Femoral head alive 16 years after a non-consolidated intracapsular fracture of the femoral neck

An anatomical and radiological study

R. LAGIER AND J. FORESTIER

Département de Pathologie de l'Université de Genève, Switzerland, and Centre de Recherches des Maladies Rhumatismales d'Aix-les-Bains, France

Before the era of modern therapy, intracapsular fractures of the femoral neck were notorious for their frequent lack of union. The head frequently developed aseptic necrosis, but occasionally it retained its vitality.

It is now difficult to observe such 'pure' cases, unmodified by surgery. A femoral head which retained its vitality under such circumstances has been studied both radiologically and anatomically. This is now described, not because of its rarity, but because it permits certain observations on an interesting point of articular pathology—the natural history of a femoral head which is placed in an abnormal mechanical and nutritional situation for purely local and accidental reasons.

Case report

HISTORY

In 1952 a woman, then 52 years old and previously well, fractured the neck of the left femur after falling from a footpath.

No x-ray examination was made at the time. On the advice of a bone-setter the patient was immobilized in bed for 3 weeks and she started walking again only after 6 months. For 16 years afterwards she walked with a slight limp, almost painlessly, and adjusted herself well to this condition.

In 1968 she sought advice because of the onset of pain in the left hip, of moderate intensity, present on walking, but absent at rest. She had heard cracking sounds in the hip and after prolonged periods of sitting the hip sometimes became locked, preventing her from walking; after several attempts the leg could again be moved.

The radiological discovery of an ununited femoral head was followed by its surgical excision. Pain, cracking sounds, and locking subsequently disappeared, but upward displacement of the greater trochanter produced an accentuation of the limp.

X-RAY STUDY

Since no x-rays were taken in the period after the accident, the exact appearance of the fracture at that time is not known. The preoperative x-ray taken 16 years later is shown in Fig. 1.

ANATOMICO-PATHOLOGICAL STUDY

The operation specimen was a very deformed femoral head (Figs 2 and 3). It was examined radiologically, macroscopically, and microscopically in five different parallel sections.

The remodelled fractured surface constituted a more or less flat base, the greater part smooth, but blown out here and there. Its thin cortex was covered by fibrous connective tissue, where some ochre deposits testified to old haemorrhages. It was flanked marginally by some remains of articular cartilage.

The convexity also had a thin bony cortex, with elevations in places, and occasionally interrupted by erosions. Some remains of articular cartilage could be seen showing several kinds of pathological changes: chondrocyte proliferation with fibroblastic dedifferentiation on the surface occasionally forming a pannus (Figs 4a and b), isolated islands embedded in a newly formed covering of connective tissue (Fig. 5), and segments buried either under a lamina of newly formed bone or under an osteo-cartilaginous formation producing the histological image of an osteophyte (Figs 3b and 4a).

The covering of the convexity was generally of connective tissue giving a smooth macroscopical appearance with occasional elevations. Some ochre deposits of haemosiderin could be seen, especially on the fringes of the hyperplastic synovial membrane, with here and there contained lymphocytes and rare giant cells (Fig. 6).

At the lower pole near the base of the fracture an osteophyte covered by fibro-cartilage could be seen. Medially and inferiorly, it was flanked by a vascularized ligamentous segment presumed to be remains of the ligament of the femoral head (Fig. 3b).

FIG. 1 Preoperative radiograph (1968) of left hip, 16 years after fracture

FIG. 2 Macroscopic appearance of operative specimen. Articular surface remodelled, showing several elevations. The bone is covered by newly-formed white fibrocartilage or by connective tissue, partly pigmented by deposits of haemosiderin. $\times 1.2$

FIG. 3 Anterior paramedial section.

(a) Macroscopic appearance. Osteophytic mass covered by newly-formed cartilage at inferior pole of surface of fracture.

(b) Histological slide corresponding to lower third of specimen. Marked osteoporosis of both cortical and cancellous bone.

On the left, two osteophytic masses covered by newly-formed fibrocartilage are separated by a segment of

vascularized ligament considered to be the remains of the ligament of the femoral head.

On the right, the contour of the former cortex is buried underneath a crescent of newly-formed bone.

Remains of hyaline cartilage observed at a higher magnification in the right part of this former cortex testify to bony invasion of the previous cartilage, the surface of which is thus transformed into fibrocartilage. Van Gieson. $\times 2.4$

FIG. 4 *Remodelling of a segment of pre-existing cartilaginous covering.*

(a) Above and below on right is a surface of hyaline cartilage on which is appended an osteophyte. The latter, on the left, is composed of bone, the thin cortex of which is covered by newly-formed fibrocartilage. This image is comparable to that of an osteophyte in osteoarthritis. *Van Gieson.* $\times 5$

(b) Detail of 4a. On the right is an accentuated basophilia around the chondrocytes; in the middle a fibrocartilaginous structure replaces hyaline; on the left the whole is covered by a pannus of vascularized oedematous connective tissue with sparse lymphocytic infiltration. *Haematoxylin and eosin.* $\times 80$

Examination of different sections showed a pronounced osteoporosis with complete obliteration of the normal trabecular architecture, and sometimes the stigma of a former remodelling (Figs 3b and 7). The marrow was fatty and vascularized. There was no evidence of necrosis of the bone or medullary tissue and there were no foam cells to indicate necrobiosis of the fat.

Discussion

A few comparable observations have previously been made with either an analogous macroscopical picture in one case with 14-year evolution (Phemister, 1929), or with some sort of integrity of the bony structure in two cases with 4 and 5 years' evolution (Santos, 1930).

FIG. 5 Erosion of cartilaginous surface distal to cartilaginous segment of Fig. 3b, and at a slightly different level. Cartilaginous remains with serrated borders are embedded in connective tissue directly in contact with the bone. Haematoxylin and eosin. $\times 200$

FIG. 6 Modifications of synovial membrane

(a) Vascularized and oedematous fringe. Hyperplasia of synoviocyte layer with discrete lymphocyte infiltration (with haemosiderin deposits). Haematoxylin and eosin. $\times 80$

(b) Hyperplastic fringe joining a non-papillary fibrous synovial membrane. Histiocyte-giant cell reaction, but with no lymphoplasmocytic inflammatory infiltration. Haematoxylin and eosin. $\times 45$

(c) Hyperplasia of synoviocyte covering, with haemosiderin punctuation. One synoviocyte is binucleated. Haematoxylin and eosin. $\times 530$

FIG. 7 Osteoporosis. Detail.

(a) Spongiosa with occasional thin trabecular bone (photomicrograph 3b). Fatty marrow. Vein upper right. Van Gieson. $\times 30$

(b, c) Stigmata of old remodelling of spongy trabeculum, by laminated apposition and by discrete deposit of metaplastic bone (section near that of 3b).

(b) normal light, (c) polarized light. Haematoxylin and eosin. $\times 80$

In the case presented here, neither the exact type of intracapsular fracture, nor details of the blood supply to the living femoral head, are known. We can only postulate that the vascular supply was provided through a pedicle of ligamentous tissue (presumably the ligament of the head) and perhaps also by vessels in adhesive tissue. The peculiar conditions of the case

do however offer the opportunity to discuss some important features of joint pathology:

(1) Being no longer the object of normal mechanical stresses, the femoral head underwent a regression of differentiated structures such as bone and articular cartilage. Such modifications were described in im-

mobilized joints by Tessier (1841) more than a century ago.

In addition to immobilization *per se*, a variety of Sudeck's dystrophy may also explain the osteoporosis. This dystrophy appears secondary to the fracture and is a well-known phenomenon (Rutishauser, Vernet, and Mazabraud, 1956; Sherman and Phemister, 1947; Willert, 1966), but it may also be maintained by mechanical conditions created by the lack of union. The appearance of a preliminary remodelling described in such cases (Willert, 1966) was observed here (Fig. 7*b* and *c*), and resorption of the femoral neck could be associated with such dystrophic changes.

(2) The various histological appearances observed in the femoral head taken separately can also be seen in the principal rheumatic diseases. In osteoarthritis, the structure of osteophytes is fundamentally identical and a hyperplastic synovial membrane may be seen with identical characteristics. Some of the synovial changes observed histologically in rheumatoid arthritis cannot be distinguished from those of certain small synovial segments in the present case: moreover articular erosion in this disease is often reflected by cartilage remnants embedded in a fibrous pannus.

In the case described here, even without knowing the clinical context, the overall morphological examination enables such diagnoses to be excluded. These histological features nevertheless emphasize two facts which are well-known but sometimes forgotten:

(a) The morphological picture of an arthrotic remodelling is an association of several non-specific lesions, and a topographical systemization is necessary for such a diagnosis (Lagier, 1972).

(b) Articular biopsies—particularly needle biopsies of the synovial membrane—must be interpreted

with caution, since the specimen available is small and not necessarily representative.

(3) Despite lack of precise knowledge concerning the vasculature of the femoral head, it may be considered to be abnormal. It appears to have been reduced at least during some—if not all—stages of the post-traumatic evolution. Nevertheless this epiphysis, showing a pseudoarthrosis, remained alive and did not display signs of aseptic necrosis such as those seen after certain types of fracture of the femoral neck. This finding corroborates other observations which suggest that the fundamental problem of 'aseptic necrosis of the femoral head' is not simply that of a disturbance of the blood supply, but is particularly related to mechanical stresses (Lagier, 1971).

Summary

(1) An anatomico-radiological study was made of a femoral head removed surgically from a 68-year-old woman, after 16 years of non-union of an intracapsular fracture of the femoral neck.

(2) The head was alive but showed marked osteoporosis. Dedifferentiation of the cartilage surface could be seen; some of the primary lesions observed were similar to those of osteoarthritis and, in some situations, to certain lesions seen in rheumatoid arthritis.

(3) Despite precarious vascularization there were no signs of aseptic necrosis.

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