

The articular cartilage after osteotomy for medial gonarthrosis

Biopsies after 2 years in 19 cases

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In 19 consecutive patients with medial gonarthrosis, an arthroscopic examination with a biopsy of the load-bearing cartilage in the medial femoral condyle was undertaken at the same time as a proximal tibial osteotomy. A follow-up arthroscopic biopsy was performed on an average of 2 years after the osteotomy. In 9 knees there was an improvement in the cartilage quality, 8 knees were unchanged, whereas 2 knees

had deteriorated. Radiographically, 6 knees had improved, 11 were unchanged and 2 had deteriorated. We found no correlation between cartilage improvement and the clinical and radiographic outcome.

Our results confirm that an osteotomy has a beneficial effect on the load-bearing cartilage in the medial femoral condyle.

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Widening of the medial joint space as well as a reduction of the subchondral sclerosis have been observed after tibial valgus osteotomy with a proper overcorrection as a result of a decrease in the stress of the load-bearing cartilage in the medial compartment (Coventry 1965, Tjörnstrand et al. 1981). However, little is known about the effect of osteotomy for gonarthrosis on load-bearing cartilage. Fujisawa et al. (1979) proposed that there was a relationship between the degree of postoperative valgus correction and the improvement observed at arthroscopy. In a recent study by Odenbring et al. (1991), signs of cartilage regeneration were observed in knees overcorrected in valgus.

We have examined the load-bearing cartilage of the medial femoral condyle before and 2 years after a proximal valgus tibial osteotomy.

Patients and methods

In 19 consecutive patients (6 women, 13 men; Table 1) with medial gonarthrosis and a median age of 56 (38-65) years scheduled for tibial osteotomy, a trans-arthroscopic biopsy of the joint cartilage on the load-bearing surface of the medial femoral condyle was done (Figure 1). A proximal tibial wedge osteotomy was performed with a metal-staple fixation on the lateral side. We aimed at 4° of valgus overcorrection

measured with the hip-knee-ankle angle. Estimates of wedge size and degrees of correction were made preoperatively on the same hip-knee-ankle radiographs. A follow-up biopsy was done after 26 (15-39) months with permission from the Ethics Committee using a standardized procedure with the knee flexed to 90° and the conchotome introduced through an anterior medial approach. When eburnation was present the biopsy specimen was taken from the immediately adjoining cartilage. The specimens were about 2 mm in size and were fixed in 10 percent neutral buffered formalin decalcified in EDTA and embedded in paraffin. The sections were stained with Mayer's hematoxylin-eosin, Safranin-O, and toluidine blue, and classified according to Mankin et al. (1971) (Table 2). The criterion of improvement or deterioration was a classification sum that differed by more than one unit.

Standard radiographs with anteroposterior, lateral, and weight-bearing projections were made before and 2 years after the osteotomy and were evaluated for arthrosis according to Ahlbäck (1968). The hip-knee-ankle angle was estimated on a weight-bearing whole lower-limb radiograph (Tjörnstrand et al. 1981).

Range of knee motion, ability to walk 500 meters with or without pain, use of walking aids, ability to work or sick-leave/retirement because of knee pain and consumption of painkillers, were recorded on the day before surgery and at the follow-up examination.

The clinical outcome was classified as *excellent* (1): knee flexion $\geq 90^\circ$, walking distance > 500 meters

Table 1. Observations in 19 patients with medial gonarthrosis operated on with tibial osteotomy

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	53	F	15	3	3	3	1	1	2	1	1	1	4	2	7	4
2	55	M	18	3	3	2	0	1	2	2	1	1	3	2	6	5
3	58	F	24	0	11	2	2	1	1	1	1	1	4	3	6	5
4	65	M	24	10	11	2	2	1	3	-	2	-	3	-	8	-
5	57	M	26	8	7	1	1	1	1	2	1	1	4	3	6	6
6	55	F	29	7	5	3	1	2	3	2	2	1	4	3	9	6
7	65	M	24	11	4	2	2	2	5	1	2	1	4	1	11	3
8	55	M	25	3	1	3	0	0	3	3	1	1	2	2	6	6
9	53	M	28	6	-2	1	1	1	1	2	3	2	4	2	8	6
10	59	M	26	9	-4	2	1	1	2	2	3	3	4	3	9	8
11	59	M	23	10	10	2	2	1	5	1	2	0	3	1	10	2
12	38	M	28	11	-2	2	2	1	5	3	2	2	3	2	10	7
13	48	F	36	10	12	2	2	2	1	1	1	1	2	2	4	4
14	64	F	24	14	5	4	1	1	4	3	2	1	3	2	9	6
15	61	M	23	8	4	1	1	1	1	3	1	1	3	3	5	7
16	56	M	39	10	8	2	2	1	3	1	2	2	2	1	7	4
17	59	F	25	8	8	3	1	1	3	2	2	2	2	2	7	6
18	43	M	27	4	5	2	1	1	1	1	3	2	3	3	7	6
19	64	M	26	9	7	1	2	1	3	3	2	2	4	2	9	7

A Case
B Age at operation
C Sex
D Observation time, months
E Preop varus angle, degrees.
F Postop valgus or varus (-) angle, degrees
G Clinical results
H Ahlbäck stage, preop.
I Ahlbäck stage, postop.
J Structure, preop.
K Structure, postop.
L Cells, preop.
M Cells, postop.
N Safranin-O staining, preop.
O Safranin-O staining, postop.
P Mankin grading, preop.
Q Mankin grading, postop.

Table 2. Histologic and histochemical grading (Mankin et al. 1971)

Structure	
Normal	0
Surface irregularities	1
Pannus and surface irregularities	2
Clefts to transitorial zone	3
Clefts to radial zone	4
Clefts to calcified zone	5
Complete disorganization	6
Cells	
Normal	0
Diffuse hypercellularity	1
Cloning	2
Hypocellularity	3
Safranin-O staining	
Normal	0
Slight reduction	1
Moderate reduction	2
Severe reduction	3
No dye noted	4

without pain or walking aids and no need for painkillers, *good* (2): improvement, *fair* (3): unchanged, and *deteriorated* (4).

For the statistical analysis, Wilcoxon's test for paired observations and correlation with regression statistics were used.

Results (Table 1)

The preoperative average *varus* angle was 8° (0°-14°). The average *valgus* angle on an average of 26 months after the proximal tibial osteotomy was 6° (1°-11.5°). Three patients were undercorrected and still in *varus* and therefore excluded from the postoperative evaluation of the average *valgus* hip-knee-ankle angle.

In 9 of the 19 patients, there was convincing improvement based on the microscopic appearance of the cartilage specimens. There were no signs of hyaline cartilage regeneration but fibrocartilage repair was present (Figures 1-3). In 8 patients, the cartilage was unchanged and in 3 patients slightly or clearly deteriorated. On the whole, the cartilage had improved ($P < 0.01$; Figure 1).

According to radiographic examination, 6 knees were improved, 11 were unchanged, and 2 had deteriorated. The average improvement was significant ($P < 0.001$).

There was no correlation between the histologic grading and the radiographic classification nor to the postoperative *varus-valgus* angle. The radiographic classifications were not correlated to the postoperative *varus-valgus* angle.

In the clinical evaluation 2 years after the osteotomy, 4 knees were excellent, 10 good, 4 fair and 1

Figure 1. Case 14. Cartilage specimens with hematoxylin-eosin staining before operation on the left and 2 years later on the right. Notice the deep clefts in the cartilage surface, irregularity, cloning of cells and loss of surface cell layers on the left compared with the specimen on the right, with only a slight surface irregularity and a diffuse hypercellularity.

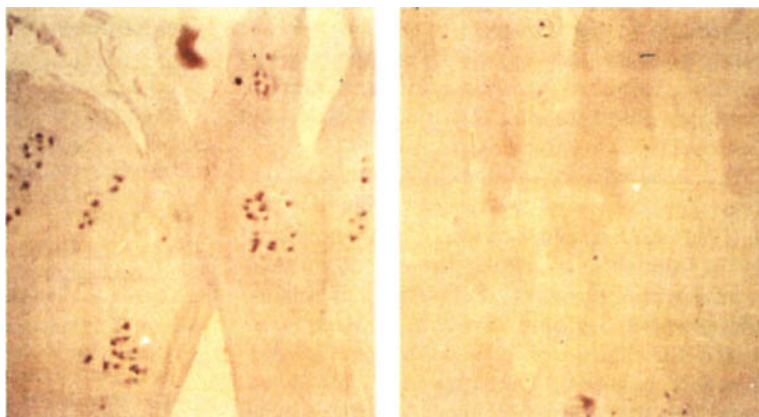


Figure 2. Case 11. Arthroscopy just before a valgus osteotomy (left). The arrow points on the denuded area of the tibial surface. On the right, 2 years later, there is a proliferation of fibrocartilage in the same area (arrow).

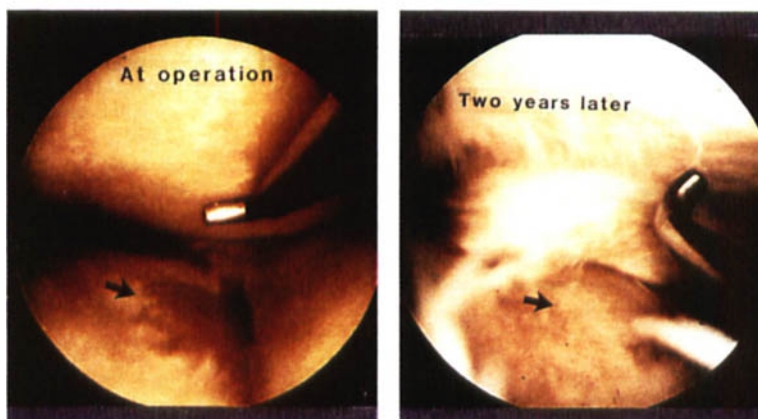
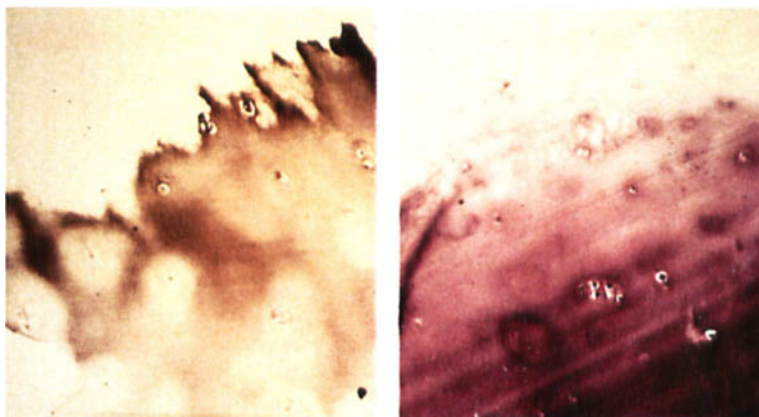


Figure 3. Two biopsy specimens from the same area of the femoral condyle in the same patient as in Figure 2, at operation and 2 years later. The specimens are stained with toluidine blue. On the left, there is loss of surface cell layers and a scarcity of matrix staining compared with the specimen on the right side taken 2 years later. The better color staining on the right indicates a higher content of proteoglycan.



deteriorated (Table 1). There was, however, no correlation between the clinical results and histology, radiographic classification, or postoperative varus-valgus angle.

Discussion

We found an improvement in the articular cartilage of the medial femoral condyle, which implies that the osteotomy had had a beneficial effect on the load-bearing

ing surface. No regeneration of hyaline cartilage was found, but there were signs of fibrocartilage repair indicating arrest of the degenerative process in accordance with Fujisawa et al. (1979), Koshino and Tsuchiya (1979) and Odenbring et al. (1991).

This improvement in load-bearing cartilage after tibial valgus osteotomy also accords with Fujisawa et al. (1979), Koshino and Tsuchiya (1979), Matsui et al. (1979), Odenbring et al. (1991). However, in our study we have applied Mankin's (1971) criteria for histologic/histochemical grading which is a more exact method than those used in previous studies of cartilage after tibial osteotomy. Odenbring et al. (1991) proposed that cartilage regeneration is found only in overcorrected knees. However, in our study, 2 of the undercorrected knees were also improved histologically: in our small series we could not find any correlation between clinical results, histology, radiographic classification, and postoperative varus-valgus angle.

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