vertebral dislocation, though due perhaps to other causes than in the cases hitherto described as spondylolisthesis«. These cases of *Treub*'s and *Olshausen*'s were afterwards made the subject of a critical study by *Neugebauer* (*Centralblatt f. Gynækologie*, 1889), who found them to be altogether dissimilar, *Treub*'s being a true spondylolisthesis, with spondylolysis in the interarticular portion of the vertebra and secondary destructions, while *Olshausen*'s was a secondary dislocation due to caries; a supposition which had already, in immediate connexion with the latter's demonstration, been voiced by *Gurlt*, and was repeated later, in 1877, by *Herrgott*. *Olshausen*'s case should rightly be classed as one of spondylizema,—a condition to which I shall come back in the following. *Neugebauer* therefore held the use of the name pseudo-spondylolisthesis to be unjustified as applied to these cases, and apt to cause confusion considering his own different definition of that term.

Both with regard to true spondylolisthesis and with regard to pseudospondylolisthesis in the sense in which that term is used by *Junghanns*, the changes which the latter mentions as secondary to the occurrence of the two conditions are worth noticing; namely, a compression of the fibro-cartilage between the dislocated vertebra and the one below it, with pressure-wear and eventual sclerosing of the adjoining vertebral surfaces, and the formation of a ridge, supporting the sliding vertebra, along

the anterior upper margin of the vertebra distal from the compressed interarticular fibro-cartilage. W. *Mueller* thinks it is impossible to decide to what extent the changes in the intervertebral disc are primary or secondary, and seems to believe that it is a matter of »circulus vitiosus«. I will come back, in the following, to these conditions, and to their bearing on the diagnosis from another pathological picture resembling spondylolisthesis.

Whitman has introduced the term: prespondylolisthesis as designation for the condition in which the sacrum is disposed well nigh horizontally, so that its upper surface faces almost straight forward, which position he considers as predisposing to spondylolisthesis. He probably has in mind, by this term, the same as *Scherb* when he speaks of »sacrum acutum«. Against *Whitman's* idea with regard to this anomaly of position—which has long been known under the correcter and more neutral name of increased lumbar lordosis—*Schaer* opposes the same arguments as against *Meyer-Burgdorff's* theory concerning the rôle of the thoracic kyphosis. Like *Glasewald*, he believes that not only does the position of the sacrum referred to in no way create any predisposition to spondylolisthesis, but that it never changes into that condition. The name prespondylolisthesis is thus a very ill chosen one. A few authors, like *Burckhardt* and *Wegener*, have expressed themselves in agreement with *Withmann*, while others, like *Hellner*, *Joisten*, *Junghanns*, *Scherb* and *Turner*, range themselves unequivocally with *Glasewald* and *Schaer* in opposition to his views.

In the chapter of his »Untersuchungen über das Wirbelgleiten« which deals with spondylolisthesis as a secondary manifestation, *Meyer-Burgdorff* says, among other things, as follows:

»Dass schliesslich auch einmal ein in der Höhe des unteren Lendenabschnittes lokalisierter Krankheitsprozess Wirbelkörper und Bogen ergreifen kann und den als Zügel für den auf der schiefen Ebene abgleitenden V:en Lendenwirbel wirkenden Bogen an annähernd symmetrischer Stelle unterbricht, ist nicht nur theoretisch möglich sondern auch praktisch beobachtet worden. Ich verweise auf die Fälle von Spondylolisthesis bei Tabes

(Breitländer), bei Tuberkulose (Herrgott) und bei Tumoren. Jedoch ist der Gleitprozess dabei eine verhältnismässig harmlose Nebenerscheinung, während der Gesamtbild immer von der Grundkrankheit beherrscht wird.«

Observations of tuberculosis of the lumbosacral region giving rise to conditions resembling spondylolisthesis are of ancient date. In a paper on caries of the spinal column, in 1867, *Kraus* wrote as follows:

»Die Caries des Kreuzbeines gewinnt dadurch noch eine besondere Bedeutung dass durch sie eine Beckenanomalie erzeugt werden kann, welche allerdings selten vorkommt aber für die Geburtswege von grosser Bedeutung ist. Durch Zerstörung der Zwischenwirbelscheibe zwischen Kreuzbein und Lendenwirbel und der Körper des oberen Kreuz- und des unteren Lendenwirbels kann in dem Fall, dass die Zerstörung auf die Proc. obliq. und auf die Bögen nebst den Proc. spin. und transv. übergeht eine Verschiebung der Lendenwirbel vor das Kreuzbein und so ein spondylolisthetisches Becken entstehen.«

Kraus, who believes that such a possibility is denied by many, proves his assertion by describing an anatomical specimen which had been lent him by his teacher, *Blasius*, who himself published a description of it the following year. This specimen—the pelvis of a woman, 51 years old, who had died from pulmonary tuberculosis, and who during life had shown symptoms of tuberculosis of the pelvis, with psoas abscess—shows extensive bone destruction at the place where the base of the sacrum meets the fifth lumbar vertebra. In the first sacral vertebra, the destruction involves a large proportion of the upper anterior part. The right articular process is almost entirely destroyed, and also the left one shows some signs of a carious process. In the fifth lumbar vertebra there is a destruction, of the inferior dorsal part, corresponding to the one in the first sacral. The arch is almost totally destroyed; likewise the spinous and both the inferior articular processus. The transverse and superior articular processes still exist, but show signs of caries. There is caries also of the adjoining bony structures, for instance in both iliosacral joints. The fifth lumbar vertebra is not

in its usual position above the first sacral one, but has slid forward and downward, so that the under surfaces of the two are on the same level, and the anterior margin of the fifth lumbar almost 2 cm. in front of the one of the first sacral (see Fig. 3, reproduced from *Kraus*). *Kraus* adds that:



Fig. 3. After *Kraus*.

»Durch Caries kann diese Form allerdings nur dann entstehen wenn die Proc. obliq. nebst dem Bogen des V:en Lendenwirbels mit von der Zerstörung ergriffen werden, was selten genug vorkommt; dass es aber der Fall sein kann zeigt dieser Fall sehr deutlich.«

Concerning the etiology of this condition, he says that the process was »wahrscheinlich nach Tuberkulose bedingt«—a conjecture the correctness of which, with our present insight into that disease, can hardly be doubted.

If I have repeated here in some detail *Kraus's* description of his post mortem investigation of this case, it is because it seems in principle to agree with the observations of which an account is to be given in the following. When the question of the etiology of spondylolisthesis was debated by the scientific world somewhat later, in the seventies and eighties of the last century, it was also discussed what part tuberculosis—or, as it was then said, caries—might possibly play in the development of that condition. It was at that time—in 1877, to be exact,—that *Herrgott* introduced into the discussion the term: spondylizema, as designation for a sinking together (*υστεμα*), due to destruction, of the fifth lumbar and first sacral vertebræ. He made an absolute distinction between the conditions implied respectively by the terms spondylizema and spondylolisthesis, as well as between either of these and what in the literature of that time was commonly referred to as »kyphotic pelvis«; and he specified the meaning of the terms by saying that by spondylizema he understood a *sinking together* of the spine immediately *above* the inlet of the pelvis, by spondylolisthesis the deformity of the pelvis resulting from the spine *sliding down into the latter*, while he reserved the term kyphotic pelvis for the deformation which leaves the pelvic inlet unchanged at the same time as the pelvic canal, and especially its inferior opening, becomes deformed as result of the altered position of the sacrum, owing to a dorsolumbar kyphosis. It should be noticed that *Herrgott*, like the others who at that time discussed the question of spondylolisthesis, was an obstetrician!

It seems as if the condition to which *Herrgott* thus gave the name of spondylizema, and the possibility of its association with certain cases of spondylolisthesis, have in recent years been a little overlooked by the writers on these subjects; or, at any rate, the name: spondylizema seems to have gone out of use. In some of the older literature at least, it is explained as characteristic of spondylizema that the partly destroyed vertebra—which sometimes, if its dorsal portion was involved by the **destruction**, would slide forward and downward under the weight of the person's body—formed a wedge whose point was directed anteriorly, while in the usual form of spondylolisthesis

the sliding vertebra was likewise wedge-shaped, but with its slope in the opposite direction, backwards. As we have already seen from the case described by *Kraus*, and as will be seen also from a number of examples in the following, this is by no means always the case. The seat of the destruction may very well be in the posterior part of the fifth lumbar vertebra, and thus give to the latter the form of a wedge with the point directed backwards, whereby the resemblance to an ordinary spondylolisthesis becomes still greater. *Kraus* also tries to explain this, when he says:

»Die Zerstörung der Bögen nebst den betreffenden Fortsätzen ist in diesem Fall deshalb leichter, weil das Kreuzbein ziemlich unbeweglich mit dem Becken vereinigt ist und sich daher nur schwer eine kyphotische Krümmung ausbilden kann, da der Kreuzbeinkörper den sich senkenden Lendenwirbelkörpern nicht entgegenkommen kann, was bei den übrigen Wirbeln der Fall ist, wodurch dann wieder eine Aufeinanderlagerung der Wirbelkörper und dadurch vermehrte Stützfähigkeit der Wirbelsäule zustande kommt. Hier jedoch haben dann also die Bögen nebst den betreffenden Fortsätzen die ganze Last fast allein zu tragen, welche hier gerade die des ganzen Oberkörpers ist, wodurch das Fortschreiten der Zerstörung auf diese Teile entschieden befördert wird. Ist aber die Verbindung des Proc. obliq. und der Bögen durch die Zerstörung erst unterbrochen, so steht dem Herabsinken der Lendenwirbel auf der durch Zerstörung des ersten Kreuzbeinkörpers entstandenen schiefen Ebene nichts entgegen.«

It should be added that *Herrgott* suggests the possibility of spondylizema and spondylolisthesis being in reality due to the same cause, only the point of attack being different, spondylizema resulting when the destruction works chiefly on the body of the vertebra, spondylolisthesis when those parts are destroyed which serve to retain the vertebra in its position,—the arch and the articular processes.

I shall describe in the following some cases of pathological conditions resembling spondylolisthesis, arisen secondarily to lumbosacral spondylitis and, consequently, answering to *Herr-*

gott's spondylizema with sliding of the vertebra. Observations of a number of spondylitis cases at the coastal sanatorium of Apelviken make me believe that such vertebral dislocations are by no means uncommon. It is undoubtedly so that the destruction and sinking down of the diseased vertebra sometimes is relatively slight and less noticeable than the dislocation; perhaps there is no destruction of the vertebral body at all, but only of the posterior part and the articular processes, in which case it is not always easy, even with the good help of roentgen, to decide in a given case whether the existing condition is one of true spondylolisthesis with fissure formation, or a dislocation due to lumbosacral spondylitis, with subsequent destruction of the posterior part of the vertebra. Some of the examples I have chosen are intended to illustrate that difficulty. It will often seem that even roentgenograms excellent in all other respects are of no help when it comes to determine the matter positively, owing to the difficulty one always finds in obtaining an absolutely distinct roentgen picture of this region, which is so hard to photograph. The method recommended by *Meyer-Burgdorff*, of photographing in oblique projection, is sometimes of good assistance, and it is to be hoped that with a still further improved technic the difficulties may eventually be overcome.

I think it important to recall in this connexion that spondylolisthesis is characterised not only by a sliding of the vertebra, but that one also very often observes a compression of the intervertebral fibro-cartilage and destruction of the surfaces of the vertebræ next to it, which in the roentgenogram finds expression in a diminished intervertebral space and blurred, irregular contours of the bones. I have the impression that this is a circumstance often overlooked in spondylolisthesis, and that, in the cases where it is observed, it often results in an erroneous diagnosis of spondylitis (*vide* the two cases nos. VIII and IX below, both of which were by the roentgen specialist diagnosed as tuberculous spondylitis), just as the fact of attaching oneself only to the dislocation may cause one to diagnose as spondylolisthesis a case which is in reality one of spondylitis with sliding of the vertebra. Of the latter mistake,

the case no. X below may possibly be an instance, just as the following cases may help to show how far *Meyer-Burgdorff* is right—or wrong—when he maintains that the dislocation, as such, is a harmless secondary finding in these cases of spondylitis.

Case II. — Journal no. 472/29. Male. — The patient was



Fig. 4.

born in 1883. At the age of fifteen he began to suffer from a pain in his back, and became bed-ridden for a couple of years. In the beginning he also had severe pains in his legs. A doctor diagnosed his case as inflammation in one of the lumbar vertebræ. There was no gibbus, but he became hollow-backed. Gradually, he got better, and by the time he was twenty-two or -three he was »quite well«. When he was about thirty, the pain in the back returned; he had a feeling, specially after any physical effort,

as if his back would »bend itself together«. He felt easier when lying down. Lately, there had been pains down the legs.

Condition in 1928 (at the age of forty-five): Only the local condition presents anything of interest. The thoracic part of the back shows no anteroposterior deformity, but there is a dextroconvex scoliosis. In the lumbar region there is very pronounced lordosis, with an angle at the point of articulation between the last lumbar vertebra and the sacrum. The upper part of the latter is projected backwards. The back is shortened, so that the ribs come down almost to the iliac crest. The whole lumbar portion of the back is fixed, and the mobility of the thoracic portion somewhat restricted. No tenderness anywhere, either to pressure or percussion.

Roentgen examination (Fig. 4): The anterior upper portion of the first sacral vertebra is destroyed; likewise the under surface of the adjoining vertebra above it. A closer study of all the obtainable roentgenograms (sagittal view and views showing the whole of the thoracic and lumbar regions) makes it clear that the latter must be the fourth lumbar, and that of the fifth lumbar there remains only the posterior part together with the transverse processes, while the body, with the exception of some slight remnants that can hardly be distinguished in the roentgenogram, has been destroyed and absorbed. The vertebral column has become displaced in a forward direction in relation to the sacrum. The posterior portion of the fourth lumbar vertebra is blurred.

Treatment with corset. Condition improved.

The clinical picture in this case is strongly reminiscent of spondylolisthesis. The roentgen examination shows that the latter is secondary to a lumbosacral spondylitis with almost complete destruction of the body of the fifth lumbar vertebra.

Case III.—Journal no. 582/29. Female.—The patient, who was born in 1912, had suffered from pain in the lower part of her back ever since she, at the age of twelve, had fallen from a bench in the school, sitting down hard on the floor. When she

was about sixteen, she noticed a protuberance of the lower part of her spine.

Condition in 1929 (at the age of 17): Only the local condition presents anything of interest. In the back, at the place where

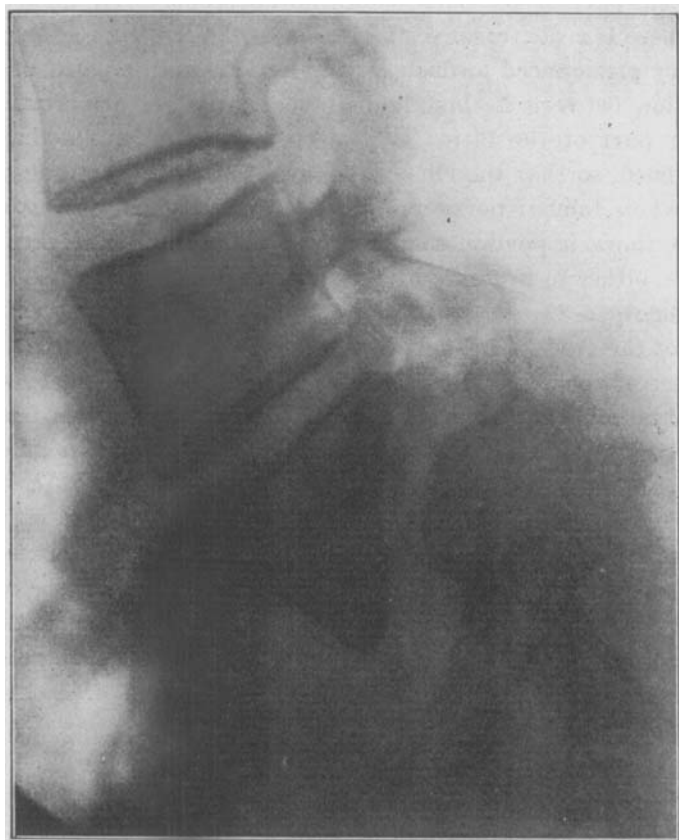


Fig. 5.

the lumbar and sacral regions meet, there is a pointed, rigid gibbus. No tenderness.

Roentgen examination (Fig. 5): The posterior inferior half of the fifth lumbar vertebra is destroyed; likewise the superior half of the first sacral one. The posterior part of the fifth lumbar is blurred, and the whole of the bone displaced 2.5

cm forward, so that its body remains in contact with that of the first sacral vertebra only for a distance of 2 cm. The design is blurred. There is partial sclerosis.

Treatment with corset. Condition improved.

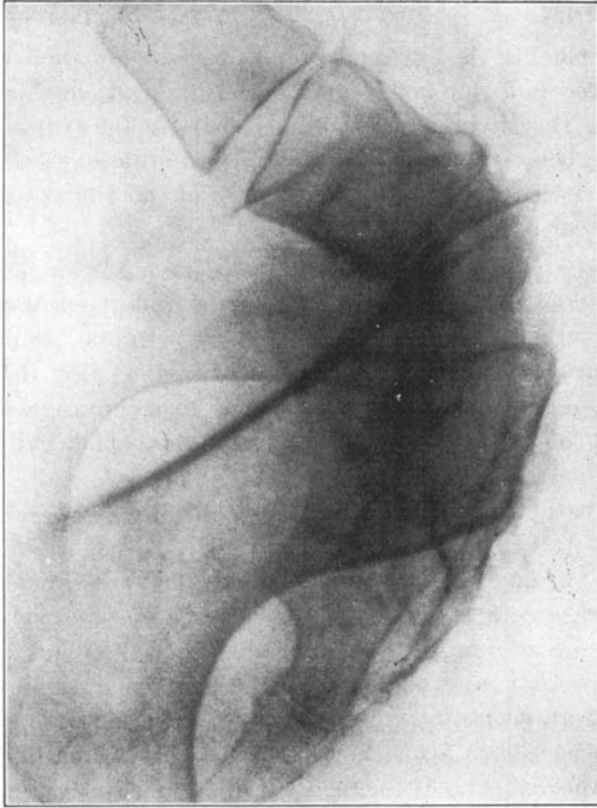


Fig. 6.

The clinical picture here does not bear so marked a resemblance to spondylolisthesis as in the foregoing case, but makes one rather suspect spondylitis. The roentgenological picture strongly resembles that of spondylolisthesis. The destructions to the fifth lumbar and first sacral vertebræ are of an extent which decidedly indicates spondylitis, probably of tuberculous nature.

Case IV.—Journal no. 914/32. Female.—The patient, who was born in 1902, began to get pains in her back when she was two years old, and already at that time its lower region began to show the formation of a »hump«. In 1929, she entered a hospital on account of a gravitation abscess in the left iliac fossa.

Condition in 1932 (at the age of thirty): Old pulmonary tuberculosis. In the lower part of the back, below the level of the iliac crest, is a rounded, tender gibbus, and above this a slight lordosis. The patient is exceedingly short in the trunk, her ribs reaching below the iliac crest. There is a fistula in the left groin, and other cicatrised ones at both sides of the gibbus and in the left gluteal region.

Roentgen examination (Fig. 6): The anterior lower one third of the body of the third lumbar, and the bodies of the fourth and fifth lumbar and first sacral vertebræ are destroyed and resorbed. The remnants have collapsed, so that the sacrum and the portion of the spine above it form an angle, opening forward, of 100° . The upper part also lies somewhat forward of the lower one.

The patient is still confined to her bed.

Apart from the abscess and the fistula, the clinical picture of this case rather strongly resembles one of spondylolisthesis, specially on account of the manner in which the trunk has sunk »telescopically« into the pelvis. The roentgen examination has disclosed an entirely different feature, however; namely a very pronounced gibbus formation, compared with which the dislocation of the vertebræ is inessential; and the case is thus rather one of spondylizema.

Case V.—Journal no. 647/32. Female.—The patient was born in 1906. In 1929 she had tuberculosis of the lungs, and in the same year it happened that for a short time she had a feeling of stiffness in the lower part of her back, which soon disappeared, however. In 1930, this sensation returned, and toward the end of the year there came, in addition, pains in the same place, radiating down into the left leg.

Condition in 1932 (at the age of twenty-six): Tuberculosis of the left lung. In her back, the spinous process of the fifth lumbar vertebra is prominent, forming a small, tender gibbus. Above it there is a slight, lordotic curvature. Otherwise the back is almost quite straight.

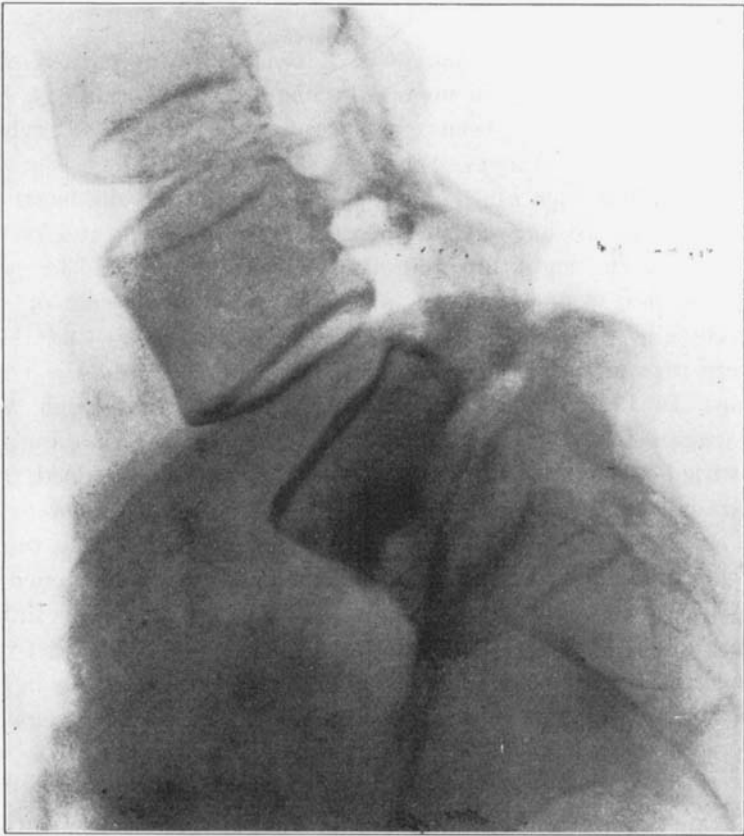


Fig. 7.

Röntgen examination (Fig. 7): The distal two thirds of the fifth lumbar, and the proximal two thirds of the first sacral vertebrae are destroyed and resorbed, the remaining portions collapsed. The design of the posterior portions of the two vertebrae is blurred, especially that of the fifth lumbar. The lat-

ter is displaced at least 1 cm forwards in relation to the first sacral vertebra.

Albee's operation. Condition improved.

The extensive destruction of the vertebræ probably leaves no doubt about the diagnosis of spondylitis being correct.

Case VI.—Journal no. 465/32. Female.—The patient was born in 1898. There is no family history of tuberculosis, but there has probably been exposure to that disease. Previous illnesses of no interest. When she was about thirty, she fell and hurt her back and right hip. After that time she began to have pains, not only in the lower part of her back and in the region of the right hip, but also in the right foot. The pain in the foot was eventually diagnosed as tuberculosis of the ankle-joint, where a fistula developed in 1930. By that time there were also signs of tuberculosis in the left foot and the right knee. In 1932, amputation was made of her right thigh, and astragalectomy of her left foot. Pathoanatomical examination verified the existence of tuberculosis in the joints named. The pain in the back has all the time varied in intensity. Sometimes it has been very pronounced, and specially whenever she would rise from a lying or sitting position, or when she happened to be driving on a rough road. On account of the tuberculosis in her foot and knee she has been confined to her bed for the last two and a half years, and has during that time felt a stiffness in her back. Of late, the trouble has been somewhat less pronounced than before.

Condition in 1932 (at the age of thirty-four): The condition of the left ankle-joint need not be considered, at it is of no interest in the present connexion. The thoracic portion of her back gives no occasion for remarks. There is pronounced lumbar lordosis, which in its inferior part, below the level of the iliac crest, goes abruptly over into a rounded gibbus, formed by the posteriorly protruding, curved sacrum. This gibbus is tender to any forcible touch or stroke.

Roentgen examination (Fig. 8): In the lateral projection,

there is seen, posteriorly and distally in the body of the fourth lumbar vertebra, close to the arcual portion of the bone, a rounded, vaguely contoured defectuosity in the posterior outline. The distal two thirds of the fifth lumbar, and almost the entire first sacral vertebra are destroyed and resorbed. The remnants are sunk together, and what is left of the fifth lumbar vertebra

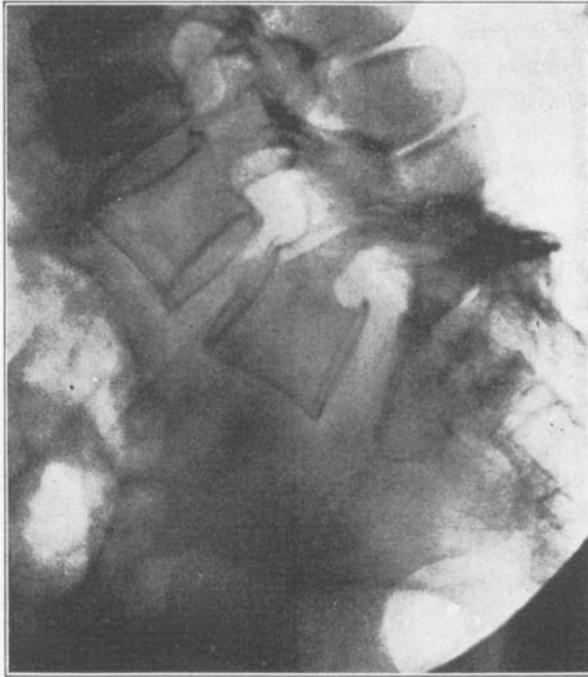


Fig. 8.

has slid forward for about 1 cm over the remainder of the first sacral one, so as to form a bayonet-curve on the spinal canal. The structural design of the posterior part of the fifth lumbar vertebra is blurred. In front of the sacrum lies a shadow about 2 cm broad (abscess).

The patient is at present lying in plaster bed.

Both the history and the roentgenological picture place it beyond doubt that the case is one of tuberculous spondylitis,

with secondary forwards dislocation of the fifth lumbar vertebra.

In cases of tuberculous spondylitis with secondary dislocation it is often possible, as in some of the cases here reported, to obtain a support for the diagnosis of spondylitis from the character of the destruction, the blurred and ill defined boundaries of the latter, and the strong atrophy of the vertebræ. In the later stages, when the process of destruction has ceased, and its boundaries have become more sharply defined, and perhaps sclerotic, and when the design and calcareous structure of the bones have come to stand out more clearly, the roentgenological picture will probably resemble still more that of the ordinary, true spondylolisthesis, especially in cases where the destruction has not been very great. An instance of this is also the following case, in which a simultaneous forward dislocation of the fourth and fifth lumbar vertebræ in relation to the ones below them has taken place owing to tuberculous destruction principally of their arcual portions.

Case VII.—Journal no. 1055/32. Male.—The patient was born in 1878. There was no hereditary tendency or probably preceding exposure to tuberculosis. In the fall of 1931, when he was thirty-five years old, he fell by slipping on a stone, and hurt his left hip. He had difficulty in getting up, but managed to walk home slowly. In the evening, the place where he had hurt himself became swollen, but the next day the pain was less, and he was able to get about, though with difficulty. As he was not yet well after four days, and the swelling had not disappeared, he went to a doctor, who made an incision, at which a quantity of »dark blood and pus« came out. After that he was looked after by a nurse at home; but as, by July 1932, there was still no healing, he was admitted into a hospital. He had then for a considerable time—perhaps already before this accident—had a feeling of stiffness in the lower part of his back. He was able to walk about, but did only small bits of light work. At the hospital, a large accumulation of pus was evacuated. This was supposed to originate from a focus near

the left iliosacral joint, which was consequently scraped out. Still, the wound refused to heal, and eventually he was admitted into the coastal sanatorium at Apelviken.

Condition in 1932 (at the age of fifty-four): The patient is pale and thin. In the left gluteal region there is a curved cicatrix, extending from the greater trochanter to the medial

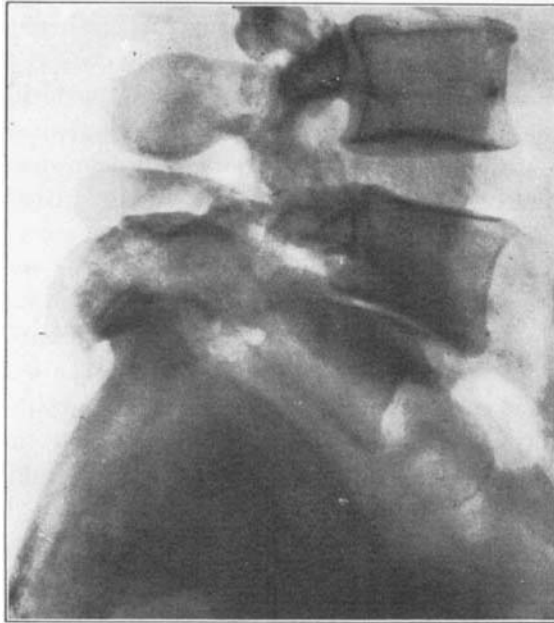


Fig. 9.

line, and in this cicatrix are several smaller and, at the highest point, one larger fistular opening, all of the appearance characteristic for tuberculous fistulae. At both sides of the cicatrix are a number of similar openings and scars after such, and after incisions. At the bottom of the largest fistula, the probe encounters denuded bone. Below and somewhat laterally from the left anterior superior iliac spine there is a diffusely infiltrated, non-fluctuating infiltration as large as an open hand, from which, when it was punctured at the hospital, there issued pus »of a tuberculous appearance«. The lumbar spine is

rigid, and on palpation the sacrum is felt standing out dorsally from it, with a slight ledge above. No symptoms from either the iliosacral or the hip-joints.

Roentgen examination (Fig. 9): In the lateral projection, the posterior inferior angle of the fourth lumbar vertebra appears to lie 1.5 cm anteriorly from the posterior superior angle of the fifth one. The shape of the fourth lumbar vertebra departs from the normal therein that its posterior part is narrower than ordinarily, its inferior surface denser than usual, and its contour lacking in sharpness. In the posterior inferior angle of the bone is seen an irregularly contoured area of destruction the size of a pea. The intervertebral foramen between the fourth and fifth lumbar vertebræ is smaller than normally, and its delimitation irregular in them both. The design of the posterior part of these vertebræ is blurred. The body of the fifth lumbar vertebra is on the whole denser in its design than normally, and the intervertebral space that separates it from the fourth only a couple of millimeters wide. The demarcation from the intervertebral space is lacking in sharpness. In the anterior contour of the bone there is a defectuosity as large as a pea, below this an osteophyte about 1 cm long, and below this again a rather clearly defined attrition hollow, 0.5 cm deep, in the body of the vertebra. Anteriorly from the latter there is a dense calcareous shadow the size of a plum (calcified abscess). The line of demarcation below the posterior part of the vertebra is sharp, and shows distinct signs of wear on the bone. The same is the case with the corresponding upper line of demarcation of the first sacral vertebra. Also the fifth lumbar vertebra has slid forward in relation to the first sacral one, for at distance of about 0.5 cm.—In the sacrum, close to the left iliosacral joint, there is a clearly defined defectuosity, the result of an operation. The marginal zone close to the joint is of a greater density both in the sacrum and the ilium.

Case VIII.—Journal no. 1020/32. Female.—The patient was born in 1916. There is no hereditary disposition to tuberculosis; she had always been well hitherto; there is no history of trauma.

For the last three years any physical effort caused her a feeling of pain in the small of her back, and during the last few months these pains had become considerably worse.

Condition in 1932 (at the age of sixteen): There is a slight kyphosis of the thoracic spine. The lumbar lordosis is considerable, and at its farthest downward point changes sharply into a moderate gibbus corresponding to the fifth



Fig. 10.

lumbar and first sacral vertebræ. There is a rather pronounced tenderness to percussion over the spinous processes of both of these, as well as to axial impact. The lowest ribs are only a couple of centimeters above the iliac crest. Tuberculin test negative (Mantoux, 1 mgr.).

Roentgen examination (Specialist's report): »The fifth lumbar vertebra is displaced forward in relation to the first sacral one for the whole length of a vertebral body, and the posterior inferior angle of the fifth lumbar touches the anterior part of the first sacral vertebra. The inferior portion of the fifth

lumbar and the superior portion of the first sacral vertebra are worn, and the contour of their cortices defective.»

On the strength of the last named circumstance, the roentgen specialist was of the opinion that the case must be diagnosed as one of tuberculous spondylitis with secondary spondylolisthesis. This would hardly agree with the actual facts, however. It has already been mentioned above that worn and defective contours of the cortices are a normal feature of the picture of spondylolisthesis. Besides, the negative tuberculin test speaks decidedly against tuberculous spondylitis. The clinching circumstance, however, is that in the roentgenogram taken in lateral projection (Fig. 10) there is distinctly seen, beside the changes mentioned above, a fissure in the arcual portion of the fifth lumbar vertebra (spondylolysis). This fissure is seen even more distinctly in a roentgenogram taken in oblique projection, which is not reproduced here.

Case IX.—Journal no. 1019/32. Female.—The patient was born in 1910. In 1927 she had pleurisy. During a pregnancy in 1929 she began to have pains in the small of her back. There was no trauma. The pain manifested itself specially whenever she would rise from a sitting posture, and on attempt at any physical effort. This trouble afterwards came again from time to time. In May, 1932, she stumbled, and in falling hurt her back. From that time, the pain in her back became worse than before, sometimes radiating down into the left leg.

Condition in 1932 (at the age of twenty-two): There is pronounced lumbar lordosis, which distally bends sharply over into a slight gibbus corresponding to the fifth lumbar and first sacral vertebrae. Below the fifth lumbar vertebra one feels on palpation the superior surface of the sacrum forming a small ledge. The thoracic kyphosis is only slightly pronounced. There is no tenderness. The mobility of the back is unimpaired, except in the most distal part of the lumbar region.

Roentgen examination (Report of the committing roentgenologist): »The interarticular fibro-cartilage between the fifth lumbar and first sacral vertebrae has disappeared as the result

of pressure, and the opposing contours of the bodies of the two vertebræ are worn down, so that the superior outline of the first sacral vertebra in lateral projection seems to form almost a half-circle, and the posterior part of the fifth lumbar vertebra is reduced almost to two thirds of its normal height. The fifth



Fig. 11.

lumbar vertebra has become displaced forward, in relation to the first sacral one, for at distance corresponding to about half of a vertebra's width.»

For the same reasons as in the foregoing case, the roentgenologist in this one was inclined to diagnose the condition as tuberculous spondylitis with secondary spondylolisthesis. This diagnosis is undoubtedly wrong. The destruction in the

upper part of the first sacral vertebra, resulting in the half-circular contour, is no greater than what is very often observed in spondylolisthesis, and there is absolutely none of the vagueness and irregularity distinctive of tuberculous destruction. As a matter of fact, the fifth lumbar vertebra is not destroyed at all, or at least only to a very slight extent. Its contour is clean and smooth everywhere. Its low posterior part—wedge-shaped, with the point in dorsal direction—is within the possibilities of variation for this extremely variable vertebra, and is, in fact, a form often found, precisely in spondylolisthesis; in many instances—just like here—in connexion with a narrow arch, whose attachment to the body of the vertebra is situated high up on the latter. In the present case, also the sagittal diameter of the vertebra is smaller than normally—in the roentgenogram about 0.5 cm. smaller than that of the first sacral vertebra; and in the picture in sagittal projection one sees, as often in cases of spondylolisthesis, a posterior spina bifida on the latter. Finally, one observes, both in the lateral view (Fig. 11) and in pictures taken in oblique projection, an irregular zone of rarefaction, almost 0.5 cm wide, in the interarticular portion of the bone (spondylolysis). In the sagittal view there can be seen a fissure also in the transverse process. The correct diagnosis is undoubtedly true spondylolisthesis.

That the decision between spondylolisthesis and spondylitis with secondary dislocation is not always easy seems to be illustrated by the following case, which has already been published by *Bjoerkroth*, of the Orthopedic Clinic of Gothenburg.¹⁾

Case X.—The patient was a man, born in 1909, who, at the age of eighteen was ill for six weeks, with symptoms of polyarthritis. In the following year he fell from a roof, a distance of seven or eight metres to the ground and hurt his back. He was unable to rise, but got better (free from symptoms?) in rather short time. Eight months after, he began to feel some

¹⁾ *Laekaretidningen* 1932, no. 23, p. 625.

pains in the lower part of his back. One day, in lifting a heavy load, he got such a pain in his back that he had to take to his bed. A doctor who was called in now ascertained hydropleurisy, and had him removed to a hospital. There it was decided that he was suffering from lumbosacral spondylitis, and for this he was sent to a hospital for surgical tuberculosis cases, where



Fig. 12.

he remained for about eighteen months, after which time he was discharged, with his lumbar spine rigid, but otherwise free from symptoms. Some time after, he applied for at pension, on which account he was sent to the Gothenburg Orthopedic Clinic for examination. The opinion of the clinic was that there was no spondylitis, but that the case was one of spondylolisthesis. The existence of the latter condition had already been observed before, but had been judged to be secondary to the spondylitis.

In my opinion, the roentgenograms taken of this patient in the various institutions—the best of the lateral views is reproduced here as Fig. 12—do not enable one to form a definite idea as to whether the case is one of spondylolisthesis or spondylitis. The superior surface of the first sacral vertebra shows destructions of the latter, with blurred contours; and in the middle of the inferior surface of the fifth lumbar vertebra there is a crescent-shaped destruction fully the size of a pea, and dorsally from this a somewhat smaller, similar one, both vaguely outlined. They are perhaps not large enough to serve as basis for a positive diagnosis of spondylitis; on the other hand, they are larger—specially those of the inferior surface of the fifth lumbar—than is usually seen in spondylolisthesis; and there are positively established cases of lumbosacral spondylitis in which the destruction of the opposed surfaces has not been in any way more extensive than here. Furthermore, it must not be overlooked that the contour of the psoas in the sagittal pictures taken in an earlier stage of the disease presents an appearance which makes one suspect an abscess of the latter, without being so wavy, however, as to warrant one in making a positive diagnosis to that effect. Finally, here is no sign of spondylolysis to be detected in any of the pictures, but, on the other hand nothing, either, in the osseous design of the arch of the fifth lumbar vertebra, so different from that of the others as to justify one in supposing any destruction of the latter. Features that might point to spondylolisthesis are the wedge-shaped fifth lumbar vertebra with its dorsally directed apex, and the narrow posterior portion of the latter, with its attachment to the vertebral body so high up, as well as a posterior spina bifida on the first sacral vertebra. In my opinion, it is impossible in this case, on the basis of the material I have had occasion to study, to take a definite stand for one diagnosis or the other, of the two here discussed.

In 1888, *Kroenig* described three cases of changes in the lumbosacral region, which clinically manifested themselves as spondylolisthesis at the same time as there was a positive

clinical diagnosis of tabes. The cases were observed only clinically, but there was dislocation in the lumbosacral region, with palpable forward displacement of the fifth lumbar vertebra and the characteristic sinking of the thorax downward into the pelvis, with resulting transverse folding of the skin on the abdomen and back. *Kroenig* believes them to be instances of arch fracture in tabetic subjects, due to some slight trauma and made possible by an increased fragility of the posterior part of the vertebrae as result of the tabes. It is a question whether the originating cause might not be sought as well, or even rather, in destructive processes at the same points as in the cases of tuberculous spondylitis described in the foregoing, and perhaps also in the intervertebral joints of the vertebrae involved.

Reisner has reported his observation of a pathological picture resembling spondylolisthesis, in which the condition had arisen through metastases from a cancer of the prostate to both interarticular portions of a vertebra.

In 1926, *Breitlaender* described a case of »indubitable tabetic arthropathy« of the lumbar spine, with considerable destructions, deformations and sclerosis of the second to fifth lumbar vertebrae, and lateral displacement toward the left, for almost the entire width of a vertebral body, of the third lumbar and the part of the spine above it. Besides, the third lumbar vertebra had suffered an inclination downward, so that its transverse axis formed an angle with the transverse axes of the vertebrae above and below it. The principal dislocation had here taken place sideways; there was no noticeable displacement in sagittal direction.

According to *W. Mueller*, sideways displacement of a vertebra is sometimes observed in cases of pronounced scoliosis in subjects of advanced age. He terms this: »Drehgleiten« (rotary displacement), wishing thereby to indicate that it is a question not merely of lateral displacement, but also, at the same time, of a torsion. *Fenkner*, who has made observations to the same effect, is of the opinion that trauma plays an important part in cases of this character. In most of *Mueller's*

cases there is no mention of trauma. *Fenkner* speaks of these sideways dislocations as »true spondylolisthesis«, to which especially *Schmorl* and *Junghans* take exception, maintaining that »Wirbelverschiebung« (vertebral displacement) would be a

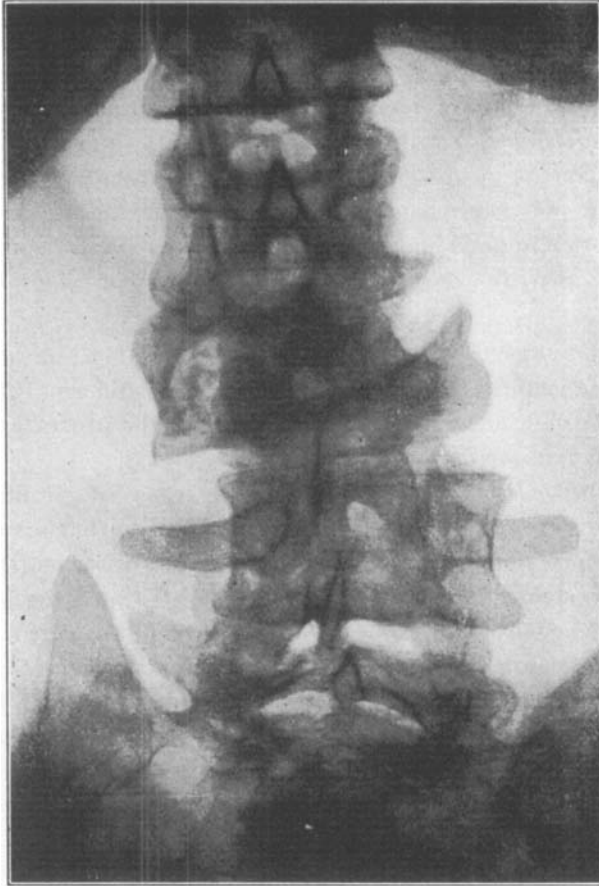


Fig. 13.

correcter term. *W. Mueller* point out that for such a sideways displacement to occur it is not necessary that there should have been any destruction of bone, but merely that the power of the intervertebral fibro-cartilage to hold the vertebra in place should have been lessened. The intervertebral joints do not,

even when completely uninjured, present any considerable hinderance to the displacement.

A case of sideways displacement of a vertebra solely as the result of a trauma is described by *Brailsford*. The displaced bone



Fig. 14.

was the first lumbar, which, after a fracture due to fall with a motor-cycle, was found displaced laterally for a distance of nearly the width of a vertebral body. A similar case is described by *Harttung*.

It will be readily understood—and is also incidentally point-

ed out by *Schmorl* and *Junghanns*—that not only traumas and tabetic changes can cause a greater or lesser sideways displacement of vertebræ, but that such displacement can be caused also by destructions due to septic osteomyelitis, tuberculosis and tumors. In tuberculosis, the feature is certainly not unusual. Figs. 13, 14 and 15 will serve to illustrate the roentgen-

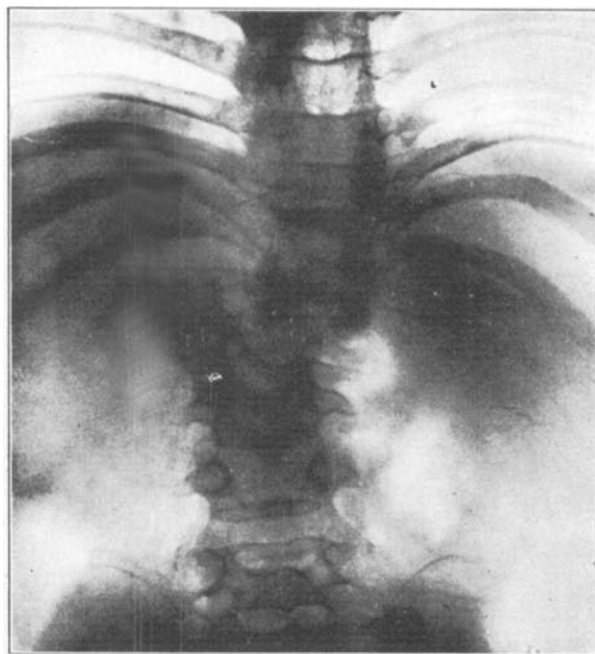


Fig. 15.

ological aspect of some such cases, without it being necessary to enter into a description which would hardly be of any particular interest here. What is of great importance in cases of this nature is—as *Schmorl* and *Junghanns* point out—a correct estimate of the greater or lesser bearing which an eventual trauma may have had on the development of the deformity; as the fact of a preceding trauma is often made use of by the patient to substantiate a subsequent claim for damages.

Waindruch and *Koretzky* have described, in 1930, a case of

a girl eight years and six months old, in which the roentgenogram showed a dislocation backwards and downwards of the fifth lumbar vertebra so great that this bone lay for almost its entire length along the posterior surface of the upper part of the sacrum. Besides, the fifth lumbar was deformed, having very nearly the shape of half a sphere, with its convexity directed toward the posterior surface of the sacrum (Fig. 16).

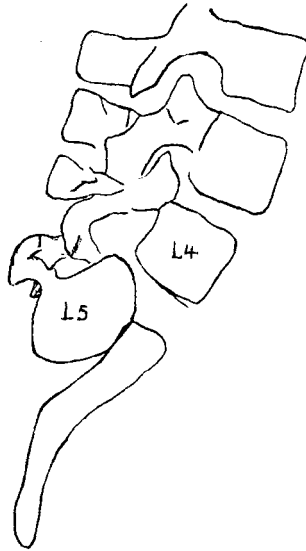


Fig. 16.
(after Waindruch and Koretzky).

Clinically, there had already at the birth of the child been observed an outward bulge, at large as a plum, in the lumbar region, and this had increased somewhat in size as she grew older. What caused the parents to have her medically examined was that she complained of pains in the lumbar region after any kind of physical effort. The examination showed a considerable disproportion between the length of her trunk and lower extremities. In upright position, the upper part of her body was bent somewhat backwards, and seemed to be sunk slightly into the pelvis. There was a distinct backward pro-

minence of the upper part of the lumbar region of her back, in the shape of a small, irreducible bulge, slightly tender to pressure. Above this was a depression, which gradually continued into a more pronounced lumbar lordosis. The inclination of the pelvis was less than normal, and the thorax so far down that the two lower ribs reached down in the pelvis. The mobility in the lumbar region was much restricted, specially the flexion forward. The clinical picture thus reminds one strongly of spondylolisthesis, what is perhaps not so surprising, either, as the symptomatic picture of that condition is determined primarily by the dislocation in vertical direction, that is, by the shortening of the trunk and spine, and only secondarily by the displacement of the vertebra sagittally. With regard to this case—which, so far as I have been able to find, is the only one of its kind described—the authors believe it to be of congenital origin, belonging to the group of *vitia primæ formationis*, resulting, in this case, from a peculiarity of the connexion between soft and osseous parts of the lumbosacral region.

Another form of backward dislocation of vertebræ has been described by *Mosenthal* and *Junghanns*. In *Mosenthal's* case, the dislocated vertebra was the first lumbar one; in six of *Junghanns'* seven cases it was the second, in one the first lumbar vertebra that had been dislocated. As *Junghanns*, in his nine series of researches, has examined the backs of no less than 10,000 subjects, such cases of dislocation in a posterior direction must be very rare. At any rate it can, so far as the published details enable one to judge, have been a matter of only very slight displacement. In every instance the intervertebral space underneath the dislocated bone had become diminished, and the edges of the opposed vertebræ sclerosed. In several of the cases, roentgenological examination showed subluxation of the intervertebral joints involved. As explanation of this backward movement, *Junghanns* suggests two possibilities. Either some trauma or destructive process may have led to deterioration of the intervertebral fibro-cartilage, thereby causing an approachment between the two vertebræ resulting in subluxation of the intervertebral joints and backward dislocation of the upper one of

the two; or else some trauma may have caused a tearing asunder of the capsules and ligaments of the intervertebral joints, resulting in a slackness or slipping of one of the latter; as a result of the consequent irregular movements the intervertebral fibro-cartilage has then been ground to pieces; and this, together with the subluxation, has made possible the dislocation, backward, of the bone. The fact that in one of his cases there are signs of an injury also to the body of the vertebra in question, seems to *Junghanns* to point to the former of these two theories as the most likely one.

Schmorl and *Junghanns* raise the question of a special tendency to backward dislocation in the upper part of the lumbar region. They argue that on account of the backward and downward direction of the articular processes in the inferior thoracic and superior lumbar region a vertebra there must slide backwards at the same time as downwards if the intervertebral fibro-cartilage is destroyed.

Also *W. Mueller* has made observations concerning dislocation of vertebræ in a posterior direction, in two cases even involving several (at least three), which then formed like steps, one above the other. The greatest displacement was about 1 cm. In one of these cases there was a history of trauma, in the other not. Also *Mueller* believes the cause to be degeneration of the intervertebral fibro-cartilage and subluxation of the intervertebral joints, together with increased lumbar lordosis.

I have myself had occasion to observe a case of this dislocation in connexion with spondylitis of the lumbosacral region.

Case XI.—Journal no. 1027/32. Male.—The patient was born in 1901. There was a family history of tuberculosis. After a riding accident in 1924 he got osteitis of the pubic bone, which, on pathoanatomical examination proved to be of tuberculous nature. Neither at that time nor in 1926, when his spine was again roentgen-examined, did he complain of any trouble with his back. In 1931 he had a pain there for three or four days, after carrying some heavy sacks, and from then on those pains would return every month or two, but lasting, on each occasion, at most four or five days. Roentgenograms taken in 1931 showed

a diminished intervertebral space between the twelfth thoracic and first lumbar vertebræ, and in the side view, in the upper part of the latter, a vaguely delimited rarefaction, the size of a hazelnut, with a denser spot as large as a millet seed (a sequestrum?) in the centre. A special roentgenogram of the lumbosacral region was not taken at the time, and in the existing pictures there are no particular changes to be observed there, except that perhaps the intervertebral space between the fifth lumbar and first sacral vertebræ is narrower than normally. He was now kept immobilised in bed for a couple of months, under the diagnosis of tuberculous spondylitis of the thoracic spine, whereupon he, in January 1932, was fitted with a plaster jacket. From then on he remained free from symptoms until the end of October, of the same year, when he stumbled over a rug and fell; and from that time the pains in his back became steadily worse, and finally became so intense that he could not move in bed without crying out aloud, and could lie only on his right side, with his legs drawn up.

Condition in Nov. 1932 (at the age of thirty-one): During the first days after his admission into the hospital, the patient could lie only on his right side, with his legs drawn up, and every attempt to turn him or examine him more closely would draw from him cries and complaints of pain in his back, and a convulsive jerking up of his legs. The patellar reflexes were increased, the plantar ones normal, and there were signs of stiffness of the neck. The lumbar puncture showed a pressure of 300 (under narcosis), but the fluid was normal as to albumen and cells. Wassermann's reaction was negative both in the blood and the spinal fluid. In the course of a week, the pains and »cramp« gradually grew less, and he now presented, from the lower part of the thoracic region down to the sacrum, a rigidly fixed back, with much diminished lumbar lordosis and the spinous process of the first lumbar vertebra somewhat projecting. Otherwise there was no deformity of the spine. There was no tenderness of the back anywhere, and he could turn about in bed without pain, though with some difficulty.

Roentgen examination: In the side view could be seen, in

the upper part of the first lumbar vertebra, a crescent-shaped destruction extending almost to the middle of the vertebral body and surrounded by a sclerotic zone. Opposite this, there was a slight rarefaction in the bone of the twelfth thoracic. The superior surface of the first lumbar was on the whole somewhat irregular.—The structural design of the fifth lumbar and first sacral vertebræ was denser than normally



Fig. 17.

(Fig. 18). The inferior surface of the former, and the superior one of the latter were destroyed to a depth of some millimetres, and had sunk toward each other. In the side view, both the anterior and the posterior margins of the body of the fifth lumbar lie 0,5 cm farther back than the corresponding margins of the first sacral. The design of the fifth lumbar vertebra, as well as that of the fourth one, is blurred. In the ventrodorsal view, this blur is more pronounced in the right half of the arch than in the left.

I would not venture any positive opinion as to whether *Jung-hanns'* and *W. Mueller's* explanation of a vertebra's dislocation

in posterior direction holds good also in this case. On the other hand, I cannot suggest any other. It only seems that, if their explanation were correct, the condition would be observed more frequently in cases of spondylitis, seeing that the preliminary condition—that of the destroyed intervertebral fibro-cartilage—



Fig. 18.

is present so relatively often. It is, of course, also possible that such a displacement backwards actually occurs in those cases, but of considerably lesser extent, and so slight that it is not noticed in the roentgenological picture. In looking over some hundred of roentgenograms of spondylitis cases from the sanatorium here, I have in several of them observed a slight backward dislocation of the upper, and in fewer instances of the lower, of two vertebræ that had sunk together; but in no

instance except the one described above did this displacement amount to more than a few millimetres. It may also be said that in the present case the dislocation might just as well—or should perhaps rather—have taken place in an anterior direction, when once a subluxation of the intervertebral joints had occurred. Why this has not been the case, I am not at present prepared to say. Perhaps it is due to the position of the articular processes. The case is still under observation; the explanation may possibly be found at some future day.

For the sake of completeness I would add that also the fracture of a vertebra may cause dislocation in a posterior direction, as shown by a roentgenogram of such a case (Fig. 18), in which earlier pictures clearly revealed fracture in the arch of the dislocated bone.

As regards the treatment of spondylolisthesis, opinion is divided between two essentially different methods—conservative treatment with jacket and operative fixation. The effect of the former I certainly consider to be very slight; by many it is regarded as wholly ineffective, at least in the case of any individual compelled to do actual physical work. As for operative fixation, the method by far most commonly employed seems to be the one indicated by Albee,—the insertion of a bridge of bone into the spinal processes. It is evident that an operation of this kind cannot, even in the best case, have any directly hindering effect on the motion of the sliding vertebra, for the simple reason that it renders immovable only the posterior part of the latter, which does not take any part in the sliding. The most that can be obtained is that a part of the body weight which bears on the moving bone and helps to push it along becomes transferred, *via* the bridge, to the portion of the spine further down. This would seem to be the explanation of the good results that have undoubtedly in a great many cases been obtained (lastingly?) by the use of Albee's method.

As a means of immobilising also the sliding part of the vertebra, *Robert Hanson* has proposed a method of operation¹⁾ which,

¹⁾ Congress of the Northern Orthopedic Association 1932.

besides fixation of the spinal process by Albee's method, includes arthrodesis of the superior intervertebral joint—whose ventral joint-end belongs, of course, to the moving part—, and, for additional stiffening, the fixation of that joint by the insertion above it, underneath the periostium of the arch, from which the cortical layer has been removed, of a thin lamina of bone, with its periostium, from the tibia. In a case operated on by this method the result is still very good six months after the operation. It is hardly necessary to add that I do not pretend to judge of the practical usefulness of the method from this one, solitary case, of which the after-observation has yet been all too short to be sufficient. In this case, the arthrodesis and the extra-articular fixation were made only on one side; in cases where it seems advisable for the sake of greater security it may, of course, with equal facility be made bilaterally. A similar idea was conceived, in 1927, by *Mouchet and Roederer*, but I do not know whether it was ever by them carried out in actual practice. Also arthrodesis alone, after the method indicated by *Hibbs*, has of course been employed in cases of spondylolisthesis. *Robert Hanson's* method may be said to be a combination of *Hibb's* and *Albee's*, with the addition of a further strengthening by means of the bone transplantation above the arch.

For the operative treatment of the conditions resembling spondylolisthesis no general plan can be laid down; where operation seems indicated, the method must be chosen with due regard to the special circumstances and features of the individual case.

ZUSAMMENFASSUNG

Der Verfasser hebt die mangelhafte Begriffsbestimmung des Namen Spondylolisthesis hervor, da viele darunter ein Vorwärtsgleiten der Wirbelsäule im Verhältnis zum os sacrum (event. im Verhältnis zum 5ten Lumbalwirbel) durch eine bestimmte Veränderung im Interarticularteil des betroffenen Wirbels verschuldet, Spondylolysis genannt (»echte Spondylolisthesis, Neugebauer«) verstehen, während andere mit dem Namen Spondyl-

olisthesis viele verschiedene Zustände die nur dies gemein haben das eine Verschiebung zwischen zwei Wirbelabschnitten stattgefunden hat, gleichgültig nach welcher Seite die Verschiebung stattgefunden hat, und was die Ursache war, benennen. Der Verfasser berührt hierauf die allgemeinen Theorien über die Ursachen der Spondylolysis und bespricht hierauf die Verschiebungen der Wirbeln nach vorne durch verschiedene Ursachen ohne Spondylolysis ebenso wie Verschiebungen seitwärts und nach hinten mit besonderem Hinblick auf die Zustände wo die Verschiebungen tuberkulösen Zerstörungen im Wirbelbogen zuzuschreiben sind. Er erinnert dabei an den von *Herrgott* im Jahre 1877 eingeführten Begriff *Spondylizema* und dessen Zusammenhang mit Spondylolisthesis. Er hebt die differentialdiagnostische Bedeutung zwischen den verengten Intervertebralaräumen und der Knochendestruktion der einander gegenüberliegenden Wirbelflächen hervor und bespricht einige Fällen theils von Spondylitis mit sekundärer Verschiebung theils von echter Spondylolisthesis, wo aber die vorhandene Knochenzerstörung zur Spondylitisdiagnose Anlass gab.

RÉSUMÉ

L'auteur signale l'emploi incertain du mot spondylolisthesis, en ce que quelques-uns comprennent par là un glissement antérieur de la colonne vertébrale par rapport au sacrum (éventuellement par rapport au L5) causé par un certain changement dans la partie interarticulaire de la vertèbre glissante, appelé spondylolyse («véritable spondylolisthesis, Neugebauer»), tandis que d'autres, par ce nom de spondylolisthesis, désignent divers états différents qui n'ont de commun que ceci, qu'un glissement entre deux sections de la colonne vertébrale a eu lieu, quelle que soit la direction — ou la cause — du glissement. Ensuite l'auteur s'occupe des théories courantes sur les causes de la spondylolyse; puis il mentionne les glissements antérieurs des vertèbres dûs à des causes différentes sans spondylolyse, et aussi des glissements latéraux et postérieurs, en faisant remarquer les cas où le glissement est dû à des destructions

tuberculeuses de l'arc vertébral. Il rappelle à cette occasion la définition de spondylizéma donnée par *Herrgott* en 1877 et ses rapports avec la spondylolisthes. Il fait valoir l'importance pour le diagnostic différentiel de l'affaissement de l'espace intervertébral entre des surfaces vertébrales adjacentes, et de la destruction de l'os de celles-ci, et décrit quelques cas, en partie de spondylite avec glissement secondaire, en partie de véritable spondylolisthesis, où une destruction pré-existante a amené le diagnostic de la spondylite.

SUMMARY

The author begins by speaking of the looseness which reigns with regard to the definition of the term spondylolisthesis, which by some writers is reserved as expression for the forward dislocation of the spinal column in relation to the sacrum or the fifth lumbar vertebra, due to a certain, definite change—spondylolysis—in the interarticular portion of the sliding bone (*Neugebauer's* »true spondylolisthesis«), while others use it as label for any number of different conditions which have in common only the fact that a dislocation has taken place between two portions of the spinal column, irrespective of the point of its occurrence and the cause from which it has arisen. He then touches on the various theories concerning the causes of spondylolysis, and goes on to speak of such forward dislocations of vertebræ as take place, from different causes, without any existing spondylolysis, as well as of dislocations in a lateral or posterior direction, with spécial mention of those conditions in which the sliding movement is due to tuberculous destructions of the vertebral arch. In that connexion, he calls attention particularly to the condition for which *Herrgott*, in 1877, coined the term: spondylizema, and discusses its relation to spondylolisthesis. He lays stress on the importance, as an indicator for the differential diagnosis, of a diminished interspace between the two vertebræ involved and of any osseous destruction of the opposed surfaces of the latter, and describes a number of cases, partly of spondylitis with secondary dislocation, partly of true spondylolisthesis,

in which an existing destruction formerly resulted in a diagnosis of spondylitis.

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