The state of the articular cartilage at the time of surgery as an indication for rotational acetabular osteotomy

Y. Yasunaga, Y. Ikuta, T. Kanazawa, K. Takahashi, T. Hisatome

From Hiroshima University School of Medicine, Japan

We have studied whether the state of the articular cartilage at the time of rotational acetabular osteotomy for dysplasia of the hip affects the outcome 2 to 5.5 years after surgery. Arthroscopy in 57 patients (59 joints) at the time of the operation showed grade-0 changes in seven, grade-1 in nine, grade-2 in 17, grade-3 in 14 and grade-4 in 12 joints, according to the classification of Outerbridge. There was radiological evidence of the progression of arthritis in four joints which were classified at arthroscopy as grade 4.

Stepwise regression analysis showed that damage to acetabular or femoral articular cartilage significantly affected the progression of arthritis. We conclude that the short-term results of successful rotational acetabular osteotomy for dysplasia are affected by the state of the articular cartilage.

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Periacetabular osteotomies for osteoarthritis (OA) secondary to hip dysplasia have theoretical advantages over other pelvic procedures such as the Chiari osteotomy, because they alter the position of the acetabulum en bloc allowing cover of the femoral head by cartilage. These procedures have produced satisfactory long- and medium-term results for early OA secondary to dysplasia of the hip. When progression of the degenerative changes has been seen, the presence of preoperative OA has been cited as the cause. Arthroscopic observations of the articular cartilage in early OA of the hip, however, vary widely. Our aim was to determine how the state of the articular cartilage affects the outcome of rotational acetabular osteotomy carried out for dysplasia of the hip.

Patients and Methods

Of 62 patients (65 joints) who underwent rotational acetabular osteotomy (RAO) between 1994 and 1998, we studied 57 (59 joints) who also had an arthroscopy during the operation. There were 55 women (57 joints) and two men (2 joints) with a mean age at the time of surgery of 37.5 years (12 to 57). OA of the hip was classified into four stages according to the radiological appearance: 1) prearthritis, no osteoarthritic change; 2) early, with slight narrowing of the joint space associated with sclerosis of the subchondral bone; 3) advanced, with narrowing of the joint space, cystic lucencies and small osteophytes; and 4) end stage, with disappearance of the joint space and marked formation of osteophytes. Ten joints had prearthritis and 35 were in the early stage and 14 in the advanced stage. The mean follow-up was for 3 years and 2 months (2 to 6.5 years).

The indications for RAO were acetabular dysplasia, characterised radiologically by a centre-edge (CE) angle of less than 20° and pain severe enough to interfere with normal activities. Patients with improvement in cover of the femoral head and joint congruency on an anteroposterior (AP) plain radiograph in abduction, were considered to be suitable for surgery. RAO was carried out using the technique of Ninomiya and Tagawa with one modification in that the rotated acetabulum was fixed by two poly-L-lactic acid screws (Gunze, Kyoto, Japan) instead of Kirschner wires. The degenerative limbus and osteophytes were not resected. We used no postoperative splintage and an active range of movement of the hip was encouraged from the seventh postoperative day. Partial weight-bearing with two crutches was allowed from the sixth postoperative week and full weight-bearing at five to six months when Trendelenburg’s sign had disappeared.

Clinical follow-up was undertaken using the scoring system of Merle d’Aubigné and Postel with pain, mobility and walking ability assessed by scores from 0 to 6. The CE angle, acetabular roof obliquity (AC angle) and head lateralisation index (HLI) were measured on the AP radiographs before and after operation and at follow-up (Fig. 1). Changes in the CE and AC angles were used to describe any medial or lateral expansion of the subchondral bone of the acetabulum caused by joint remodelling.
Diagram showing the radiological indices of the hip: α, CE angle; β, AC angle; and HLI, $\frac{\alpha}{\beta}$. 

**Fig. 1**

Diagrams showing the classification of postoperative joint congruency.

**Fig. 2**

Diagram showing the classification of postoperative joint congruency.

**Fig. 3**

Diagram showing the sites of the acetabulum evaluated by arthroscopy (a, anterior; b, middle; and c, posterior).

Postoperative joint congruency was classified as follows: 1) excellent, in which the configuration of the acetabulum and femoral head was almost identical and the joint space maintained; 2) good, in which the confirmation of the acetabulum and femoral head was not identical, but the joint space was adequately maintained; 3) fair, with partial narrowing of the joint space; and 4) poor, with partial disappearance of the joint space.

For arthroscopic evaluation we used a Storz instrument of 5 mm diameter with 30° optics (Karl Storz, Culver City, California) introduced through an anterolateral portal. We subdivided the articular surface of the acetabulum into anterior, middle and posterior areas (Fig. 3) and assessed these and the articular surface of the femoral head. The arthroscopic appearance of the articular cartilage was classified into five grades according to Outerbridge, grade 0, no abnormalities; grade 1, softening and swelling of the cartilage; grade 2, fragmentations or fissuring in an area 1 cm or less in diameter; grade 3, as grade 2, but with an area of more than 1 cm in diameter involved; and grade 4, erosion of the cartilage to bone.

### Results

Before surgery the mean clinical score was 14.7 ± 1.7 (10 to 17). This improved to a postoperative score at follow-up of 17.2 ± 1.5 (10 to 18) (Wilcoxon signed-rank test, $p < 0.0001$) which was mainly due to decreased pain and improved walking ability. The pain scores increased from 3.8 ± 1.1 (1 to 5) to 5.7 ± 0.8 (2 to 6) ($p < 0.0001$) and walking ability from 5.0 ± 0.7 (3 to 6) to 5.6 ± 0.6 (3 to 6) ($p < 0.001$) whereas mobility scores remained unchanged ($p = 0.463$). In two patients (2 joints) the total scores decreased from 13.5 (13 to 14) to 11.5 (10 to 13). None of the patients has required further surgery.

Radiologically, the CE angle showed a significant improvement from a mean of 0.4° before operation to a mean of 27°, the AC angle improved from a mean of 30.4° to a mean of 6.8° and the HLI from a mean of 0.65 to a mean of 0.61, with no case of deterioration. Thereafter, there were statistically significant changes in the CE and AC angles by joint remodelling (Table I).

Postoperative joint congruency was excellent in 33 joints, good in 20 and fair in six. None was judged to be poor. All joints showing prearthritis at the preoperative radiological assessment had an excellent result.

The arthroscopic findings were as follows: grade 0 in seven, grade 1 in nine, grade 2 in 17, grade 3 in 14 and grade 4 in 12. Of those with changes in the articular cartilage, 30 showed degeneration in the anterior, 12 in the middle, and 14 in the posterior areas of the acetabulum. With regard to degeneration of the femoral head, in 32 it was in the anterior, in ten in the middle and in five in the posterior areas. In both the acetabulum and femoral head, degeneration of the articular cartilage was more commonly observed anteriorly. There was a tendency for the number of sites showing degeneration to increase relative to the grade. The arthroscopic grading correlated with the preoperative clinical score (Kruskal-Wallis rank test, $p < 0.01$) and the score at follow-up ($p < 0.05$).

Progression of OA was observed radiologically at follow-up in four joints. Before operation, it was at an early stage in one joint and at an advanced stage in three. Postoperative joint congruency was good in two joints and fair in two, and the arthroscopic findings were grade 4 in all four joints (Fig. 4). Stepwise regression analysis showed that the age of the patient at surgery, the preoperative radiological stage, the postoperative CE and AC angles, and
postoperative joint congruency did not affect the progression of OA, but that the grading at arthroscopy significantly affected progression ($p = 0.0066$).

**Discussion**

Since patients who undergo periacetabular osteotomy are young, favourable long-term results are essential. Previous reports on the medium- and long-term results of this procedure have indicated that preoperative OA and unsatisfactory joint congruency after surgery cause early postoperative progression of OA. Faulty operative technique must be avoided, particularly damage to the joint surface, necrosis of the acetabulum from an osteotomy which is too thin and excessive rotation of the acetabulum.

The presence or absence of OA has previously been assessed before operation by radiological staging, but the status of the articular cartilage as a whole cannot be accurately assessed by studying only the centre of the hip.
on the AP view. Miller, Brand and Andrew,17 in their study of radiological indices pertaining to the results of osteotomy, stated that the joint space is the primary factor involved, but since this was an evaluation based on the AP view, it was clearly limited. Noguchi et al8 in their arthroscopic evaluation of the articular cartilage of dysplastic hips reported that even at an early stage, severe degeneration of cartilage with subchondral exposure may be present, and at an advanced stage it is usually present, suggesting the need to evaluate cartilage changes in greater detail than by conventional radiography. The preoperative arthroscopic findings are therefore required in order to assess the indications for RAO. The results of our study indicate that the level of degeneration of articular cartilage is the most important factor affecting the early postoperative results.

Periacetabular osteotomies such as RAO cause considerable changes in joint morphology and increase the postoperative load on the articular cartilage, particularly in the medial part of the acetabulum.18,19 Unless there is only prearthritic or minimal degeneration of the articular cartilage before operation, the joint may be unable to cope with the biomechanical changes and OA will progress early after surgery.20,21 We recently described joint remodelling after this procedure.13 There have been cases which showed extension of the subchondral bone of the acetabulum, suggesting an enlargement of the load-bearing area by cartilaginous metaplasia. This does not develop unless there is biological elasticity in the existing articular cartilage. If the preoperative degeneration of the cartilage is minimal, we believe that the redistribution of load after RAO will encourage regeneration of degenerative cartilage and cartilaginous metaplasia of the acetabulum.

Even when postoperative joint congruency is good, there is the possibility that OA will progress if the arthroscopic evaluation is grade 4. At an advanced stage, the indication for RAO should be restricted to patients whose joint congruency is very satisfactory and the arthroscopic evaluation is less than grade 3. We have found preoperative arthroscopic evaluation to be desirable, but when this is not feasible, intraoperative arthroscopic evaluation is recommended.

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