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ARTHROSIS: NEW DIAGNOSTIC PROCEDURES

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The name arthrosis includes several affections of different aetiology which have only one thing in common: a destructive lesion of the cartilage accompanied by structural alterations in the bone.

The diagnosis of arthrosis is based above all on radiological signs considered to be characteristic of the disease: narrowing of the joint line, osteophytes, osseous sclerosis and cysts.

Unfortunately these signs already represent an advanced step in the disease where the debut, as a rule, has been characterized by a clinical period of articular pain without radiological signs which corresponds to an initial localized lesion in the cartilage (the pre-radiological stage of the arthrosis).

In order to permit the physician to make an early diagnosis in this stage of the chondrosis, we propose two new methods based on comparisons of several parameters, namely:

1. An anatomic-functional exploration of the cartilage which permits us to establish an early diagnosis.
2. A vascular and functional exploration of the bone which permits us to begin to narrow down the diagnosis of primary arthrosis.

METHODS

1. *The anatomic-functional exploration of the cartilage* focusses on the tissue itself and includes:

A comparative study of the joint space on radiographs in standard views and in arthrography in order to estimate the real thickness of the cartilage in the position of function, as well as the surface of the cartilage.

A macroscopic study of the cartilage surface in arthrotomy (or in arthroscopy) to determine whether it is intact or fissured; the consistency is evaluated by palpation.

The biopsy through the whole width of the cartilage and the subchondral bone which will be examined by light microscopy and by electron microscopy.

The biochemical study: the amount of glycosaminoglycans, etc.

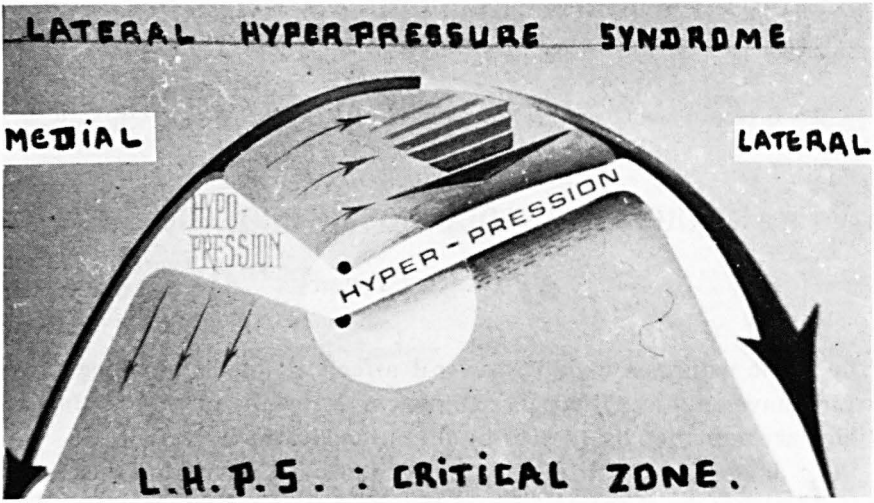

Figure 1. Lateral hyperpressure syndrome with lateral tilt of the patella induced by hypertension of the thickened lateral retinaculum.

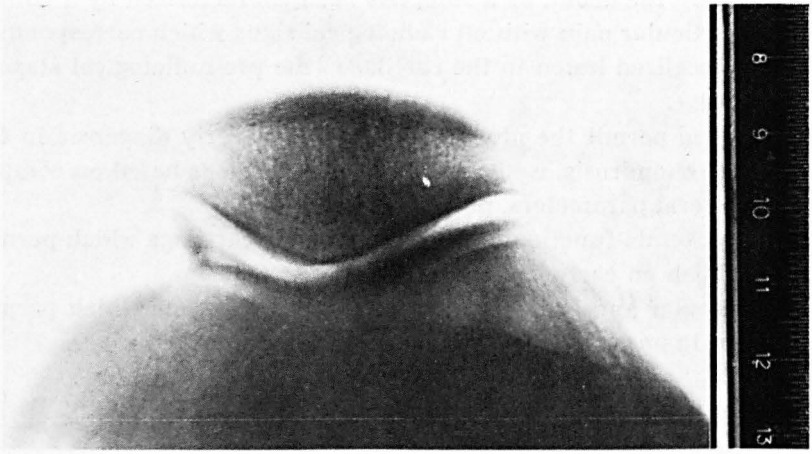

Figure 2. Narrowing of the patellar cartilage in the critical zone (whereas the joint space on the standard skyline view seems to be normal). This is due to the softening of the cartilage depressed by the articular pressure in vivo *as shown in Figure 3.*

Results of exploring the cartilage

The anatomic-functional exploration of the cartilage was made in the patella in cases of chondromalacia and femoro-patellar arthrosis and, in particular, in 180 cases with the lateral hyperpressure syndrome where the aetiology is carefully defined, the mechanism is distinct (hyperpressure) and a very early diagnosis dur-

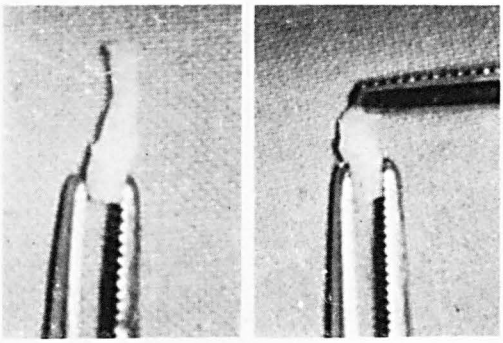

Figure 3. Specimen of core biopsy of the cartilage with its subchondral bone held by forceps. On the left, the cartilage measured 17 mm on the photograph; on the right, the same specimen compressed by forceps measured only 6 mm. This explains the flattening of the softened area on the patella in vivo *as seen in contrast arthrography.*

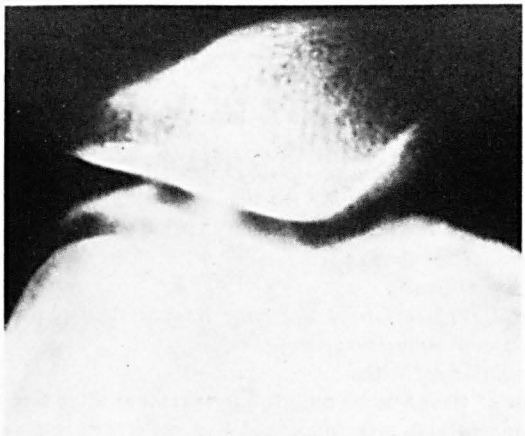

Figure 4. Contrast view of a fissured chondromalacia. We can see three fissures clearly and the central one, in the middle of the lateral facet, goes through the cartilage to the bone. The joint space is normal on the standard view.

ing the stage of closed chondromalacia is made possible by the technique of skyline-view arthrography (Figure 1).

Although the patient presents a painful patellar syndrome, initially there is only a localized softening of the cartilage with a macroscopically intact surface and a practically normal X-ray (Figures 2–5).

The biopsy of these lesions shows the first signs of degeneration in the cartilage, i.e. ultramicroscopic structural changes of the three elements of the cartilage:

- Degenerated chondrocytes
- Fragmented and dislocated collagen fibres of unequal length

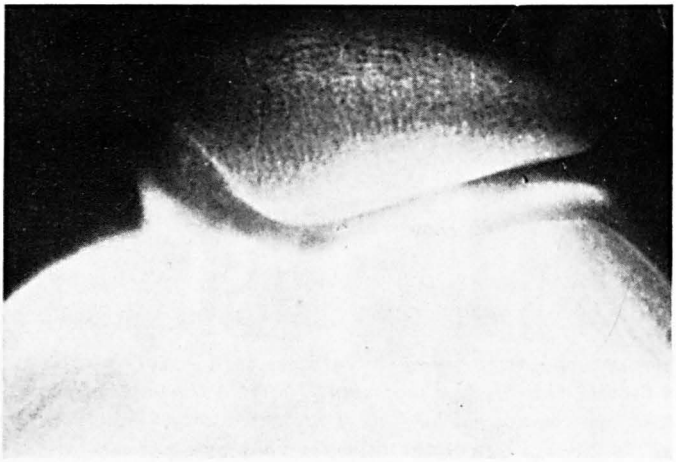

Figure 5. Contrast view showing an ulceration of the cartilage on the lateral facet. The contrast substance reaches the bone; we can see sclerosis of the subchondral bone in the same region. The joint space is normal on the standard view.

– Oedematous ground substance due to imbibition of water and loss of glycosaminoglycans.

The difference between the thickness of the cartilage measured by arthrography (*in vivo* and under pressure) and the thickness of the biopsy is proportional to the degree of softening and the loss of elasticity. Sectioning the lateral retinaculum, which leads to lessened articular tension in cases of hyperpressure, represents an effective therapeutic measure.

2. *The functional exploration of the bone* is concerned mainly with the intraosseous circulation and comprises:

– *A haemodynamic part* with:

a) Measurement of the basic intramedullary pressure after 5 minutes of waiting: normally $\leq$ 30 mmHg and after provoked hyperpressure test (augmentation less than 10 mmHg 5 minutes after injection of 5 ml of physiologic saline).

b) *Intraosseous phlebography* to determine venous drainage: absence of stasis and reflux.

– *A histopathological part* with:

a) Drill biopsy of the bone in the metaphysis-epiphysis to determine the effects on the tissues of the impaired circulation.

b) Additional analyses: oxymetry, bone blood flow, strontium, temperature.

Results of bone analyses

We will here limit the application to the cases of coxarthrosis. *The haemodynamic exploration* often shows abnormal values in the cases of established coxarthrosis, but the vascular changes seem maximal in primary coxarthrosis.

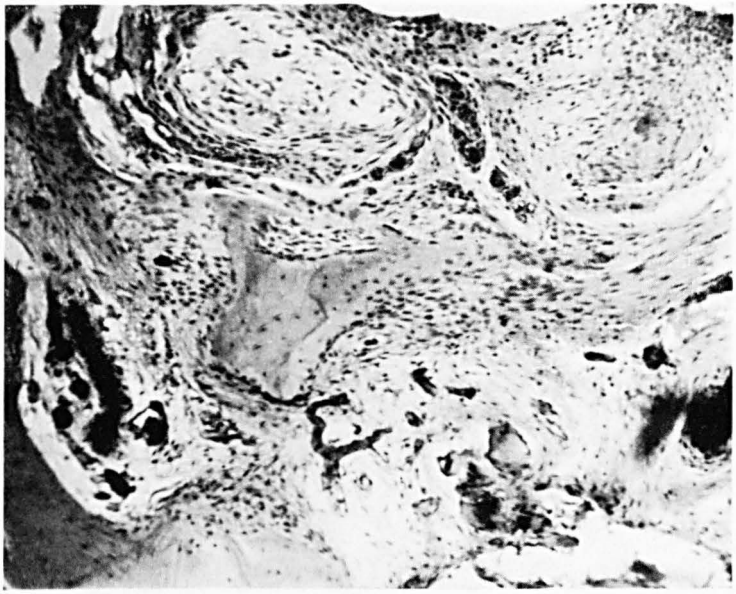

Figure 6. Marrow of "arthrosic type". Fibrosis, new bone formation, foci of stasis.

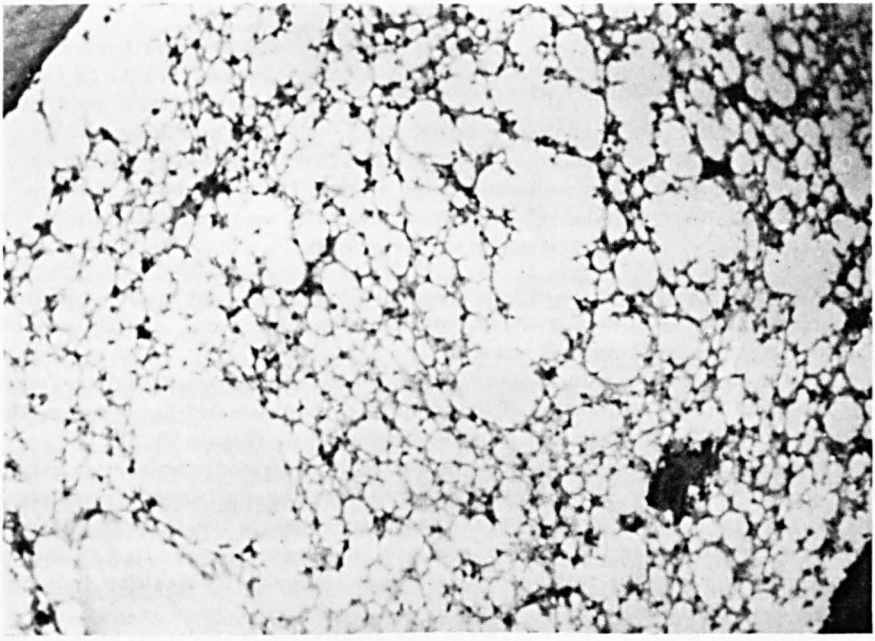

Figure 7. Marrow of "necrotic type" with fragmentation of the adipose cells contrasting with cystlike appearance of confluent other cells.

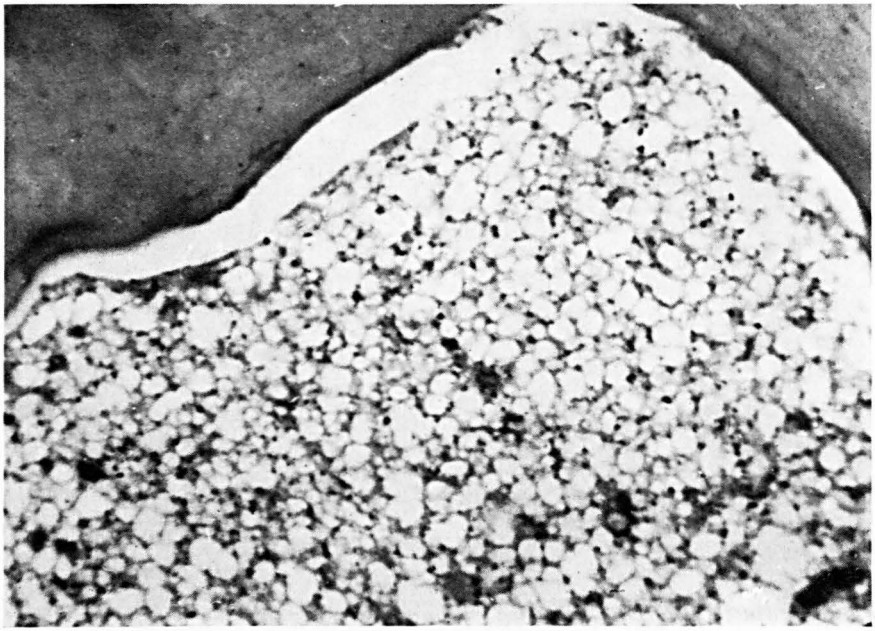

Figure 8. Marrow of "necrotic type". Medullary necrosis of reticular eosinophilic type along the total length of the specimen.

Syndrome of stasis and ischaemia:

Basic intramedullary pressure	> 30 mmHg
Provoked hyperpressure test	> 10 mmHg
Phlebography: absence of one or more efferent veins	
reflux to the diaphysis	
stasis in the metaphysis	

On the other hand *the histopathologic examination* of the bone marrow obtained by drill biopsy and especially of the marrow under the areas of sclerosis and eburnation shows two groups of lesions:

1. *"Arthrosic" marrow* with scattered areas of stasis and oedema, medullary fibrosis, chondroid islands, thickening of the trabeculae, small isolated patches of necrosis near the surface (type 1), but no widespread necrosis (Figure 6).

This group then shows impaired circulation (positive haemodynamic tests) but no necrosis of the marrow. It is the group of true coxarthrosis (secondary post-dysplastic coxarthrosis and some primary coxarthrosis) where the primary and predominant affection is in the cartilage. Only in late stages does one find secondary changes of the bone as a reaction to the altered biomechanics resulting from the changes in the cartilage.

2. *Marrow of "necrotic" type:* in this second group there is also stasis and oedema (type 1). In addition one finds a diffuse medullary necrosis sometimes extending throughout the whole drill biopsy of predominantly reticular eosinophilic (type 2),

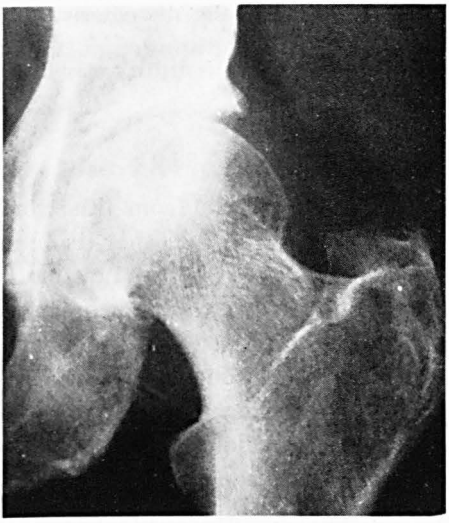

Figure 9. Ischaemic coxopathy without dysplasia. Slight narrowing of the supero-medial joint line. Cyst of the head inside a sclerotic area. No osteophytosis. Intramedullar pressure at 65 mmHg in the head. Biopsy: total necrosis of the bone and marrow.

occasional trabecular necrosis (type 3) and the appearance of newly formed bone (type 4). This is the group that corresponds to the *primary coxarthrosis* of a particular kind (Figures 7 and 8).

a) *Clinically:*

- Late age of onset (after 50 years of age)
- Often acute
- Pseudoradicular pain at night, when coughing, radiating to an area below the knee
- Limitation of movements, occasionally paradoxical
- Major haemodynamic syndrome, especially at the level of the caput femoris.

b) *Radiologically* (Figure 9):

A uniform or supero-internal narrowing of the joint line, few or no osteophytes and a dense or occasionally decalcified bone structure.

c) *Histologically:*

The medullary structure is identical to that of osteonecrosis. The diffusion and the extension of this necrosis suggest that the marrow is affected primitively and predominantly, restricting the degeneration of the cartilage to a lesion of secondary importance. The coxarthrosis could really be said to be the consequence of disturbed intra-osseous circulation which inevitably must be associated with the osteonecrosis.

What speaks in favour of primitive circulatory trouble is that the same lesions are observed in "arthrosis incipiens", with slight and partial narrowing of the joint line without osteophytes and without remodeling of the bone structure, and in stage 1 in osteonecrosis except for the narrowing of the joint line in the latter.

The contrast between a very small, local lesion in the cartilage and an extensive,

massive lesion in the marrow suggests that the degeneration of the cartilage is secondary to the circulatory trouble.

The prophylactic effect of the intraosseous drilling may influence the evolution of the disease.

CONCLUSION

Two main conclusions can be drawn from this work, one concerning the early diagnosis of arthrosis and the other its aetiology.

1. Diagnosis has been made easier by two new methods:

a) *Arthrography* permits the discovery of chondromalacia of the patella in a very early stage of localized softening as yet unaccompanied by fissures in the surface or X-ray changes detectable by standard techniques. This is done by comparing skyline-views taken at 30, 60 and 90 degrees of flexion in the knee joint.

Microscopic studies at this stage have shown changes in the three constituents of the cartilage.

We find no better word than chondrosis to describe this state.

b) *The functional exploration* of the bone has brought about an important modification of the haemodynamic and anatomo-pathological parameters in certain cases of coxarthrosis consisting of an ischaemia of the sub-chondral bone which can be demonstrated at an early stage of localized narrowing of a joint line.

2. *The nosological entity* which we recognize as arthrosis must be sub-divided in view of these new discoveries. Apart from post-traumatic arthrosis, one can distinguish two forms of cartilage degeneration which are by far the most frequent:

a) *One of mechanical origin,* observed in the patella and in dysplastic hips and which is mainly the effect of incongruence and hyperpressure.

b) *The other of vascular origin* which we have described in certain primary cases of coxarthrosis without dysplasia and which is the effect of the vascular disturbance associated with ischaemia (ischaemic coxopathy).

After the mechanical and vascular disturbances have been treated, preventive treatment of the arthrosis may be undertaken thanks to the early diagnosis achieved by means of these new medullar and cartilage explorations.

SUMMARY

The authors emphasize two new methods for determining the real state of the cartilage and bone structure. These methods permit the early

diagnosis of arthrosis and necrosis before X-ray changes appear and perhaps a better management and prognosis.

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