Arthroscopic treatment of labral tears in femoroacetabular impingement

A COMPARATIVE STUDY OF REFIXATION AND RESECTION WITH A MINIMUM TWO-YEAR FOLLOW-UP

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Labral tears are commonly associated with femoroacetabular impingement. We reviewed 151 patients (156 hips) with femoroacetabular impingement and labral tears who had been treated arthroscopically. These were subdivided into those who had undergone a labral repair (group 1) and those who had undergone resection of the labrum (group 2). In order to ensure the groups were suitably matched for comparison of treatment effects, patients with advanced degenerative changes (Tönnis grade > 2, lateral sourcil height < 2 mm and Outerbridge grade 4 changes in the weight-bearing area of the femoral head) were excluded, leaving 96 patients (101 hips) in the study. At a mean follow-up of 2.44 years (2 to 4), the mean modified Harris hip score in the labral repair group (group 1, 69 hips) improved from 60.2 (24 to 85) pre-operatively to 93.6 (55 to 100), and in the labral resection group (group 2, 32 hips) from 62.8 (29 to 96) pre-operatively to 88.8 (35 to 100). The mean modified Harris hip score in the labral repair group was 7.3 points greater than in the resection group (p = 0.036, 95% confidence interval 0.51 to 14.09). Labral detachments were found more frequently in the labral repair group and labral flap tears in the resection group. No patient in our study group required a subsequent hip replacement during the period of follow-up.

This study shows that patients without advanced degenerative changes in the hip can achieve significant improvement in their symptoms after arthroscopic treatment of femoroacetabular impingement. Where appropriate, labral repair provides a superior result to labral resection.

Femoroacetabular impingement (FAI) has been proposed as a cause of osteoarthritis of the hip.1,2 There are two mechanisms of impingement: cam and pincer. Cam impingement is caused by a non-spherical femoral head which damages the anterosuperior articular cartilage of the acetabulum with detachment of the labrum attributed to centrally-directed shear forces exerted on the junction between the labrum and the articular cartilage. By contrast, pincer impingement is caused by excessive acetabular cover. As the hip moves, the labrum is crushed between the acetabular rim and the femoral neck causing a tear which extends at right angles to the labrum. Repeated microtrauma causes degeneration at the base of the labrum which subsequently ossifies.2 Tears of the labrum secondary to impingement can therefore be distinguished histologically.2,3 While these commonly occur in association with FAI, a limited understanding of the function of the labrum makes it difficult to recommend specific treatment. The labrum acts as a seal to contain synovial fluid in the joint to ensure even fluid-film lubrication and nutrition of the articular cartilage.4,6 Disruption of the labrum may lead to premature degeneration of the articular cartilage.7 The majority of labral tears occur at the junction of labrum and articular cartilage. This area has a relatively poor blood supply which can complicate the spontaneous healing of tears on the articular side of the labrum. In contrast the vascularity is better on the capsular side.8,9

Although there is a tendency to recommend labral repair over labral resection,10-12 the number of studies comparing the two techniques is still very limited10 and only short-term follow-up results have been reported. During labral repair acetabular retroversion may be corrected by trimming the acetabular rim.3 The aim of this study was to compare labral repair and resection in patients who had undergone arthroscopic treatment for FAI. Our hypothesis was that patients without advanced degenerative changes who had undergone labral repair would have a better clinical outcome after a minimum of two years than if they had undergone labral resection. We also aimed to define the types of labral tear.
True anteroposterior (AP) pelvis and cross-table lateral radiographs were taken and calibrated using a 3 cm diameter marker ball. Acetabular version was assessed by looking at the relationship of the anterior wall to the posterior acetabular wall. Patients were defined as having a pincer abnormality when a crossover sign and/or a prominent ischial spine were present. The acetabulum was classified as protrusio if the femoral head overlapped the ilioischial line medially and profunda if the floor of the acetabular fossa touched the ilioischial line.

Acetabular cover was assessed by measuring the lateral centre-edge angle. Patients with a centre-edge angle < 25° were excluded from the study. The cross table lateral view was used to assess the anterior femoral head-neck offset (angle). Patients with an angle > 55° were defined as having a cam lesion. We evaluated degenerative changes, assessing joint space narrowing, by measuring the lateral sourcil height and using the Tönnis classification.

Arthroscopy was performed with the patient supine under general anaesthesia with muscle relaxation. A commercial distractor (Hip Positioning System; Smith & Nephew, Memphis, Tennessee) was used to achieve 10 mm distraction of the hip. An image intensifier was used to assess distraction and for portal placement. We used two standard portals; lateral trochanteric and mid-anterior. The procedure consisted of a central compartment arthroscopy performed under traction and a peripheral compartment procedure without traction.

When a pincer deformity was found, the overhang was resected using a 4 mm burr. The presence of a cam deformity was confirmed during dynamic assessment and the excess bone resected using the powered burr. The hip was subsequently examined in flexion, internal rotation and abduction to exclude persistent impingement (Fig. 1).

Labral pathology was assessed and classified. We divided the labral tears into detachment (Fig. 2), full thickness, flap (Fig. 3), mid-substance and complex tears. A labral detachment describes a separation between acetabular and labral cartilage while the attachment to the bone is preserved. In a full thickness tear there is complete avulsion from the acetabular rim. The status of the labrum was assessed and classified as normal, degenerative, contused, hypertrophic and ossified. The decision to repair or resect the labrum was based on the type and morphology of the tear and the status and size of the labrum. The tear was often extended and the labrum further detached to expose the acetabular rim for rim resection (Fig. 4). On average, two bio-absorbable suture anchors were used for a labral repair (Fig. 5). When the labrum was not suitable for repair, it was trimmed to a stable remnant with the shaver and a radiofrequency probe (Fig. 6).

Associated chondral damage of the acetabulum and femoral head was assessed. The type of acetabular cartilage lesion was classified as: normal; wave sign, defined as unstable articular cartilage but macroscopically intact; partial thickness delamination, defined as fissuring, fibrillation and flap tear of articular cartilage (Fig. 7); or full thickness

**Fig. 1**

Arthroscopic view of the femoral neck osteoplasty following a labral repair.

which would be suitable for repair using current arthroscopic techniques.

**Patients and Methods**

Between March 2006 and May 2008 the senior author (ES) carried out 156 hip arthroscopies for FAI associated with a labral tear in 151 patients. We excluded those who had undergone previous hip surgery or other procedures such as capsulorrhaphy or trochanteric bursectomy and those with avascular necrosis, rheumato logical disorders, dysplasia or incomplete records. In order that the effect of treatment could be examined without the presence of any confounding variables, we excluded patients with a lateral sourcil distance of < 2 mm, a Tönnis grade greater than 2 and Outerbridge grade 4 cartilage damage to the weight-bearing area of the femoral head. This left 101 hips in 96 patients of which 76 hips (75.25%) were in men and 25 (24.75%) were in women. The mean age for the total group was 37 years (15 to 71). The patients were retrospectively classified into two groups; group 1 had labral repair; group 2 had resection of the labral tear. The study was a registered audit project in our institution.

The location of pain was identified and recorded as being in the region of the groin, trochanter, buttock or adductors. The presence of instability and mechanical symptoms were noted. The provocative anterior impingement test was performed in which the hip was flexed beyond 90° then adducted and internally rotated. The Faber distance was measured on both hips. This is measured with the patient supine with the hip in figure-four position, between the genicular line and the examination couch. The distance for both hips is compared.

Patients were assessed radiologically for cam impingement, acetabular version, degree of acetabular cover and the presence of degenerative changes.
delamination, defined as detached articular cartilage with exposure of subchondral bone. The depth of a cartilage lesion was measured using a 1 mm calibrated probe and graded using the Outerbridge classification.14

Post-operatively, a passive and active range of movement programme was started which included cycling on a stationary bicycle from the first day. Patients were partially weight-bearing on crutches for between two and four weeks. In total, the rehabilitation programme lasted seven weeks. When microfracture was performed patients remained partially weight-bearing for six weeks.

**Outcome analysis and statistical methods.** Outcomes were measured pre- and post-operatively using the modified Harris hip score (MHHS).20 This scale ranges from 0 (worst) to 100 (best). The ceiling effect of the maximum score can cause problems of distribution when using statistical methods to analyse outcomes, particularly when a significant proportion of the sample achieves a post-operative score which is close to 100. We therefore decided to use the increase in the MHHS (Inc MHHS) while still checking for potential ceiling effects, using both regression analysis and an independent t-test. A normal regression model was established using the treatment group as a predictor to estimate the difference in the means of the increase in MHHS, between those who had undergone labral repair and those who had a labral resection. We also included the type of the cartilage lesion and depth of the cartilage lesion using a standard ordinary least squares multiple
The mean follow-up was 2.44 years (2 to 4).

In group 1 (labral repair, 69 hips), a gradual onset of symptoms was noted in 52 hips (75%) and a sudden onset in 17 (25%); clicking was reported in 26 hips (38%), and instability in five (7%). Pain in the groin was present in 62 hips (90%), around the greater trochanter in 17 (25%), in the region of the adductors in eight (12%) and in the buttock in three (4%). The C sign, which refers to combined groin and trochanter pain, was found in only 13 hips (19%). All except one patient in the labral repair group had a positive impingement sign and 59 hips (86%) demonstrated an increased Faber distance on the affected side.

In group 2 (labral resection, 32 hips), a gradual onset of symptoms was noted in 27 hips (84%) and a sudden onset in five (16%); clicking was reported in nine hips (28%) and instability in two (6%). Pain in the groin was present in 29 hips (91%), around the trochanter in seven (22%), in the region of the adductors in five (16%) and in the buttock in two (6%). The C sign was present in five hips (16%). In both groups the pain could be located in more than one area. In group 2, all patients had a positive impingement test and 25 hips (78%) demonstrated an increased Faber distance.

Analyzing the pre-operative radiographs, there were 33 hips with a cam deformity in the labral repair group, 45 hips with a retroverted acetabulum and 14 with coxa profunda. In the labral resection group there were 23 cam deformities, 13 hips with a retroverted acetabulum and five with coxa profunda. Table I gives details of the lateral joint space measurements and Tönnis grading in the two groups.

In the labral repair group all patients underwent labral refixation, 68 had trimming of the acetabular rim, 48 a femoral osteoplasty and five a microfracture. We found 52 labral detachments, two flap tears, 14 full-thickness tears and one midsubstance tear. The status of the labrum was classified as normal in 40 hips, degenerative in 23 and contused in six. A total of 60 hips (87%) had associated cartilage lesions.

In the labral resection group, 14 patients had trimming of the acetabular rim, 26 a femoral osteoplasty and six an acetabular microfracture. In this group we noted three labral detachments, 22 flap tears, four full-thickness tears, two midsubstance tears and one complex tear. The status of the labrum was classified as normal in three hips, degenerative in 24, contused in two and ossified in three. In this group, 27 hips (84%) had associated cartilage lesions.

Table II shows the different types of acetabular cartilage lesions. A normal regression model showed no significant linear effect of depth or type of cartilage lesion when treated as a covariate. The type of cartilage lesion and the

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**Table I.** The radiological findings in both groups

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<th>Group 1</th>
<th>Group 2</th>
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<tr>
<td>Mean lateral source height (mm) (95% CI)</td>
<td>3.75 (3.56 to 3.94)</td>
<td>3.43 (3.02 to 3.84)</td>
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<tr>
<td>Mean lateral centre-edge angle (°) (95% CI)</td>
<td>38.1 (36.7 to 39.4)</td>
<td>38.3 (36.6 to 39.9)</td>
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<tr>
<td>Tönnis grade 0 (n, %)</td>
<td>16 (23.7)</td>
<td>4 (12.5)</td>
</tr>
<tr>
<td>Tönnis grade 1 (n, %)</td>
<td>51 (73.9)</td>
<td>24 (75.0)</td>
</tr>
<tr>
<td>Tönnis grade 2 (n, %)</td>
<td>2 (2.9)</td>
<td>4 (12.5)</td>
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* CI, confidence interval.
depth were strongly associated with each other (Pearson product moment correlation coefficient, \( r = 0.589, p < 0.001 \)), but did not make a significant contribution to the outcome measure of the Inc MHHS (\( p = 0.808 \) and \( p = 0.858 \) for type and depth of lesion, respectively).

Table III shows the pre- and post-operative MHHS and compares the labral repair with the labral resection group. This shows that the mean increase in the MHHS was 33.4 (0 to 76) for the repair group and 26.1 (0 to 61) for the resection group. The mean post-operative score was 93.59 (55 to 100) in the repair group and 88.84 (35 to 100) in the resection group. Post-operatively, the SD is lower in both groups probably because of the ceiling effect intrinsic in the MHHS. The ordinary least squares multiple regression model calculated that the repair group performed significantly better by a mean 6.99 points on the MHHS (\( p = 0.042, 95\% \) confidence interval (CI) 0.27 to 13.73).

The final model chosen uses only the treatment group as a predictor because there was no significant effect of depth and type of lesion. This turns the normal regression model into a simple \( t \)-test of treatment group. The mean benefit of the labral repair is 7.30 points on the Inc MHHS (CI 0.51 to 14.09).

### Discussion

This study clearly shows that arthroscopic treatment of FAI with an associated labral tear is effective whichever method of treatment is used: this confirms the findings of other authors.\(^{12,22-26}\) It also supports the previously published studies\(^{10,11}\) that compare the outcomes of labral repair versus labral resection for the treatment of FAI, and favour repair. However, Laude et al\(^{26}\) compared repair with resection using an arthroscopically-assisted anterior approach and reported no clinical difference between the two groups, but with a 20% rate of failure for labral repair: the technique of repair could explain this difference. The authors did not comment on further differences between the two groups. Espinosa et al\(^{11}\) and Larson and Giveans\(^{10}\) produced comparable groups in terms of pathological findings, age and gender, but only Larson and Giveans\(^{10}\) commented on the type of labral tear and identified an ideal labrum for repair as one located anterosuperiorly and lacking significant intrasubstance degeneration, calcification, ossification or complex tearing. The effects of repair and resection were only assessed for this type of tear. The authors also elected to only include patients with pincer and mixed type impingement. In our study labral tears associated with all types of FAI were included, but to obtain a fair comparison of the treatment groups we excluded patients with advanced degenerative changes. In order to achieve this we used previously described predictors of outcome\(^{12,27}\) such as joint space narrowing and Tönnis grading, but also added Outerbridge grade 4 changes of the weight-bearing articular cartilage of the femoral head as an exclusion criterion. Although ideally our study group would have contained only isolated labral tears, it is difficult to assess the labrum independently from the acetabular articular cartilage because of the pathomechanics of FAI\(^{1,2,12}\). The decision to repair or resect labral tears in FAI depends on the type of tear, the ability of the labrum to heal, the size of the labrum, the location, the status of the articular cartilage and the surgical skills of the surgeon.\(^{28}\) In order to define the type of tear a classification system specific for FAI is required which describes not only the morphology of the tear but also the status of the labrum.

Lage, Patel and Villar\(^{29}\) described four types of labral tears: radial flap, radial fibrillated, longitudinal peripheral and unstable. The extent of the tear and the anatomical location was also described. Radial flap tears were the

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<th>Table II. Distribution of the different types of acetabular articular cartilage lesions between the groups</th>
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<td>Group</td>
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<tr>
<td>Group 1</td>
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<td>Group 2</td>
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<th>Table III. Mean (range) modified Harris hip score (MHHS) for the labral refixation and labral resection groups</th>
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<tr>
<td>Group</td>
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<tr>
<td>Repair</td>
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<td>Resection</td>
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<td>Total</td>
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most common. Beck et al\(^2\) were the first to describe a classification system of labral tears that was specific for FAI. The labral damage is described as degeneration, full thickness tear, detachment and ossification. Isolated cam impingement is usually associated with labral detachment while pincer impingement is associated with a more degenerative labrum and ossification. Their study also showed that in cam impingement the damage to the acetabular articular cartilage is usually located anterosuperiorly with a mean depth of 11 mm, while in pincer impingement the damage is usually restricted to a narrow circumferential band with a mean depth of 4 mm. This study also showed that the degenerative status of the labrum is not necessarily associated with more advanced articular cartilage damage but can be the result of the morphology of the acetabulum. Philippon et al\(^12\) classified articular cartilage damage but can be the result of the morphology of the acetabulum using the classification provided by Beck et al\(^2\) (wave sign, partial thickness, full thickness) rather than that of Outerbridge.\(^14\)

Philippon et al\(^9\) showed healing of labral repairs in a sheep model after 12 weeks. A later paper from the same group\(^12\) reported that a lower MHHS, a lateral sourcil distance < 2 mm and labral resection correlated with a lower post-operative MHHS. In our study we found a predominance of flap tears in the labral resection group and labral detachments in the labral repair group. These findings are similar to Philippon et al\(^12\) and suggest that different types of tears should be treated differently. These observations also highlight the difficulties that might be encountered with a randomised control study which compares the two methods of treatment in that some of the labral tears allocated to the labral repair group might not be suitable for repair.

Weaknesses in this study are its retrospective nature and the lack of randomisation. Although both groups were treated simultaneously and not sequentially, the decision to repair or to resect was taken intra-operatively which is potentially a source of bias. There may be issues of non-independence of measurement for the five patients who had bilateral surgery but this is a minor consideration in a sample of this size.

We conclude that labral detachments usually require repair of the labrum whilst flap tears and tears with significant degenerative change usually need to be resected. Because we excluded patients with advanced degenerative changes we were unable to establish the depth of acetabular articular cartilage damage over which it would be inadvisable to repair a torn labrum.

References


