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OSTEOCHONDRITIS DISSECANS OF THE HEAD OF THE FEMUR

By

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Osteochondritis dissecans (O.D.) is a radiological and clinical syndrome involving one or more joints, manifesting itself by a local aseptic necrosis of subchondral bone and usually resulting in osseocartilaginous sequestration. In the femur, the most frequent site of involvement is the superolateral corner.

Before the 10 cases reported in this paper are considered, it will be reasonable to make some general remarks on O.D. on the basis of the comprehensive literature on the subject.

The first case of a loose body in a joint cavity was described by *Ambroise Paré* in 1558. Later, in 1726, *Monro* observed a loose fragment in the knee joint corresponding to a defect in the medial condyle of the femur. The first comprehensive study on O.D. was a thesis published by the Donish investigator *Kragelund* in 1886. Independently of *Kragelund, König* published a description of O.D. in 1887. *Cruveilhier,* in 1825, was the first to describe O.D. of the head of the femur. More recently, O.D. of this localization was considered by *Haenisch* in 1925 and by *Flashman and Ghormley* in 1949 in a very comprehensive study in which they described 21 cases of their own and reviewed another 21 cases from the literature.

According to *Lavner,* the most frequent localization of O.D. is the medial condyle of the femur with about 85 per cent. of all cases; the second most frequent site of involvement is the capitulum humeri, which is homologous with the medial condyle of the femur. However, the great majority of cases encountered in the Departments of Radio-

logy in Viborg and Gentofte were located in the capitulum humeri. Other sites of involvement, in the order of decreasing frequency, are the head of the femur, the trochlea of the humerus, the head of the radius, talus, patella, the head of the first metatarsal bone, and the proximal ends of the phalanges. Several rarer sites have also been described.

The frequency of O.D. of the knee or hip joint is almost equal on the right and left sides, whereas the right elbow is more frequently involved than the left. The condition was present on both sides in 20 per cent. of the cases (*King* and *Richards*), but involved both hip joints only in 4.8 per cent. (*Flashman* and *Ghormley*).

O.D. has its highest incidence in men and in persons with hard physical work. The age at which O.D. begins to produce symptoms is in several reports stated to be 16–18 years. Patients with O.D. of the hip are usually somewhat older; thus, the average age of such patients was reported to be 33.5 years by *Flashman and Ghormley* and 23 years by *Hermodsson.*

As in other forms of aseptic necrosis, the aetiology is still partially unknown, but several factors have been demonstrated to be of importance, and various causal theories have been advanced. The two most important factors are heredity and trauma. In addition, tumours, tuberculosis, rickets and neurological factors have been reported to be contributory causes, but most investigators have been unable to reveal evidence in favour of such causal agents. Thus, rickets, particularly the late variety, was stated to be a causative factor by *Fromme* and others, who emphasized that the histological pictures of the two conditions resembled each other, but as demonstrated by *Müller,* this may also be seen in other diseases. *Wegelin, de Quervain, Scabell, v. Seemen, Liek, Friedl* and others showed that O.D. is frequent in cretinism, but as suggested by *Hermodsson,* it will be more reasonable to classify these cases as secondary O.D.

The importance of heredity has been emphasized by *Nielsen, Rahm, Bernstein, Ribbing* and others. Thus, *Nielsen* demonstrated familial occurrence in support of this view. Some authors go so far as to claim that O.D. is actually a mild abortive form of multiple epiphyseal disturbances. Thus, *Müller* arrived at this result after having studied a large number of various forms of epiphyseal disturbances and correlated these with numerous reports from the literature. Others, including *Stören, Ribbing,* and *Zellweger* have reported on families revealing a large number of cases with various epiphyseal destructions

of which several resembled O.D. However, again as suggested by *Hermodsson,* these cases should preferably be classified as secondary O.D.

A marked diversity of opinion exists as to the significance of trauma. Some authors simply deny that trauma is of any importance, while others, for example, *Hellstrøm* and *Bang Rasmussen,* claim that both a traumatic and a non-traumatic form exist. Most investigators concur with *Burckhardt* that the following observations are in support of the significance of trauma as a causative factor:–

1. A history of traumatic injury is frequently present in the series reported. (This was the case in 60 per cent. of *Lavner*'s patients as against only 12 out of *Nielsen*'s 168 patients.)
2. The disease is most frequent in men.
3. The disease is most frequent in persons with hard physical work.
4. It is most frequent on the right side.
5. Joints with marked incongruity are the sites of predilection.

The point on which opinions are most divergent is, in fact, the question: What importance should be attached to trauma as a causative factor? Most authors support one of the following two principal theories:–

I. Trauma gives rise to aseptic necrosis, possibly in association with other factors (theory of trauma).

II. Trauma occurs to an articular surface on which there is already an aseptic necrosis (theory of necrosis or nutritional disturbance).

The followers of the latter theory deny that O.D. may occur after trauma to a healthy articular surface because, as emphasized, for example, by *Nielsen* and *Ribbing:*–

1. O.D. is often bilateral, and patients who have sustained an unquestionable trauma to one joint often reveal bilateral involvement.
2. The sites of predilection are homologous areas in homologous joints.
3. Familial occurrence (heredity) is not uncommon.
4. Signs of lesion of the cartilage have never been revealed in O.D., which is frequently found, even after the lapse of long time, when a trauma has been sustained. Thus, in O.D., as distinct from trauma, the bone is less resistant than the cartilage.
5. Traumatic injury in experimental animals has never resulted in O.D.

The most difficult point in the theory of necrosis is to explain why necrosis invariably occurs in a certain sharply demarcated area. Several theories have been advanced; nearly all of them postulate some

form of nutritional disturbance. *Rieger, Ludloff,* and *Löhr* explained the necrosis on the basis that the blood supply according to *Lexer* occurs through a terminal artery, but *Nussbaum* demonstrated that there is a large number of collateral arteries in the epiphyses. In addition, *Neumann* and *Suter* stated that the vessels assumed by *Ludloff* also supply areas which are not typical of O.D. However, in contrast to this, *Nielsen* reported that autopsy on a patient, aged 16, showed that the anastomoses are not always ample. The assumption of some form of embolism has also been offered as an explanation. Thus, in his first studies, *Axhausen* assumed mycotic embolism, but later revised this view.

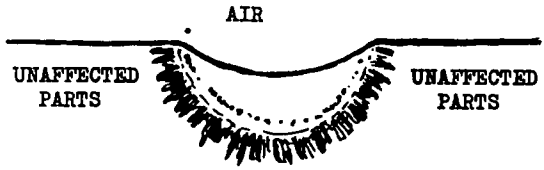
König was the first who advocated the theory of necrosis, offering the explanation that spontaneous demarcation of the cartilage-covered articular surface was the cause of O.D. Similar views were later adopted by other investigators, including *Axhausen, Bergmann, Buchner, Deutschländer, Green, Heine, Hermodsson, Hildebrand, Howald, Jansson, Konjetzny, Lacroix, Lehmann, Ludloff, Löhr, Martens, Nielsen, Paget, Sommer,* and *Rieger. Axhausen* and, in agreement with him, *Hermodsson* outline the following development of O.D.: fracture at an area of aseptic necrosis, atrophy and abnormal pliancy of the surrounding bone. According to *Axhausen,* the free body constitutes part of the necrosis, while *Kienböck* and *Selka* state that it comprises the entire primary necrosis.

The theory of trauma has also many followers, inter alios, *Barth, Brailsford, Broca, Burckhardt, Börner, Cocchi, Conway, Fischer, Häuptli, Kappis, Kleinschmidt, Kragelund, Kroh, Lang, Lange, Lavner, Leb, Littlejohn, Monro, Nagura, Schmieden, Schmidt, Shanks,* and *Wilms.* Some of these, for example, *Nagura,* believe that a regular traumatic separation is present, while others, including *Broca, Ray,* and *Shanks,* express the opinion that the trauma sustained results in a local nutritional disturbance and hence through ischaemia leads to necrosis.

Several investigators have tried to produce experimental O.D. by exposing animals to traumatic injury. For most of these, including *Axhausen, Barth, Burckhardt, Börner, Gies, Hildebrand, Kragelund, König, Martens, Panner, Poncet,* and *Schmidt,* the attempt proved unsuccessful, while others, above all, *Nagura,* believed that O.D. did develop, but *Ribbing* stated that the lesions produced were regular fractures. In his experiments, *Axhausen* chiselled off a fragment of the articular surface and placed it either in its proper place or somewhere

else within the joint cavity. In the former cases reunion occurred, whereas the fragment was absorbed in the latter cases. *Bentzon,* who believes that the trauma blocks the vasomotor nerves, produced necrosis by injection of alcohol.

The failure to produce experimental O.D. and the frequent absence of traumatic injury in the past history is, however, explained by *Bandi, Schinz, Branderberger, Cocchi, Reischauer* and others by assuming that O.D. is due to the sequelae of a fatigue fracture (Ermüdungsfraktur). The experiments performed by *Reischauer* and *Bandi* are especially in favour of this assumption.



Reischauer studied the changes occurring in ball-pressure experiments on an armour plate, i.e. one-point stress. He found recrystallization and crystal enlargement maximally in the areas farthest from the point of contact with a spherical nimbus-like border towards the unaffected parts as indicated in the accompanying diagram.

He compared these observations with the three typical zones of separation in O.D. and expressed the view that it is reasonable to assume that a spherical "umbau" zone develops in O.D.—in analogy with the changes seen in the armour plate at the border towards the unaffected parts—followed by separation along this border, possibly produced by a second trauma. *Fromme* had previously mentioned this mode of production. Even though the order of magnitude of the remote affections is not quite comparable, this explanation seems to be superior to any others so far offered for the spherical zone of separation.

Based on his own investigations, *Bandi* conceives O.D. as a fatigue fracture. In the knee joint, he believes that the condition is caused by the concentric pressure exerted by the patella and the head of the tibia on the femoral condyles; the place with the smallest surface of contact and the highest pressure effect is the site of typical O.D. A combination of this pressure effect and movements causes, by summation, the actual damage. Inadequacy of the lateral ligaments and rotational movements in the longitudinal axis of the knee joint are contributory factors in the demarcation.

The multiple familial occurrence is explained by a hereditary mechanical inferiority. In this connexion special mention must be made of the more or less demarcated bone nuclei and protuberances considered by *Ribbing*, who published sketches showing that these occupied a place corresponding to the site of O.D. *Ludloff* had previously described the presence of protuberances, but did not associate these with O.D. *Ribbing* expressed the opinion that these multiple ossifications were the central cause of O.D., referring to the theory advanced by *Lehmann* as to constitutionally weak epiphyses; this epiphyseal weakness should be due to their poor vascular supply, which has also been demonstrated in autopsy specimens.

The presupposition for the development of O.D. should then be a disproportion between the excessive strain and the mechanical inferiority, although a vigorous or long-continued strain would presuppose a smaller degree of mechanical inferiority.

The conception of O.D. as a fatigue fracture associated with hereditary mechanical inferiority satisfies the requirements set up by *Ribbing* with regard to an adequate theory of the development of O.D., which should be able to explain the following factors:–

1. Sites of predilection: the medial condyle of the femur and the capitulum humeri.
2. The frequent occurrence of bilateral involvement.
3. The familial occurrence with a male preponderance.
4. The fairly narrow age range for the onset of the condition.
5. The relatively high incidence in persons with hard physical work.
6. The highest rate of involvement on the right side.
7. Correlation with certain endocrine disorders.
8. The histopathological appearance.

However, changes in the hip joint similar to those observed by *Ribbing* in the knee and elbow joints have not been described, but special static and mechanical factors due to the form of the femoral head and the acetabulum come into play here; these will be considered after the case reports.

Another theory which satisfies the aforementioned requirements is the one advanced by *Bentzon* (personal communication). In refutation of the hypothesis that aseptic necrosis should be due to interruption of the vascular supply *Bentzon* calls attention to certain bone operations in which the vascular supply to a certain part of a bone is completely

interrupted, or in which bone grafts (e.g. bone chips) are employed. In either case, no necrosis, but union usually occurs. In slipping of the femoral head epiphyseal necrosis is a rare occurrence, although pronounced displacement may be present. He therefore expresses the opinion that aseptic necrosis is not due to interruption of the vessels but to contusional injury to the vessels in such a manner that the lumina of the vessels are preserved, whereas damage is caused to the vasomotor nerves, resulting in a periarterial sympathectomy, which gives rise to a callus reaction in the bone (possibly in the epiphysis or apophysis). Aseptic necrosis should thus be due to a callus reaction, which is not, as usual, excited by a fracture.

The various localizations with certain sites of predilection are explained by the assumption that the course of the arteries in these regions render some of the arteries particularly liable to injury (bruising, excessive stretching or rupture). The lesion is due to an adequate trauma, which in turn depends on (1) the coarse anatomical conditions and (2) certain conditions related to growth, viz. the thickness of the epiphyseal cartilage. To exemplify (1) it may be mentioned that aseptic necrosis of the head of the radius rarely occurs because this bone is well protected by the annular ligament, so that the only possibility of an adequate trauma occurring here is a blow in the longitudinal direction. – If the navicular of the hand is flat, repeated subluxations may result in arterial damage. As examples of (2) may be mentioned the heads of the second and third metatarsal bones; here a certain thickness of the epiphyseal cartilage is required in order that repeated epiphyseal separation with subluxation and damage to the arteries can occur. This explains why aseptic necrosis occurs here at a certain age.

According to this theory, the development of aseptic necrosis of the hip joint may be related to impaired vascular supply due to an abnormal form of the joint associated with a variation in the supply of vessels which renders this very liable to injury.

It is now possible to study the arterial supply to the head of the femur in vivo, viz. after injection of a contrast medium into the femoral artery. In September 1955, *Müssbichler* reported an arteriographic study on 28 affected hip joints (including several cases of capital necrosis) and 15 unaffected hip joints. By this method it should be possible to demonstrate variations in the vascular supply to the femoral head and contusional injury of some of the vessels, which according to *Bentzon* should form the basis for the development of O.D.

Our knowledge of the patho-anatomical conditions originates from operations and cases studied post mortem. At autopsy on a patient with O.D., *Lavner* found that the affected area was flat; the sequestrum, which was lodged in a cavity of the bone, was kept in place by normal cartilage and the synovial capsule, but it was easily dislodged. Histological examination revealed necrotic bone in the centre with thick hyaline cartilage on the articular aspect and a thick layer of fibrocartilage on the opposite side. These findings are in agreement with those reported by other investigators. Histologically, *Lavner* found viable normal cartilage connected with dead subchondral bone, in which the trabeculae were partially or completely absorbed and invaded or replaced by fibrous tissue.

Roentgenographically, a distinction may be made between early and late changes. Early changes are fragmentation, patchy decalcification and sclerosis of an elipsoid zone, most frequently in the superolateral corner, with compression of the affected portion, which is usually sharply demarcated by sclerotic tissue towards the unaffected part of the bone.—Late changes are osteo-arthritis with narrowing of the joint space, flattening and displacement of the femoral head, osteophytes at the margins of the joint and cystic and sclerotic changes in the head. Finally, obliteration of the osteochondritic process occurs. A free body is never present.

PERSONAL INVESTIGATIONS

Ten cases of O.D. of the head of the femur are reported below. Of the patients, five originate from Viborg Amts og Bys Sygehus (VABS), one from Aarhus Kommunehospital (AKH)[1] and four from Københavns Amtssygehus, Gentofte (KASG). In all the ten cases the diagnosis was based on the roentgenographic appearance, which is usually characteristic. In most cases, the ordinary films were supplemented by exposures in Lauenstein's projection; if there is any doubt as to the diagnosis, stereoscopic films and tomograms may be helpful.

CASE 1.—A smallholder's wife (VABS), aged 26, noticed pain in the right hip joint after some rapid movements in 1942. Variable pain persisted, but the patient was not admitted to hospital and did not receive any treatment. At an examination in 1953 external rotation was abolished. The patient had a slight limp, but showed no other abnormalities.

[1] Director of the Department of Radiology (AKH): Professor Carl Krebs.

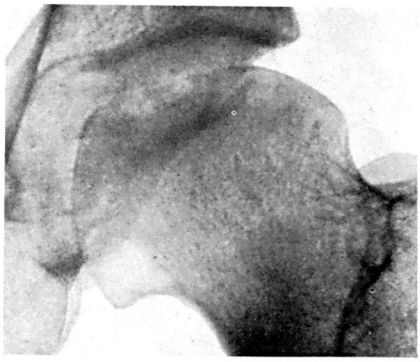


Fig. 1.
Case 2, March 1942; 12 months after the onset of symptoms.

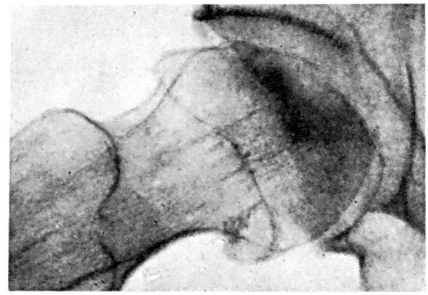


Fig. 2.
Case 3, June 1953, Lauenstein's projection; 5 years after the onset of symptoms.

A roentgen examination in February 1952 revealed fairly flat acetabula and pronounced coxa valga. At the superolateral corner of the right femoral head the bony pattern was slightly irregular with several small areas of rarefaction and sclerosis. In Lauenstein's projection the affection was distinctly elipsoid with sclerotic demarcation and narrowing of the joint space at that level. Otherwise the joint space appeared normal. The affection measured 2.5×0.5 cm.

Follow-up roentgenograms taken in June 1953 showed unchanged conditions.

CASE 2.—A farm-hand (VABS), aged 37, had had progressively severe pain in the right hip joint since 1941, especially at night. He was admitted to hospital in 1942. The gait was broad-based and waddling, but the hip joints showed normal mobility. In addition, considerable kyphoscoliosis was noted. Conservative treatment was given. In June 1953, the patient wrote that his condition was poor with pain in the right hip joint both day and night. There were no symptoms on the left side.

Roentgen examination in March 1942 (fig. 1) showed fairly flat acetabula and wide, somewhat angular femoral heads. On both sides, there was almost symmetrical flattening of the superolateral corner of the femoral head, which occupied one third of the articular surface. Below this, the bony structure was irregular with several areas of rarefaction and sclerotic demarcation towards the unaffected bone.

CASE 3.—A mentally deficient housemaid (VABS), aged 31, with pronounced kyphoscoliosis had first noticed pain in the right hip region in relation to a pregnancy in 1947. She had some difficulty in walking, which later increased in severity. Conservative treatment was given. At a follow-up examination in 1953 the mobility of the hip joint was practically unrestricted, but the patient had a slight limp.

Roentgen examination in August 1947 showed mild halisteresis of the entire femoral head and a slight narrowing of the joint space laterally, with a corresponding irregularity of the articular surface of the head. A film taken in Lauenstein's projection revealed an oval destruction in the superolateral corner of the femoral

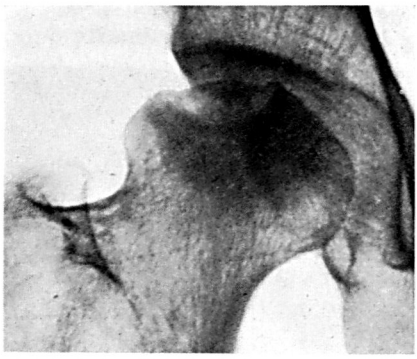


Fig. 3.
Case 5, October 1952; 6 months after the onset of symptoms.

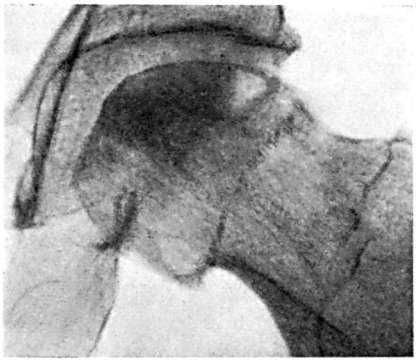


Fig. 4.
Case 5, May 1954, Lauenstein's projection; no symptoms on this side.

head, surrounded by slight sclerosis and a distinct depression of the articular surface at this level.

Repeated roentgen examinations during the next few years showed slow progression of the pathological process.

A roentgen examination in July 1953 (fig. 2) now showed more distinct sclerotic demarcation, and a mild osteophytic reaction had developed.

CASE 4.—A female shop assistant (AKH), aged 65, had a fall in 1943, followed by the development of progressively severe pain in the right hip joint in relation to walking. Conservative treatment was given. During the last two years she had been unable to work, but otherwise she managed all right. At a follow-up examination in July 1953, rotation was abolished and other movements were moderately restricted; slight limping was present.

Roentgen examination in October 1945 revealed an oval defect, 1 × 3 cm, in the superolateral part of the head of the femur, bounded by irregular but sharply demarcated sclerosis. The hip joint showed slight valgus position, and a mild osteophytic reaction was present at the margins of the joint.

At a roentgen examination in July 1953 the sclerotic demarcation had become more pronounced, and there was now distinct osteo-arthritis with marginal osteophytes and subchondral areas of rarefaction.

CASE 5.—A female fitter (KASG), aged 35, sustained a fracture of the sacrum; two months later (February 1952) progressively severe pain in the right hip joint developed. Conservative treatment was given. She has no difficulties in attending to her usual sedentary activities. There is not, and has never been, any symptoms on the left side. At a follow-up examination in May 1954 internal rotation was slightly reduced, with pain when the right hip joint was placed in the extreme external position; a slight limp was present.

A roentgen examination in February 1952 revealed normal bone structure in both hip joints. The right acetabulum was relatively flat, and there was slight valgus position on both sides.

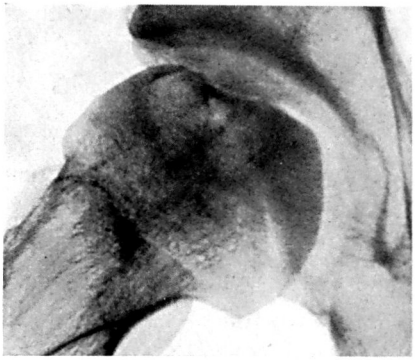


Fig. 5.
Case 6, October 1945, Lauenstein's projection; 25 years after the onset of symptoms.

Fig. 6.
Case 7, June 1953; 20 years after the onset of symptoms.

Roentgen examination in October 1952 (fig. 3) showed an oval defect, 1 × 2 cm, in the superolateral part of the right femoral head, with sclerotic demarcation and some flattening of the affected area. There were no abnormalities on the left side.

Repeated roentgen examination in April and November 1953 and May 1954 showed progressive development of small cystic areas of rarefaction in the sclerotic portion of the right femoral head. It became less well-defined and slight osteophytic reactions developed. On the left side, progressive irregular sclerosis with rarefied areas in the superolateral corner of the head was seen; the last examination (fig. 4) showed a typical affection with flattening of the corresponding part of the articular surface and osteophytic reaction at the articular margins of the head.

CASE 6.—A gardener (VABS), aged 47, had noticed pain in the right hip joint in relation to a trauma sustained by lifting a heavy burden in 1920. Since then, he had slight periodical pain; one attack of pain caused him to have a roentgenogram taken in 1945. Conservative treatment was given. At a follow-up examination in June 1954, the patient complained of mild pain in the hip joint; rotation was slightly restricted; no limping.

Roentgen examination in October 1945 (fig. 5) revealed some confluent, slightly irregular areas of rarefaction, the entire area being the size of a walnut and situated in the upper lateral half of the femoral head, which was wide and flat. Lauenstein's projection showed distinct flattening of the articular surface with a body above, the size of a date stone. The demarcation towards the rest of the bone was slightly sclerotic.

Roentgen examination in June 1953 showed more ill-defined areas of rarefaction interspaced with diffuse sclerosis. No signs of loose bodies or osteo-arthritis were present.

CASE 7.—An unskilled worker (VABS), aged 60, noticed pain in the left hip joint on movements in 1933. Two brothers had loose bodies of the knee. He was admitted to hospital in 1942. He complained of pain on movements, but the range of mobility

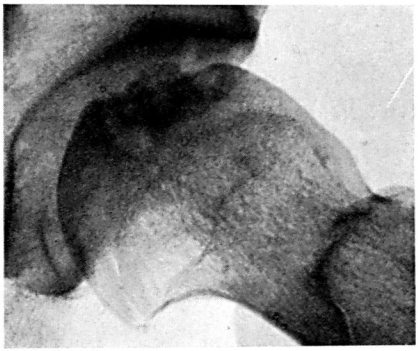


Fig. 7.
Case 8, July 1954, Lauenstein's projection ; 12 months after the onset of symptoms.

Fig. 8.
Case 10, October 1954, Lauenstein's projection; 6 years after the onset of symptoms.

was normal. Operation was advised, but the patient refused, for which reason conservative treatment was given. Since then the condition had become progressively worse, but the patient was able to do light work. At a follow-up examination in June 1953 rotation and abduction of the left hip joint were abolished, and movements to the extreme positions caused pain; he had a slight limp.

Roentgen examination in April 1942 showed pronounced osteo-arthritis of the left hip joint with flattening of the femoral head, a narrow joint space, sclerosis of the articular surfaces and small osteophytes at the margin. Superolaterally, the bony structure was irregular with a large cystlike osteolytic area. No valgus position, but the acetabulum was sclerotic. An area of rarefaction was seen in the head of the right femur, which did not show other abnormalities. Both elbow joints showed pronounced O.D. with loose bodies.

Roentgen examination in June 1953 (fig. 6) showed progression of the osteoarthritis and a very narrow joint space. The bony structure of the upper part of the femoral head showed patchy sclerosis; the defect had now been smoothed out.

CASE 8.—A locksmith apprentice (KASG), aged 15, noticed pain in the left hip joint without any preceding trauma in 1953. After a convalescence period of about two months the pain disappeared and has since been absent. A follow-up examination in July 1954 revealed slightly restricted internal rotation; no limping.

Roentgen examination in June 1953 showed a mushroom-shaped head of the left femur, which was flattened and increased in width, with irregular bony structure and several small areas of rarefaction in the superolateral corner and separation of a small shell of the epiphysis. The affected portion showed sclerotic demarcation towards the rest of the bone.

Roentgen examination in October 1953 and January 1954 showed unchanged conditions.

Roentgen examinations in March and June 1954, Lauenstein's projection (fig. 7), showed a long flat dense area of bone, 1 cm in length, above the pathological process.

CASE 9.—A housewife (KASG), aged 76, had been unable to sit on a cold or hard chair for the last 40 years. She had received conservative treatment, but had never been admitted to hospital. In February 1955 she wrote that she had pain only after much walking; a slight limp was present.

Roentgen examination in October 1954 showed flattening of the superolateral part of the head of the right femur, with two pea-sized areas of rarefaction and narrowing of the joint space. Pronounced valgus position of both hip joints, particularly on the right side, where the femoral head protruded outside the joint.

CASE 10.—A housewife (KASG), aged 62, had had pain in the right hip joint without antecedent trauma since 1948. She had received conservative treatment but had never been admitted to hospital. An examination in October 1954 revealed abolished rotation and slightly reduced flexion of the right hip joint; a slight limp was present.

Roentgen examination in April 1954 showed slight flattening of the superolateral portion of the head of the right femur. The bony structure of the upper third of the head was irregular and sclerotic, with several large areas of rarefaction; sclerotic demarcation towards the rest of the bone. Pronounced valgus position, with about one third of the head projecting outside the acetabulum, was present. A large osteophyte was seen on the lateral part of the acetabulum. The joint space was narrowed laterally and increased medially. Pronounced valgus position was observed on the left side, but the bony structure was normal, and there was no subluxation.

Roentgen examination in October 1954 (fig. 8) showed unchanged conditions, apart from increased subluxation in Lauenstein's projection.

COMMENTS

The average age of the patients in the present series was 31 years, which corresponds well with that reported in the literature. The youngest patient was 14 and the oldest 57 years at the onset. At the first roentgen examination, the ages of the patients ranged from 14 to 71 and averaged 40 years. Six patients were women. Two cases were bilateral.

Three patients revealed familial predisposition, with a family history of O.D. Roentgenograms of elbow joints, hands and knee joints were taken in seven of the patients, but only in one case was involvement of another joint revealed, viz. the elbow. Thus, none of the patients can be classified under the group of secondary O.D. which is called multiple epiphyseal disturbances. Two of the patients had pronounced kyphoscoliosis but not Scheuermann's disease.

None of the patients showed signs of systemic disease, such as endocrine dysfunction or vitamin deficiencies.

Only three patients gave a history of antecedent trauma, and in

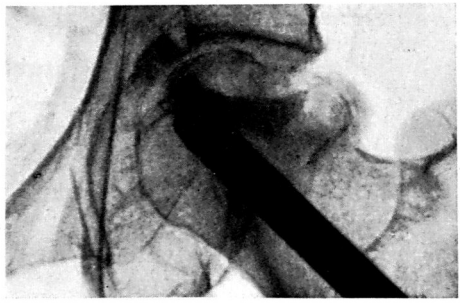


Fig. 9.
Fracture of the neck of the femur, with local capital necrosis; 3 years after successful reduction.

these the trauma had been slight and of an indefinite localization. Thus, the series is in support of the theory that trauma is, at most, of secondary importance in the development of O.D. However, it is unquestionable that a localized aseptic necrosis, highly reminiscent of O.D., may develop due to vascular damage caused by traumatic injury. Several cases of this aseptic necrosis are on record in the literature, most of them developing after fracture of the neck of the femur. Thus, *Stören* reported a case in which aseptic necrosis of the superolateral corner of the femoral head developed 18 months after a successfully reduced fracture of the femoral neck, and the series reported by *Bjørn Ibsen* also contain several, although slightly less typical, cases. In addition, I have personally seen a similar case (fig. 9).

In all the cases considered here the localization was typical, viz. the superolateral corner of the femoral head. In five cases the condition could be classified as early roentgenographic changes; in the remaining cases secondary osteo-arthritis was present. Two cases revealed joint mice, but not free in the joint. In case 5 it was possible to follow the development from normal hip joints to O.D. in its complete form on both sides.

As already mentioned, deviations from normal in the form of the hip joint in association with the special mechanical conditions of the joint may be conceived to be a contributory factor in the development of O.D. The form of the normal hip joint and the importance of deviation from normal in the development of diseases, such as O.D., Calvé-Legg-Perthes' disease, subluxation and osteo-arthritis have been discussed in detail by *Morville, Hermodsson, Murk Jansen* and *Calot*. Our knowledge of the hip joint originates from autopsy studies and from roentgen

examinations. The former are not very numerous as it is a rare occurrence that the hip joint constitutes part of an autopsy; in the latter it is important, for the purpose of comparison, that the joint occupies a certain, uniform position in the various views, and that the centring and distance used in these are identical. Concerning the form of the normal hip joint and the various measurements and diameters used in its evaluation, the reader is referred to the investigations of *Hermodsson* and *Köhler;* here it will suffice to mention that the acetabulum normally encircles three quarters of the head of the femur.

During the first years of life, the form of the hip joint differs from what is seen later on. The centre of ossification of the femoral head is first seen in roentgenograms at the age of 10 months, and not until the age of 4–5 years does the hip joint assume the form it has in adults. The epiphyseal line fuses at the age of 18 years. The acetabulum has three centres of ossification, the epiphyseal lines of which close at the age of 17 years. At birth, the epiphyseal line of the femoral head is at a right angle to the neck; at first it turns upwards and later downwards again. The cup-shaped roof of the acetabulum is formed during the first few years of life. Ontogenetically, no other joint seems at birth to be so retarded in its development as the hip joint.

Special importance has been ascribed to the form of the acetabulum in the development of *Calvé-Legg-Perthes'* disease. O.D. and several other diseases of the hip; in particular, *Murk Jansen* has claimed that these diseases are due to an abnormally flat acetabulum. In addition, great importance has been attached to *Calot*'s assertion that these diseases are caused by congenital subluxation of the hip. However, *Morville* has demonstrated that these theories were based on an erroneous presupposition due to insufficient knowledge of the anatomy of the hip joint in infants. *Morville* showed that the acetabulum is always flat in newborn infants, and that slight subluxation is a physiological phenomenon during the first two years of life. The cause of congenital subluxation of the hip joint is that the acetabulum remains flat during the growth due to abnormal pressure conditions; an increased pressure inhibits the growth and vice versa. *Morville* concluded that, in the last analysis, the explanation of the aforementioned disorders is that for various reasons our bones are, in many cases, unable to cope with the prevailing adverse mechanical and functional conditions in the hip joint; this is the price we must pay for our erect posture. An account of the functional anatomy was published by *Getz* in February 1956.

The changes in the form of the hip joint which were observed in the

present case material are tabulated below. In this evaluation the first roentgenograms taken of the patients were used, and on this basis it was possible to figure out the original form of the hip joint.

Short acetabulum	Cases 10, 7, 5 (right)
Abnormal form of femoral head	Cases 2, 6, 8
Valgus position of femoral head	Cases 1, 9, 10
Subluxation	Cases 10, 7, 5 (right)
Normal form	Cases 3, 4, 5 (left)

Thus, only three of the cases showed a normal form of the hip joint, while incongruity between the head of the femur and the acetabulum was present in the remaining cases. In most of the patients, the acetabulum was relatively flat, but nevertheless within normal limits; all the patients showed slight sclerosis of the acetabulum.

In order to study the frequency of deviations from normal in the form of the hip joint as compared with a series of randomly selected patients, I studied the form of the hip joint in 25 patients who had been subjected to urography; in the latter series deviation from normal was present only in one patient.

In case 6 and, to a lesser degree, in case 8 there were cystic areas of rarefaction of such a severity that they must be presumed to have been present before the development of O.D. and, accordingly, may have been a contributory cause. In both these patients the form of the acetabulum was abnormal. In two cases, pronounced kyphoscoliosis was present; through the resulting erroneous weight-bearing this may have been a contributory cause of O.D.

Thus, a strikingly large proportion of the patients revealed an abnormal form of the hip joint. However, it must be emphasized that this anomaly is thought only to be a contributory cause in the development of O.D., especially in view of the fact that three of the patients showed perfectly normal hip joints. Arteriographic studies were not performed.

On the basis of a review of 21 cases from the literature and the study of 21 cases of their own, *Flashman* and *Ghormley* reported that the symptoms of O.D. are pain, limping, stiffness, difficulty in walking, atrophy and limited mobility. Practically all the patients complained of pain, which was most severe on movements. One third of the patients complained of stiffness; one third limped, and one third had atrophy. One tenth of the patients showed no symptoms. The duration of symptoms ranged from 2 months to 7 years.

Fig. 10.
Case of tuberculous coxitis immediately after the onset of symptoms.

Of the patients in the present series, only one was without symptoms, but another patient who had bilateral O.D. had symptoms on one side only. All the remaining patients had pain. Limping was present in all the patients but one, but it was only slight in five patients. Limitation of mobility was seen in six patients, in two only to a slight extent; the range of mobility was not determined in two. The symptoms were pronounced in two, moderate in one, and mild in the remaining cases

The following conditions must be considered in the differential diagnosis: Calvé-Legg-Perthes' disease, chondromatosis, neuropathy (tabes, syringomyelia) and tuberculosis, since, as already mentioned, the O.D.-like changes in certain systemic disorders (e.g. cretinism and hypothyreosis) and in fracture of the head of the femur are classified as secondary O.D. Personally, I have seen a case in which the appearance of the first roentgenogram (fig. 10) gave rise to a tentative diagnosis of O.D., but the case was actually one of tuberculous coxitis. However, slight halisteresis was also present, and the form of the affection was not typical.

According to *Flashman* and *Ghormley,* the therapeutic aim must be revascularization and reunion of the fragments with maintenance of the normal outline. Most of their patients were treated with various types of surgical measures, usually with a good result. *Hubert* recommends immobilization of the extremity in a certain position for two years. *Valls* and *Muscolo* advocate conservative treatment in cases with mild symptoms without progression, and surgical treatment in the presence of intense pain and serious radiological signs.

In two cases of the present series the disease was left untreated, while physical therapy was employed in the remaining cases, usually

resulting in some improvement of short duration. Considering the relatively mild discomfort experienced by eight of the ten patients and the long periods which elapsed before symptoms developed or before the patients applied for medical aid, one should certainly be reluctant in advising surgical intervention.

SUMMARY

The history and occurrence of osteochondritis dissecans (O.D.) are briefly reviewed. Various factors which have been regarded as essential or contributory causes of the disease are discussed on the basis of the literature. It is concluded that the most plausible causal theory is that O.D. occurs on the basis of a fatigue fracture of a joint with mechanical inferiority. In the elbow and knee joints it may be due to the epiphyseal changes described by *Ribbing,* and in the hip joint to deviations from the normal form. In addition, the theory advanced by *Bentzon* is considered; according to this theory, aseptic necrosis occurs due to contusional injury to the vessels resulting in periarterial sympathectomy, which in turn gives rise to an abnormal callus reaction. Ten cases, of which two were bilateral, are reported. In one case, developments were followed from normal hip joints on both sides to O.D. in its complete form. Symptoms, differential diagnosis and treatment are briefly considered.

RESUME

L'histoire et la fréquence de l'ostéochondrite disséquante sont brièvement passés en revue. Différents facteurs qui ont été considérés comme essentiels ou comme causes contributaires de la maladie sont discutés sur la base de la littérature. Il est conclu que la théorie causale la plus plausible est que l'ostéochondrite disséquante apparaît à la suite d'une fracture due à la fatigue d'une articulation en état d'infériorité mécanique. Dans les articulations du coude et du genou, elle peut être due à des altérations épiphysaires décrites par Ribbing et, dans la hanche, à des déviations de la forme normale. Par ailleurs, il est tenu compte de la théorie avancée par Bentzon; d'après cette théorie, la nécrose aseptique est due à une lésion par contusion des vaisseaux dont il résulte une sympathectomie périartérielle qui, à son tour, provoque une réaction anormale de callus.

Dix cas, dont deux étaient bilatéraux, sont rapportés. Dans l'un des

cas l'évolution a été suivie à partir de l'articulation normale de la hanche des deux côtés jusqu'à la forme complète d'ostéochondrite disséquante. Les symptômes, le diagnostic différentiel et le traitement sont brièvement examinés.

ZUSAMMENFASSUNG

Ein kurzer Überblick der Geschichte und des Vorkommens der Osteochondritis dissecans (O.d.) wird gegeben. Verschiedene Faktoren, die als wesentliche oder beitragende Ursachen der Erkrankung angesehen werden, werden an Hand der Literatur besprochen. Die Schlussfolgerung wird erreicht, dass O.d. auf Grundlage eines Ermüdungsbruches in einem mechanisch minderwertigen Gelenk entsteht. Im Ellbogen- und Kniegelenk tritt sie möglicherweise im Zusammenhang mit den Epiphysenveränderungen, wie sie von *Ribbing* beschreiben sind, auf, und im Hüftgelenke auf Grund von Abweichungen von der normalen Form. Ausserdem jedoch wird die Theorie von *Bentzon* in Betracht gezogen. Gemäss dieser Theorie kommt es zu aseptischer Nekrose infolge von Kontusionsschäden der Gefässe, die zu periarterieller Sympathektomie führen, welche letztere eine abnormale Kallusreaktion hervorruft. Zehn Fälle, von denen zwei doppelseitig waren, werden berichtet. In einem Fall wurde die Entwicklung in normalen Hüftgelenken auf beiden Seiten bis zur voll ausgeprägten Form der O.d. verfolgt. Die Symptome, die Differentialdiagnose und Behandlung werden kurz besprochen.

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