A tiered system using substantial clinical benefit and patient acceptable symptomatic state scores to evaluate 2-year outcomes of hip arthroscopy with the Hip Outcome Score

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ABSTRACT

There is no information to define variations in hip arthroscopy outcomes at 2-year follow-up using the Hip Outcome Score (HOS). To offer a tiered system using HOS absolute substantial clinical benefit (SCB) and patient acceptable symptomatic state (PASS) scores for 2-year hip arthroscopy outcome assessment. This was a retrospective review of patients having hip arthroscopy for femoroacetabular impingement and/or chondrolabral pathology. On initial assessment and 2 years (±2 months) post-operatively, subjects completed the HOS activity of daily living (ADL) and Sports subscale scores. Receiver operator characteristic analysis identified absolute SCB and PASS HOS ADL and Sports subscale scores. Subjects consisted of 462 (70%) females and 196 (30%) males with a mean age of 35.3 years [standard deviation (SD) 13] and mean follow-up of 722 days (SD 29). SCB and PASS scores for the HOS ADL and Sports subscales were accurate in identifying those at a ‘nearly normal’ and ‘normal’ self-report of function and at least 75% and 100% levels of satisfaction (area under the curve >0.70). This study provides tiered SCB and PASS HOS scores to define variations in 2-year (±2 months) outcome after hip arthroscopy. HOS ADL subscale scores of 84 and 94 and Sports subscale scores of 61 and 87 were associated with a ‘nearly normal’ and ‘normal’ self-report of function, respectively. HOS ADL subscale scores of 86 and 94 and Sports subscale score of 74 and 87 were associated with being at least 75% and 100% satisfied with surgery, respectively. Level of evidence: III, retrospective comparative study.
INTRODUCTION

Outcome assessment in orthopedic surgery continues to evolve with an interest in the interpretation of scores obtained from patient-reported outcome measures (PROM) [1–4]. Studies have found that while desired outcome may be achieved within 6 months, improvements may continue for at least 2 years [5, 6]. This supports a 2-year follow-up as the acceptable time period to report on surgical outcomes. The Hip Outcome Score (HOS) is a PROM commonly used to assess the outcomes of hip arthroscopy for femoroacetabular impingement (FAI) and/or chondrolabral pathology, with procedures that include osteoplasty, labral repair/debridement and labral reconstruction [3, 7–10]. In a study that looked at the psychometric properties of commonly used PROMs after arthroscopic FAI surgery, only pre-operative HOS scores were found to be predictive of patient outcomes [11, 12]. While there is evidence to support the interpretation of scores obtained from the HOS [7, 11–18], there is no information to interpret scores and define variations in outcome at a 2-year post-operative follow-up interval. A tiered system to evaluate variations in 2-year outcome could be useful in health care systems that rely on ‘value-based care’ and ‘merit-based incentive payment systems’ to dictate reimbursement [1, 19, 20].

Determining if a patient has improved in their daily activities using scores obtained from PROMs can be done with minimal clinically important difference (MCID), patient acceptable symptomatic state (PASS) and substantial clinical benefit (SCB) values [15, 21–24]. MCID is defined as a change in outcome that represents the lowest improvement from pre-operative status that the patient perceives as important [2, 23, 25]. Whereas MCID is the minimal acceptable goal for clinical benefit [25, 26] change score for SCB represents an improvement in outcome from pre-operative status that the patient considers to be a considerable or substantial [11, 21]. There are also absolute scores to define SCB and PASS values that can be used as standalone assessments [11]. An absolute SCB score represents a health status that the patient would consider as excellent, while a PASS score is defined as a satisfactory outcome [27]. A disadvantage of the MCID is that it cannot be used as a standalone value. Also, MCID is typically determined using a statistical calculation and may be difficult to interpret due to variability in calculation methods [28]. PASS and SCB values seek to determine how meaningful the change in status is to the patient and represent the intermediate and upper threshold for clinically significant improvement, respectively [15]. A tiered approach may establish specific values that define degrees of normalcy and satisfaction in outcome from the patient’s perspective.

A single PASS score only represents whether the patient is satisfied or not with their outcome and does not give information about the level of satisfaction. Similarly, a single SCB value does allow for defining variations in how close the patient may be too normal. Absolute PASS and SCB values are available to interpret HOS activities of daily living (ADL) and Sports subscale scores at a 1-year outcome interval following hip arthroscopy [11, 13–15]. At 1-year post-hip arthroscopy for FAI, absolute PASS and SCB values for the HOS ADL subscale were found to be 87 and 93, respectively [11, 13]. PASS and SCB values for the HOS Sports subscale at 1-year were found to be 75 and 84, respectively [11, 13]. These single values do not define variations in outcome related to the patient’s perception of normalcy and satisfaction with their outcome. A tiered approach that establishes a number of stratified outcome scores to describe the degree of normalcy and satisfaction may be useful.

The purpose of this study was to offer a tiered system using absolute SCB and PASS scores for the HOS ADL and Sports subscales to assess post-operative outcomes of hip arthroscopy for FAI and/or chondrolabral pathology at a 2-year outcome interval. It was hypothesized that absolute SCB scores for the HOS ADL and Sports subscales would be accurate in identifying those at a ‘nearly normal’ and ‘normal’ self-report of function and PASS scores would be accurate in identifying those reporting being at least 75% and 100% satisfied with their surgery at a 2-year post-operative follow-up interval.

MATERIALS AND METHODS

This was a retrospective review of prospective collected data maintained in a secure electronic registry. The registry consisted of patients of seven independent surgeons who consented to undergo hip arthroscopy at one of seven centers between January 2015 and April 2017. Inclusion criteria specific to this study included subjects who underwent primary hip arthroscopy for FAI and/or chondrolabral pathology with pre-operative PROM available. Patients with dysplasia (<20° lateral center edge angle) or borderline dysplasia (20°–25°) lateral center edge angle were included in the study, at the surgeons’ discretion. Revision surgeries were excluded. The follow-up data were required to be collected 2-year (± 2 months) post-surgery. Exclusion criteria included conditions contra-indicated for arthroscopic hip surgery, such as those with primary lumbo pelvic pathology or hip arthrosis (Tonnis 1). An inability to read or understand English was also exclusion criteria for the registry. Data were collected and entered into the registry by the surgeon or clinical-research support personal. An investigator assessed data and applied the
inclusion and exclusion criteria for this study. The pre-hoc collection and storage of agreed upon clinical data points was granted according to individual institutional requirements and Institutional Review Board approval granted to review the de-identified registry of patient data.

Pre-operatively subjects were given PROM that included the HOS ADL and Sports subscales and a categorical self-rating of function to complete. For 2-year (± 2 months) follow-up data collection, subjects were emailed the HOS subscales, self-rating of current function and post-operative satisfaction visual analog scale (VAS) to complete between 670 and 790 days after surgery. The self-rating of function consisted the following question: 'How would you rate your current level of function?' The subjects had the following categorical responses to choose from: 'severely abnormal', 'abnormal', 'nearly normal' or 'normal'. The post-operative satisfaction VAS considered the following questions: 'What is your overall satisfaction with your surgery?' and was scored using a 100 mm horizontal line with the anchors defined as '0% satisfied' (0 mm) and the '100% satisfied' (100 mm). Demographic information was recorded from the electronic registry.

Psychometric analysis
Absolute SCB and PASS scores were calculated with anchor-based methods in similar fashion to that previously described [11, 12, 15, 29]. Absolute post-operative SCB and PASS scores were calculated with receiver operator characteristic (ROC) analysis calculating the area under the curve (AUC) at a 95% confidence interval (95% CI) [30, 31]. Absolute post-operative SCB scores were calculated to determine a score that would be associated with a self-report of being ‘nearly normal’ and a score associated with a self-report of being ‘normal’. PASS scores were calculated to determine a score that would be associated with a patient report of being at least 75% satisfied (≥75 mm) and a score associated with being 100% satisfied (100 mm) with surgery. The AUC of the ROC analysis defines the strength of association and the accuracy of the score in distinguishing between groups [31]. An AUC >0.7 and a 95% CI that does not contain 0.5 are considered acceptable levels of responsiveness [31–33]. Youden’s Index was used to optimize sensitivity and specificity values to identify HOS scores that are likely to represent a patient who reports the following: (i) ‘nearly normal’ function; (ii) ‘normal’ function, (iii) being at least 75% satisfied with surgery and (iv) 100% satisfied with surgery [34]. Demographic and outcome information, including mean 2-year HOS ADL and Sports subscales score for those with age >50 years, body mass index (BMI) >30 and Tonnis grade >0, as well as scores for males and females, were determined. Statistical analysis was performed using the SPSS software package (Version 24, SPSS Inc., Chicago, IL, USA).

RESULTS
Participants
Out of 723 eligible patients, 658 (91%) subjects met the inclusion criteria for this study and had follow-up outcome data available for analysis (Fig. 1). The mean follow-up time was 722 [standard deviation (SD) 29] days. Demographic information, including age, sex, BMI, diagnosis and procedures performed are presented in Table I. A total of 518 (77%) subjects had more than one procedure performed during hip arthroscopy, with femoroplasty and labral repair being the most common combination.

Psychometric results
Mean pre-operative and 2-year post-operative HOS scores, pre-operative and post-operative rating of function and those reporting at least 75% and 100% satisfaction with their surgery are presented in Table II. The results of the ROC analysis for absolute HOS ADL and Sports subscale scores associated with a ‘nearly normal’ and ‘normal’ ratings of function, and PASS scores for those reporting at least 75% and 100% satisfaction with their surgery are

Fig. 1. PRISMA flowchart.
presented in Table III. Absolute SCB and PASS scores for the HOS ADL and Sports subscales were accurate in identifying those at a ‘nearly normal’ self-report of function, least 75% satisfied, 100% satisfied and a ‘normal’ self-report of function at a 2-year (± 2 months) follow-up period as the AUCs were >0.70 with 95% CIs not containing 0.5. Mean 2-year (± 2 months) HOS ADL and Sports subscales score for those with age >50 years, BMI >30 and Tonnis grade >0 as well as scores for males and females are presented in Table IV.

**DISCUSSION**

The most important finding from this study is the tiered absolute SCB and PASS HOS scores that can be used to evaluate 2-year (± 2 month) outcomes in patients following hip arthroscopy for FAI and chondrolabral pathology. HOS ADL subscale scores of 84 and 94 and Sports subscale score of 61 and 87 were associated with a ‘nearly normal’ and ‘normal’ self-report of function, respectively. HOS ADL subscale scores of 86 and 94 and Sports subscale score of 74 and 87 were associated with being at least 75% and 100% satisfied with surgery, respectively. The hypothesis of this study was supported as these values were associated with a high degree of accuracy. Clinically this tiered approach may be useful as stratified HOS scores have been defined to help describe the magnitude of the normalcy and level satisfaction.

There has been increased interest in a ‘value-based care’ and ‘merit-based incentive payment systems’ in the United States [1]. In order to assess post-operative patient outcomes, a tiered evaluation system has been suggested to better reward value [1]. PROMs are a direct measure of outcome from the patient perspective and, therefore, offer important insight into improvement and health care value. This study provides absolute SCB scores for what a patient would perceive as ‘nearly normal’ and ‘normal’ function as well as PASS scores for being at least 75% and 100% satisfied with surgery. Because absolute SCB and PASS values are each associated with limitations and not mutually exclusive, outcomes may be best interpreted when multiple scores are used in combination to assess for variations in outcome [1]. The absolute SCB and PASS scores defined in this study may also provide a way to grade a range of meaningful outcomes and be helpful in managing patient expectations [14]. SCB may best represent the functional domain where PASS represents satisfaction in outcome. PASS may, therefore, be more dependent on factors, such as pre-treatment expectations as well as psychosocial and cultural issues [27]. As expected Sports subscale absolute SCB and PASS scores were lower than ADL subscale scores and a report of ‘nearly normal’ was lower than 75%

### Table I. Subject demographics

|                |            |
|----------------|------------|
| **Mean age**   | 35.3 years (SD 13) |
| **Sex**        |            |
| Female         | 462 (70%)  |
| Male           | 196 (30%)  |
| **Mean BMI**   |            |
| Male           | 25.3 (SD 10) |
| Female         |            |

### Table II. Pre- and post-operative HOS, rating of function and satisfaction with surgical outcome

|                | Pre-operative | 2-Year post-operative |
|----------------|---------------|-----------------------|
| **Mean HOS ADL** | 64 (SD 17)    | 86 (SD 17)            |
| **Mean HOS sports** | 39 (SD 21)   | 73 (SD 27)            |
| **Rating of function** |            |                      |
| Normal          | N = 5 (1%)    | N = 263 (40%)         |
| Nearly normal   | N = 114 (17%) | N = 265 (40%)         |
| Abnormal        | N = 416 (63%) | N = 117 (18%)         |
| Severely abnormal | N = 98 (15%) | N = 13 (2%)           |
| Missing         | N = 25 (4%)   |                       |
| **Overall satisfaction with surgery** |            |                      |
| At least 75% satisfied | N = 461 (70%) |                       |
| 100% satisfied   | N = 224 (35%) |                       |

ADL, activities of daily living; SD, Standard deviation.
satisfaction. However, it was expected an absolute SCB score for ‘normal’ function would be higher than being 100% satisfied with surgery. The demographics of the patients in this study, including a mean younger age, may explain why the patients seemed to equate 100% satisfaction with a complete return to a normal level of function.

The approximate 2-year follow-up time period used in this study has several important implications for health care policy and research. Previous studies found patients who undergo hip arthroscopy may show improvement for at least 2-year post-surgery [5, 6]. Specifically, Nwachukwu et al. [5] found while desired outcome may be achieved within 6 months, improvements may continue for at least 2 years. As the US health care system has shifted toward ‘value-based care’ and ‘merit-based incentive payment systems’, a tiered system may become important to evaluate PROM scores and outcomes over a period that allows a patient to achieve maximal improvement. Absolute SCB and PASS scores have been defined for the HOS at a 1-year post-operative follow-up period [11, 13–15]. A summary of the results from these studies are presented in Table V. This current study found the HOS ADL and Sports subscales PASS values for being 100% satisfied and SCB values for ‘normal’ function at 2-year follow-up were similar to the SCB of ‘much improved’ for primary FAI at 1-year follow-up. The HOS ADL and Sports subscale PASS values for being 75% satisfied found in this current study were similar to the PASS score found using the question ‘current state is satisfactory?’ Given the SCB and PASS values seem similar between the 1- and 2-year follow-up periods, future research may look to identify patient characteristics that could be used to identify those who are likely to improve, remain the same, or decline in status over time.

The mean HOS ADL and Sports subscales scores for the subjects in this study, of 86 and 74, respectively met the PASS score for being 75% satisfied. Subjects with an age >50, BMI >30 and Tonnis grade >0 had lower mean 2-year (± 2 months) HOS ADL and Sports subscale scores with scores not meeting the PASS score for being 75% satisfied. This agrees with previous studies that found age, chondral status and arthritis to effect SCB values in hip arthroscopy [35–41]. Revision surgery is known to affect SCB values [15]. Because of these subjects with satisfaction.

| Table III. Two-year absolute SCB and PASS values for the HOS ADL and Sports subscales |
|---------------------------------|--------|--------|------------------|------------------|
|                                | Score  | Sensitivity | Specificity | AUC (95% CI)     |
| HOS ADL                        |        |            |                |                  |
| SCB nearly normal              | 84     | 0.86       | 0.86          | 0.92 (0.90–0.94) |
| PASS 75% satisfied             | 86     | 0.85       | 0.74          | 0.87 (0.85–0.90) |
| PASS 100% satisfied            | 94     | 0.78       | 0.75          | 0.82 (0.79–0.85) |
| SCB Normal                     | 94     | 0.81       | 0.86          | 0.82 (0.79–0.85) |
| HOS Sports                     |        |            |                |                  |
| SCB nearly normal              | 61     | 0.88       | 0.88          | 0.94 (0.92–0.96) |
| PASS 75% satisfied             | 74     | 0.81       | 0.78          | 0.87 (0.84–0.90) |
| PASS 100% satisfied            | 87     | 0.76       | 0.76          | 0.83 (0.80–0.86) |
| SCB normal                     | 87     | 0.81       | 0.83          | 0.89 (0.86–0.92) |

AUC, area under the curve; CI, confidence interval.

Table IV. Average mean two-year HOS ADL and Sports subscale scores for those with age >50 years, BMI >30 and Tonnis grade >0 as well for males and females

| 2-Year mean HOS          | ADL   | Sports  |
|--------------------------|-------|---------|
| Age >50 years            | 78 (SD 26) | 60 (SD 33) |
| BMI >30                  | 80 (SD 21) | 65 (SD 29) |
| Tonnis grade >0          | 80 (SD 21) | 68 (SD 25) |
| Female                   | 86 (SD 17) | 73 (SD 27) |
| Male                     | 86 (SD 18) | 73 (SD 27) |

SD, standard deviation.


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| PASS 75% satisfied             | 86     | 0.85       | 0.74          | 0.87 (0.85–0.90) |
| PASS 100% satisfied            | 94     | 0.78       | 0.75          | 0.82 (0.79–0.85) |
| SCB Normal                     | 94     | 0.81       | 0.86          | 0.82 (0.79–0.85) |
| HOS sports                     |        |            |                |                  |
| SCB nearly normal              | 61     | 0.88       | 0.88          | 0.94 (0.92–0.96) |
| PASS 75% satisfied             | 74     | 0.81       | 0.78          | 0.87 (0.84–0.90) |
| PASS 100% satisfied            | 87     | 0.76       | 0.76          | 0.83 (0.80–0.86) |
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|--------------------------|-------|---------|
| Age >50 years            | 78 (SD 26) | 60 (SD 33) |
| BMI >30                  | 80 (SD 21) | 65 (SD 29) |
| Tonnis grade >0          | 80 (SD 21) | 68 (SD 25) |
| Female                   | 86 (SD 17) | 73 (SD 27) |
| Male                     | 86 (SD 18) | 73 (SD 27) |

SD, standard deviation.
revision surgery were excluded as not to confound the results of those undergoing primary hip arthroscopy. A tiered system for those undergoing revision hip arthroscopy could be investigated in further studies. The study did not analyse radiographic information, such as center edge angle[42], which also may play a role in outcome. As there is some controversy as to the effect of sex on outcome [5, 43–45], it was interesting that males and females had identical mean 2-year (± 2 months) HOS ADL and Sports subscale scores. In addition to age, BMI, chondral damage, arthritis, previous surgery, sex, radiographic findings, as well as other factors, such as smoking and mental health status should be investigated to see how they may directly alter the interpretation of SCB and PASS values [46, 47].

Table V. One-year follow-up absolute SCB and PASS values for Hip Outcome Score ADL and Sports subscales

| Authors               | SCB for primary FAI | Anchor              | ADL   | Sports  |
|-----------------------|---------------------|---------------------|-------|---------|
| Nwachukwu et al. [14] | SCB for primary FAI | ‘Much improved’     | 99    | 97      |
| Nwachukwu et al. [11] | SCB for primary FAI | ‘Much improved’     | 93    | 84      |
| Nwachukwu et al. [15] | SCB for revision hip arthroscopy | ‘Much improved’ | 88    | 86      |
| Chahal et al. [13]    | PASS for primary FAI| ‘Current state satisfactory’ | 87 | 75 |

CONCLUSION

This study provides tiered absolute SCB and PASS HOS scores that can be used to evaluate 2-year (± 1 month) outcomes in patients following hip arthroscopy for FAI and chondrolabral pathology. HOS ADL subscale scores of 84 and 94 and Sports subscale scores of 61 and 87 were associated with a ‘nearly normal’ and ‘normal’ self-report of function, respectively. HOS ADL subscale scores of 86 and 94 and Sports subscale score of 74 and 87 were associated with being at least 75% and 100% satisfied with surgery, respectively.

CONFLICT OF INTEREST STATEMENT

None declared.

REFERENCES

1. Bernstein DN, Nwachukwu BU, Bozic KJ. Value-based health care: moving beyond "minimum clinically important difference" to a tiered system of evaluating successful clinical outcomes. Clin Orthop Relat Res 2019; 477: 945–7.
2. Nwachukwu BU, Runyon RS, Kahlenberg CA et al. How are we measuring clinically important outcome for operative treatments in sports medicine? Phys Sportsmed 2017; 45: 159–64.
3. Renouf J, Pergaminelis N, Tran P et al. Prevalence and trends of patient-reported outcome measures used in hip arthroscopy. Orthopedics 2019; 42: e305–8.
4. Ramisetti N, Kwon Y, Mohladi N. Patient-reported outcome measures for hip preservation surgery—a systematic review of the literature. J Hip Preserv Surg 2015; 2: 15–27.
5. Nwachukwu BU, Chang B, Adjei J et al. Time required to achieve minimal clinically important difference and substantial clinical benefit after arthroscopic treatment of femoroacetabular impingement. Am J Sports Med 2018; 46: 2601–6.
6. Lund B, Mygind-Kløv sen B, Gronbech Nielsen T et al. Danish Hip Arthroscopy Registry (DHAR): the outcome of patients with femoroacetabular impingement (FAI). J Hip Preserv Surg 2017; 4: 170–7.
7. Kemp JL, Collins NJ, Roos EM et al. Psychometric properties of patient-reported outcome measures for hip arthroscopic surgery. Am J Sports Med 2013; 41: 2065–73.
8. Kierkegaard S, Langeskov-Christensen M, Lund B et al. Pain, activities of daily living and sport function at different time points

Limitations

While this study represents a large multicenter study, there are a number of limitations that need to be acknowledged. These findings are only applicable to English speaking patients who underwent surgery for FAI and/or chondrolabral pathology at a 2-year (± 2 months) follow-up period. This study is also limited to the anchor-based questions and response for self-reported level of function and VAS for post-operative satisfaction used. Other methods to determine SCB and PASS values may provide different results. Additionally, only subjects with complete data sets were included and a majority of subjects were female which could introduce bias and affect the results. It also should be noted absolute SCB and PASS scores are only estimates and will have some error associated with them. A description of PASS and SCB values were intended to be at a 2-year follow-up time period. However, the average response was slightly <2 years as subjects had a 2-month window before and after their 2-year post-operative date to complete their PROM information. Finally, the HOS is only one of several PROMs that have been used for hip pathology. Although the HOS has been the subject of rigorous psychometric evaluation, there are other PROMs suitable for a population following hip arthroscopy for FAI.
after hip arthroscopy in patients with femoroacetabular impingement: a systematic review with meta-analysis. Br J Sports Med 2017; 51: 572–9.

9. Erickson BJ, Cvetanovich GL, Frank RM et al. International trends in arthroscopic hip preservation surgery—are we treating the same patient? J Hip Preserv Surg 2017; 2: 28–41.

10. Sim Y, Horner NS, de Sa D et al. Reporting of non-hip score outcomes following femoroacetabular impingement surgery: a systematic review. J Hip Preserv Surg 2015; 2: 224–41.

11. Nwachukwu BU, Chang B, Fields K et al. Defining the “substantial clinical benefit” after arthroscopic treatment of femoroacetabular impingement. Am J Sports Med 2017; 45: 1297–303.

12. Martin RL, Philippon MJ. Evidence of validity for the hip outcome score. Arthroscopy 2017; 33: 1812–8.

13. MacLean C. Value-based purchasing for osteoarthritis and total knee arthroplasty: what role for patient-reported outcomes? J Am Acad Orthop Surg 2017; 25: 555–9.

14. Goldman AH, Kates S. Pay-for-performance in orthopedics: how we got here and where we are going. Curr Rev Musculoskelet Med 2017; 10: 212–7.

15. Glassman SD, Copay AG, Berven SH et al. Defining substantial clinical benefit following lumbar spine arthrodesis. J Bone Joint Surg Am 2008; 90: 1839–47.

16. Katz NP, Paillard FC, Ekman E. Determining the clinical importance of treatment benefits for interventions for painful orthopedic conditions. J Orthop Res Surg Res 2015; 10: 24.

17. Kwien TK, Heiberg T, Hagen KB. Minimal clinically important improvement/difference (MCII/MCID) and patient acceptable symptom state (PASS): what do these concepts mean? Ann Rheum Dis 2007; 66: ii40–1.

18. Harris JD, Brand JC, Cote MP et al. Research pearls: the significance of statistics and perils of pooling. Part 1: clinical versus statistical significance. Arthroscopy 2017; 33: 1102–12.

19. Larson CM. Editorial commentary: patient-related outcome measures, minimal clinically important differences, and substantial clinical benefits for adolescent hip arthroscopy: making progress with outcome measures or unquestionably spinning out of control? Arthroscopy 2017; 33: 1819–20.

20. Briggs KK. Editorial commentary: outcomes after hip arthroscopy—am I better, improved, or who knows? Arthroscopy 2019; 35: 417–8.

21. Nwachukwu BU. Editorial commentary: PASSing the test versus acing it: understanding clinically significant outcome improvement in arthroscopic hip surgery. Arthroscopy 2019; 35: 1463–5.

22. Schwind J, Learman K, O’Halloran B et al. Different minimally important clinical difference (MCID) scores lead to different clinical prediction rules for the Oswestry disability index for the same sample of patients. J Man Manip Ther 2013; 21: 71–8.

23. Martin RL, Kivlan BR, Christoforetti JJ et al. Minimal clinically important difference and substantial clinical benefit values for the 12-item international hip outcome tool. Arthroscopy 2019; 35: 411–6.

24. Beaton DE. Understanding the relevance of measured change through studies of responsiveness. Spine 2000; 25: 3192–9.

25. Lasko TA, Bhagwat JG, Zou KH et al. The use of receiver operating characteristic curves in biomedical informatics. J Biomed Inform 2005; 38: 404–15.

26. Park SH, Goo JM, Jo CH. Receiver operating characteristic (ROC) curve: practical review for radiologists. Korean J Radiol 2004; 5: 11–8.

27. Gortmaker SL, Hosner DW, Leshem S. Applied logistic regression. Contemp Sociol 1994; 23: 159.

28. Schisterman EF, Perkins NJ, Liu A et al. Optimal cut-point and its corresponding Youden Index to discriminate individuals using pooled blood samples. Epidemiology 2005; 16: 73–81.

29. Menge TJ, Briggs KK, Dornan GJ et al. Survivorship and outcomes 10 years following hip arthroscopy for femoroacetabular impingement: labral debridement compared with labral repair. J Bone Joint Surg Am 2017; 99: 997–1004.

30. Byrd JW, Jones KS. Hip arthroscopy for labral pathology: prospective analysis with 10-year follow-up. Arthroscopy 2009; 25: 365–8.

31. Sawyer GA, Briggs KK, Dornan GJ et al. Clinical outcomes after arthroscopic hip labral repair using looped versus pierced suture techniques. Am J Sports Med 2015; 43: 1683–8.

32. Gupta A, Redmond JM, Stave CE et al. Does primary hip arthroscopy result in improved clinical outcomes?: 2-year clinical follow-up on a mixed group of 738 consecutive primary hip arthroscopies performed at a high-volume referral center. Am J Sports Med 2016; 44: 74–82.

33. Philippin MJ, Schroder E, Briggs KK. Hip arthroscopy for femoroacetabular impingement in patients aged 50 years or older. Arthroscopy 2012; 28: 59–65.

34. Donib BG, Linder D, Finley Z et al. Outcomes of hip arthroscopy in patients aged 50 years or older compared with a matched-pair control of patients aged 30 years or younger. Arthroscopy 2015; 31: 231–8.

35. Gupta A, Redmond JM, Hammarstedt JE et al. Does obesity affect outcomes in hip arthroscopy? A matched-pair controlled study with minimum 2-year follow-up. Am J Sports Med 2015; 43: 965–71.
42. Wyatt MC, Beck M. The management of the painful borderline dysplastic hip. *J Hip Preserv Surg* 2018; 5: 105–12.

43. Pontiff M, Ithurburn MP, Ellis T et al. Pre- and post-operative self-reported function and quality of life in women with and without generalized joint laxity undergoing hip arthroscopy for femoroacetabular impingement. *Int J Sports Phys Ther* 2016; 11: 378–87.

44. Frank RM, Lee S, Bush-Joseph CA et al. Outcomes for hip arthroscopy according to sex and age: a comparative matched-group analysis. *J Bone Joint Surg Am* 2016; 98: 797–804.

45. Christensen JC, Marland JD, Miller CJ et al. Trajectory of clinical outcomes following hip arthroscopy in female subgroup populations. *J Hip Preserv Surg* 2019; 6: 25–32.

46. Martin RL, Christoforetti JJ, McGovern R et al. The impact of depression on patient outcomes in hip arthroscopic surgery. *Orthop J Sports Med* 2018; 6: 232596711880649.

47. Kamath AF, Componovo R, Baldwin K et al. Hip arthroscopy for labral tears: review of clinical outcomes with 4.8-year mean follow-up. *Am J Sports Med* 2009; 37: 1721–7.