Arthroscopic Treatment of Femoroacetabular Impingement in Adolescents Provides Clinically Significant Outcome Improvement

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Purpose: To define minimal clinically important difference (MCID) and substantial clinical benefit (SCB) for adolescents undergoing arthroscopic femoroacetabular impingement (FAI) surgery. **Methods:** A prospective institutional hip preservation registry was reviewed to identify hip arthroscopies performed for FAI. Patients with pre-existing hip conditions such as slipped capital femoral epiphysis and Legg-Calve-Perthese were excluded. Included patients were 18 years and younger. The modified Harris Hip Score (mHHS), the Hip Outcome Score (HOS), and the international Hip Outcome Tool (iHOT-33) were administered as part of the registry. MCID was calculated using a distribution-based method, and SCB was calculated using a physical function anchor question. Receiver operating characteristic analysis with area under the curve (AUC) was used for psychometric analyses. **Results:** Forty-seven adolescents were identified. The majority of patients were female (n = 32, 68.1%) with a mean age of 16.5 (±1.1) years. The MCID (% achieving) for the mHHS, HOS activities of daily living (ADL), HOS Sport, and iHOT-33 was 9.5 (85%), 9.8 (79%), 12.1 (85%), and 10.7 (94%), respectively. Ninety-two percent of adolescents reported some form of improved hip physical ability on the anchor question. The following 1-year absolute outcome scores were significantly representative of an SCB state on the mHHS, HOS ADL, HOS Sport, and mHHS, respectively (AUC): 93.5 (0.79), 98.5 (0.84), 96.9 (0.81), and 85.9 (0.76). **Conclusions:** Adolescents undergoing arthroscopic FAI surgery achieve clinically significant outcome improvement. We found that the vast majority of adolescents achieve MCID on hip-specific patient-reported outcome tools. However, although adolescents readily achieve MCID, a considerable improvement in postoperative outcome score is often needed to perceive a substantial benefit (SCB). The available hip outcome tools may be subject to ceiling effects for measuring clinically significant outcome improvement in adolescents. **Level of Evidence:** Level IV, case series.

Femoroacetabular impingement (FAI) is increasingly recognized as an important cause of hip pain and disability.[1,2] Arthroscopic treatment of FAI has been demonstrated to provide a high level of clinical success in adult populations.[3-5] Despite increased outcome reporting for FAI treatment, there has been a paucity of evidence on outcome for arthroscopic treatment of FAI in children and adolescents.[6]

Because of anatomic considerations and the technical challenges of performing hip arthroscopy in the pediatric hip, preliminary data for pediatric FAI has been focused on the safety profile of this surgical approach in children and adolescents.[7,8] Pediatric hip FAI outcome studies are limited. Philippon et al.[9] reported excellent early outcome in 16 adolescent athletes undergoing arthroscopic treatment of FAI. A follow-up study by Philippon et al.[10] reporting outcome on 60 adolescents noted significant outcome score improvement at 2-year follow-up. Similarly, Fabricant et al.[11] reported good outcome improvement in a series of 27 adolescents undergoing arthroscopic treatment of FAI. Although these prior studies have documented outcome improvement for arthroscopic treatment of FAI in the

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pediatric hip, relatively little is known about what constitutes clinically significant outcome improvement in this population.

Within the orthopaedic literature at large, there is increased interest in defining outcome score improvements that can be considered clinically significant and/or meaningful to the patient. The minimal clinically important difference (MCID) is defined as the lowest outcome difference that the patient perceives as clinically important.[12] As such, MCID is one of the more commonly reported measures of clinical significance.[13] As a complement to MCID, substantial clinical benefit (SCB) has also been derived and is now being increasingly reported.[14,15] In contrast to the minimum appreciable values associated with MCID, SCB is defined as the clinical value that the patient considers to be considerable.[15] In this respect, MCID and SCB can be considered complementary measures for defining a minimum and upper threshold for clinically significant outcome.

The purpose of this study was to define MCID and SCB for adolescents undergoing arthroscopic FAI surgery. We hypothesize that arthroscopic treatment of FAI in adolescents provides clinically significant outcome improvement.

Methods

Participants and Procedures

Data included in this study were obtained from a prospective hip preservation registry at our institution. Data access was approved by the Hospital's Institutional Review Board. Patients included in the registry between April 1, 2010, and October 15, 2014, were reviewed to identify adolescents undergoing arthroscopic treatment of FAI. All patients aged 18 years and younger were included. Patients with the following pre-existing hip conditions were excluded: slipped capital femoral epiphysis, Legg-Calve-Perthese, and protrusio acetabuli. Patients captured as part of the registry undergo a focused history, physical examination, and diagnostic assessment. Preoperatively, patients undergo multiple studies, which include radiographs with orthogonal views of the pelvis, computed tomographic (CT) scan of the pelvis with 3-dimensional reconstruction, and magnetic resonance imaging of the affected hip. CT-based FAI parameters are transcribed from the official attending radiologists' interpretation into the registry database. Commonly used measures of FAI[16-18] are recorded within the registry; these parameters include alpha angle, sagittal center-edge angle (CEA), coronal CEA, acetabular version at 1, 2, and 3 o'clock, and femoral version. Patients enrolled in the registry complete patient-reported outcome measures (PROMs), which are delivered preoperatively and at 1-year follow-up assessment. Included PROMs are the Hip Outcome Score activities of daily living (HOS ADL), HOS Sport, modified Harris Hip Score (mHHS), and the international Hip Outcome Tool (iHOT-33). The articular status of the femoral and acetabular cartilage is scored using Outerbridge scoring at the time of surgery.

Psychometric Analysis

MCID and SCB were used to define meaningful outcome improvement. We considered MCID as a floor or minimum threshold for meaningful outcome improvement whereas SCB is the upper threshold for clinical success.[15]

MCID can be calculated using a distribution, anchor, or consensus method.[12] As part of distribution-based analyses for MCID or minimal detectable change, statistical methods are used to calculate changes in outcome that represent minimal clinically significant change occurring beyond expected variance or error. Commonly used distribution-based methods used to derive minimal clinically significant outcome include calculations for the standard error of the mean (SEM) or ½ standard deviation.[19,20] As part of anchor-based methods, for calculating MCID, outcome scores are compared against an "anchor" question. An anchor question seeks to ascertain the degree of patient self-reported improvement, and these questions are often based in the physical function or global function domains.[21] Using a patient self-reported assessment for degree of improvement, anchor questions can be used to determine both MCID and SCB values.

In this study, we adopted a distribution-based method for MCID to maximize analytical power. A distribution-based MCID can be reliably derived using half the standard deviation of outcome scores for a given instrument within a study population.[20,22-25] As part of our distribution-based method, we calculated half the standard deviation for the change in preoperative to 1-year outcome scores for the HOS, mHHS, and iHOT-33 to obtain MCID values. SCB was calculated using an anchor-based method similar to previously published data.[15] Our anchor-based question was a domain-specific question for hip function after hip arthroscopy. Patients included in the hip preservation registry are asked the following question at 1-year follow-up: *Since your hip arthroscopy, how would you rate your overall physical ability?* As such this served as our anchor question. Patients' answer choices are as follows: no change, slightly worse, worse, much worse, slightly improved, improved, and much improved. As such, these responses served as our anchor responses. Patients indicating that they had no change, slightly improved, or slightly worse ($n = 9$) were used as controls, and patients indicating much improved ($n = 18$) were deemed to have achieved a considerable change that was consistent with SCB. Mean health state transitions were then calculated by determining the mean