The radiographic classification of medial gonarthrosis

Correlation with operation methods in 200 knees

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Ahlbäck's classification of gonarthrosis can be applied with improved precision by careful interpretation of anteroposterior varus stress and lateral radiographs of the knee. The tibial lesion in early gonarthrosis is located in the anterior and middle part of the medial plateau. In more advanced disease, when the anterior cruciate ligament is invariably damaged, the lesion extends to the posterior margin of the medial tibial plateau.

We studied the preoperative radiographs of 200 knees with arthrosis. We were able to predict the integrity of the anterior cruciate ligament (and the use of unicompartmental arthroplasty) with 95 percent accuracy and rupture or damage to the anterior cruciate ligament (and the use of total condylar arthroplasty) with 100 percent accuracy.

We believe that the Ahlbäck classification reflects the anatomic and pathologic progression of medial compartment gonarthrosis, and is of value in allowing more accurate comparisons to be made of different methods of treatment.

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Arthrosis affects the medial tibiofemoral compartment much more commonly than the lateral compartment. The most widely employed radiographic classification was introduced by Ahlbäck (1968), based on the study of 370 randomly selected radiographs. This classification relies on measurements of cartilage and bone attrition on the anteroposterior radiograph under weight bearing. In particular, the distinction between Ahlbäck's Grades 3 and 4 depends on the depth of the tibial erosion, measured from the supposed level of the original joint surface. We have found that this measurement is difficult to make.

At the time that Ahlbäck described his classification, arthroplasty of the knee was rarely performed, and the underlying pathologic anatomy of early arthrosis of the knee was poorly understood. The pattern of attrition of the medial tibial plateau and its relation to the state of the anterior cruciate ligament in the early stages of gonarthrosis have recently been described (White et al. 1991). Attrition of the cartilage, and later of the bone, was shown to involve only the anterior and middle parts of the tibial plateau and not the posterior one third. Indeed, in 47 consecutive cases treated by unicompartmental arthroplasty, no tibial lesion involved the posterior margin of the medial tibial plateau. A feature of all of these knees was that the anterior cruciate ligament was intact. This pattern contrasts with the appearance seen in more advanced disease, when the anterior cruciate ligament is often damaged. In these cases attrition involves the whole extent of the medial tibial plateau and often the lateral compartment as well. These observations suggest that Ahlbäck's Grades 3–4 of medial arthrosis of the knee would be better described in terms of the posterior extent of the tibial lesion than by the depth of erosion into the tibia.

A classification based on these anatomic observations was tested retrospectively by interpreting the preoperative radiographs of 200 knees with arthrosis.

Patients and methods

The routine preoperative radiographs of 200 knees were studied: 40 were before high tibial osteotomy, 90 before unicompartmental replacement, and 70 before total condylar replacement.

The respective mean age was 50 (40–66) years in the osteotomy group (28 men and 12 women), 64 (58–74) years in the unicompartmental group (30 men and 60 women), and 68 (64–84) years in the total condylar group (30 men and 40 women).

Bilateral anteroposterior (AP) standing knee radiographs, AP varus/valgus stress views, and lateral radiographs in 20° and 90° of flexion were available in all the cases. The AP stress views had all been made

Table 1. Ahlbäck's radiographic grading of medial gonarthrosis. Assessment of lateral projections added to Ahlbäck's AP projections

Grade	Anteroposterior stress radiograph	Lateral radiograph
1	Reduction of joint space	
2	Obliteration of joint space	
3	Tibial plateau attrition < 5 mm	Posterior part of plateau intact
4	Attrition 5–10 mm	Attrition extends to posterior margin of the plateau
5	Severe subluxation of the tibia	Anterior subluxation of the tibia > 10 mm

under the direct supervision of the surgical team with the quadriceps relaxed and the knee flexed 20° to relax the posterior capsule (Gibson and Goodfellow 1986). The film-to-tube distance was 1 meter, and the beam was centered on the inferior pole of the patella for the AP films and was aligned with the tibiofemoral articulation for the lateral films.

The radiographic classification

Our classification is based on 1) an AP varus stress radiograph and 2) a lateral radiograph in 20° of flexion (Table 1).

The hallmark of the earliest stage of arthrosis is thinning of the articular cartilage. Ahlbäck recognized that nonweight-bearing radiographs might fail to demonstrate reduction and later obliteration of the joint space; but, as he pointed out, the standing anteroposterior radiographs are not always reliable. In early cases, the true state of the articular cartilage is better revealed in an AP varus stress radiograph in 20° of flexion (Figure 1). Weight-bearing films failed to reveal the extent of cartilage loss in 21 instances in which stress films revealed it. We therefore employ varus stress radiographs to distinguish Grades 1, 2, and 3.

Grades 3 and 4 are defined from lateral films taken with the knee in 20° of flexion. These were easier to interpret than those taken with the knee at 90° of flexion, mainly because there were fewer variations of rotation. The image of the medial tibial plateau can be distinguished in the lateral radiograph by the method described by Jacobsen (1981). Sclerosis of the condyle makes the distinction more obvious in arthrosis than in the normal knee.

If tibial attrition does not extend to the posterior margin of the medial plateau, the knee is Grade 3; total erosion of the plateau indicates Grade 4 (Figure 2). Anterior subluxation of the tibia of more than 1 cm classifies the knee as Grade 5 (Figure 3). The amount of tibial subluxation is measured as the distance between vertical lines drawn from the posterior edge of the medial femoral condyle and the posterior margin of the medial tibial plateau (Deschamps 1987). Osteophytes should be ignored in the measurement (Ahlbäck 1968).

Interpretation of AP stress radiographs and of tibial subluxation on lateral radiographs have both been previously described (Gibson and Goodfellow 1986, Deschamps 1987), but interpretation of the extent of the erosion of the medial tibial plateau from lateral knee radiographs has not previously been reported. We therefore performed an error study. The isolated lateral radiographs of 50 arthrotic knees were independently reviewed by 4 observers who were unaware of the treatment undertaken and of the state of the anterior cruciate ligament. 25 knees had an intact anterior cruciate ligament and had undergone unicompartmental

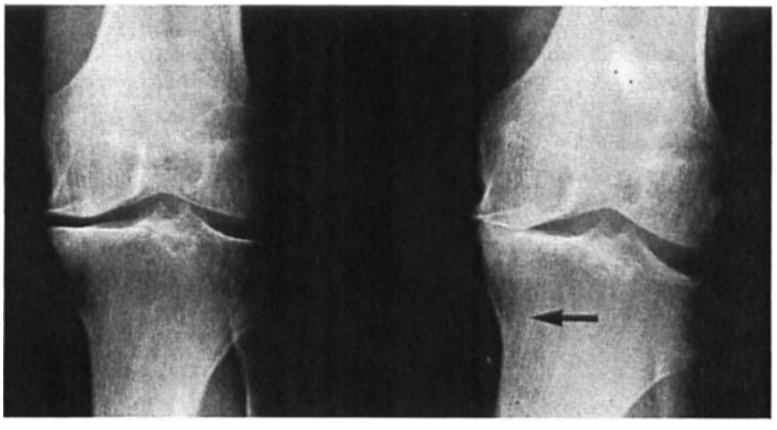
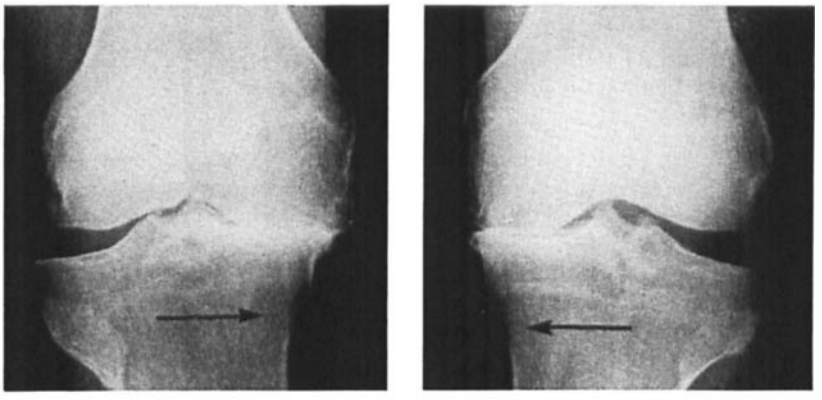
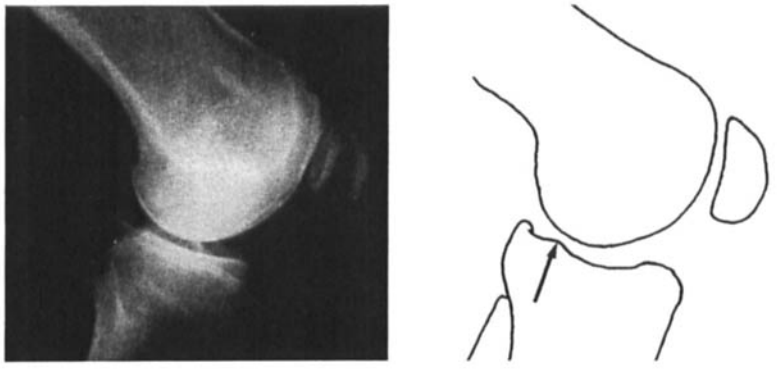


Figure 1. Anteroposterior radiographs of a left knee. Weight bearing and stressed into varus (arrow). The complete loss of articular cartilage in the medial compartment is demonstrated only in the varus stress view.

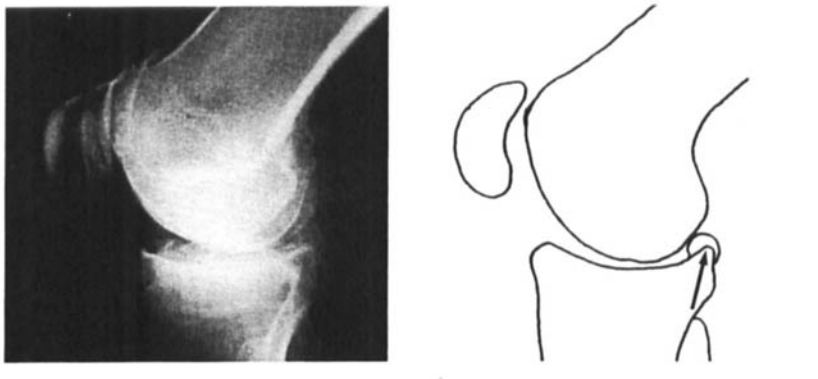
Figure 2. Radiographs and pathologic specimens of the knees of a 66-year-old man with bilateral medial compartment arthrosis. A unicompartmental replacement was performed in the left knee. In the right knee, the erosion extends to the posterior margin of the medial plateau. The anterior ligament was ruptured, and a total condylar replacement was required.



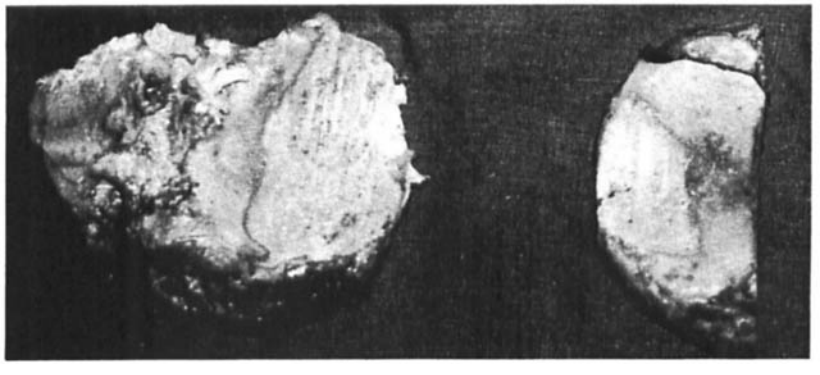
Anteroposterior varus stress radiographs demonstrate complete loss of articular cartilage in the medial compartment. It is not possible to determine whether or not the anterior cruciate ligaments are intact.



Left knee radiograph. The posterior part of the plateau appears intact, and it is classified as Grade 3. The radiographic features are also demonstrated in the tracing of the radiographs. The arrow indicates the posterior extent of the medial plateau erosion.



Right knee. The erosion of the plateau can be seen extending to the posterior margin of the medial plateau, and it is classified as Grade 4. The arrow in the tracing indicates the posterior extent of the medial plateau erosion.



The excised tibial plateaus. In the left knee, the posterior part of the plateau is intact. The anterior cruciate ligament was normal, and a unicompartmental re- placement was performed. On the right, the erosion extends to the posterior margin of the medial plateau. The anterior cruciate was ruptured, and a total condylar replacement was required.

Figure 3. The lateral radiograph reveals more than 1 cm of posterior subluxation of the femur on the tibia, and there is severe erosion of the posterior margin of the medial tibial plateau. This knee is classified as Grade 5.

arthroplasty, whereas 25 knees had no functioning anterior cruciate ligament and had undergone total condylar arthroplasty.

Results

All 4 observers assessed all the radiographs of the knees with an intact anterior cruciate ligament as Grade 2 (Table 2). Three observers classified two of the 25 knees that had a ruptured or damaged anterior cruciate ligament as Grade 2 and the remainder as Grade 3. One observer classified three of the 25 knees with a ruptured anterior cruciate ligament as Grade 2 and the remainder as Grade 3.

Discussion

The treatment of medial gonarthrosis depends on the extent of joint destruction. The respective roles of tibial osteotomy, unicompartmental arthroplasty, and total condylar replacement are not yet clearly defined. If meaningful comparisons are to be made between series of patients treated by various methods, the patient groups should be similar and an accurate classification is essential.

In our practice, tibial osteotomy is performed much less commonly than joint replacement, and the grade of arthrosis is generally lower than for knees undergoing joint replacement. In our series the majority were Grades 1, 2, or 3, with only 5/40 of the osteotomies performed for Grade 4 disease.

In distinguishing Grades 1, 2, and 3, we have used the varus stress radiograph. Ahlbäck (1968) recognized that standing films did not always provide an accurate representation of the state of the articular cartilage, and sometimes he made his patients exercise before having their radiographs taken. We have found AP stress radiographs to be the most reliable method of detecting and distinguishing between partial and complete cartilage loss.

Unicompartmental arthroplasty has the theoretic advantage over total condylar replacement of preserving the normal compartment and the cruciate ligaments; absence of the anterior cruciate ligament is associated with a higher incidence of failure (Goodfellow et al. 1988). The decision to perform a unicompartmental replacement is usually made only after arthrotomy when the extent of joint destruction and the integrity of the anterior cruciate ligament can be assessed. With increasing experience and from observing patterns of joint destruction of the medial tibial plateau, we have come to rely more extensively on the information provided by the radiographs for preoperative planning.

The distinction between Grades 3 and 4 appears to be the effective division between cases suitable for

Table 2. Radiographic grading of medial gonarthrosis correlated with treatment

Grade	High tibial osteotomy	Unicompartmental replacement	Total condylar replacement	Total
1	1	0	0	1
2	11	0	0	11
3	23	90	5	118
4	5	0	62	67
5	0	0	3	3
Total	40	90	70	200

unicompartmental and those suitable for total condylar arthroplasty. Of the 95 knee replacements performed for Grade 3 disease, 90 were unicompartmental. Five of the total condylar group were classified as Grade 3, and were therefore predicted to be suitable for unicompartmental replacement. All 62 knee replacements performed for Grade 4 disease and the three replacements performed for Grade 5 disease were total condylar replacements.

The most informative feature of the lateral radiograph is the posterior extent of the tibial erosion. Rupture of the anterior cruciate ligament appears to allow the tibial plateau erosion to extend posteriorly (White et al. 1991).

Occasionally, posterior osteophytes are evident on the lateral radiograph, but we did not find the analysis to be affected by their presence. Interpreting the lateral radiograph may be difficult if a true lateral view of the knee is not obtained.

Conclusions

With the aid of lateral projection, the radiographic classification of arthrosis of the medial compartment of the knee becomes more precise and hence clinically relevant.

In Grade 1, there is reduction in height of the medial articular cartilage. In Grade 2, there is obliteration of the joint space, i.e., loss of articular cartilage down to bone. In Grade 3, there is anteromedial bone attrition of the tibial plateau. In Grade 4, the lesion includes the posterior margin of the plateau; the progression from Grade 3 to Grade 4 is associated with rupture of the anterior cruciate ligament. In Grade 5, there is anterior subluxation of the tibia.

This classification reflects the anatomic progression of medial compartment arthrosis. It is of value in comparing different methods of treatment.

Acknowledgement

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