Criteria for the Operating Room Confirmation of the Diagnosis of Hip Instability: The Results of an International Expert Consensus Conference

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Purpose: The purpose of this study was to establish an international expert consensus on operating room findings that aid in the diagnosis of hip instability. **Methods:** An expert panel was convened to build an international consensus on the

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operating room diagnosis/confirmation of hip instability. Seventeen surgeons who have published or lectured nationally or internationally on the topic of hip instability were invited to participate. Fifteen panel members completed a pre-meeting questionnaire and agreed to participate in a 1-day consensus meeting on May 15, 2021. A review of the literature was performed to identify published intraoperative reference criteria used in the diagnosis of hip instability. Studies were included for discussion if they reported and intraoperative findings associated with hip instability. The evidence for and against each criteria was discussed, followed by an anonymous voting process. For consensus, defined a priori, items were included in the final criteria set if at least 80% of experts agreed. **Results:** A review of the published literature identified 11 operating room criteria that have been used to facilitate the diagnosis of hip instability. Six additional criteria were proposed by panel members as part of the pre-meeting questionnaire. Consensus agreement was achieved for 8 criteria, namely ease of hip distraction under anesthesia (100.0% agreement), inside-out pattern of chondral damage (100.0% agreement), location of chondral damage on the acetabulum (93.3% agreement), pattern of labral damage (93.3% agreement), anteroinferior labrum chondral damage (86.7% agreement), perifoveal cartilage damage (97.6% agreement), a capsular defect (86.7% agreement), and capsular status (80.0% agreement). Consensus was not achieved for 9 items, namely ligamentum teres tear (66.7% agreement), arthroscopic stability tests (46.7% agreement), persistent distraction after removal of traction (46.7% agreement), findings of examination under anesthesia (46.7% agreement), the femoral head divot sign (40.0% agreement), inferomedial synovitis (26.7% agreement), drive-through sign (26.7% agreement), iliopsoas irritation (26.7% agreement) and ligamentum teres—labral kissing lesion (13.3% agreement). All experts agreed on the final list of 8 criteria items reaching consensus. **Conclusion:** This expert panel identified 8 criteria that can be used in the operating room to help confirm the diagnosis of hip instability. **Level of evidence:** Level V expert opinion.

Hip instability, defined as "extraphysiological hip movement causing pain," is increasingly recognized as a cause of nonarthritic hip pain and dysfunction, particularly in young patients and athletes.[1-6] The term "microinstability" has been used to reflect that instability that cannot easily be visualized, although concerns have been raised that this term may somewhat belittle the intrusive symptoms experienced by these patients. Therefore, to avoid ambiguity and to maintain consistency, the term "instability" is used throughout this article. However, to be clear, this article is referring to instability that is not hip dislocation. The underlying pathophysiology is complex and may result from various factors. These include (1) soft tissue deficiency or failure (such as collagen disorders, hypoplastic soft tissues, capsular injury, and labral failure); (2) bony factors (including dysplasia and version related abnormalities); and (3) exposure of the hip to supraphysiological conditions (related to activity).[7] At present, there is no currently accepted standard diagnostic criteria of this condition.[3] This ambiguity creates a barrier to clinical acceptance of this condition, limits patients understanding, and creates considerable challenges for researchers seeking to better understand its epidemiology, pathogenesis, and optimal treatment.

A number of challenges limit the ability to create clear diagnostic criteria.[3] In part, the dynamic nature of hip instability complicates the diagnosis as most available tools rely on static measurements. Moreover, the hip joint is deep, relatively constrained, and is surrounded by a thick soft tissue envelope making clinical evaluation difficult. Many patients have coexisting features of subtle dysplasia or impingement, adding further complexity to the clinical picture.[8,9] However, a number of examination findings and radiographic parameters have demonstrated associations with hip instability and may aid diagnosis. Physical examination tests include the abduction-hyperextension-external rotation test,[10] the prone instability test,[10] and the hyperextension-external rotation test.[10] Radiological findings include the femoroepiphyseal acetabular roof index,[1] the cliff sign,[9] the divot sign,[11] and a range of chondral and labral injury patterns on magnetic resonance imaging (MRI), in addition to the traditional center-edge angle of Wiberg, the anterior Center-edge angle of Lequesne, and the Tönnis angle (or roof slope or acetabular index).[12,13]

However, the reference criteria for diagnosis of hip instability has varied considerably between these studies and remains a considerable source of ongoing debate. As such, there is a pressing need for the development of "gold standard" criteria to confirm that the presumed diagnosis of hip instability is correct. The purpose of this study was to establish an international expert consensus on operating room findings that aid in the diagnosis of hip instability. It was hypothesized that there would be considerable variation in the methods used to confirm instability among experts but that consensus among experts on a number of operating room tests, maneuvers, and findings to aid the diagnosis of hip instability would be achieved.

Methods

Expert Panel

A working group of 4 senior hip arthroscopy surgeons (M.R.S., V.K., N.B., and M.B.) was established and convened an expert panel to establish consensus among

Table 1. Reported Operating Room Reference Criteria of Hip Instability

Criteria	Description	Publications using criteria
Stanford Criteria	1. Hip distraction under GA with body weight alone. 2. Adequate distraction of the hip joint with <11 turns of fine traction, equivalent to 44 mm of screw traction (MIS Hip Interventions table; Maquet, (Getinge Group, Getinge, Sweden). 3. Inability of the hip joint to fully reduce after release of negative intra-articular pressure and removal of traction. 4. Arthroscopic confirmation of instability, including: a. Tearing of the ligamentum teres b. Direct anterior labral tears c. Direct lateral labral tears d. Anterior inside-out chondral wear pattern.	Truntzer et al. AJSM 2019[1] Packer et al. OJSM 2018[9]
Ease of distraction and residual widening	Distraction <10 turns or residual widening (>3mm) after venting and release of traction	Shibata et al. KSSTA 2017[14] Kalisvaart et al. KSSTA 2017[2] Abrams et al. Arthroscopy 2017[15]
Force of distraction	No details provided	Kapron et al. OJSM 2018[16]
Traction force	"Displacement of the operative hip with minimal traction force"	Magerkurth et al. Arthroscopy 2013[17]
Distraction with gentle manual traction	Diagnosis confirmed by a hip that distracted under fluoroscopy with gentle manual traction – some distracting with two fingers pulling on the foot of the traction table.	O'Neil et al. AJSM 2020[18] Wylie et al. AJSM2015[19]

GA, general anesthesia.

a group of experts on operating room findings that aid in the diagnosis of hip instability. Each person in the working group was asked to select 3 or 4 surgeons world-wide who were considered experts in the field. For inclusion, experts must have published or lectured nationally or internationally on the topic of hip instability. A total of 17 experts were invited, with 1 individual declining participation. The working group aimed to have representation from across the world and deliberately chose people known to hold disparate views, representing as wide a spectrum of opinion as possible and included surgeons who evaluate and regularly treat patients with hip instability—through both open and arthroscopic approaches. Of these 16, one (B.D.) was unable to commit to being available on the day of the consensus conference but contributed by answering the preconference questionnaire and participated in the critical review of this article describing the conclusion of this consensus meeting. In total, 15 clinicians and academics from 7 countries on 4 continents participated in the process. The panel members had been in clinical practice for a mean of 19 years (range 10-31 years) and had been performing hip arthroscopies for a mean of 18 years (range 10-30 years). The average number of hip arthroscopies performed per annum by the panel was 263 (range 45-500 cases per year). Sixty-nine percent of panel members performed both open, as well as arthroscopic, hip surgery, with arthroscopy taking up 53% of the mean surgical cases performed by each surgeon (20%-95%). The panel members had been treating hip instability for a mean of 10 years (range 3-21 years), performing a mean of 74 (range 5-300) hip instability procedures per year. The panel included 6 past presidents of the International Society for the Hip Arthroscopy (ISHA), now known as ISHA—The Hip Preservation Society. All Authors were asked to declare competing interests.

Preliminary work

To inform the consensus meeting a literature search was performed by 2 authors (I.R.M. and M.R.S.) of relevant databases (PubMed and Cochrane Library), using the search terms "hip AND instability" and "hip AND microinstability" on May 6, 2021. Studies were included for discussion if they reported intraoperative findings associated with hip instability (i.e., once in the operating room, after induction of anesthesia, criteria used to confirm the diagnosis of instability, which can be before or after incision for arthroscopy). Clinical history or examination findings or the findings of imaging studies were excluded. These findings were only included if authors related the finding specifically to hip instability and not a concomitantly treated pathology.

Before the consensus meeting, experts were sent an electronic questionnaire to establish the criteria that they use to determine/confirm the diagnosis of hip instability in the operating room. Suggestions of additional observations or findings that may be of relevance were also solicited. A list of potential criteria for discussion at the consensus meeting was compiled from criteria described in the clinical literature and those currently used or proposed by the clinical experts.

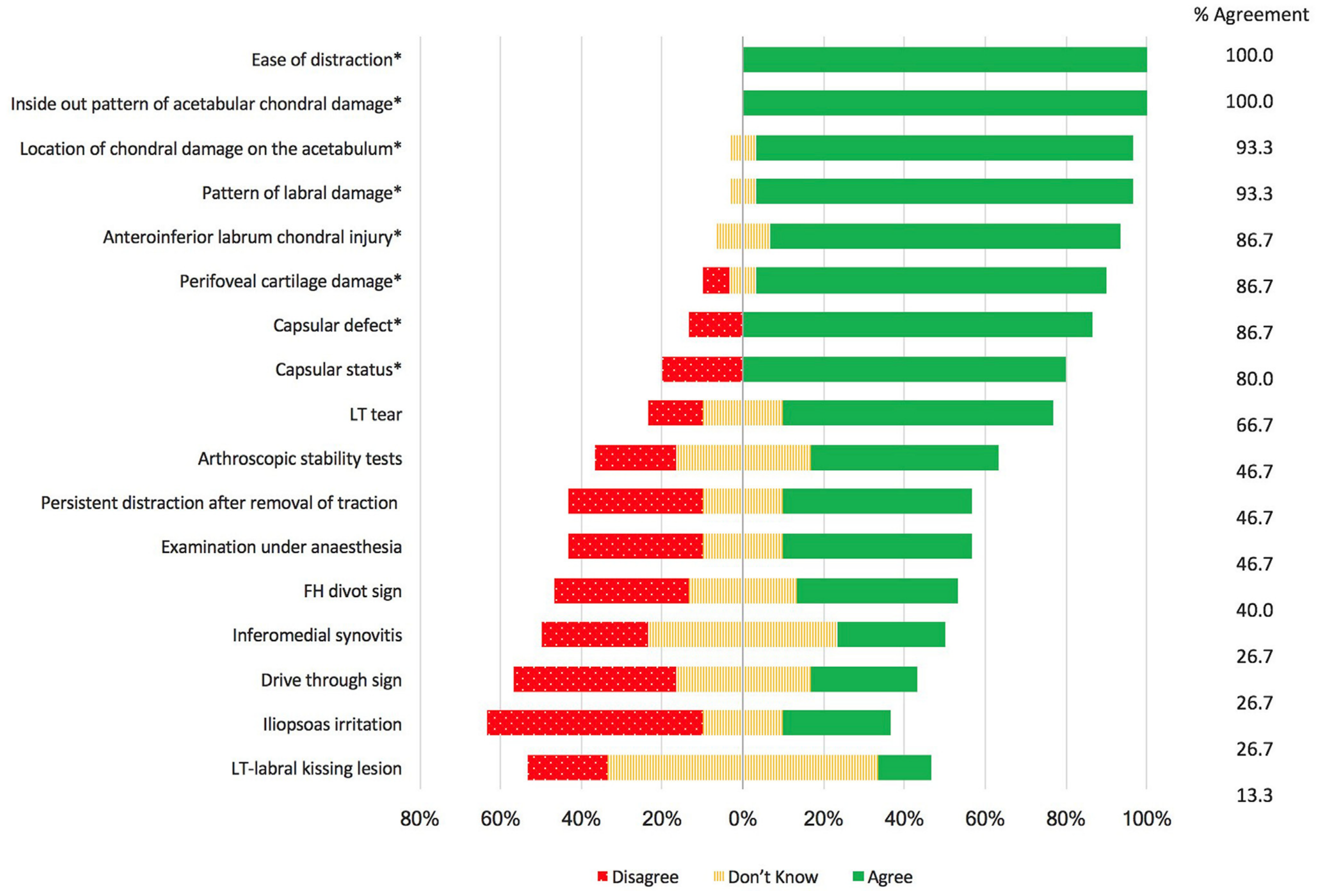

Fig 1. Levels of agreement with the inclusion of operating room findings in criteria for hip instability. LT, ligamentum teres; FH, femoral head.

Agreement Meeting

On May 15, 2021 (May 16, 2021, in Oceania), the panel met virtually on Zoom (San Jose, CA) to formulate the agreement. The meeting was chaired by M.R.S., who also participated in the consensus process, and transcribed by I.R.M., who was present as an

Table 2. Levels of Agreement With the Inclusion of Operating Room Findings in Criteria for Hip Instability

Criteria	Disagree (%)	Don't Know (%)	Agree (%)
Ease of distraction	0	0	100*
Inside-out pattern of acetabular chondral damage	0	0	100*
Location of chondral damage on the acetabulum	0	6.7	93.3*
Pattern of labral damage	0	6.7	93.3*
Anteroinferior labrum chondral injury	0	13.3	86.7*
Perifoveal cartilage damage	6.7	6.7	86.7*
Capsular defect	13.3	0	86.7*
Capsular status	20	0	80*
Ligamentum teres tear	13.3	20	66.7
Arthroscopic stability tests	20	33.3	46.7
Persistent distraction after removal of traction	33.3	20	46.7
Examination under anesthesia	33.3	20	46.7
Femoral head divot sign	33.3	26.7	40
Inferomedial synovitis	26.7	46.7	26.7
Drive-through sign	40	33.3	26.7
Iliopsoas irritation	53.3	20	26.7
Ligamentum teres−labral kissing lesion	20	66.7	13.3

*Items reaching minimum levels of agreement required to be considered consensus (≥80%).

Table 3. Criteria for the Operating Room Confirmation of the Diagnosis of Hip Instability

Ease of distraction
"Inside-out" pattern of chondral damage
Location of chondral damage on the acetabulum (straight anterior [3 o'clock], or straight lateral [12 o'clock])
Pattern of labral damage (including stretching of chondrolabral junction)
Anteroinferior labrum chondral damage
Perifoveal cartilage damage
Presence of a focal capsular defect
Capsular status (thickness and quality)

observer. The meeting was recorded to facilitate transcription. The findings of the review of the current literature of criteria used to confirm the diagnosis of hip instability, as well as the literature of the intraoperative findings associated with hip instability, were reviewed. Solicitation to assure the literature review was complete was confirmed by the participants. For each topic, the chairman facilitated a structured discussion of the existing literature and the experience of the panel members leading to a proposed wording for consideration. Panel members then voted on each item using an anonymous internet-based polling system (www.pollev.com; San Francisco, CA). For consensus, defined a priori, items were included in the final information set if at least 80% of the experts agreed.

Results

Preliminary Work

The published intraoperative reference criteria that have been used to define the diagnosis of hip instability identified through the literature search are outlined in Table 1. The published intraoperative findings that have been reported to be associated with hip instability are summarized in Appendix Table A1. Furthermore, additional criteria items put forward by experts as being used in their routine clinical practice to help confirm or guide the diagnosis of hip instability or as being of potential relevance (in addition to those published criteria noted in Appendix Table A1) are summarized in Appendix Table A2.

Developing a Tool To Confirm Diagnosis

The group discussed different systems that could be used to confirm diagnosis. These included a system in which a threshold of agreed criteria were met. Second, a system using "major" (needed for diagnosis) and "minor" (helpful but not mandatory) criteria was discussed. However, concerns were raised that there is currently insufficient evidence to set a defined number of criteria or to give an appropriate weighting or score to different factors. As such 100% (15/15 experts) agreed on the following statement: "While it is possible to establish a list of criteria that, based on current best evidence and clinical experience, are associated with hip instability, there is currently insufficient evidence to assign a scoring or weighting system to confirm diagnosis." All experts agreed that these criteria could then be used as a basis for further studies to refine a scoring or weighting system.

Criteria for the Operating Room Diagnosis of Hip Instability

Levels of agreement for inclusion of proposed items within criteria for hip instability are summarized in Fig 1 and Table 2. In a final poll, all experts agreed with the final list of items identified during this meeting as criteria for the operating room confirmation of the diagnosis of hip instability listed in Table 3. All experts agreed that this list can be used as a basis for further studies to refine a scoring system or weighting system.

Discussion

The most important finding of this international expert consensus conference was strong agreement on 8 criteria that can be used in the operating room confirmation of the diagnosis of hip instability. These included ease of distraction, inside-out pattern of chondral damage, location of chondral damage on the acetabulum, pattern of labral damage, anteroinferior labrum chondral damage, perifoveal cartilage damage, a capsular defect, and capsular status. This list can be used as a basis for further studies to refine a scoring system or a system of weighting to stratify relative importance of these criteria to the diagnosis of hip instability. By prospectively recording data relating to these items, investigators could stratify the relative

Table 4. Method of Assessing Ease of Distractibility in Clinical Practice Reported by Members of the Expert Group

"Pull-out test": Gross manual traction is placed on the operative leg. The distraction distance between the FH and acetabulum is then measured to determine the distraction distance. A pull length of 1.3 cm identifies those patients with hip instability.
Diagnosis confirmed by a hip that distracted under fluoroscopy with gentle manual traction—some distraction achieved with 2 fingers pulling on the foot of the traction table.
Distraction <10 turns of the investigator's specific traction device on their fracture table
Distraction of >1 cm achieved with 50 lbs of traction force
Distraction of >2 mm after venting joint with patient in a Trendelenburg position
Distraction achieved using body weight alone or with <10 turns
Quantification using tensiometer within boot
Quantification using tensiometer within postless traction table: level of distraction achieved with 25, 50, and 75 lbs of applied traction and compared to expected findings for patient of similar weight.
Intraoperative volume of injected fluid as surrogate of distraction (usually over 18-20 mL)
Ability to achieve distraction greater than half size of femoral head

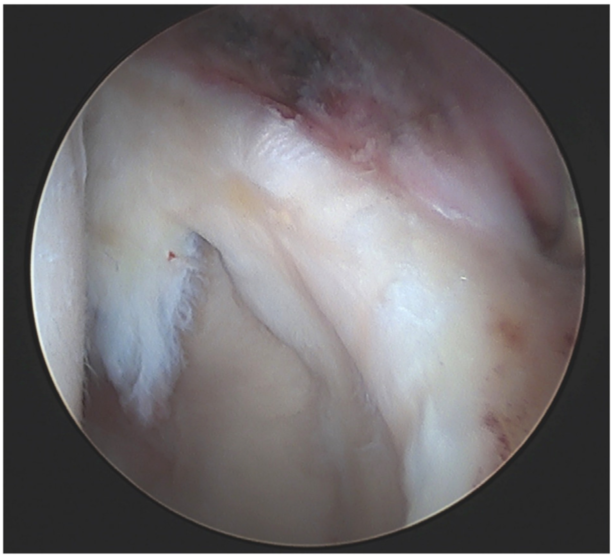

Fig 2. "Inside out" pattern of chondrolabral damage on the acetabulum in the setting of hip instability. A centrally originating chondral defect is seen with a contiguous chondrolabral sleeve extending peripherally. Left hip, viewing from anterolateral portal.

importance of these items to symptomatology and response to treatment. A discussion of each item considered by the expert panel is summarized below:

1. Ease of Distraction (level of agreement: 100% (15/15 experts)

Ease of distraction following induction of anesthesia is the most widely cited criteria used in the diagnosis of hip instability.[1,2,9,14-19] A range of ways to assess and quantify ease of distraction have been described in the clinical literature (Table 1), with further variations described by the expert group as being used in their clinical practice (Table 4). At present there is no universally accepted system, and current methods of assessing ease of distraction are largely qualitative. There are considerable challenges to establishing a universally applicable, valid and objective system of measuring ease of distraction. First, there are many factors that influence hip distractibility beyond intrinsic capsular laxity including patient size, level of muscular relaxation/paralysis, degree of Trendelenburg and time since commencement of traction. Second, and despite the introduction of tensiometers,[20] accurate measurement of applied force has been difficult to reliably and consistently assess between individuals and different traction table designs. Third, the degree of distraction is difficult to accurately measure as radiological assessment is influenced by the centering position of the X-Ray beam, screen magnification, and the distance of the cathode from the hip joint. Attempts to add fluoroscopic markers to the operative field have so far proved impractical. Finally, there is considerable variation in the surgical techniques used by surgeons with some not applying traction until after peripheral compartment work is completed and a capsulotomy has been performed.

It was deemed that although ease of distraction is a universally accepted criteria for hip instability, it is not possible to apply objective criteria for defining joint laxity at this stage.[3] Future studies should be conducted to establish a "normal distribution" of distraction for given traction forces using systems that can be applied universally across traction tables.

2. "Inside-out" pattern of chondral damage on the acetabulum (level of agreement: 100% [15/15 experts])

Characteristic patterns of acetabular chondral damage have been described in a range of hip conditions including hip instability.[13] In all subtypes of femoroacetabular impingement (FAI), there is conflict between the acetabular rim and femoral head-neck junction, thereby resulting in chondral and labral injury starting in the periphery of the joint and progressing centrally ("outside-in" mechanism).[21-24] In contrast, instability (and hip dysplasia) is marked by centrally originating chondral defects and a contiguous chondrolabral sleeve that may extend peripherally ("inside-out" mechanism) resulting from abnormal sheer forces within the joint (Fig 2).[13,25] The acetabular rim chondral damage has been shown to be narrower in patients with isolated instability and associated with tearing at the chondrolabral junction, differing from the intrasubstance tearing characteristic of FAI.[14]

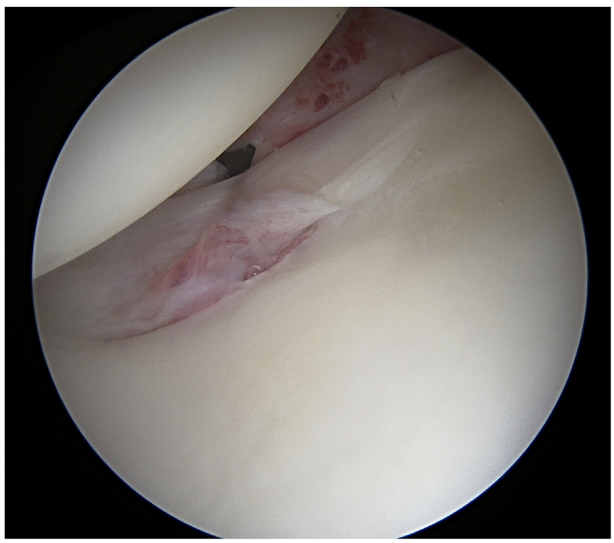

Fig 3. Straight anterior labrochondral injury. This lesion is in the region of the psoas notch which corresponds to the 3 o'clock position. Left hip, viewing from posterolateral portal.

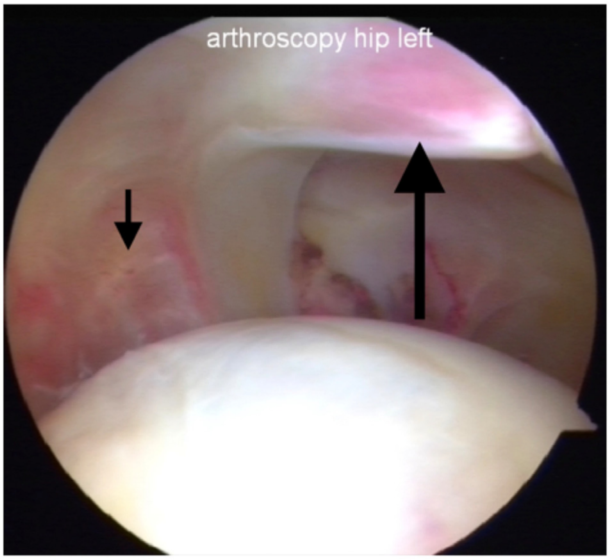

Fig 4. Arthroscopic image demonstrating synovitis of the labrum (*large arrow*) and psoas with bursitis (*small arrow*). Left hip, viewing from anterolateral portal.

3. Location of chondral damage on the acetabulum (level of agreement: 93.3% [14/15 experts])

The location of acetabular chondral injury can also provide a clue to the underlying cause.[3,26,27] Classically, patients with hip instability have chondral-labral damage straight anteriorly (3 o'clock position, in those with anterior deficient anterior acetabulum) (Fig 3) or straight laterally (12 o'clock position, in patients with a high Tönnis angle). This is in contrast to patients with FAI, where the damage is most frequently anterolateral.[14] This finding was observed in the clinical practice of almost all experts.

4. Pattern of Labral damage (level of agreement: 93.3.0% [14/15 experts])

Differences in acetabular labral damage patterns can be explained by considering their pathoanatomy.[13] In patients with cam type FAI, the nonspherical femoral head impinges on the acetabular rim as it forces itself into the acetabulum, thereby resulting in an outside-in chondral flap with disruption of the anterosuperior chondrolabral junction and cleavage along the corresponding portion of the articular cartilage.[22,28] Pincer-type FAI, however, is marked by diffuse intrasubstance labral pathology including hypoplasia and osseous metaplasia.[22,28] Hip instability and anterolateral migration of the femoral head can lead to chronic shear stresses between the femoral head and acetabular roof resulting in compensational labral hypertrophy.[29] However, this persistent shear stress may also lead to a labral tear with stretching out of the chondrolabral junction.[13,30] In these patients anteroinferior chondrolabral injury with or without synovitis is reported. Tears associated with the base of the labrum have been reported to be more common in patients with FAI, whereas tears associated with the body of the labrum were more common in those with severe dysplasia.[31] Furthermore, the frequency of articular cartilage damage adjacent to labral base tears was significantly higher than cartilage damage adjacent to labral body tears.[31] However, it is recognized that chronicity can influence pattern—with disease caught early only demonstrating a fraction of these features. A number of experts also reported observing increased labral synovitis at the level of the iliopsoas—thought to represent reactive change secondary to iliopsoas tendinitis occurring as a result of overload of this hip dynamic stabilizer (Fig 4).

5. Anteroinferior labrum chondral injury (level of agreement: 86.7% [13/15])

Experts agreed that a specific pattern of anteroinferior labral injury with associated chondrolabral injury and synovitis should be considered as a criteria for *hip instability*.

6. Perifoveal Cartilage Damage (level of agreement: 86.7% [13/15 experts])

Supraphysiological hip motion can result in characteristic wear or injury patterns on the femoral head, acetabulum, or labrum.[14] Cadaveric models have demonstrated that the central femoral head moves relative to the acetabulum in all planes at extremes of motion.[7,32,33] The increased motion of the central femoral head may place this region at particular risk in patients with instability, as the femoral head translates to, or over, the edge of the acetabular rim, potentially resulting in chondromalacia, or a shear injury to the

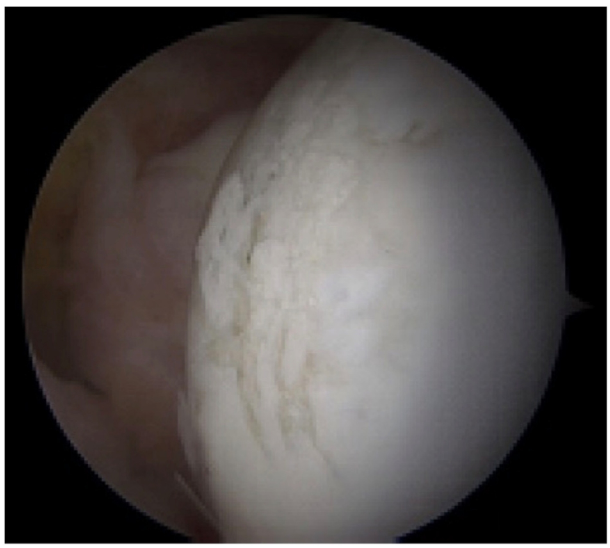

Fig 5. Perifoveal chondral damage. Central femoral head chondromalacia viewed from a posterolateral portal. Right hip, viewing from posterolateral portal.

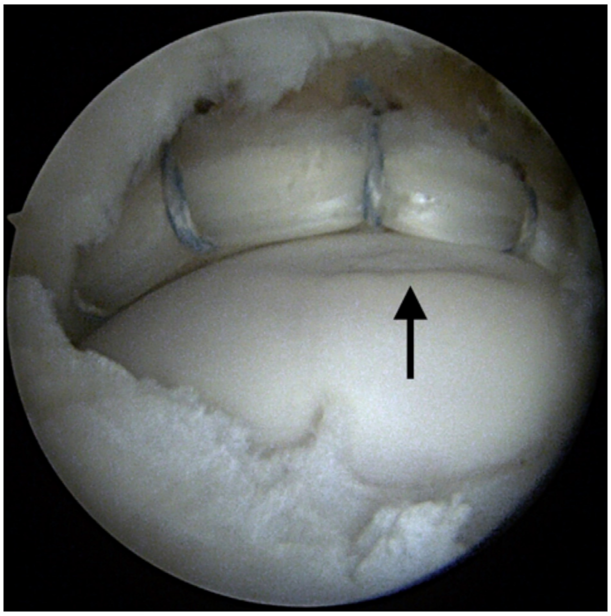

Fig 6. The femoral head divot sign. Characteristic appearance of the femoral head divot. The arthroscopic viewing portal is the anterolateral portal. After release of traction, upon reduction of the femoral head, with the hip in 60° of flexion and neutral rotation, the indentation (*arrow*) is seen lateral and parallel to the acetabular rim. Left hip, viewing from anterolateral portal.

central femoral head articular cartilage (Fig 5). Others have suggested that chondral damage in this central portion may reflect chondral elevation as the ligamentum teres is brought into tension. Emerging clinical data have revealed that perifoveal cartilage damage (also referred to as central femoral head chondromalacia) is prevalent in patients with hip instability and can represent a spectrum of chondral loss that begins in the central region of the femoral head, but delamination can extend into the periphery of the femoral head. This is in keeping with the clinical experience of many members of the panel. Although possible to visualize this pattern of chondral injury from a standard anterolateral viewing portal, it is perhaps most clearly seen through a posterolateral portal and so may be underreported in those performing 2-portal arthroscopy. Early data suggest that the presence of perifoveal cartilage loss is not associated with detrimental long-term outcomes once the instability has been addressed.

7. Capsular defect (level of agreement: 86.7% [13/15 experts])

Defects in the iliofemoral ligament increase femoral head translation and joint laxity.[34,35] Moreover, iliofemoral ligament defect size is associated with increased ease of hip distraction.[36] Capsular defects have been associated with hip dislocations and likely lesser degrees of instability.[3,27,37,38] The association between the presence of capsular defects and hip instability was recognized by almost all experts, particularly in the setting of revision arthroscopy.

8. Capsular status (thickness and quality) (level of agreement: 80.0% [12/15 experts])

A number of experts reported that they find the integrity of the capsule, particularly its quality and thickness at the time of arthroscopy, to be helpful in confirming the diagnosis of hip instability. Observations that may be indicative of hip instability include low resistance to portal introduction at the capsule, ease of cutting the capsule, increased intra-articular space or "patulous capsule," and decreased capsular thickness.

Cadaveric and MRI studies have provided a comprehensive analysis of hip joint capsular thickness a various points throughout the joint.[17,39,40] Devitt et al.[41] assessed capsular thickness at the anterolateral portal and demonstrated that generalized joint hypermobility was highly predictive of capsular thickness with a Beighton's score ≥4 correlating significantly with a capsular thickness of <10 mm in a series of 100 consecutive hip arthroscopies. Of note, they also found a higher rate of ligamentum teres (LT) pathology in those patients with a capsular thickness <7.5 mm and Beighton's score ≥4.[41]

In a study of 27 patients, Magerkurth et al.[17] reported that patients exhibiting displacement of the operative hip with minimal traction force had significantly thinner capsular distal to the zona orbicularis on axial sections on pre-operative magnetic resonance arthrography (MRA). This was confirmed in women by Packer et al.[42] In a dynamic MRI study, Blakey et al.[43] reported that capsular attenuation was most marked distally, beyond the zona, in a series of patients with clinical capsular deficiency.

A number of surrogate measures have been used to quantify capsular insufficiency. Waterman et al.[44] demonstrated that the volume of fluid contained within the capsule was reduced after T-capsulotomy with plication and interportal capsulotomy with capsular shift, suggesting that the capsule in these patients was relatively "slack" when compared to before the procedure. Experts within the group also reported using a measurement of the distance between the medial gutter and zona orbicularis, with distances greater than 25 mm considered "patulous" and correlating with higher intra-articular volumes of saline solution injected before insertion of the arthroscope.

9. LT tears (level of agreement: 66.7% [10/15 experts])

There is increasing acceptance that the LT contributes to the stability of the hip and has an important role in joint proprioception.[45] Recent biomechanical studies have shown that the LT plays an important role in limiting flexion, abduction, and internal and external rotation.[46,47] Studies have also demonstrated an association between instability and LT thickening[48] and LT tears.[15,49-51] It is thought that tears to the LT may result from chronic overload in the setting of hyperlaxity, instability, or chronic irritation such as seen in femoral head translations associated with FAI.[26]

LT tears may not always be appreciated on preoperative imaging, so it is important to assess for these injuries during arthroscopy. The incidence of complete LT tears at the time of all hip arthroscopies for various pathologies has been between 1.5% and 3.8% (7/1084) in a report by Cerezal et al.[49,52,53] However, partial tearing is more frequently seen in between 13.6% and 88% of cases.[49,52,53] Tearing of the LT has been associated with laxity, indicated by increased distraction on traction MRA,[49] capsular probing at arthroscopy[52] and dynamic evaluation at arthroscopy.[50] Cerezal et al.[49] stated the degree of distraction on traction MRA increased significantly with partial and complete LT tear compared with an intact ligament ($P = .001$) whereas Suter et al.[48] reported thickening of the LT in the group with positive distraction on traction MRA ($P < .05$).[48]

The LT may have a more important role in those who have risk factors for instability such as generalized hypermobility, osseous deficiency or capsular laxity. Alternatively, it has been proposed that atraumatic LT pathology may be a consequence rather than a cause of hip instability as LT hypertrophy and tearing are often present in hip dysplasia,[54] hip instability,[27,55] gymnasts,[56] and ballet dancers[57] and may be asymptomatic.[57]

The group discussed the intraoperative finding of LT tears as a criteria for hip instability. Although the majority of experts agreed that LT pathology was frequently noted in patients with instability, this sign was not very specific and can occur as a result of a range of pathologies. The group also felt that there was insufficient evidence to indicate bundle specific pathology relating to hip instability.

10. Arthroscopic stability tests (level of agreement: 46.7% [7/15 experts])

A number of experts indicated that they frequently perform arthroscopic stability tests to aid in the diagnosis of hip instability. These tests include the observation of femoral head subluxation with the hip in a position of flexion, external rotation, or in a dynamic assessment that includes rotation. Others raised concerns about the influence of a capsulotomy or joint fluid on interpretability of these assessments.

11. Persistent distraction after removal of negative pressure and release of traction (level of agreement: 46.7% [7/15 experts])

The presence of persistent distraction, after needle removal of intra-articular negative pressure and release of traction, before arthroscope insertion has been used as a sign to indicate hip instability.[1,2,9,10,15] To be considered pathological, the level of distraction must be greater than the distraction distance present before initial application of traction. Experts agreed that this sign is only valid if performed before insertion of the arthroscope and potential violation of the capsule. Of note, this sign had not been observed by members of the expert group using postless traction.

12. Findings of examination under anesthesia (EUA) (level of agreement: 46.7% [7/15 experts])

Approximately half of experts in the expert group routinely perform an EUA. Those performing an EUA cited findings that would increase their diagnostic suspicion of hip instability as including increased range of motion above expected, high Beighton's score in an anesthetized patient, reduced distance between the lateral joint line and table with the leg in a figure of 4 position, a positive log roll test with loss of elastic recoil, and maneuvers to assess for anterior distraction (anterior drawer) and distal distraction (telescoping). A number of experts stated that the findings of EUA added little diagnostic information to the examination performed in clinic. It was noted that because patients are not able to report symptoms, provocative tests under examination may indicate laxity but cannot directly be used to indicate instability.

13. Femoral head divot sign (level of agreement: 40.0% [6/15 experts])

Rosinsky et al.[11] recently described an arthroscopic finding of a linear chondral or osteochondral indentation on the anterior surface of the femoral head, running roughly in parallel with the acetabular rim and labrum. This indentation appears on the femoral head, just lateral to the labrum, with the hip in flexion and neutral rotation. On flexion and rotation of the hip joint, the divot can be seen entering under the labrum and into the functional joint (Fig 6). They observed this "femoral head divot sign" in 2.0% of cases in a series of 690 primary hip arthroscopies. All patients in whom the sign was observed had characteristic clinical or radiographic findings of hip instability. A number of explanations for this phenomenon have been proposed. One possibility is that in patients with instability, the femoral head subluxates from the acetabular socket and impinges on the acetabular rim at this location, with the repetitive edge loading leading to deformation of the femoral head in this location. In the setting of mixed type FAI, Philippon et al.[58] described a vertical chondral fissure located on the posterior femoral head termed a "crevasse" lesion in patients undergoing arthroscopy that appears distinct to this lesion described in hip instability.

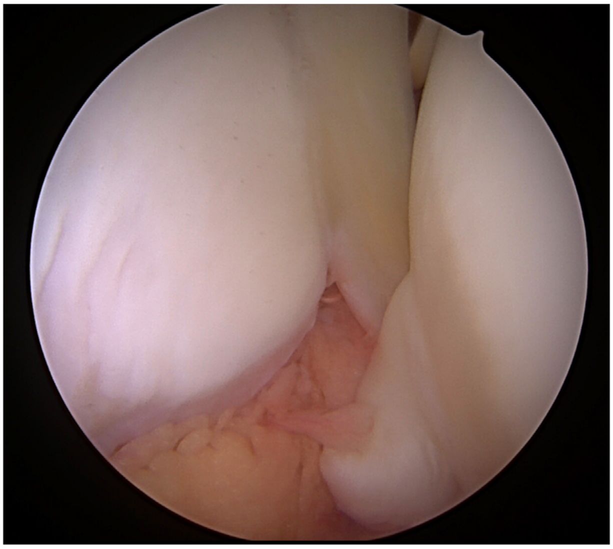

Fig 7. The drive-through sign of the hip. Positive drive-through sign is shown by the ease of maneuvering the arthroscope deep to the iliofemoral ligament on arthroscopy. Right hip, viewing from anterolateral portal.

14. Inferomedial synovitis (level of agreement: 26.7% [4/15 experts])

A number of experts reported observing a distinct inferomedial pattern of synovitis at the time of arthroscopy in cases of hip instability. It was noted that asymmetrical wear of the femoral head and/or acetabulum in osteoarthritis can lead to a form of instability with synovial inflammation observed in this setting.[59] In support of instability precipitating synovial inflammation, Abrams et al.[15] reported increased baseline levels of synovial inflammation in FAI and instability patients. However, they reported that synovial inflammation was most increased in those patients requiring increased force to achieve distraction at the time of surgery. Experts were in agreement that this was an area of interest requiring further study.

15. Drive-through sign (level of agreement: 26.7% [4/15 experts])

Similar to the drive-through sign described in knee and shoulder arthroscopy,[60,61] increased laxity of the hip capsule can be shown by the ease of passing an arthroscope between the femoral head and labrum at the level of the iliofemoral ligament (Fig 7).[62] Although this sign was first intended for use in the setting of iatrogenic instability, a number of experts found that, if present, a positive drive-through sign was helpful in confirming the presence of hip instability in patients without prior surgery. Although related to ease of distraction, this sign was considered by a number of experts to provide some objectivity in gauging distraction that can be individualized to patients.

16. Iliopsoas irritation (level of agreement: 26.7% [4/15 experts])

The iliopsoas musculotendinous unit is a recognized secondary stabilizer of the hip joint. In the setting of hip instability, iliopsoas tendinitis can occur because of compensatory loading.[26,37,63] However, in the absence of a capsular rent or fenestration, inflammation within the tendon can be difficult to identify at the time of arthroscopy, limiting its utility as an operating room criteria.

17. LT/labral kissing lesions (level of agreement: 13.3% [2/15 agreement])

LT—labral "kissing lesions" have been observed by one of the experts in patients with hip instability. With the patient on traction and the arthroscope viewing through the anterolateral portal, the hip is placed in maximal external rotation. In patients with hip

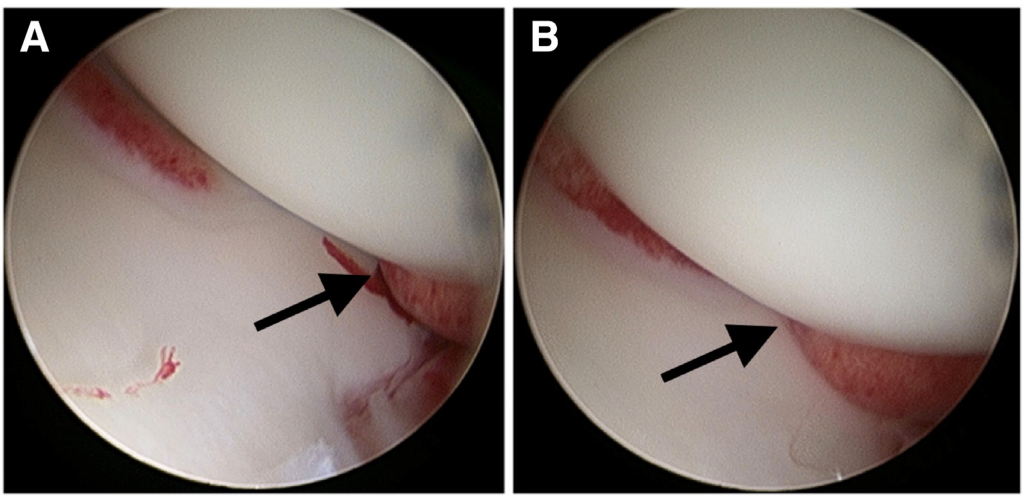

Fig 8. LT/labral kissing lesion. The "kiss" occurs in full external rotation. Arthroscopic images demonstrating the location of the "kiss" (*black arrow*) in neutral rotation (A) and in partial external rotation (B). Right hip, viewing from anterolateral portal.

instability, the expert noted an increased incidence of the LT reaching the level of the labrum with both the labrum and LT having corresponding areas of hypervascularity. Illustrative arthroscopic images of the location of the “kiss” are shown in Fig 8. Although this this sign did not reach the threshold of agreement for inclusion within the criteria for hip instability, all experts felt that it was worthy of further study.

Current ambiguity in the defining criteria for hip instability has limited clinical acceptance of this condition, restricted patient understanding, and created considerable challenges for researchers seeking to better understand its epidemiology, pathogenesis, and optimal treatment.[3] Although the ideal system for defining hip instability would include clear quantifiable thresholds for each criteria, experts accepted that data to inform the definition of such thresholds was not present for a number of criteria including ease of distraction and capsular status. As such experts agreed that proposing qualitative measures and thus highlighting the need for future refinements was preferable to establishing arbitrary thresholds not grounded on data.

The methods used in this consensus study sought to combine the benefits of group-based processes that enable interactive discussion, and the anonymity of online polling.[64] Furthermore, online methods are more likely to improve rather than jeopardize the quality of the consensus process, with greater flexibility for those involved, reduced cost and increased speed.[65] Seventeen experts were invited to participate in this process because published consensus studies using 9 to 23 experts have been shown to yield stable, reliable results.[66] Although Delphi methodology has some advantages over group-based consensus meetings, a live panel discussion was used here because it allows interactive discussion that can be helpful especially in clarifying complex concepts or gauging understanding of themes by members of the group. Furthermore, responses within Delphi studies can be limited by individual interpretation of wording of questions.

Limitations

The authors recognize that this study has some limitations. Panel consensus groups are at risk of bias in the selection of participants. It is also possible that individual biases relating to the involvement with industry may have influenced certain responses. The working group sought to minimize these risks by including experts from different backgrounds, working in a range of clinical settings, with representation from multiple continents.[67,68] Although as few as 10 experts are considered adequate for content validation,[69] a larger group was chosen to reduce the potential influence of any single individual. Additionally, threshold levels of agreement for consensus were set high. Although experts were drawn from throughout Europe, Australasia, and South America, the majority were based in North America, and this may limit how generalizable these findings are to international settings.

Conclusion

This expert panel identified 8 criteria that can be used in the operating room to help confirm the diagnosis of hip instability.

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Appendix Table 1. Operating Room Findings Associated With Hip Instability

Finding	Description	Publication
Pull-out test	Gross manual traction is placed on the operative leg. The distraction distance between the FH and acetabulum is then measured to determine the distraction distance. A pull length of 1.3 cm identifies those patients with microinstability.	Economopoulos et al. 2019[70]
Straight anterior and straight lateral labral pathology	Significant predilection of "straight-anterior" or "lateral" labral injury, characteristically a labral-chondral separation	Shibata et al. 2017[14]
Shallow width articular cartilage & 'inside-out' wear pattern	Chondral damage in acetabulum with wearing down pattern (inside-out pattern) 1 to 3 mm from the rim straight anteriorly and straight laterally	Shibata et al. 2017[14]
inside-out acetabular chondral injury	Chondral flaps exhibiting an intact chondrolabral junction with a detached sleeve of chondrolabral tissue from the central acetabulum	Kraeutler et al. 2019[13]
LT rupture	LT rupture associated with increased laxity at arthroscopy	Chahla et al. 2016[52] Martin et al. 2012 [50] Mei-Dan et al. 2012[71] Menge et al. 2016[72] O'Donnell et al. 2020[73]
FH divot sign	Linear chondral or osteochondral indentation on the anterior surface of the FH, running roughly parallel to acetabular rim and labrum.	Rosinsky et al. 2020[11]
Central FH chondromalacia	Central FH chondromalacia	Shibata et al. 2017[14] Pullen et al, 2021[74]
"Drive-through" sign	Ease of passing an arthroscope between the FH and labrum at the level of the iliofemoral ligament.	Levy et al. 2016[62]
Patulous capsule	"Patulous capsule"	Levy et al. 2016[62]
Capsular thickness	Capsular thickness <10 mm with Beighton's ≥ 4 and LT tear with capsular thickness <7.5 mm and Beighton's ≥ 4	Devitt et al. 2017[41]

FH, femoral head.

Appendix Table 2. Additional Criteria Items Put Forward by Experts as Being Used in Clinical Practice or of Potential Relevance to the Diagnosis of Hip Instability

Ease of distraction
Persistent distraction after traction released
Increased ROM
Stability stress testing (axial distraction examination)
Log roll (and recoil)
LT tear
Matching LT—labral kissing lesion
Perifoveal chondral damage
"Inside-out" chondral damage
Pattern of labral damage
FH divot
Capsular thickness
Capsular appearance ("patulous")
Arthroscopic stability test (excessive anterior FH translation with ER and other dynamic assessment)
Drive-through sign
Iliopsoas irritation
Intra-articular lesions not explained by FAI
Excessive inferomedial synovitis in absence of other pathology
Presence of a capsular defect in the setting of revision surgery

ROM, range of motion; EUA, examination under anesthesia; LT, ligamentum teres; FH, femoral head; ER, external rotation; FAI, femoroacetabular impingement.