

Recovery Trajectory and Patient Specific Predictors Following Periacetabular Osteotomy: A 24 Month Prospective Study

Vincent J. Leopold^{1, 2}, Stéphane Poitras³, Sasha Carsen¹, John Clohisy⁴, Ira Zaltz⁵, Michael Stover⁶, Ernest Sink⁷, Etienne Belzile⁸, Paul E. Beaulé¹

¹ Division of Orthopaedic Surgery, The Ottawa Hospital, Ottawa, Ontario, Canada; ² Charité, University Hospital Berlin, Center for Musculoskeletal Surgery, Berlin, Germany; ³ Faculty of Health Sciences, University of Ottawa, Ottawa, Ontario, Canada; ⁴ Washington University, St. Louis, Missouri, USA; ⁵ Beaumont Hospital, Royal Oak, Michigan, USA; ⁶ Northwestern Memorial Hospital, Chicago, Illinois, USA; ⁷ Hospital for Special Surgery, New York, New York, USA; ⁸ CHU de Québec, Université Laval, Québec, Canada.

Disclosures: Paul E. Beaulé (Code 5 Research or Institutional Support: Canadian Institutes of Health Research CIHR). All other authors: N.

INTRODUCTION: Although the hip joint is inherently stable due to the deep articulation between the femoral head and acetabulum, soft tissue structures, particularly the capsular ligaments and acetabular labrum, are critical for maintaining dynamic stability. When these stabilizing elements are compromised by conditions such as developmental dysplasia, connective tissue disorders, or iatrogenic injury, patients may experience subtle or overt instability. Several clinical and radiological indicators have been proposed for diagnosing atraumatic hip instability; however, the condition remains poorly defined and diagnostically challenging due to the absence of a definitive test and a universally accepted biomechanical framework. To address this gap, we conducted a Delphi consensus study with an international panel of experts to establish standardized clinical statements across three key domains: biomechanical and pathomechanical features of hip instability, clinical assessment strategies, and imaging characteristics relevant to diagnosis.

METHODS: A consensus study using the modified Delphi technique was conducted in accordance with the ACCurate CONsensus Reporting Document (ACCORD) guideline. The consensus meeting was held during the 15th Symposium on Joint Preserving and Minimally Invasive Surgery of the Hip, which took place in Quebec City, Quebec, Canada, in June 2025. The process involved a multidisciplinary steering committee and a diverse panel of 58 international participants representing nine countries across North America, Europe, and Australia. Following a scoping review, statements were developed addressing the biomechanics, clinical assessment, and imaging characteristics of hip instability. These statements were refined and voted on across two Delphi rounds using a structured online survey, with consensus defined as $\geq 75\%$ agreement. The Delphi process is illustrated in Figure 1.

RESULTS: Anatomic contributors to hip instability were identified through consensus, with bony morphology recognized as the primary factor. This was complemented by static stabilizers such as the labrum and joint capsule, and dynamic stabilizers including the surrounding musculature. Femoral head translation exceeding 3 mm was considered abnormal; however, current evidence was insufficient to clearly distinguish micro-instability from conventional instability. Three physical examination tests, the Abduction–hyperextension–external rotation (AB-HEER), prone instability, and anterior apprehension (HEER) tests, achieved consensus as clinically useful, along with additional assessments including physical characteristics and the Beighton score. Symptomatically, patients often reported anterior hip pain during daily activities, sitting, squatting, or sports, accompanied by mechanical symptoms such as popping, clicking, or grinding, and subjective feelings of looseness or instability. Female sex and borderline hip dysplasia were identified as key risk factors associated with atraumatic hip instability. (Results of imaging: up to 7 lines)

DISCUSSION: Hip instability biomechanically reflects an unpredictable trajectory of the femoral head relative to the acetabulum, driven by a complex interplay among bony morphology, capsulolabral integrity, and dynamic muscular control. Existing metrics for assessing instability remain heterogeneous and lack standardization, hindering consistent differentiation across the clinical spectrum. The concept of "micro-instability" remains poorly defined and should be applied with caution in both research and clinical settings. To enhance diagnostic precision, there is a need for repeatable, three-dimensional in vivo measurements of hip joint motion that can reliably distinguish physiological laxity from pathological instability. Clinically, individual physical examination tests assess distinct components of hip function. As such, the use of a combination of tests has been suggested to enhance diagnostic specificity and produce higher likelihood ratios. However, further research is warranted to assess intra- and inter-rater reliability and correlations between clinical findings and imaging-based assessments.

SIGNIFICANCE/CLINICAL RELEVANCE: The results of this consensus study offer guidance to support a more consistent and evidence-based evaluation of hip instability, aiming to reduce variability in future research and clinical practice.