

Does the Nature of Chondrolabral Injury Affect the Results of Open Surgery for Femoroacetabular Impingement?

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Abstract

Background The degree to which patient characteristics, clinical outcomes, and the nature, severity, and corresponding treatment of chondrolabral injury in femoroacetabular impingement (FAI) is associated with failure after surgery is incompletely understood.

Questions/purposes (1) Are patient factors associated with failure (age, sex, body mass index, and preoperative modified Harris hip score [mHHS]) in the open surgical treatment of FAI? (2) Is the nature of chondrolabral injury associated with failure? (3) Are any specific chondrolabral injury treatment methods superior?

Methods Between 2000 and 2008, 172 open surgical procedures in 167 patients were performed for the treatment of FAI by two surgeons at two separate academic

medical centers. Ultimately, 142 patients were included in this retrospective study. Mean followup was 3 years (range, 1–12 years). Patient and clinical factors along with the nature, severity, and treatment of chondrolabral injuries were assessed for an association with failure, defined as conversion to THA or the inability to achieve the minimum clinically important difference of the mHHS. Thirty-two percent (45 of 142) of patients failed open surgical treatment of FAI.

Results Patient factors associated with failure included age (odds ratio [OR], 1.04; $p = 0.036$) and preoperative mHHS (OR, 4.42; $p = 0.033$). Neither the nature of the labral lesion nor the severity of the chondral lesion demonstrated a relationship with failure ($p > 0.05$). Surgically, labral refixation was associated with a decrease in the risk of failure (OR, 0.31; $p = 0.039$).

Conclusions We were unable to identify an increased risk of poor outcomes based on sex, body mass index, or severity of chondrolabral lesions. We did find an increased risk of poorer outcomes associated with age. Labral refixation was associated with a decrease in the risk of failure indicating that treatment methodology, rather than the nature of the chondrolabral injury, may be associated with clinical failure. Future studies will be needed to help determine optimal treatment strategies for chondrolabral injuries.

Level of Evidence Level IV, therapeutic study.

Each author certifies that he or she, or a member of his or her immediate family, has no funding or commercial associations (eg, consultancies, stock ownership, equity interest, patent/licensing arrangements, etc) that might pose a conflict of interest in connection with the submitted article.

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Each author certifies that his or her institution approved the human protocol for this investigation and that all investigations were conducted in conformity with ethical principles of research.

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Introduction

Femoroacetabular impingement (FAI) is a clinical diagnosis related to structural hip abnormalities and motion conflict leading to abnormal abutment of the proximal femur and acetabular rim during hip movement [15]. The

resulting impingement can lead to isolated labral damage or combined chondrolabral damage and has been shown to be a risk factor for development of osteoarthritis of the hip [5, 29]. Most studies regarding FAI to date have been single-surgeon case series with small sample sizes that have investigated clinical outcomes and factors associated with failure [3, 7, 9, 11, 21, 22, 27, 28]. To further investigate these relationships, we sought to assess similar outcomes using data from two separate institutions experienced in the treatment of FAI. This multicenter approach differed from previous studies in that the focus was specifically directed at determining whether the nature of the chondrolabral injury and its corresponding treatment were related to the ultimate clinical outcome.

Although there is general agreement that treatment of FAI should include correction of the underlying bony morphologic abnormality, the ideal treatment of associated chondrolabral damage has yet to be definitively established [5, 15, 16, 25, 29, 32]. Osseous abnormalities are typically treated with femoral and acetabular osteoplasty, but treatment of damaged labral tissue and hyaline cartilage is less standardized and includes multiple methods such as labral repair, débridement as well as hyaline cartilage resection, microfracture, or even neglect of the chondrolabral pathology [5, 10–12, 20, 33]. Moreover, the association of the nature, severity, and corresponding treatment of chondrolabral injury in FAI with improvement in clinical pain, function, and clinical failure has, to date, been investigated in relatively small numbers of patients [1, 12, 18, 30, 34]. Nevertheless, surgical management of chondrolabral injury in the setting of FAI has undergone rapid change. For example, labral refixation or reconstruction has become the standard of care in many communities although the evidence supporting this technique is relatively small [12, 18].

Thus, the purpose of this investigation was to determine what factors were associated with failure in the treatment of chondrolabral injury patterns and corresponding treatments. Specifically we intended to determine the following: (1) Are patient factors associated with failure (age, sex, body mass index, and preoperative modified Harris hip score [mHHS]) in the open surgical treatment of FAI? (2) Is the nature of chondrolabral injury associated with failure? (3) Are any specific chondrolabral injury treatment methods superior?

Materials and Methods

Between 2000 and 2008, 172 open surgical procedures in 167 patients were performed for the treatment of FAI by two orthopaedic surgeons (CLP, JP) at two separate academic medical centers. To be included in the study, we required a minimum followup of 12 months for each hip. Twenty-five

Table 1. Patient characteristics by lost to followup

Patient characteristic	Lost (n = 25)	Included (n = 147)	p value
Age (years), mean (range)	31 (18–51)	31 (14–56)	0.879
Sex, number (%)			
Male	20 (80)	88 (60)	0.073
Female	5 (20)	59 (40)	
BMI (kg/m ²), mean (range)	26 (19–37)	26 (18–37)	0.597
Preoperative mHHS, mean (range)	67 (53–75)	65 (14–96)	0.695

BMI = body mass index; mHHS = modified Harris hip score.

Table 2. Patient characteristic by failure

Patient characteristic	Failed (n = 45)	Survived (n = 97)	p value
Age (years), mean (range)	34 (14–56)	29 (15–52)	0.025
Sex, number (%)			
Male	25 (56)	59 (61)	0.552
Female	20 (44)	38 (39)	
BMI (kg/m ²), mean (range)	26 (19–37)	25 (17–37)	0.105
Preoperative mHHS, mean (range)	69 (29–96)	62 (14–77)	0.008

BMI = body mass index; mHHS = modified Harris hip score.

hips (14.5%) did not have sufficient followup and were deemed lost to followup (LTF). To treat progressive postoperative pain, three patients underwent conversion to THA before 12 months; these patients remained in the analysis. Hips that were LTF were similar in age, sex, and body mass index (BMI) to the patients included in the analysis (Table 1) and also had similar preoperative scores for the mHHS [7]. Excluding hips that were LTF, there were 147 hips (85%; 84 males, 58 females; mean age 31 years, range 14–56 years). To simplify the analysis, patients with bilateral hips had one hip randomly selected for inclusion resulting in 142 hips from 142 patients that were included in this retrospective study. The institutional review board at both institutions approved this study.

The clinical results were analyzed at a mean followup of 3 years (range, 1–12 years). Patients who failed treatment were similar in sex and BMI to those who did not (Table 2). However, patients who failed treatment were older ($p = 0.025$) and had greater preoperative mHHS scores ($p = 0.008$). All patients were diagnosed with FAI and presented with hip pain exacerbated with flexion activities such as sitting, squatting, or certain work-specific maneuvers. The impingement test, performed at 90° of flexion with internal rotation and adduction of the femur, produced pain in all patients [26, 31, 35]. Clinical results were graded using the mHHS obtained during routine

Table 3. The proportion of patients with each level of the Outerbridge grading system

Outerbridge classification	Proportion, number (%)
0	33 (23)
1	29 (20)
2	13 (9)
3	16 (11)
4	51 (36)

office visits by the resident, fellow, or physician assistant responsible for that visit. During the study period, the mHHS was collected at each institution preoperatively, at 6 months and 1 year postoperatively, and yearly thereafter as part of the standard of care.

The integrity of the chondrolabral tissue was assessed and damage was classified intraoperatively by the primary surgeons (CLP, JP). Labral and acetabular cartilage lesions were described using the clock classification system [5, 19]. Damage to the acetabular labrum or underlying articular cartilage was detected in all cases and was observed in the anterosuperior quadrant (12-3 o'clock) of the acetabulum at the region of abutment of the femoral head-neck junction against the acetabulum. The acetabular articular cartilage damage was graded according to the Outerbridge grading system of chondral injury (Table 3) and attention was visually assessed for delamination, including wave phenomenon-type lesions [2, 4, 23]. The nature of the labral lesions was classified as no labral lesion (24 of 142 [17%]), ossified labrum (24 of 142 [17%]), or as a labral tear (94 of 142 [66%]). For the purposes of this study, a labral tear was defined as any tear within the labrum including when the labrum is torn free from the underlying acetabular rim. There were 99 hips with both chondral and labral pathology. Of the remaining 43 hips, 19 had isolated chondral lesions, 20 had isolated labral lesions, and four patients with FAI had neither a chondral nor a labral lesion.

Open surgical treatment for FAI was performed using one of two surgical approaches between 2000 and 2008. Surgical approach was determined solely by surgeon preference at each institution; 59 hips were treated with surgical hip dislocation (CLP) and 88 hips were treated with a minianterior approach (JP) [9]. There was no difference in the mean age (29 years; range, 14–50 years versus 32 years; range, 15–56 years; $p = 0.122$), sex (53% versus 64% male; $p = 0.195$), or mean BMI (26 kg/m²; range, 17–36 kg/m² versus 26 kg/m²; range, 18–37 kg/m²; $p = 0.670$) between hips based on surgical approach.

Surgical dislocation was performed using techniques that have been previously described [14, 28]. The minianterior approach was performed through a modified Smith-Petersen approach with the patient lying supine [9].

The abductor muscles were left intact and an I-shaped anterior arthrotomy allowed visualization of the labrum and femoral head. Additional manual leg traction allowed a view of the articular labrum and the hyaline cartilage of the acetabular rim. More technical details can be found in a previous publication [9]. Patients were managed postoperatively according to the standard of care and treatment protocols at each institution.

Treatment strategies for chondral lesions were categorized as no treatment (nine of 119 [8%]), acetabular rim trimming (77 of 119 [65%]), or microfracture (33 of 119 [28%]). Labral lesions were treated with neglect if deemed appropriate (42 of 132 [32%]), débridement alone (11 of 132 [8%]), or labral refixation (79 of 132 [60%]). Fourteen patients without a diagnosis of a labral lesion underwent takedown of the labrum with subsequent repair.

To assess for factors related to failure, we chose to use methodology similar to that of Naal et al. [22] who reported on the largest midterm series of results for surgical dislocation in the treatment of FAI to date. Patient characteristics and outcomes between groups were assessed using the Wilcoxon rank sum test for the comparison of continuous data resulting from the nonparametric nature of the data as measured by the Shapiro-Wilk test. Chi-square, or Fisher's exact test when appropriate, was used to assess binary data. A Wilcoxon signed rank test was used to compare pre- and postoperative mHHS for all patients. To identify predictors of failure we performed a multivariable logistic regression analysis using failure as the dependent variable. Patients who experienced worsening pain and/or function with time and were converted to THA were considered as having failed treatment regardless of duration from initial surgery as were patients who were unable to meet the minimal clinically important difference of 20 points on the mHHS at last followup [7, 8]. With this definition of failure, 32% (45 of 142) of patients failed open surgical treatment of FAI. The independent variables were assessed in separate analysis depending on their relation to each individual research question: (1) age, sex, BMI, and preoperative mHHS; (2) nature of the labral pathology and Outerbridge classification. Interaction between labral pathology and the Outerbridge classification was added to the model but was not found to be significant and thus not included in the final model (all interactions, $p > 0.806$); and (3) treatment of the labral pathology, treatment of the chondral pathology, surgical approach, and year of surgery. Significance was assessed at the 0.05 level.

Results

Patient factors associated with failure included age (Fig. 1) and preoperative mHHS. For each year increase in age,

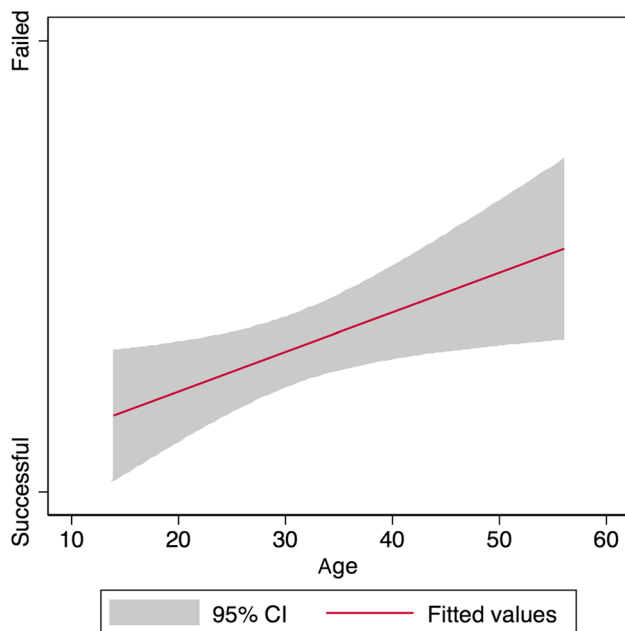


Fig. 1 This linear prediction plot demonstrates the increasing risk of failure with each increased year in age.

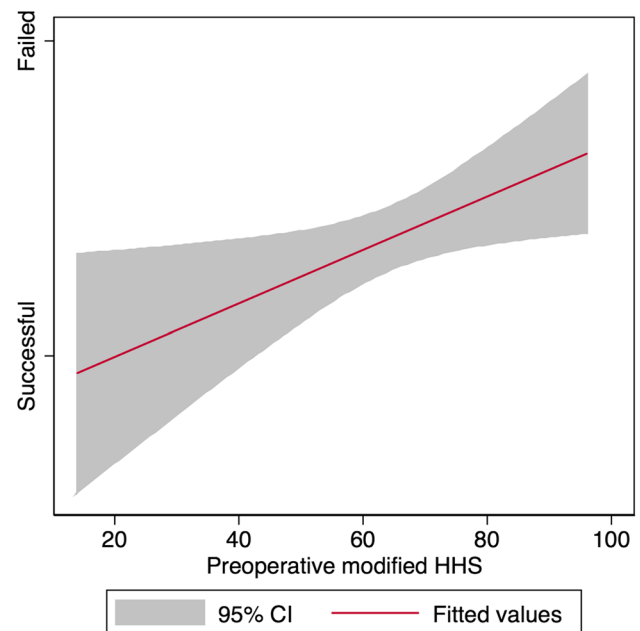


Fig. 2 Increased risk of failure with higher preoperative modified Harris hip score is shown on this linear prediction plot.

there was a 4% increased risk for failure (odds ratio [OR], 1.04; 95% confidence interval [CI], 1.002–1.07; $p = 0.036$). Failure was not associated with BMI (OR, 1.07; 95% CI, 0.98–1.18; $p = 0.138$) nor was there an increased risk of failure in females compared with males (OR, 1.55; 95% CI, 0.71–3.39; $p = 0.273$). Patients with a higher preoperative mHHS (Fig. 2) were more likely to fail (OR, 4.42; 95% CI, 1.13–17.27; $p = 0.033$). The median preoperative mHHS was 73 (interquartile range [IQR], 61–80) in patients who failed and 65 (IQR, 55–71) in patients who survived ($p = 0.008$). Overall, patients improved from a median preoperative mHHS of 66 (IQR, 55–73) to a median postoperative mHHS of 94 (IQR, 80–99; $p < 0.001$).

Neither the nature of the labral lesion nor the severity of the chondral lesion demonstrated a relationship with failure in this population of patients undergoing open surgical treatment of FAI (Table 4). Of the patients who failed, 29 of 45 (64%) had a torn labrum, six of 45 (13%) had an ossified labrum, and 22% (10 of 45) were noted as having no labral lesion. These proportions are similar to those who survived ($p = 0.447$) with 67% (65 of 97) having a torn labrum, 19% (18 of 97) an ossified labrum, and 14% (14 of 97) with no labral lesion. The proportions of Outerbridge classifications were also similar between failures and successes ($p = 0.175$; Table 5).

Surgically, labral refixation was associated with a decrease in the risk of failure (OR, 0.31; 95% CI, 0.10–0.94; $p = 0.039$). Apart from this, we found no other associations with failure in regard to surgical procedure,

approach, or year of surgery (Table 6). Of the patients who underwent labral repair, 76% (60 of 79) were successful, 73% (eight of 11) of the patients who underwent débridement were successful, and 60% (25 of 42) of patients in whom the labral lesion was neglected were considered a success. Patients treated with neglect of the labral lesion included 15 patients with an ossified labrum and 27 with a labral tear. Of the chondral lesions, 61% (20 of 33) of patients were treated with microfracture, 74% (56 of 77) were treated with rim trimming, and 56% (five of nine) of patients in which the acetabular lesion was neglected were deemed successes. Of the chondral lesions that were neglected, four had an Outerbridge grade of 1, one had an Outerbridge Grade 2, and two were classified as Grade 4.

Discussion

Chondrolabral lesions associated with FAI are believed to be the cause of early and progressive development of osteoarthritis [2, 5, 12, 30]. In addition to correction of the structural abnormality, management of chondrolabral injury may impact the outcomes of patients with FAI. We sought to identify clinical and surgical factors associated with treatment failure. More specifically, we wanted to assess whether the nature and severity of the chondrolabral pathology and the corresponding treatment methods were associated with failure, particularly because there is a paucity of literature supporting current treatment methodologies.

Table 4. Associations between the nature of chondrolabral lesions and failure

Lesion and Outerbridge classification	Odds ratio	95% CI	p value
Labral lesion			
None	Referent		
Ossified	0.37	0.10–1.41	0.146
Torn	0.57	0.21–1.52	0.261
Outerbridge classification			
Grade 0	Referent		
Grade 1	0.32	0.09–1.08	0.067
Grade 2	0.25	0.05–1.41	0.118
Grade 3	1.10	0.31–3.83	0.885
Grade 4	0.93	0.36–2.40	0.881

CI = confidence interval.

Table 5. Outerbridge classification between patients who survived and those who failed

Outerbridge classification	Survived (n = 97)	Failed (n = 45)
Grade 0, number (%)	21 (22)	12 (27)
Grade 1, number (%)	24 (25)	5 (11)
Grade 2, number (%)	11 (11)	2 (4)
Grade 3, number (%)	10 (10)	6 (13)
Grade 4, number (%)	31 (32)	20 (44)

This study has several limitations. First, this is a retrospective review of separate clinical databases at two institutions. Therefore, this study is subject to the inherent limitations of a retrospective analysis including the lack of complete data extracted from medical records. Additionally, it may suffer from treatment biases at individual institutions as well as differential LTF between the two sites. However, those patients LTF had similar patient characteristics and comparable mHHS scores at the pre-operative visit compared with the study population assessed (Table 1). The number of patients lost reflects nearly 15% of the potential study population and may have resulted in underreporting of outcomes and failure rates. For those patients who remained in the study, they were treated with two different surgical approaches (surgical dislocation and miniopen anterior approach) by two separate surgeons (CLP, JP) and there was no standardization of treatment strategies, postoperative management, or stringent classification systems before the study. Nevertheless, the two senior authors (CLP, JP) are experienced hip preservation surgeons with similar philosophical approaches to FAI treatment and classification and have previously collaborated on hip preservation-based studies [24]. Additionally, the comparison of treatment methodology included surgical approach in the model as a

Table 6. Association between surgical factors and failure

Surgical factor	Odds ratio	95% CI	p value
Labral treatment			
None	Referent		
Débridement	0.38	0.07–2.14	0.274
Refixation	0.31	0.10–0.94	0.039
Chondral treatment			
None	Referent		
Rim trimming	0.50	0.08–2.93	0.439
Microfracture	0.95	0.13–7.07	0.961
Surgical approach			
Minianterior	Referent		
Surgical dislocation	1.76	0.52–5.95	0.360
Year of surgery	1.08	0.43–0.69	0.668

CI = confidence interval.

covariate. An additional limitation is that the procedures were performed over an 8-year time period, during which there likely were improvements in surgical technique associated with increasing surgical experience. However, we included the year of surgery in the surgical analysis to account for the potential effect of a learning curve. Additionally, throughout the study period there was general agreement with both senior surgeons that labral preservation and retention of native acetabular hyaline cartilage were preferable.

Patient factors associated with failure previously reported in the literature have included poorer age and patient weight as having an increased risk for poorer outcomes [22, 30, 36]. We were unable to identify an increased risk based on sex or BMI; however, we did find an association between age and failure with each year increase in age resulting in a 4% increase in the risk of poorer outcomes including conversion to THA.

In this study, neither the nature of the labral lesion nor the severity of the chondral lesion demonstrated a relationship with failure. Specific to the severity of the chondral injury, other authors have reported a relationship between the severity of the chondral injury and treatment failure [3, 6, 13, 17]. These reports specifically describe large delaminated cartilage lesions as being associated with failure although specific treatment of these lesions was variably performed and reported. In the largest series of open treatment of FAI to date, Naal et al. [22] found that residual full-thickness cartilage defects requiring microfracture after rim trimming were predictive of subjective dissatisfaction. This report and the results of our study indicate that the type of chondral injury treatment may actually be a more important factor than the nature of the injury itself. Additionally, the experience of Naal et al. [22] and the results of this study emphasize that hip

survivorship or patient-reported outcome (mHHS) is dependent on a variety of factors including individual patient factors, injury subtype, and treatment methodology.

In 60 hips with FAI, Espinosa et al. [12] reported substantially better Merle d'Aubigné-Postel hip scores and less progression of degeneration on radiographs in hips that had undergone labral refixation compared with labral resection. Similarly, in a retrospective study of 94 hips comparing outcomes of labral refixation with an earlier cohort of labral débridement or excision, Larson et al. [18] found that labral refixation was associated with better mHHS, more good to excellent results, and less progressive hip degeneration at a mean 3.5-year followup. In the present study of 142 hips, we found labral refixation was associated with a decrease in the risk of failure, supporting and expanding on the findings of Espinosa et al. [11] and Larson et al. [18]. Thus, given that three separate studies using both open and arthroscopic techniques now support labral refixation or preservation to be superior to labral excision or débridement, the discussion should perhaps now move to identifying which techniques of labral refixation are preferable or more successful.

In conclusion, we were unable to identify an increased risk of poor outcomes based on severity of chondral lesions, sex, or BMI, although we did find a 4% increase in the risk of poorer outcomes with each additional year of age. We found that labral refixation was associated with a decreased risk of failure. Clearly there is much to be learned about treatment of chondrolabral lesions in hips with FAI. Future multicenter prospective studies with large cohorts will be needed to further elucidate the optimal treatment algorithm for patients with FAI with chondrolabral injury.

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