Consensus-based classification system for intra-operative management of labral tears during hip arthroscopy—aggregate recommendations from high-volume hip preservation surgeons

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This study was performed in accordance with the ethical standards in the 1964 Declaration of Helsinki. This study was carried out in accordance with relevant regulations of the US Health Insurance Portability and Accountability Act (HIPAA). Details that might disclose the identity of the subjects under study have been omitted. This study was approved by the IRB. (IRB ID: 5276)

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ABSTRACT

The purpose of this study was to survey high-volume hip preservation surgeons regarding their perspectives on intra-operative management of labral tears to improve decision-making and produce an effective classification system. A cross-sectional survey of high-volume hip preservation surgeons was conducted in person and anonymously, using a questionnaire that is repeated for indications of labral debridement, repair and reconstruction given the torn labra are stable, unstable, viable or non-viable. Twenty-six high-volume arthroscopic hip surgeons participated in this survey. Provided the labrum was viable (torn tissue that is likely to heal) and stable, labral debridement would be performed by 76.92% of respondents for patients > 40 years of age and by > 84% of respondents if the labral size was > 3 mm and located anteriorly. Presence of calcified labra or the Os acetabuli mattered while deciding whether to repair a labrum. In non-viable (torn tissue that is unlikely to heal) and unstable labra, labral reconstruction would be performed by 84.62% of respondents if labral size was < 3 mm. The majority of respondents would reconstruct calcified and non-viable, unstable labra that no longer maintained a suction seal. Surgeons performing arthroscopic hip labral treatment may utilize this comprehensive classification system, which takes into consideration patient age, labral characteristics (viability and stability) and bony morphology of the hip joint. When choosing between labral debridement, repair or reconstruction, consensus recommendations from high-volume hip preservation surgeons can enhance decision-making.
INTRODUCTION

In a patient who presents with hip or groin pain in the context of trauma, femoroacetabular impingement (FAI), capsular laxity/hip hypermobility, dysplasia or degeneration, there is a reported 22–55% prevalence of an associated labral tear [1–3]. Indeed, labral pathology represents an ever-increasing, common indication for hip arthroscopy. In the past, it was believed that the labrum had little functional importance and the appropriate treatment for symptomatic labral tears was excision [4]. However, within the last decade, there has been a paradigm shift away from the classical resection and/or debridement of symptomatic acetabular labral tears, and a move towards labral preservation [5, 6]. The inspiration for this change comes as a direct result of the better understanding of the anatomy, function and biomechanics of the hip joint, along with the development of advanced hip preservation techniques such as arthroscopic labral repair and labral reconstruction [6]. At its foundation, the main role of the labrum is to provide stability to the hip [7]. Its presence alone within the acetabular socket provides inherent stability, increasing the volume of the acetabulum by 33% [8]. Hip joint stability is a compromise between complementary static and dynamic forces that function in unison to maintain joint congruity throughout range of motion. Once labral injury is diagnosed, biomechanical evidence supports the role of restoring labral anatomy and architecture in reestablishing a more stable hip joint, with maintenance of a labral seal [9–11].

There is a plethora of studies describing improved patient-reported outcomes following hip arthroscopy in the management of intra-articular chondrolabral pathology [6, 12–16]. Existing knowledge supports labral preservation and, when appropriate, selective debridement or resection, in an effort to maintain functional hip mechanics [10, 15]. Currently, the Seldes classification is the gold-standard for the description of labral pathology; however, this classification only takes into consideration the location of the injury, either mid-substance or at the chondrolabral junction, without regard to the viability or stability of the pathologic tissue [8]. The purpose of this study was to survey high-volume hip preservation surgeons (performing >50 procedures per annum) [18–21] with regard to intra-operative decision-making of pathologic labra, including assessment of location, viability and stability. Consensus from expert surgeons’ preferred treatment strategies will lead to an algorithmic approach to labral preservation and reconstruction using a new classification system. It was hypothesized that labral debridement, repair or reconstruction, in the setting of labral pathology would be a case-specific, highly important resource of treatment among high-volume hip specialist orthopedic surgeons.

MATERIALS AND METHODS

In June 2019, a cross-sectional survey questionnaire was administered to high-volume hip arthroscopy orthopedic surgeons who attended XXX conference. Based on a previous high-volume hip arthroscopy surgeon consensus, high-volume was defined as an orthopedic surgeon who is performing more than 50 hip arthroscopy procedures annually) [18–21]. Although the questionnaire itself was not a validated questionnaire, it contained a list of relevant indications hip arthroscopy surgeons consider and have debated regarding intra-operative indications dictating the decision of labral treatment.

The survey asked a series of 24 questions three times, once each for three different indications: debridement, repair reconstruction. Thus, a total of 72 questions were asked per participant. Each set of 24 questions were subcategorized based on considerations of patient age, labral size, location of tear, tear morphology, color and consistency of the labrum, lateral coverage as measured by Wiberg’s lateral center-edge angle (LCEA), degree of cam morphology as measured by alpha angle, dynamic impingement testing and physical probing of the labrum (Supplementary Appendix). These attributes were selected as they were deemed to reflect the most relevant factors considered by arthroscopic hip surgeons during intra-operative decision-making for labral tear management. The questions were reported as multiple-choice questions, allowing for more than one choice with an additional section that allowed for a free text response. The participants completed their anonymous surveys either in-person or online.

The study was exempt from institutional review board approval because of the confidential and anonymous nature of the survey. Consent from each individual surgeon was obtained before participation. The lead surgeons (BGD (Benjamin G. Domb) and ACL (Ajay C. Lall)) developed the questionnaire for this study in consultation with the Institution Statistics Department. As it is a descriptive study of expert hip arthroscopy surgeon’s current practice, no statistical analysis was required.

RESULTS

A total of 26 high-volume hip preservation surgeons responded to the survey and all of them completed the survey (100% response rate). The results of the three surveys are shown in Table I and Fig. 1.
Across labral treatment types, 76.92% of respondents preferred performing labral debridement in older patients (>40 years of age), provided the labra were stable and viable. In contrast, >80% of respondents preferred performing labral repair or reconstruction in younger patients (≤40 years of age) when presented with a non-viable labrum.

When participants were asked to take into consideration labral size, 80.77% of respondents preferred to reconstruct labra <3 mm in thickness provided it was deemed unstable and non-viable. When labral thickness reached >3 mm, 84.62% of respondents elected to perform labral repair, provided the labrum was viable. Labral size did not seem
Labral tear location
Location did not seem to affect the decision-making of the respondents in terms of labral treatment grossly for debridement or repair. However, for a labrum that is unstable and of poor quality, 96.15% of respondents felt that the labrum would be more amenable to reconstruction if the tear is situated in the anterosuperior region compared with anterior or posterior locations.

Tear morphology
For tears located in the chondrolabral junction, most respondents (96.15%) preferred repairing the labrum. Tears found intra-substance were preferred to be either debrided by 84.62% of respondents, provided the labra were deemed stable and viable, or reconstructed by 84.62% of respondents, provided the labra were deemed unstable and non-viable.

Labral consistency
All respondents opted to repair labra that were non-viable yet stable and had normal-appearing tissue. The majority of respondents did not opt for labral reconstruction when the labrum had normal-appearing tissue. Reconstruction was more popular (92.31%) in cases of calcification of the labrum or in the presence of Os acetabuli (73.08%; Fig. 2).

Lateral center edge angle
Most respondents (88.46%) would only debride a labral tear in patients with an LCEA > 35°. However, a majority of participants would opt for repair or reconstruction of a labral tear in patients that not only have adequate acetabular coverage but also present with borderline dysplasia (LCEA 18°–25°), irrespective of labra viability. Patients with frank dysplasia (LCEA < 18°) were not considered candidates for hip arthroscopy by most respondents.

Alpha angle
Many respondents (84.62%) opted for debridement when there was no associated Cam deformity (alpha angle > 60°). Consideration for alpha angle was not greatly different in indicating treatment management for most participants when considering performing labral repair or reconstruction, so long as it could be addressed appropriately.
Fig. 2. Illustration of an arthroscopic view of the right hip showing (A) a shredded, non-viable labrum, (B) a labrum containing calcified deposits, (C) a labrum in close proximity to an Os Acetabuli and (D) a reconstructed labrum. Ac, acetabulum; c, calcified deposit; FH, femoral head; L, labrum; OA, Os Acetabuli; P, probe.

Fig. 3. Illustration of an arthroscopic view of the right hip showing (A) a viable and stable labrum amenable to debridement and (B) a viable but unstable torn labrum signified by architectural disruption by the probe, P. Ac, acetabulum; FH, femoral head; L, labrum.
Dynamic impingement testing
With a torn labrum, most respondents would perform labral reconstruction (88.46%) when the labral seal was absent. If the labral seal was present, surgeons (88.46%) opted to debride the labrum, provided the labra was stable or repair (80.77%) the labrum, provided it was unstable.

Labral probing
Debridement was preferred (88.46%) when the labrum was stable upon probing (Fig. 3). Respondents (88.46%) preferred repairing the labrum when the labrum was found to be unstable but viable (Fig. 4), whereas they (96.15%) preferred to reconstruct the labra when it was both unstable and non-viable. Approximately one-quarter of those who responded, would reconstruct a stable labrum (23.08%).

Consensus-based classification system
After analysis of the results, an algorithmic classification system for labral tear management was derived (Fig. 5). We chose key variables identified by consensus data (labral
tear morphology [location/severity], labral size and labral tissue viability) which showed the most consensus between surgeons in delineating when they would perform either labral debridement, repair or reconstruction depending upon whether the torn labrum is stable or unstable. Subcategorization of the variables was based on observed differences between consensus findings. For example, intra-operative decision-making for labral size differed between labra <3 mm vs. labra 3–5 mm or >5 mm but did not differ between labra 3–5 mm vs. >5 mm.

**DISCUSSION**

The findings from this consensus study based on the survey conducted, confirm that accurate arthroscopic diagnosis of the various physical attributes of a torn labrum along with certain patient demographic and radiographic information are vital in hip preservation surgery treatment decisions. This information helped derive a classification system that may aid in effective intra-operative management of labral tears by helping improve decision-making. Utilizing this comprehensive classification system (Fig. 5) along with the decision tree provided in the Venn diagram (Fig. 1), using patient specific attributes such as age, labral characteristics (viability and stability) and bony morphology of the hip joint; hip arthroscopic surgeons may choose appropriate labral treatment between debridement, repair or reconstruction.

In the setting of a stable and viable labra, the majority of respondents agreed to debride the labral tear if it was in a patient above 40 years of age and was considered of normal looking quality, posteriorly located or intra-substance (i.e. Type IIA1 or IIB1) provided the labral seal was intact, there was normal acetabular coverage and there was no associated cam lesion. If a significant cam lesion was found to be associated with the labral tear, the respondents preferred to restore the labrum either by repair or reconstruction while addressing the cam appropriately. In the setting of an unstable yet viable labrum, most respondents were in agreement to repair the torn labrum provided the patient’s age was below 40 years, the labrum was more than 3 mm in thickness, the tear was located anteriorly or near the chondrolabral junction, and the tissue was of normal quality (i.e. Type IA1), even if borderline dysplasia existed. Labral augmentation or reconstruction (segmental or circumferential) was the preferred approach by most of the respondents if the torn labrum was not viable and was unstable in nature. Moreover, respondents were more inclined to reconstruct the torn labrum if the labral thickness was less than 3 mm, the labrum being non-viable, that was calcified (i.e. type IB2 or IIB2), Os acetabuli was present, the tear was situated anterosuperiorly, or the labral seal was absent.

It was previously thought that the acetabular labrum was a vestigial remnant that, when damaged, caused ‘catching’ and ‘locking’ of the joint [22]. In order to prevent pain and overall sense of instability within the hip, historically, selective resection and labral debridement were the mainstay treatment for torn labrum. Analogous to the acetabular labrum, the history of the management of meniscal tears followed a similar course. Both structures are important in maintenance of a pressurized fluid layer that improves load distribution within the joint, thereby protecting underlying articular cartilage [23–25]. Long-term results of subtotal and total meniscectomy have been published showing clear progression to arthritis of the joint and inferior outcomes, recommended meniscal preservation approach, particularly in young patients with traumatic meniscal injury [26]. A similar trend emerged with regard to published patient reported outcomes following hip labral preservation by repair or reconstruction, having superior outcomes and lower conversion rates to total hip arthroplasty (THA), compared with patients who underwent segmental resection and or debridement [12, 27, 28]. However, with narrowed indications and appropriate patient selection, recent literature has shown labral debridement to produce patient outcomes comparable to labral preservation techniques [17, 29]. These indications came as a direct result of studies delineating the determinants of poor outcomes during labral management. Meftah et al. [13] showed that labral debridement in patients with residual post-operative cam type FAI produces inferior outcomes. However, when the underlying bony pathology is accurately managed, selective debridement can produce improved patient-reported outcome scores. Furthermore, a number of biomechanical studies that focused on labral suction seal which helps maintain a pressurized fluid layer, improving load distribution and overall stability within the hip joint, suggested that reduction of labral thickness may disrupt the physiological seal between the labrum and femoral head [25, 30–32]. Several other studies have shown an association between acetabular labral tears and early onset osteoarthritis. When the normal labral architecture is disrupted, contact stress between the acetabulum and femoral head may increase as much as 92% [33–35].

Philippon et al. [36] published a simplified algorithm for acetabular labral tears in 2012 based solely on intra-operative findings of the labrum. They advocated for debridement to be performed only if there was enough tissue to maintain normal labral function and repair/reconstruction of torn or detached labra. Herickhoff and Safran [37] also examined the surgical decision-making for labral repair and
debridement and found that intra-operative appearance of the labrum is the most important factor. They also realized that the indications to repair a torn acetabular labrum are highly variable among hip arthroscopic surgeons. Hence, this study attempts to simplify a complex subject into a comprehensive scheme for addressing labral tears. To further expand on the aforementioned studies, our expert consensus study describes indications for repair and reconstruction, as opposed to only labral debridement or repair. In cases where the labrum is found to be shredded, of poor consistency (i.e. calcified), or unstable, >80% of respondents believe other means of treatment should be sought in order to restore this suction seal relationship, consequently improving patient outcomes.

Labral reconstruction is a relatively new technique for addressing labral tears. Due to the technically demanding nature of the procedure, only few reports of short-term, let alone mid-term, outcomes are published to date [38–42]. Indications for labral reconstruction have revolved around labra that are non-viable and hence, not amenable to repair. What constitutes a non-viable labrum is not clearly defined within the literature. Maldonado et al. [31] performed the only consensus study specifically examining the indications, graft type and technique for labral reconstruction amongst high-volume hip preservation surgeons [18–21]. Similar to the present study, labra that were of poor tissue quality were indicated for labral reconstruction by the majority of respondents. Labra that previously failed repair or inadequate reconstruction were deemed non-viable and were also indicated for labral reconstruction. In addition, our study advocates for labral reconstruction in young adults with compromised labral consistency, as in cases of Os acetabuli or labral calcifications. Additionally, labral reconstruction was preferred (by >75% of respondents) if labral thickness is <3 mm, there is an absent labral seal, and/or the tear is located anterosuperiorly. Presumably, anterosuperior location of non-viable labra having an impact on decision-making may be due to the ease of joint access for accurate diagnostics earlier in the learning curve [43, 44]. Moreover, labral management was discouraged in patients with frank dysplasia, presumably because they are indicated for periacetabular osteotomy rather than isolated hip arthroscopy. When comparing a systematic review performed by Mana et al. [45] to one performed by Ayeni et al. [38], a trend of improvement in patient outcomes and decreased failure rates and/or conversion to THA within the last 5 years in patients undergoing labral reconstruction was revealed. However, the indications for performing the procedure (young, active adults with a ‘functional’ labrum) were yet to be fully elucidated. With more comprehensive indications for labral reconstruction via expert consensus, the field of hip preservation can theoretically expect more reproducible patient reported outcomes following this technically demanding procedure.

In summary, taking into consideration patient age, labral characteristics (viability and stability), as well as bony morphology of the hip joint, optimal surgical management of injured labra follow consensus-based algorithms. To expand on the current literature, this study presents a simple, comprehensive intra-operative diagnostic classification system (Fig. 5), based on consensus recommendations from high-volume hip preservation surgeons [18–21]. This novel system considers location (I or II), labral thickness (A or B) and viability (1 or 2). As an example, a labrum with an unstable tear pattern of chondrolabral separation, >3 mm residual thickness, and viable appearance would be considered a Type IA1 labrum, which is amenable to labral repair. Whether performing labral debridement, repair or reconstruction, we strongly believe this classification system can aid arthroscopic hip surgeons and enhance intraoperative decision-making, in an attempt to achieve reproducible improvements in patient outcomes.

Strengths

Given the expertise of study respondents, this study contains a number of strengths that should be highlighted. First, this is the first consensus study to collect aggregate recommendations of high-volume arthroscopic hip surgeons regarding indications for labral debridement, repair and reconstruction. Moreover, the circumstances for each management pathway were used to create an algorithmic classification system for labral pathology. The results of this study provide clinicians with consensus-based criteria readily applicable in the intra-operative setting.

Limitations

Inherent limitations of this consensus study exist and need to be acknowledged. The questionnaire used for survey purposes was not a validated one. This study presents opinions and the expertise of high-volume specialized arthroscopic hip surgeons, which are not necessarily generalizable. Though based on previous publications [18–21], the number of cases required to define a high-volume hip arthroscopy surgeon, was arbitrary and requires validation. Although there are several physical attributes of a torn labrum that were surveyed and could be considered, only three variables (Seldes type, thickness and tissue viability) were taken into consideration while coming up with the classification, which we agree is an important limitation of this study. However, we strongly feel that these are the most commonly studied attributes of a torn labrum, based
CONCLUSION
Surgeons performing hip arthroscopy for labral management may utilize the comprehensive classification system provided here, which takes into consideration patient age, labral characteristics (viability and stability) and bony morphology of the hip joint. When choosing between labral debridement, repair or reconstruction, consensus recommendations from high-volume hip preservation surgeons can enhance decision-making.

SUPPLEMENTARY DATA
Supplementary data are available at Journal of Hip Preservation Surgery online.

Data Availability
The data underlying this article will be shared on reasonable request to the corresponding author.

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This study was performed at the American Hip Institute.

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