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AMYLOID IN OSTEOARTHRITIC HIP JOINTS

A Pathoanatomical and Histological Investigation of Femoral Head Cartilage

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A total of 116 osteoarthritic femoral heads were studied with regard to the relationship between amyloid deposits in the cartilage and osteoarthritic changes. All the femoral heads were found to be deformed and only 10 were covered by cartilage over the whole surface. Sixty-five per cent of the femoral heads showed amyloid degeneration of the cartilage surface. The amount of amyloid did not correlate with the extent of the erosion. Neither was there a significant correlation between the amyloid degeneration on the one hand and fibrillation and flaking of the cartilage surface on the other.

A reduction in the amount of chondroitin sulphate was observed in all 116 femoral heads to varying degrees, but no correlation with amyloid could be demonstrated. Thus, in the present study no correlation between the morphological and histochemical degrees of osteoarthritis and amyloid has been found. Six out of seven femoral heads with pyrophosphate deposits in the cartilage also contained amyloid.

Key words: amyloid; cartilage; hip joint; osteoarthritis

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The pathoanatomical changes which take place in the hip joint in cases of osteoarthritis are innumerable, but well known.

The most important changes are fibrillation and flaking of the cartilage surface (Byers et al. 1970, Emery & Meachim 1973) and atrophy of chondrocytes with reduction of the amount of glucosaminoglycans in the intercellular substance (Collins & McElligott 1960, McDevitt 1973, Meachim et al. 1965, Sokoloff 1969, Sokoloff 1979, Stokwell 1970, Sweet et al. 1977). These changes lead to erosion, which in the most advanced stages leaves the bone exposed in larger or smaller areas of the pressure-loaded parts (eburnation) (Collins 1950).

In an autopsy material we found amyloid in the cartilage surface from femoral heads (Ladefoged & Christensen 1980). The object of the present investigation has been to describe the deposits of amyloid in the surface of the cartilage from femoral heads in relation to osteoarthritic changes.

MATERIAL AND METHODS

The material consisted of tissue from 116 femoral heads removed consecutively in connection with hip joint arthroplasty according to the method of Charnley. All the operations were performed because of severe hip joint osteoarthritis and were carried out at the Department of Orthopaedic Surgery O of the Odense University Hospital.

The average age of the patients was 61 years (range 32–74). There were 47 women and 69 men. None of the patients had clinical signs of primary amyloidosis, myelomatosis or tuberculosis. One had concurrent rheumatoid arthritis.

Immediately after the operation the head of the femur was placed in 10 per cent formalin for 24 hours. Thereafter a macroscopic evaluation was carried out with regard to deformation of the femoral head as well as erosion of the cartilage.

Deformation was interpreted either as exostosis on the head or as compression with flattening. The exostosis could be seen either localized to the fovea or along the margins. Compression was measured as the ratio of two diameters on the femoral head, the first perpendicular to the neck axis and the second parallel to this axis and beginning at the cartilage margin. Femoral heads with this ratio between 1.2 and 1.7 plus exostosis

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were considered to be slightly deformed, with a ratio between 1.8 and 2.2 moderately deformed and over 2.2 severely deformed.

Erosion of the cartilage was classified by measuring the largest diameter of exposed bone.

After this, tangential and radial sections were removed from both the pressure and less pressure-loaded parts of the cartilage. The tissue was then subjected to routine treatment and 6 μ thick sections stained with haematoxylin and eosin, toluidine blue in a 1 per cent concentration and at a pH of 3.1 and alkaline congo red according to the method of Puchtler et al. (1962). Amyloid degeneration was interpreted as being present when the reddish colour of the alkaline congo red staining gave green dichroism in polarized light.

The deposits of amyloid and the reduction in staining with toluidine blue, measured from surface to tidemark, as well as fibrillation and flaking of the cartilage surface, were assessed semiquantitatively so that 0 indicated none, + slight, ++ moderate and +++ severe degree.

RESULTS

In 75 of the 116 femoral heads (65 per cent), amyloid degeneration was seen in the surface of the cartilage. Forty were affected to a slight extent and 28 contained moderate deposits, while seven showed massive amyloid degeneration.

All 116 femoral heads were deformed. Sixty-nine to a slight extent, 36 moderately while 11 femoral heads were severely compressed, with prominent osteophyte formation (Figure 1). The ligamentum capitis femoris was intact in 33 cases; in 39 cases it contained partly cartilaginous and partly new osseous formation. In 44 cases osteophyte formation was observed in the fovea. No correlation between degree of deformation and amyloid could be found (Table 1).

Only 10 of the femoral heads were covered with cartilage over their entire surface. In the remaining heads there was total destruction of the cartilage in the area corresponding to the pres-

Table 1. Degree of deformation of the femoral head in relation to the amount of amyloid deposition

Deformation ratio of femoral head	Amyloid deposition 0	+	2+	3+	Total
1.2–1.7	26	26	13	4	69
1.8–2.2	13	10	11	2	36
>2.2	2	4	4	1	11
Total	41	40	28	7	116

Table 2. Diameter of exposed bone in relation to the amount of amyloid deposition

Exposed bone (diameter in mm)	Amyloid deposition 0	+	2+	3+	Total
0	2	3	5	0	10
1–30	10	4	5	0	19
31–50	20	27	14	4	65
>50	9	6	4	3	22
Total	41	40	28	7	116

Figure 1. Severely deformed femoral head with marginal osteophytes (1 arrow). Totally degenerated ligamentum capitis femoris. Bone cysts filled with fibrocartilage (2 arrows) and destruction of the cartilage throughout the whole of the pressure-loaded area (cartilage margin 3 arrows).

Figure 2. Fibrillation and flaking of the cartilage surface. Amyloid deposits can be traced right down into the bottom of the fissures (×100). Alkaline congo red.

Figure 3. Amyloid degeneration in a half-moon shape around chondrocytes both in the areas of the loose degenerated superficial layers as well as in the deeper intact cartilage (×250). Alkaline congo red.

Figure 4. Absence of metachromasia in the upper part of the joint cartilage with toluidine blue staining (×100).

Figure 5. Joint cartilage covered by reparative fibrocartilage. The holes are artefacts. The amyloid is localized to the original surface of the cartilage below the fibrocartilage (arrow) (×100). Alkaline congo red.

Figure 6. Surface of cartilage with large amounts of pyrophosphate (arrow) and amyloid (2 arrows) (×100). Alkaline congo red.

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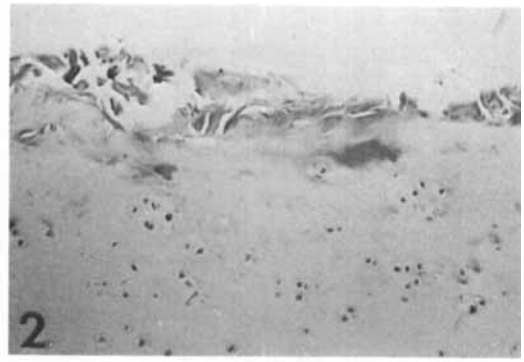

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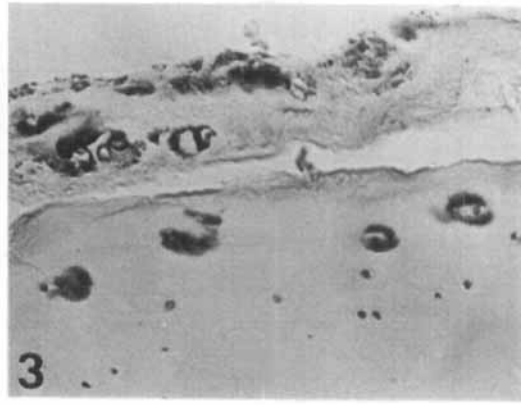

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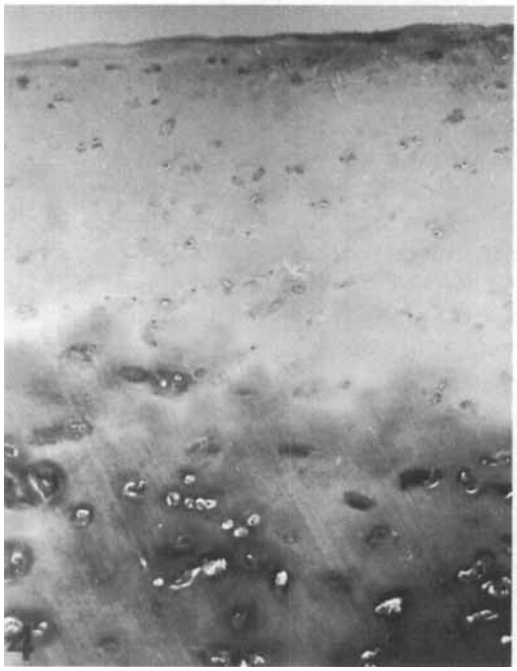

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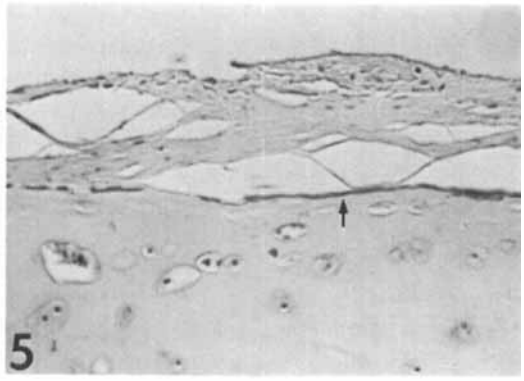

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Table 3. Degree of fibrillation in relation to the amount of amyloid deposition

Fibrillation	Amyloid deposition 0	+	2+	3+	Total
0	0	0	0	0	0
+	18	16	10	2	46
2+	20	15	12	1	48
3+	3	9	6	4	22
Total	41	40	28	7	116

Table 4. Degree of chondroitin sulphate reduction in relation to the amount of amyloid deposition

Chondroitin sulphate reduction	Amyloid deposition 0	+	2+	3+	Total
0	0	0	0	0	0
+	17	17	16	3	53
2+	22	21	12	4	59
3+	2	2	0	0	4
Total	41	40	28	7	116

sure-loaded part of the head. Nineteen femoral heads had areas of bone exposure with diameters from 1–30 mm, 65 with diameters from 31–50 mm and 22 had areas with diameters above 50 mm. No significant relationship was found between amyloid degeneration and the size of the area of exposed bone (Table 2).

Fibrillation and flaking of the cartilage surface were observed to varying degrees in all the cases. The amyloid degeneration of the cartilage could be traced down into the fissures (Figure 2), and was also observed in half-moon like areas around the chondrocytes (Figure 3) and in small "spots" just below the surface. However, no constant relationship was found between the amyloid degeneration and fibrillation (Table 3). Thus intact cartilage surfaces were seen with degenerative substance, while, on the other hand, severely fibrillated cartilage could also be seen without any amyloid deposits.

An absence of metachromasia in the upper part of the joint cartilage with toluidine blue staining was interpreted as a reduction in the amount of chondroitin sulphate (Figure 4). All of the 116 femoral head surfaces showed a varying amount of reduction in the chondroitin sulphate content. However, no quantitative correlation with the content of amyloid was found (Table 4).

Irregular areas of pannus-like proliferation of fibrocartilage extended from the periphery in over the cartilage in 80 per cent of the studied cases. Amyloid was not observed in this reparative tissue, but was often localized to a border below it in the original cartilaginous surface (Figure 5).

Pyrophosphate deposits were found in the surface of the cartilage in seven of the 116 femoral heads. Six of these were from men, and amyloid deposits were found in six. The rhomboid pyrophosphate crystals lay in accumulations close to the surface of the cartilage (Figure 6), in several cases closely surrounded by amyloid.

DISCUSSION

Fibrillation and flaking of the surface of the joint cartilage has for many years been considered as the first histological sign of incipient osteoarthritis (Collins 1950). However, Byers et al. in 1970 and Emery & Meachim in 1973 divided fibrillation into a non-progressive form, which often occurs in the non-pressure-loaded part of the joint; this type is asymptomatic and does not lead to additional destruction of the cartilage. The second type is a progressive form, commencing in the pressure-loaded area itself. The latter form leads to total destruction of the cartilage with exposure of the underlying bone as a result. This was the case in 106 of the 116 femoral heads. The amount of amyloid, however, was independent of the size of the exposed area of bone.

The factors leading to fibrillation and flaking in the lamina splendens of the surface of the cartilage are still not fully elucidated. However, Barland et al. found in 1966 that the amount of mucopolysaccharides was reduced before the cartilage began to fibrillate. It is also now well-known that the amount of glucosaminoglycans in the uppermost layer of the cartilage decreases with increasing age and in cases of degenerative

disease. In the present material, a reduction was observed in the content of chondroitin sulphate in the surface of the cartilage in all 116 femoral heads. This condition expresses itself as an absence of metachromasia with toluidine blue, but there is also a more coarse fibrillar appearance of the cartilage collagen, as seen under polarized light (unmasking). Various enzymes – among these cathepsin – are responsible for the cleavage of the chondroitin sulphate molecule (Ali & Bayliss 1973, Ali & Bayliss 1975, Ali 1978, Bentley 1975).

Cessi & Cessi (1959) and Schmitz-Moormann (1967) have been successful in producing amyloidosis in mice by the parenteral administration of chondroitin sulphate. It is therefore probable that joint amyloidosis is induced by the chondroitin sulphate molecules which with advancing age are liberated from the superficial layer of the joint cartilage, and presumably also in lesser quantities from the metaplastic cartilaginous tissue in cases of secondary chondromatosis in the joint capsule. Chondromatosis of the joint capsule correlates closely with amyloid degeneration of the capsular tissue (Sørensen et al. 1981, Teglbjærg et al. 1979).

Whether or not any pathogenetic relationship exists between amyloid degeneration on the one hand and fibrillation and flaking on the other cannot be determined on the basis of the present investigation.

However, no correlation between the morphological and histochemical degrees of osteoarthritis and the amount of amyloid has been found in the present material.

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