Systematic Review

The Prevalence of Hip Labral and Chondral Lesions Identified by Method of Detection During Periacetabular Osteotomy: Arthroscopy Versus Arthrotomy

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Purpose: Periacetabular osteotomy (PAO) has become an accepted treatment option for patients with severe hip dysplasia. In addition to correcting acetabular architecture, consideration has been given to concomitant joint evaluation and treatment of coexisting intra-articular pathologic conditions, which can be identified with hip arthroscopy or through an open arthrotomy. The purpose of this systematic review was to evaluate the prevalence of intra-articular pathologic conditions identified arthroscopically compared with that of those identified with open arthrotomy. **Methods:** A systematic review of the literature was performed by a search of PubMed using the words "periacetabular osteotomy," "Bernese osteotomy," and "Ganz osteotomy." Two reviewers searched for relevant articles that met established inclusion criteria, which follow: (1) they were in the English language, (2) they contained data on patients who underwent periacetabular osteotomy, (3) the study patients underwent concomitant arthroscopy or arthrotomy, and (4) the studies contained data on the intra-articular findings at the time of osteotomy. Exclusion criteria included review articles, technique articles, articles reporting on the same patient population, and articles without reported patient data. **Results:** After review of 361 references and abstracts, 8 articles met the inclusion criteria. A total of 775 patients who had undergone PAO were included in the 8 articles. Three articles inspected all joints at the time of PAO and accounted for 345 PAOs. Arthrotomy was used to evaluate 151 hips, and 31 (21%) labral tears were identified. Arthroscopy was used to evaluate 194 hips, and 162 (84%) labral tears were identified. The difference in prevalence is statistically significant ($P < .05$). Two of the 3 articles reported chondral injury: 141 (73%) acetabular chondral injuries and 52 (27%) femoral chondral injuries were noted in 194 hips. **Conclusions:** The prevalence of intra-articular damage, including labral injuries and pathologic conditions of cartilage, at the time of PAO is substantial. Labral tears and chondral injury appear to be better recognized with concomitant arthroscopy when compared with arthrotomy at the time of PAO. Further study is needed to determine whether the treatment of chondrolabral injuries can improve patient outcome and reduce reoperations. **Level of Evidence:** Level IV, systematic review of Level IV studies.

Morphologic abnormalities of the hip often precede and may herald the early onset of the development of degenerative joint disease. Femoroacetabular impingement (FAI) and hip dysplasia are the 2 most common morphologic abnormalities encountered before the onset of hip arthritis.[1] Periacetabular osteotomy (PAO) is now an established treatment option for patients with hip dysplasia and, in some cases, acetabular retroversion.[2,3] The goal of PAO is to correct acetabular architecture before the onset of degenerative changes, and multiple reports have documented satisfactory patient outcome and osteotomy survival.[4,5]

Treatment of symptomatic hip dysplasia has traditionally focused on correction of extra-articular deformity, and initial reports of PAO did not include routine inspection of the hip joint.[6] Recently, 2 observations have been made that suggest joint inspection may be beneficial during PAO: (1) intra-articular pathologic conditions are common and may be symptomatic, and (2) acetabular reorientation may result in iatrogenic FAI.[7]

Hip dysplasia results in structural instability and acetabular rim overload. This environment can cause

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intra-articular damage, i.e., labral pathologic conditions, chondral damage, and ligamentum teres hypertrophy.[2] Recently, more attention has been given to the intra-articular pathologic conditions present at the time of PAO, because these lesions may be responsible for persistent postoperative symptoms.[7-10]

Correcting dysplasia by reorienting the acetabulum can also lead to iatrogenic FAI.[11,12] After osteotomy, the femoral head becomes covered anteriorly, which can result in impingement during hip flexion. A preexisting cam lesion that previously did not engage a dysplastic acetabulum may cause subsequent impingement after PAO. This potential for iatrogenic FAI after PAO has also been part of the rationale for joint inspection during the procedure, because it allows correction of the femoral deformity.

Hip arthroscopy is well suited for intra-articular joint inspection at the time of PAO. It allows full access to the hip joint for evaluation and treatment of intra-articular pathologic conditions and can also be used to correct abnormal femoral architecture. To date, the prevalence of intra-articular lesions and femoral deformity has been poorly understood and inconsistently reported in the literature.

Joint inspection at the time of PAO can be performed arthroscopically or through an open arthrotomy. To our knowledge, no literature is available comparing the prevalence of intra-articular pathologic conditions identified arthroscopically and that identified through arthrotomy. The purpose of this systematic review was to evaluate the prevalence of labral tears and chondral lesions identified arthroscopically compared with those identified through open arthrotomy.

Methods

In August 2013 we searched the PubMed and Medline literature databases for articles pertaining to PAO. Articles were identified using the search terms "periacetabular osteotomy," "Bernese osteotomy," and "Ganz osteotomy." Two authors (J.M.R. and A.G.) independently reviewed titles and abstracts to identify articles for full text review. Articles were included if they met the following criteria: (1) were in the English language, (2) contained data on patients who underwent periacetabular osteotomy, (3) contained data on patients who underwent concomitant arthroscopy or arthrotomy, and (4) contained data on the intra-articular findings at the time of osteotomy. Exclusion criteria included review articles, technique articles, articles reporting on the same patient population, and articles without reported patient data (Table 1). If it was unclear whether the study reported intra-articular findings after reviewing the abstract, a full review was performed. Additional articles were found after searching the bibliography of identified papers if they met the preceding criteria.

Table 1. Inclusion and Exclusion Criteria Used to Identify Articles in This Systematic Review

Inclusion Criteria	Exclusion Criteria
English language	Review articles
Contained periacetabular osteotomy data	Technique articles
Contained patients undergoing concomitant arthroscopy or arthrotomy	Contained overlapping patient populations
Contained data on intra-articular findings	

A full text review was performed to determine several data points, including demographics, number of osteotomies, number of joints inspected, rationale for joint inspection, intra-articular findings, intra-articular treatment, method of joint inspection, revision data, and level of evidence.

Only articles that reported inspection of all joints at the time of PAO were used to calculate the prevalence of intra-articular pathologic conditions. A χ-squared test was used to compare the prevalence of labral tears in the arthroscopy and arthrotomy groups.

Results

In August 2013, a search yielded 361 articles from the PubMed and Medline databases. After reviewing the title and abstract of these articles, we selected 59 articles for full text review. Fifty articles were then excluded because of lack of data on intra-articular findings during PAO. A total of 9 articles met the inclusion criteria for this systematic review. One article was removed because it reported on the same patient population as another study, which left 8 articles for systematic review (Fig 1).[3,7-9,11,13-15]

Data Extraction

From the 8 available articles, there were a total of 755 PAO procedures reported (Table 2). Six studies inspected the joint by arthrotomy and 2 studies inspected the joint by arthroscopy. Three of the 8 studies performed joint inspection on all the PAOs reported, and this accounted for 345 PAOs. Five of the 8 studies selectively reported joint inspection during PAO. In these 5 studies, the indication for joint inspection included magnetic resonance imaging findings, a positive impingement test, mechanical symptoms, and routine inspection in a portion of the study. Five articles reported postoperative complications caused by intra-articular pathologic conditions. All articles included in this review were Level IV evidence retrospective case series.

Prevalence

Three articles inspected all joints at the time of PAO and accounted for 345 PAOs. A total of 193 (56%) labral tears were identified in both groups. Arthrotomy was used to evaluate 151 hips, and 31 (21%) labral

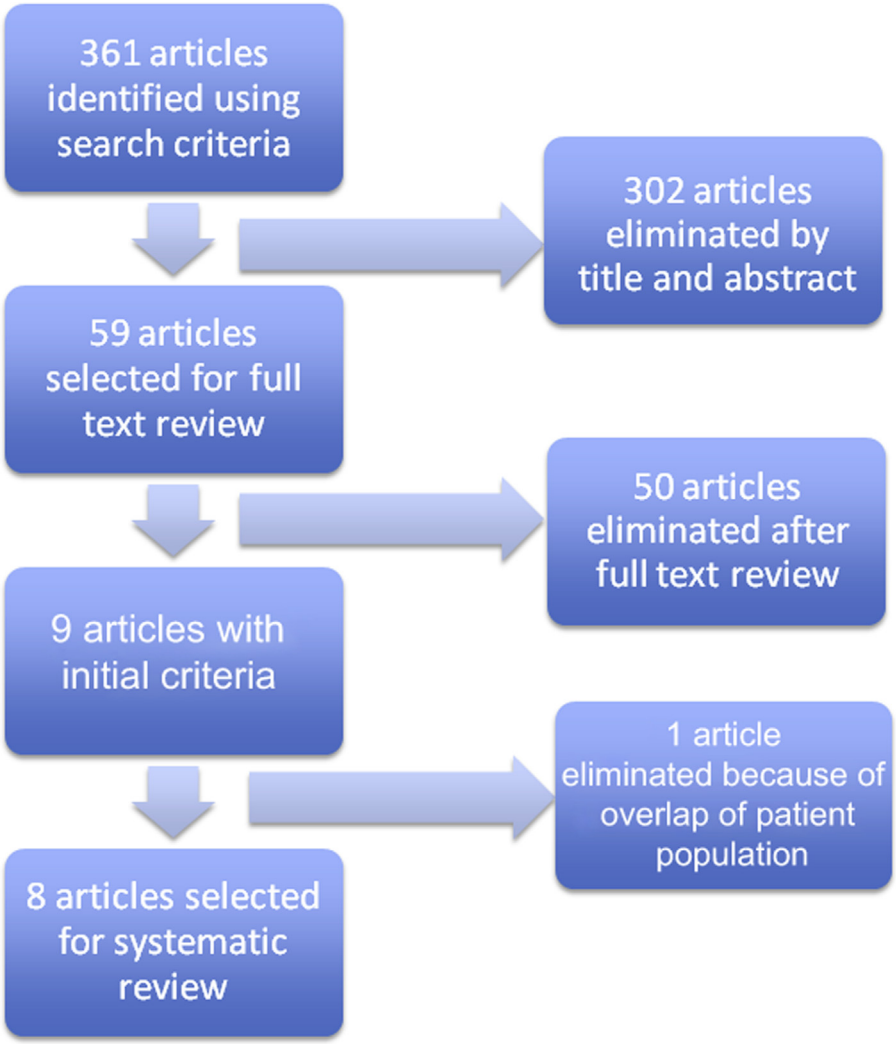

Fig 1. Search strategy flowchart.

tears were identified. Arthroscopy was used to evaluate 194 hips, and 162 (84%) labral tears were identified. The difference in prevalence is statistically significant ($P < .05$). The results are shown in Fig 2.

Two articles described studies that performed arthroscopic evaluation on all joints and commented on chondral lesions. Acetabular chondral lesions were reported in 141 (73%) of 194 hips. Femoral chondral lesions were reported in 52 (27%) of 194 hips. The results are shown in Fig 3. One article reported acetabular chondral injuries identified during arthrotomy in 16 (62%) of 26 hips inspected. Not all joints were inspected in this study.

Five articles reported selective joint inspection by arthrotomy at the time of PAO. Four of these studies reported the percentage of joints inspected, which ranged from 29% to 61%. Of the articles that selectively performed joint inspection by arthrotomy, there were 189 joints inspected and 76 (40%) of these joints had labral tears. The percentage of labral tears ranged from 22% to 100%. The indications for inspecting these joints were variable, and these numbers should not serve as true prevalence numbers.

Five articles reported revisions for intra-articular pathologic conditions during the follow-up period. The numbers and types of revisions are reported in Table 2.

Discussion

Hip dysplasia represents a spectrum of abnormal acetabular architecture that can lead to instability, mechanical overload, and subsequent early degenerative joint disease. PAO has become a well-established treatment option for addressing dysplasia and, in some cases, acetabular retroversion. In these patients, abnormal hip mechanics frequently lead to intra-articular pathologic conditions such as labral tears and chondral injury. Based on the results of this systematic review, the prevalence of chondrolabral injuries at the time of PAO is substantial. The prevalence of labral tears identified through arthroscopy appears to be greater than that identified through arthrotomy.

Table 2. Study Characteristics and Findings

Study	Year	Osteotomies	Average Age (y)	Indication	All Inspected	Number Inspected	Findings	Labral Treatment	Femoral Treatment	Rationale for Joint Inspection	Inspection Type	Intra-Articular Revisions
Ginnetti et al.[10]	2013	151	25.5	Dysplasia	Yes	151	31 labral tears 129 cases of head-neck offset 7 loose bodies or cysts	Not reported	129 osteochondroplasties	All from 2002–2009	Arthrotomy	Not reported
Ross et al.[8]	2011	73	28	Dysplasia	Yes	73	Acetabulum 63 labral tears or degeneration 46 cases of labral hypertrophy 5 normal 48 labral tear 50 cases of chondromalacia 24 cases of malacia 13 cases of debonding 7 cases of cleavage 6 full thickness defects Femur 8 cases of chondromalacia 3 cases of malacia 3 cases of debonding 2 cases of cleavage	19 labral debridements 1 open labral debridement 12 labral repairs	6 osteochondroplasties	Mechanical symptoms	Arthroscopy	Not reported
Fujii et al.[13]	2011	121	37.5	Dysplasia	Yes	121	24 labral lesions 75 full-thickness labral tears 22 acetabular cartilage lesions 11 femoral cartilage lesions 69 acetabular subchondral bone exposures 33 femoral subchondral bone exposures	Not reported	Not reported	All	Arthroscopy	Not reported

(continued)

Table 2. Continued

Study	Year	Osteotomies	Average Age (y)	Indication	All Inspected	Number Inspected	Findings	Labral Treatment	Femoral Treatment	Rationale for Joint Inspection	Inspection Type	Intra-Articular Revisions
Nassif et al.[9]	2012	88	28.3	Dysplasia	No	51		6 labral repairs 5 labral debridements	40 osteochondroplasties	Not reported	Arthrotomy	4 labral repairs/2 osteochondroplasties 1 labral debridement
Thawrani et al.[15]	2010	83	15.6	Dysplasia	No	30	3 labral repairs 13 labral debridements		5 osteochondroplasties	MRI, positive impingement test	Arthrotomy	1 FAI and labral tear
Matheney et al.[14]	2009	135	26.7	Dysplasia	No	82	23 labral tears	22 labral debridements	Not reported	After September 1994	Arthrotomy	15 chondrolabral scope debridements
Siebenrock et al.[3]	2003	29	23	Acetabular retroversion	No	26	15 partial tears 11 complete tears 16 chondral lesions	2 labral debridements	24 osteochondroplasties	All patients late in the series	Arthrotomy	1 posterior impingement 1 FAI labral tear
Siebenrock et al.[11]	1999	75	29.3	Dysplasia	No	Not reported	15 labral tears	Not reported	Not reported	Not reported	Arthrotomy	2 labral resections

FAI, femoroacetabular impingement; MRI, magnetic resonance imaging.

In the report by Matheney et al.,[14] 82 of 135 hips underwent arthrotomy at the time of PAO. In this series, patients underwent routine arthrotomy after September 1994. Before that date, patients did not have arthrotomy performed for joint inspection. Twenty-two hips were found to have labral tears, and these patients were treated with labral debridement. Labral tears were not found to predict conversion to total hip arthroplasty in this series. Fifteen hips (11%) required hip arthroscopy in the postoperative period for labral or chondral lesions. Only one of the 15 patients had not undergone joint inspection at the time of PAO. Eleven of these patients improved after postoperative arthroscopy. In this study, it did not appear that joint inspection protected against repeated surgery for chondrolabral injuries. Although the present review is limited by the number of studies evaluating all joints at the time of PAO, arthroscopy appears to identify a higher percentage of labral tears than arthrotomy, 84% versus 21%. It is possible that many of the labral tears that required reoperation were present at the time of PAO but not identified.

Ginnetti et al.[7] recently reported their experience with PAO and intra-articular inspection. A group of 151 patients who had undergone PAO and underwent arthrotomy for joint inspection were retrospectively compared with a control group of 39 patients who did not undergo arthrotomy. Using revision PAO or conversion to total hip arthroplasty as the definition of failure, they found that the procedure failed in 8 (5.3%) of 151 patients who underwent arthrotomy compared with 7 (17.9%) patients who underwent nonarthrotomy procedures; this difference was not statistically significant. The authors acknowledged several limitations in comparing the 2 groups, including dissimilar cohorts and differences in follow-up. Although not the focus of this review, it is interesting to note the high rate of head-neck offset correction in the report by Ginnetti et al. In their report, 129 (85%) of 151 hips undergoing PAO had poor head-neck offset. Abnormal femoral morphologic features have the potential to engage a reoriented acetabulum. There is now some evidence showing that correcting femoral morphologic conditions can improve results after PAO by eliminating the potential iatrogenic cam or pincer impingement created by the index surgery.[12]

Nassif et al.[9] compared 40 patients undergoing PAO with femoral osteochondroplasty to a control group of 48 patients undergoing PAO alone at a minimum of 2 years. During the study period, one reoperation was required in the study group for a labral pathologic condition compared with 4 reoperations in the control group. This difference was not statistically significant ($P = .37$). All 5 patients improved after subsequent treatment, suggesting that labral pathologic conditions can impact outcomes after PAO.

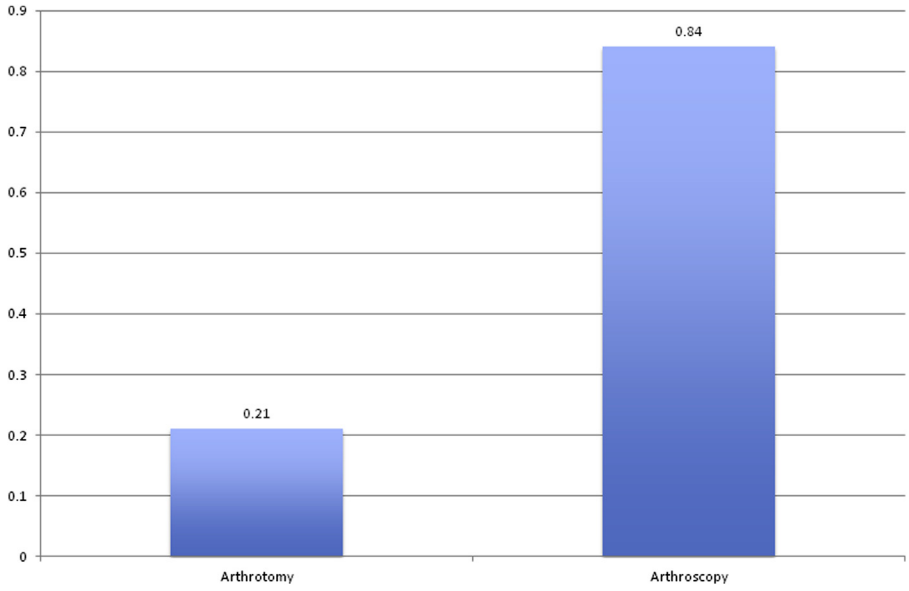

Fig 2. The prevalence of labral lesions identified using arthrotomy and arthroscopy during periacetabular osteotomy (PAO).

Of note, only 21 of 193 labral lesions across these 8 studies underwent labral repair. There is now good evidence that labral repair is preferable to labral debridement.[16,17] The labrum in dysplastic hips clearly has different morphologic characteristics than the labrum in hips treated for FAI; however, labral repair in this setting may be preferable to debridement and improve patient outcomes. Further research is needed to determine the effect of labral repair in this setting.

We believe hip arthroscopy may be ideally suited for joint inspection during PAO. It allows joint inspection before the surgical dissection required for osteotomy or capsulotomy. If this inspection yields a joint with significant degenerative changes, the osteotomy may be aborted in favor of later arthroplasty. It also stands to reason that arthroscopy will more effectively identify all concomitant intra-articular pathologic conditions present during PAO. Joint inspection by arthrotomy without joint distraction is likely less effective at identifying chondrolabral injuries than is arthroscopy, and the data from these 8 articles supports this. Only one article reported on chondral injuries identified by arthrotomy. This likely results from the inability to see the articular surface well by arthrotomy. Whether chondral defects treated with debridement or microfracture can improve results is yet to be seen.

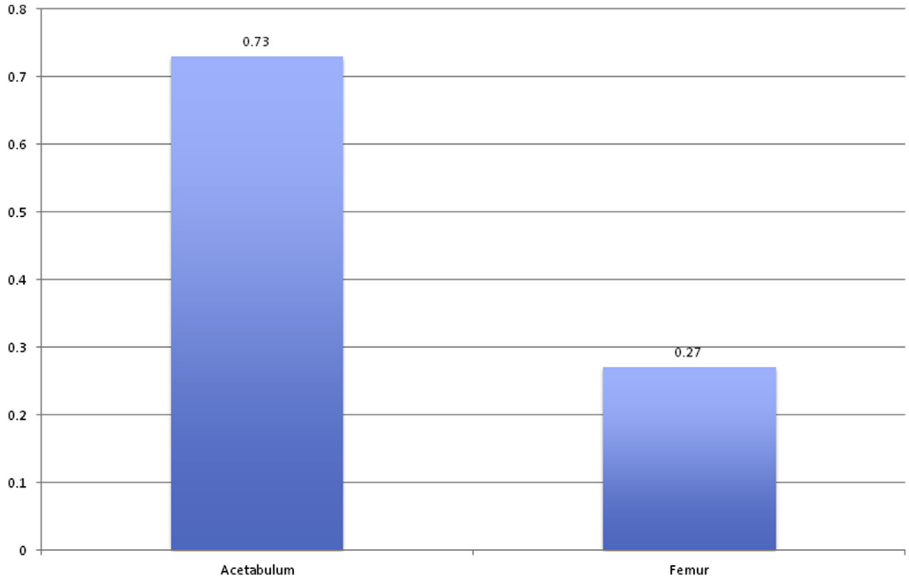

Fig 3. The prevalence of chondral lesions identified via arthroscopy involving the acetabulum and femur during periacetabular osteotomy (PAO).

Limitations

This systematic review is limited by a number of factors. The number of articles that report routine joint inspection during PAO is limited. The 3 articles identified as reporting intra-articular findings on all patients represented different populations and different methods of joint inspection. In the study by Ross et al.,[8] arthroscopic visualization during PAO was performed if patients had mechanical symptoms. It is impossible to know if these results are applicable to patients without mechanical symptoms. Nonetheless, this appears to be the best available data for determining the prevalence of intra-articular lesions during PAO. In the article by Ginnetti et al.[7] arthrotomy was performed without distraction of the hip joint, which likely alters the ability to identify chondrolabral injury. In the report by Fujii et al.[13] the arthroscope was introduced through an incision in the anterior capsule. Although this likely improves joint visibility, it may not provide visual access to the entire hip joint. Traditional hip arthroscopy was used in only one of the 8 identified studies.[8] The ability to identify intra-articular pathologic conditions is likely highly dependent on the method of joint inspection.

Conclusions

The prevalence of intra-articular damage including labral injuries and pathologic cartilage conditions at the time of PAO is substantial. Labral tears and chondral injury appear to be better recognized with concomitant arthroscopy compared with arthrotomy at the time of PAO. Further study is needed to determine whether the treatment of chondrolabral injuries can improve patient outcomes and reduce reoperations.

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