Different patterns of cartilage wear in medial and lateral gonarthrosis

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ABSTRACT – We studied the morphologic changes of cartilage wear on the resected parts of the joint in 42 knees operated on with a total knee prosthesis. The medial and lateral compartments were divided into 6 equal regions on both the tibial and femoral sides. The amount of cartilage/bone destruction was classified into 4 grades in each region. In medial and lateral arthrosis, maximal wear was found in the middle of the joint, but it was more marked in the lateral group. In the medial group, wear was greater in the anterior regions. In the lateral group, we found more wear in the posterior regions. We ascribed these findings to different anterior/posterior translations of the medial and lateral condyles during flexion/extension of the knee joint.

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A few studies (Cooke et al. 1989, 1997) have described differences in the condylar shape and angulation of the joint in knees with medial or lateral arthrosis. Keyes et al. (1992) noted that the tibial cartilage lesion in medial gonarthrosis was located anteriorly in the early stages. In patients with manifest medial and unicompartmental disease, White et al. (1991) found that the degenerative changes were mainly located anteriorly. In more advanced stages, when the anterior cruciate ligament became stretched or ruptured, the degenerative changes supposedly progressed in a posterior direction. Some radiostereometric studies (Kärrholm et al. 1988, Jonsson and Kärrholm 1994) have shown that the tibia rotates internally with increasing flexion. Recent studies during weight bearing have confirmed this (Hill et al. 2000, Kärrholm et al. 2000) and shown that this rotation corresponds to posterior translation of the lateral and anterior displacement of the medial femoral condylar flexion facet centers.

We hypothesized that the wear pattern in medial and lateral arthrosis mirrors this difference in condylar motions. Therefore more anterior wear of the cartilage should occur in cases with medial and more posterior degeneration than in those with lateral arthrosis.

Patients and methods

We collected the resected parts of the distal femur and proximal tibia from 42 tricompartmental total knee replacements in 42 knees (median age 73 (53–89) years, 30 women). All patients were operated on in the Department of Orthopaedics, Halmstad Hospital, February 1998 to May 2000. There were 32 knees (21 women) with medial (group 1) and 10 (9 women) with lateral arthrosis (group 2).

The patients received a Freeman Samuelson total knee prosthesis (Sulzer, Switzerland). We used standard instrumentation with an intramedullary guide on the femoral and an extramedullary guide on the tibial side. In all cases, the incision was made a few millimeters below the level of the most worn part of the medial or lateral compartment. The tibial part of the joint was always removed in one piece. The cartilage/bone pieces were marked for orientation and stored at –70 ºC.

An analysis of joint area morphology was done after median 6 (1–12) months. When the pieces had thawed, the medial and lateral parts of the femoral and tibial joint areas were divided into 6

squares. In each of the 4 articulations a line was drawn from anterior to posterior in the middle of each area. Two lines perpendicular to the first one separated each articulation into six regions of almost equal size. The degenerative changes were originally divided into 5 Grades: no visible changes (0), cartilage fibrillation (1), cartilage destruction with no visible bone (2), bone without cartilage and no or minor attrition of bone (3), obvious attrition of bone (4). In regions with varying types of degeneration, the type of lesion, which dominated that particular region, was regarded as representative.

To study interobserver reliability, two observers independently graded the cartilage/bone pieces from the femur and tibia in 11 patients.

Statistics

We used Friedman's test and the Mann-Whitney U-test. Values are median and range. The weighted kappa was calculated to determine interobserver reliability.

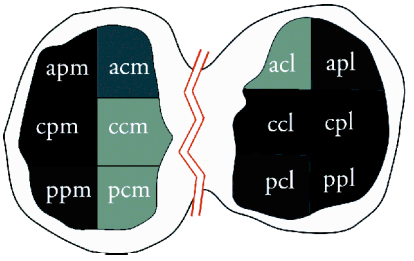

Table 1. Grading of cartilage destruction/ bone attrition in medial and lateral arthrosis of the tibial plateau. Median values and range. Template used to separate the 6 areas on the tibial plateau is illustrated above. The 4 gray scales correspond to one of the 4 Grades used. The darker the area, the more marked the degenerative changes (median value)

Tibia	Medial arthrosis n 30		Lateral arthrosis n 12	
	Medial side		Lateral side	
	Peripheral	Central	Central	Peripheral
Anterior	3 (0–4)	1.5 (0–4)	1 (1–4)	2 (1–3)
Central	3 (2–4)	1 (1–4)	2.5 (0–4)	4 (3–4)
Posterior	2 (0–4)	1 (0–4)	2 (1–4)	3 (2–4)

a anterior, c central, p posterior in 1st position, peripheral in 2nd position, m medial, l lateral

Results

132 regions were evaluated by the 2 observers. In 55%, there was complete agreement, in 43%, the classification differed with 1 Grade and in 2%, with 2 Grades (weighted kappa = 0.52).

The tibial specimens from the two groups with medial and lateral arthrosis showed an uneven distribution of degenerative changes on the most affected side in the 6 regions (Table 1). In medial arthrosis, the severest changes were located in the central-peripheral-medial region (cpm) followed by the anterior-peripheral-medial (apm) one (median values: 3.0, ranges 2–4, 0–4). We found less marked changes in the posterior-peripheral and in the central regions (1.0, 0–4; $p < 0.0005$, Friedman's test including all regions medially).

Similarly, cases with lateral arthrosis showed the severest degenerative changes in the central-peripheral-lateral region (cpl: 4.0, 3–4). The second most worn region was located posterior-peripherally (ppl: 3, 2–4; $p < 0.0005$, Friedman's test including all regions laterally).

A comparison between the medial side in group 1 and the lateral side in group 2 showed more degenerative changes antero-peripherally in the former group (regions apm vs. apl: $p = 0.02$, Mann-Whitney U-test). On the other hand, cases with lateral arthrosis showed more degenerative changes posteriorly, both peripherally and centrally (regions pcm vs. pcl: $p = 0.03$; ppm vs. ppl: 0.001, Mann-Whitney U-test). The attrition of bone tended to be more marked in the peripheral and central regions in the group with lateral arthrosis (cpm vs. cpl: $p = 0.04$).

In medial arthrosis, the degenerative changes were fairly evenly distributed between the 6 medial regions (Table 2) on the femoral side ($p = 0.3$, Friedman's test including all regions medially). In lateral arthrosis, the central and posterior regions in the lateral compartment showed the severest changes ($p = 0.001$, Friedman's test including all regions laterally). A comparison of femoral regions in the most worn compartment of cases with lateral and medial arthrosis revealed no obvious differences ($p = 0.07$–0.7, Mann-Whitney U-test).

The location of degenerative changes on the tibial and femoral sides did not differ between men and women with medial arthrosis ($p = 0.07$–0.9, Mann-Whitney U-test).

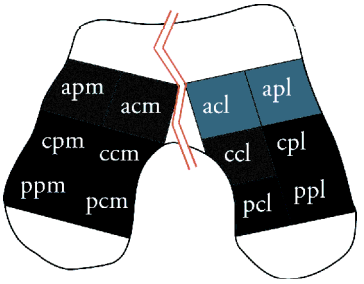

Table 2. Grading of cartilage destruction/ bone attrition in medial and lateral arthrosis of the femoral condyles. Median values and range. See legend to Table 1

Femur	Medial arthrosis n 30 Medial side		Lateral arthrosis n 12 Lateral side	
	Peripheral	Central	Central	Peripheral
Anterior	2 (0–4)	2 (0–4)	1.5 (0–3)	1.5 (0–4)
Central	3.5 (0–4)	3 (0–4)	2 (0–4)	3.5 (1–4)
Posterior	4 (0–4)	3 (0–4)	2.5 (0–4)	4 (1–4)

On the unaffected sides (i.e., the lateral side in medial, and the medial side in lateral arthrosis), we found a macroscopically intact cartilage layer in all cases (median values = 0).

Discussion

We described the presence of bone attrition only as present or absent, which we think was sufficient for our aim to locate the position of the most marked changes. The locations recorded are consistent with our primary hypothesis. However, it is important to realize that we observed cartilage wear at a comparatively late stage in the disease, i.e., when the patients were operated on with a total knee replacement. In the early stages of the disease, the degenerative changes might have been located mainly in the anterior part of the tibial joint area (Cooke et al. 1989, 1997, Keyes et al. 1992). Our patients had more advanced disease and about equal amounts of "wear" in the anterior and central peripheral regions consistent with posterior progression. Our observation of slightly more central than posterior wear on the lateral side might suggests the occurrence of posterior progression similar to that in medial arthrosis.

Harman et al. (1998) studied the effect of a deficient anterior cruciate ligament (ACL) on the wear pattern on tibial plateaus resected during TKA. Absence of this ligament resulted in a more posterior location of maximum wear in the medial compartment of the knee, but there was no change laterally. This observation does not correspond to known changes in the pattern of knee motion after ACL rupture. Brandsson et al. (2001) reported that patients with rupture of the anterior cruciate ligament maintained a more externally rotated tibial position on the injured side during extension from 55 degrees. This loss of internal rotation was mainly due to a more anterior position of the lateral condyles and only to a small and insignificant increase in the posterior femoral condylar location medially. Harman et al. (1998) found a more varus angulation and wear in cases with ACL rupture. Therefore, it seems likely that their findings were an effect of late degenerative rupture of the ligament not being the primary etiology of the arthrosis.

In normal knees, the femur rotates externally with flexion provided that the foot is in neutral rotation. Up to 40 degrees of flexion, the flexion facet centers displace about 4–5 mm anterior-posteriorly (Kärrholm et al. 2000). There is anterior translation on the medial and posterior translation on the lateral side. This pattern of motion implies that the maximum load during gait will be somewhat differently transferred to the tibia in the 2 compartments. In an ongoing study using gait analysis, we found an increase in internal tibial rotation in knees with lateral arthrosis consistent with an increase in posterior translation of the lateral femoral condyle (unpublished data). The differences between the amounts of cartilage wear on the tibial and femoral sides could be an effect of a greater contact area on the femoral side. As indicated above, the medial and lateral flexion facets only displace a few mm during motion, which means that a larger area of the cartilage is used during knee motion on the femoral side. One might speculate that patients who develop arthrosis move their knees in an abnormal way. A changed pattern of anterior-posterior condylar displacement could be anticipated.

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