HIP

Validation of the classification system for acetabular chondral lesions identified at arthroscopy in patients with femoroacetabular impingement

S. Konan,
F. Rayan,
G. Meermans,
J. Witt,
F. S. Haddad

From University College Hospital,
London, England

There have been considerable recent advances in the understanding and management of femoroacetabular impingement and associated labral and chondral pathology. We have developed a classification system for acetabular chondral lesions. In our system, we use the six acetabular zones previously described by Ilizaliturri et al. The cartilage is then graded on a scale of 0 to 4 as follows: grade 0, normal articular cartilage lesions; grade 1, softening or wave sign; grade 2, cleavage lesion; grade 3, delamination; and grade 4, exposed bone. The site of the lesion is further classed as A, B or C based on whether the lesion is less than one-third of the distance from the acetabular rim to the cotyloid fossa, one-third to two-thirds of the same distance and greater than two-thirds of the distance, respectively. In order to validate the classification system, six surgeons graded ten video recordings of hip arthroscopy.

Our findings showed a high intra-observer reliability of the classification system with an intraclass correlation coefficient of 0.81 and a high interobserver reliability with an intraclass correlation coefficient of 0.88.

We have developed a simple reproducible classification system for lesions of the acetabular cartilage, which it is hoped will allow standardised documentation to be made of damage to the articular cartilage, particularly that associated with femoroacetabular impingement.

Arthroscopy of the hip is a safe and reproducible method for treating chondral and labral lesions.1-6 Specific cartilage lesions have been demonstrated in association with morphological abnormalities of the hip, such as those found in femoroacetabular impingement.7,9 Arthroscopic techniques have evolved so that the correction of cam- and pincer-type abnormalities are possible and treatment is often required for the associated lesions of the articular cartilage.10 It is likely that the extent of such lesions is an important determinant of the outcome of treatment for femoroacetabular impingement.7,9,11-14 Beck et al17,11 provided a descriptive classification of the types of lesion seen in association with surgical dislocation of the hip for the treatment of patients with femoroacetabular impingement. To date there is no agreed method for describing the location and extent of the lesion or for assisting in the development of an algorithm for its treatment. Without such a system a comparison of the outcome of studies is unsatisfactory.

During arthroscopy the clock-face method is one method of defining the location of acetabular chondral lesions. Errors can occur with this system particularly when identifying the six o’clock position at the mid-point of the transverse acetabular ligament, and there may be perceptual errors arising as a result of acetabular inclination and anteversion. In order to address this, Ilizaliturri et al15 developed a zone-based method for assessing the acetabulum and femoral head. This showed good reproducibility when tested by six hip arthroscopists. We have adopted this zonal system for the location of lesions of the articular cartilage in our classification system.

Our aim is to describe the new classification system which we have developed and to validate it for consistency of diagnosis of chondral lesions and reproducibility.

Materials and Methods
The study involved two phases. First, a classification system was developed for chondral lesions encountered during arthroscopic hip surgery. In the second phase the new classification system was validated for internal consistency and observer reliability.
Development of the chondral classification system. The acetabulum was first divided into anatomical zones. For this purpose, those described by Ilizaliturri et al.\textsuperscript{15} were used and the acetabulum was divided into six zones as follows: the anterior inferior (zone 1), the anterior superior (zone 2), the middle superior (zone 3), the posterior superior (zone 4), the posterior inferior (zone 5) and the middle inferior (zone 6; cotyloid fossa). These are illustrated for the left and right acetabulum in Figure 1. Once the zones of the chondral lesion were determined, the chondrolabral junction and articular cartilage were assessed and classified as grades 0 to 4 with normal cartilage being grade 0. Grade 1 was classified as loss of fixation to the subchondral bone resulting in a wave sign. We defined a wave sign as occurring when the capsular side of the labrum was pushed inwards with a probe resulting in bulging of the adjacent articular cartilage indicating that it was not firmly attached to the underlying subchondral bone. The presence of a cleavage tear was classified as grade 2. In these lesions, there was an obvious separation at the chondrolabral junction, but arthroscopic probing of the tear showed adherence of the articular cartilage to the underlying bone with no evidence of delamination. Grade 3 was classified as delamination of the articular cartilage. This signified macroscopic debonding of the cartilage from the acetabular bone. Grade 4 involved exposed bone in the acetabulum. Grades 1, 3 and 4 were further grouped as A, B and C based on whether the lesion was less than one-third of the distance from the acetabular rim to the cotyloid fossa (A), one-third to two-thirds of this distance (B) or greater than two-thirds of this distance (C). Grade-2 lesions were further classified as grade-2A, grade-2B and grade-2C. Grade-3 lesions were further classified as grade-3A, grade-3B and grade-3C. Grade-4 lesions were classified as grade-4A, grade-4B and grade-4C.

Assessment of the internal consistency and reproducibility of the chondral classification system. In order to validate the classification system we analysed the intra- and interobserver variability of the system and the internal consistency. Surgeons were asked to classify selected video recordings of arthroscopic hip procedures carried out by one surgeon (JW). Each surgeon classified the videos in a random order and at three-week intervals in order to establish the intra-observer reliability. A sample-size analysis had shown that for a power of 80% and a p-value < 0.05, 55 observations were necessary to obtain agreement of 94%. Six surgeons classified ten videos giving a total of 60 observations. These 60 observations were used to assess interobserver reliability.

The video clips of diagnostic arthroscopy used for the study were selected from our database of adult patients undergoing arthroscopy. All the videos were anonymised with respect to the patient or the surgeon. The selected video clips clearly showed intra-articular structures in the hip including the capsule, the acetabular rim, the acetabular labrum, the articular surface of the acetabulum, the cotyloid fossa, the ligamentum teres and the articular surface of the femoral head. All the arthroscopies had been performed in a supine position using standard portals and all the video clips clearly showed the site of entry of the arthroscopic probe which could be used by the observers to orientate themselves to the intra-articular anatomy of each hip. The total duration of each video clip was between five and ten minutes. Video clips with a haemarthrosis obscuring the view and ‘second-look’ videos of patients undergoing repeat hip arthroscopy were excluded.

There were seven zone-3 grade-2 lesions, three zone-2 grade-2 lesions, two zone-3 grade-3A lesions and one each of zone-2 grade-3A, zone-3 grade-1A, zone-4 grade-3A and zone-4 grade-2 lesions. All the hip surgeons participating in the study had a minimum experience of two years of independent therapeutic performance of arthroscopic procedures at the hip. They were provided with the details of the classification systems and a link to access the videos. The videos and classification systems could be viewed any number of times. The surgeons were not aware of other participants in the study and could not discuss any aspect of the study. All were also asked to rate the use of the classification system as easy, moderately difficult and very difficult.

Statistical analysis. An independent observer, not involved in the study, performed all the statistical analyses. The intraclass correlation coefficient (ICC) with 95% confidence intervals (CI) was used for assessing the reliability of the classification system. Chronbach’s alpha\textsuperscript{16} was used to test internal consistency. SPSS version 14 (SPSS Inc., Chicago, Illinois) statistical software was used for the analyses. Statistical significance was set at p < 0.05.

Results
A statistically significant intra-observer reliability was noted for the chondral classification system (ICC 0.81, 95% CI 0.23 to 0.95, p = 0.011). All the surgeons classified...
the ten videos. They unanimously agreed that the classification system was easy to understand and incorporate into daily clinical practice. It was found to have a high internal validity with Cronbach’s alpha of 0.89 and a statistically significant interobserver reliability with an ICC of 0.88 (95% CI 0.72 to 0.97, p < 0.001).

**Discussion**

It is possible to grade and type lesions of the articular cartilage seen at hip arthroscopy reliably using our proposed classification system. The universal adoption of one system would be useful for the documentation of lesions and comparison of studies from different centres and is likely to have prognostic implications.

The standard reference for the evaluation and management of cartilage lesions is arthroscopy. It is a useful tool for the debridement of loose flaps and the removal of free cartilage fragments. Microfracture of medium-sized defects has been performed in many patients with full-thickness lesions. Cartilage resurfacing procedures may have a role in large cartilage defects. The logical justification for the use of arthroscopic hip surgery in the treatment of chondral injuries is the difficulty in diagnosing these lesions and the inability to improve symptoms by non-operative treatment. The location of intra-articular lesions in the hip has a prognostic implication. Hence, it is essential to have a reliable classification system for the chondral lesions seen at arthroscopy of the hip.

There are two main types of classification system, numerical and descriptive. Most of the numerical systems grade the lesions from 1 to 4 or from 0 to 4. Descriptive systems use more criteria, such as the size, depth or location of a defect.

We reviewed the published literature on surgically-managed femoroacetabular impingement of the hip to determine how surgeons were documenting the cartilage lesions identified at the time of operation (Table I). Most studies used the Outerbridge system and a few used the system of Beck et al.

In 1961 Outerbridge described a four-grade classification of the lesions of the hyaline articular cartilage. It is simple and reproducible, but also inaccurate, since grade II and grade III were defined as fragmentation and fissuring, but the depth of involvement was not defined in either grade. Instead, the distinction between the two grades was based on the diameter of the chondral defect only. Also grade I and grade IV do not state any size of the lesion.

An ideal classification system should be simple, reproducible and assess the size and extent of the articular damage. The grading system should provide a guide to the management of the condition and also be of prognostic value. The articular lesions of the hip seen in patients with femoroacetabular impingement seem to follow a typical pattern. The postulated mechanism of advancement of the lesion is that initially there is loss of firm fixation of the articular cartilage to the underlying subchondral bone, producing the so-called wave sign. A separation between the two can then occur at the chondrolabral junction (cleavage tear). As the lesion progresses in severity it is associated with delamination of the articular cartilage from the region of the chondrolabral junction towards the

---

**Table I. Summary from the literature of the classifications used to assess cartilage lesions of the hip**

<table>
<thead>
<tr>
<th>Authors</th>
<th>Number of patients</th>
<th>Classification system</th>
<th>Surgical approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Byrd and Jones</td>
<td>9</td>
<td>Outerbridge</td>
<td>Arthroscopy</td>
</tr>
<tr>
<td>Beck et al</td>
<td>22</td>
<td>Beck</td>
<td>Open</td>
</tr>
<tr>
<td>Espinosa et al</td>
<td>52 (60 hips)</td>
<td>Standardised map of lesions</td>
<td>Open</td>
</tr>
<tr>
<td>Peters and Erickson</td>
<td>29</td>
<td>Outerbridge</td>
<td>Open</td>
</tr>
<tr>
<td>Philippin et al</td>
<td>45</td>
<td>Outerbridge</td>
<td>Arthroscopy</td>
</tr>
<tr>
<td>Johnston et al</td>
<td>102</td>
<td>Outerbridge + sized using probe</td>
<td>Arthroscopy</td>
</tr>
<tr>
<td>Stähelin et al</td>
<td>22</td>
<td>Outerbridge</td>
<td>Arthroscopy</td>
</tr>
<tr>
<td>Laude et al</td>
<td>97 (100 hips)</td>
<td>Beck</td>
<td>Combined mini-open and arthroscopy</td>
</tr>
<tr>
<td>Philippin et al</td>
<td>122</td>
<td>Outerbridge</td>
<td>Arthroscopy</td>
</tr>
<tr>
<td>Streich et al</td>
<td>50</td>
<td>Outerbridge</td>
<td>Arthroscopy</td>
</tr>
<tr>
<td>Peters et al</td>
<td>94 (96 hips)</td>
<td>Outerbridge</td>
<td>Open</td>
</tr>
</tbody>
</table>

* Outerbridge,21 Table II
† Beck et al,711 Table III

---

**Table II. Details of the Outerbridge classification system**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Softening or oedema</td>
</tr>
<tr>
<td>II</td>
<td>Fragmentation/tear 0.5 in (1.3 cm)</td>
</tr>
<tr>
<td>III</td>
<td>Fragmentation/tear 0.5 in (1.3 cm)</td>
</tr>
<tr>
<td>IV</td>
<td>Bare open laying subchondral bone</td>
</tr>
</tbody>
</table>
acetabular fossa. We feel that our classification takes into account the progressive nature of the development of these lesions and documentation of the nature of the damaged area is relatively straightforward. The nature of the initiating lesion may vary somewhat according to the type of impingement, be it cam, pincer or combined. When reporting the outcome in relation to the pathological process it is clearly important that there has been an accurate assessment of the morphological abnormality. We felt that it would be confusing to attempt to produce a different classification depending on the pathological process, especially as there remains considerable inconsistency in determining the type of impingement abnormality. If the classification is applied correctly, it should become evident which type of lesion is more severe in terms of outcome and which lesions present most often in various conditions.

We have adopted the zonal method described by Ilizaliturri et al. in our classification system for localising the site of the lesion. The alternative clock-face method has been widely used for describing intra-articular hip pathology on the acetabulum and the acetabular rim. However, perception of the six o’clock position of the centre of the transverse ligament may be altered arthroscopically because of the positioning of the patient as well as acetabular anteversion and inclination. In addition, the position of the ‘hours’ is not the same for the right and left acetabula. confirmed in their cadaver study that the zonal method is not affected by positioning or acetabular anteversion and inclination because it is based on the acetabular fossa.

We have not provided a separate classification system for the femoral head since, in our experience, damage to the articular cartilage follows a more conventional pattern at a later stage than injury to the chondro-labral junction and articular cartilage on the acetabular side. Mapping of the site of damage to the femoral head can be done using the zonal system proposed by Ilizaliturri et al.

This classification, integrating as it does the topographical description and the grading of cartilage injury in the acetabulum, is simple and reproducible and may act as a guide to treatment as well as grant prognostic significance.

---

**Table III. Details of the classification system of Beck et al.**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Normal; macroscopically sound cartilage</td>
</tr>
<tr>
<td>1</td>
<td>Malacia; roughening of surface, fibrillation</td>
</tr>
<tr>
<td>2</td>
<td>Debonding; loss of fixation to the subchondral bone, macroscopically sound cartilage, carpet phenomenon</td>
</tr>
<tr>
<td>3</td>
<td>Cleavage; loss of fixation to the subchondral bone: frayed edges, thinning of the cartilage, flap</td>
</tr>
<tr>
<td>4</td>
<td>Defect; full-thickness defect</td>
</tr>
</tbody>
</table>

---

**References**


