Evaluation of outcome reporting trends for femoroacetabular impingement syndrome—a systematic review

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Abstract

Purpose: The aim of this systematic review was to evaluate the trends in the literature regarding surgical treatment for femoroacetabular impingement syndrome (FAIS) and to present which patient-reported outcome-measures (PROMs) and surgical approaches are included.

Methods: This systematic review was conducted with the PRISMA guidelines. The literature search was performed on PubMed and Embase, covering studies from 1999 to 2020. Inclusion criteria were clinical studies with surgical treatment for FAIS, the use of PROMs as evaluation tool and studies in English. Exclusion criteria were studies with patients < 18 years, cohorts with < 8 patients, studies with primarily purpose to evaluate other diagnoses than FAIS and studies with radiographs as only outcomes without using PROMs. Data extracted were author, year, surgical intervention, type of study, level of evidence, demographics of included patients, and PROMs.

Results: The initial search yielded 2,559 studies, of which 196 were included. There was an increase of 2,043% in the number of studies from the first to the last five years (2004–2008)—(2016–2020). There were 135 (69%) retrospective, 55 (28%) prospective and 6 (3%) Randomized Controlled Trials. Level of evidence ranged from I-IV where Level III was most common (44%). More than half of the studies (58%) originated from USA. Arthroscopic surgery was the most common surgical treatment (85%). Mean follow-up was 27.0 months (± 17 SD), (range 1.5–120 months). Between 1–10 PROMs were included, and the modified Harris Hip Score (mHHS) was most commonly used (61%).

Conclusion: There has been a continuous increase in the number of published studies regarding FAIS with the majority evaluating arthroscopic surgery. The mHHS remains being the most commonly used PROM.

Keywords: Femoroacetabular impingement syndrome, FAIS, Patient-reported outcome measures, PROM, Hip arthroscopy
Femoroacetabular impingement syndrome (FAIS) results from an abnormal morphology of either the femoral head (cam) or the acetabulum (pincer) or a combination of both. This causes an incongruence in the hip joint and is a common source of hip pain, especially in the young active population [216]. Surgical treatment of FAIS aims to restore the normal hip joint morphology and thereby reduce symptoms [154]. Open hip dislocation was initially considered the gold standard for surgical treatment of FAIS, however, the use of a minimally invasive approach with arthroscopy has increased during the 2010’s [46, 154].

With an escalation of the arthroscopic procedures performed, there has been a corresponding increase in the studies published regarding FAIS [106]. Furthermore, several registries have been developed to keep track of performed arthroscopies and evaluate the outcomes after the procedures [93, 126, 185]. Patient-reported outcome measures (PROMs) are commonly used for evaluating the patients’ perspective of outcome of surgical treatment [158]. According to the Warwick Agreement, defined in 2016, the Hip and Groin outcome score (HAGOS) [205], Hip Outcome Score (HOS) [134] and the international Hip Outcome Tool (iHOT) [84, 143] are recommended as preferable PROMs for evaluating the outcome after FAIS surgery [82]. These PROMs are noted to be valid, reliable and responsive after FAIS surgery [170]. Yet, the PROMs used for FAIS have most commonly been developed for an older patient category with osteoarthritis, such as Harris hip score (HHS), while the PROMs recommended for the younger population are gradually being adopted [206]. With the use of PROMs developed for another patient category or condition, there is a risk of ceiling or wash-out effects due to the inclusion of non-relevant items.

The aim of this systematic review was to evaluate the trends in the literature pertaining to FAIS. More specifically, the aim was to present trends for the PROMs used and which surgical approaches have been performed to treat patients with FAIS. The hypothesis was that an increase in the number of studies with arthroscopic procedures performed would be observed with the majority using hip specific PROMs.

Methods
The systematic review was governed in agreement with the Preferred Reporting Items for Systematic Review and Meta-Analysis protocols (PRISMA) [142].
to the author, year and journal of publication. After all full texts were independently decided by the two reviewers, any disagreements regarding inclusion of studies were solved with discussion between the two reviewers.

**Data items**

The data extracted included the level of evidence, title of the study, authors, year of publication, journal where study was performed, type of study (retrospective, prospective, RCT), included number of, and which different PROMs used in the study. The proportion of “hip specific” PROMs in the study was recorded in the extraction sheet. In addition to exploring the development of included PROMs over the years, 2016, when the Warwick agreement was stated, was used as a cut-off to evaluate the adoption of recommended PROMs. It was noted if the study had included any type of “rate of return to sport” (RTS) apart from using a regular PROM and if the study evaluated patient satisfaction. Inclusion of any RTS assessment was in this study defined dichotomously (yes or no). Type of interventions assessed in the study were divided into open, arthroscopic or a combination of arthroscopic/open. Further data as proportion of sex, follow-up time, and number of patients were collected. The number of patients were defined as the patients undergoing surgical intervention, i.e., if the control group consisted of patients without receiving intervention, the control group was not included.

Distribution of sex and mean follow-up for the last visit were recorded.

**Statistical analyses**

Interoobserver agreement for full-texts was calculated with the Cohen kappa coefficient (κ) [119]. According to previous recommendations the values of κ were set a priori with a κ of 0–0.2 equals slight agreement, 0.21–0.4 fair agreement, 0.41–0.6 moderate agreement, 0.61–0.8 substantial agreement and >0.8 equals to near perfect agreement. Descriptive statistics were used to present the data. Mean, standard deviation (SD), median and range values were presented when appropriate. Follow-up period was presented either as average follow-up period, or if not presented in the study, as minimum follow-up period. For studies comparing two or more groups, and no average follow-up period was mentioned for the entire cohort, a combined average follow-up was calculated. The analyses were performed with Microsoft Excel (version 16.40, Microsoft Corporation).

**Results**

**Study identification and characteristics**

The first search revealed 2,085 studies in PubMed and 2,218 studies in Embase. After removing duplicates, a total of 2,559 unique studies were eligible for the screening process. Figure 1 displays a flowchart of the screening process in accordance with the PRISMA guidelines. The agreement between the two readers for inclusion of full-text was 97% with a Cohen kappa value of 0.82, considered as near perfect agreement.

There were 6 (3%) RCTs, 55 (28%) prospective studies and 135 (69%) retrospective studies included in this systematic review. There were 6 (3%) Level I studies, 21 (11%) Level II studies, 86 (44%) Level III studies and 83 (42%) Level IV studies (Table 1). The included studies were published between 2004–2020. There was a large increase of published studies in the latter years where 143 (73%) of the studies were published in the last 5 years (2016–2020) compared to 7 (4%) in the first 5 years (2004–2008), an increase of 2,043% (Fig. 2).

More than half of the studies (58%) were conducted in USA. Most studies were published in The American Journal of Sports Medicine (21%), followed by Arthroscopy: The Journal of Arthroscopic and Related Surgery (19%). A total of 32,303 patients were included counting the patients in all studies together, with an average of 165 patients per study (range 8–1,102). The mean follow-up period was 27.0 months (±17 SD), (range 1.5–120) (Table 1).

**Surgical procedure**

The majority of the included studies (85%) were evaluating arthroscopic treatment. Only 5% of the included studies were examining solely open dislocation while the remaining 10% discussed either both open and arthroscopic or defined a mini-open technique with arthroscopic assistance. The procedure described in each study is reported in Table 1.

**Patient-reported outcome measures**

A total of 39 different PROMs were found in the studies, of these, 15 (38%) were hip-specific (Table 3, in Appendix). Between 1–10 PROMs were used in each study with an average of 3 (±1.8 SD) PROMs per study. Before 2016, the median of included PROMs was two per study, and after 2016 the median had increased to three per study.

The most common used hip-specific PROM was mHHS (used in 120 studies (61%)), followed by HOS (81 studies (41%)) (Fig. 3). An additional question of return to sport/return to activity was seen in 13% of the included studies. Of 196 studies, 40% included a question on satisfaction of which the majority used the visual analog scale.

During the first five years (2004–2008), the Merle d’Aubigné and Postel score and the Western Ontario
and McMaster Universities Osteoarthritis Index (WOMAC) were equally the most commonly used scores, reported in 3 (43%) of the studies during that period. During the last five years (2016–2020), the mHHS was the most commonly used, in 93 (65%) of the studies.

Of the 143 studies published during or after 2016, 67 (47%) studies have included the HOS, 46 (32%) included either iHOT-12 or iHOT-33 and 12 (8%) studies included the HAGOS (Fig. 3). Fifty-two of the 143 studies (36%) did not use any of the three PROMs recommended by the Warwick agreement [82] (Table 1).
| Author                        | Year | Level of evidence | Country     | Study type | Follow-up | RTS | Participants | Included PROMs                      | Hip specific PROMs | Men% | Surgery       |
|-------------------------------|------|-------------------|-------------|------------|-----------|-----|--------------|-------------------------------------|--------------------|------|---------------|
| Abrahamsson, J. [1]           | 2020 | III               | Sweden      | Retrospective | 23.4   | y   | 551          | HAGOS, iHOT-12, HSAS               | 3                  | 77   | ARTHROSCOPIC  |
| Aguilera-Bohórquez, B. [2]    | 2020 | IV                | Colombia    | Retrospective | 12     | n   | 17           | WOMAC                              | 1                  | 47   | ARTHROSCOPIC  |
| Atzmon, R. [3]                | 2019 | III               | Israel      | Retrospective | 50°    | n   | 64           | HOS, mHHS, satisfaction            | 2                  | 74   | ARTHROSCOPIC  |
| Avnieli, I. B. [4]            | 2020 | III               | Israel      | Retrospective | 24     | y   | 133          | HOS, mHHS, VAS satisfaction        | 2                  | 62   | ARTHROSCOPIC  |
| Balázs, G. C. [5]             | 2018 | II                | USA         | Prospective  | 1.5    | n   | 59           | HAGOS, iHOT-33, PCS, VAS pain      | 2                  | 54   | ARTHROSCOPIC  |
| Barastegui, D. [6]            | 2018 | IV                | Spain       | Retrospective | 24     | y   | 21           | HOS (ADL + SS), mHHS, VAS pain    | 2                  | 100  | ARTHROSCOPIC  |
| Bardakos, N. V. [7]           | 2008 | III               | England     | Retrospective | 12     | n   | 71           | mHHS                               | 1                  | 58   | ARTHROSCOPIC  |
| Basques, B. A. [8]            | 2019 | III               | USA         | Retrospective | 24     | n   | 624          | HOS (ADL + SS), mHHS, VAS pain, VAS satisfaction | 2                  | 35   | ARTHROSCOPIC  |
| Beaulé, P. E [10]             | 2017 | IV                | Canada      | Prospective  | 24.5   | n   | 10           | HOOS                               | 1                  | 100  | ARTHROSCOPIC  |
| Beaulé, P. E [9]              | 2007 | IV                | Canada      | Retrospective | 36     | y   | 34           | SF-12, UCLA, WOMAC                | 1                  | 53   | OPEN          |
| Beck, E. C. [12]              | 2019 | III               | USA         | Retrospective | 32.9   | n   | 108          | HOS (ADL + SS), mHHS, VAS pain, VAS satisfaction | 2                  | x    | ARTHROSCOPIC  |
| Beck, E. C. [14]              | 2020 | III               | USA         | Retrospective | 24     | n   | 249          | HOS (ADL + SS), iHOT-12, mHHS, VAS pain, VAS satisfaction | 3                  | 35   | ARTHROSCOPIC  |
| Beck, E. C. [16]              | 2020 | IV                | USA         | Prospective  | 6      | n   | 74           | HOS (ADL + SS), iHOT-12            | 2                  | 23   | ARTHROSCOPIC  |
| Beck, E. C. [17]              | 2020 | III               | USA         | Retrospective | 24     | n   | 647          | HOS (ADL + SS), iHOT-12, mHHS, VAS pain, VAS satisfaction | 3                  | 24   | ARTHROSCOPIC  |
| Beck, E. C. [15]              | 2020 | III               | USA         | Retrospective | 24     | n   | 384          | HOS (ADL + SS), mHHS, VAS pain, VAS satisfaction | 2                  | 32   | ARTHROSCOPIC  |
| Beck, E. C. [11]              | 2020 | III               | USA         | Retrospective | 50     | n   | 264          | HOS (ADL + SS), mHHS, VAS pain, VAS satisfaction | 2                  | 34   | ARTHROSCOPIC  |
| Beck, E. C. [13]              | 2019 | III               | USA         | Retrospective | 24     | n   | 336          | HOS (ADL + SS), iHOT-12, mHHS, VAS pain, VAS satisfaction | 3                  | 30   | ARTHROSCOPIC  |
| Beck, M. [18]                 | 2004 | IV                | Switzerland | Retrospective | 564    | n   | 19           | The Merle d’Aubigné and Postel hip score | 1                  | 74   | OPEN          |
| Bennett, A. N. [19]           | 2016 | IV                | England     | Prospective  | 12     | n   | 101          | FAA, NAHS, VAS pain               | 1                  | 75   | ARTHROSCOPIC  |
| Bolla, I. K. [20]             | 2019 | III               | USA         | Retrospective | 80°    | n   | 126          | HOS (ADL + SS), mHHS, SF-12, VAS satisfaction | 2                  | 57   | ARTHROSCOPIC  |
| Boone, G. R. [21]             | 2012 | IV                | USA         | Retrospective | 45.6   | n   | 21           | UCLA                               | 0                  | 64   | OPEN          |
Table 1 (continued)

| Author                          | Year | Level of evidence | Country      | Study type     | Follow-up | RTS | Participants | Included PROMs                                                                 | Hip specific PROMs | Merits | Surgery                  |
|--------------------------------|------|-------------------|--------------|----------------|-----------|-----|--------------|--------------------------------------------------------------------------------|-------------------|--------|--------------------------|
| Briggs, K. K. [22]             | 2019 | III               | USA          | Retrospective  | 61.2      | n   | 230          | HOS (ADL + SS), mHHS, SF12, VAS satisfaction, WOMAC, Telegner                   | 3                 | x      | ARTHROSCOPIC              |
| Bryan, A. J. [23]              | 2016 | III               | USA          | Retrospective  | 24        | n   | 201          | HOS (ADL + SS), mHHS                                                            | 2                 | 69     | ARTHROSCOPIC              |
| Byrd, J.W. [24]                | 2009 | IV                | USA          | Prospective    | 16        | n   | 207          | mHHS                                                                           | 1                 | 67     | ARTHROSCOPIC              |
| Byrd, J.W. [25]                | 2016 | III               | USA          | Retrospective  | 37³       | n   | 108          | mHHS                                                                           | 1                 | 52     | ARTHROSCOPIC              |
| Byrd, J.W. [26]                | 2019 | III               | USA          | Retrospective  | 18.9      | n   | 42           | iHOT, mHHS                                                                     | 2                 | 52     | ARTHROSCOPIC              |
| Campoamor González, M. [27]    | 2020 | III               | Spain        | Retrospective  | 6         | n   | 57           | HHS                                                                            | 1                 | 68     | INCLUDING BOTH           |
| Cancienne, J. [28]             | 2019 | III               | USA          | Retrospective  | 24        | n   | 1102         | HOS (ADL + SS), mHHS, VAS pain, VAS satisfaction                               | 2                 | 35     | ARTHROSCOPIC              |
| Carreira, D. S. [29]           | 2018 | IV                | USA          | Prospective    | 12        | n   | 45           | HOS (ADL + SS), mHHS, iHOT-12, SF-12                                          | 3                 | 36     | ARTHROSCOPIC              |
| Casartelli N. [30]             | 2014 | IV                | Switzerland  | Prospective    | 30        | y   | 8            | HOS (ADL + SS), satisfaction (1–5), pain change (1–5)                          | 1                 | 38     | ARTHROSCOPIC              |
| Catelli, D. S. [31]            | 2019 | II                | Canada       | Prospective    | 24        | n   | 11           | HOOS                                                                           | 1                 | 100    | INCLUDING BOTH           |
| Catelli, D. S. [32]            | 2019 | II                | Canada       | Prospective    | 24        | n   | 11           | HOOS                                                                           | 1                 | 100    | INCLUDING BOTH           |
| Cetinkaya, S. [33]             | 2016 | III               | Turkey       | Retrospective  | 45.2      | n   | 67           | HOS, VAS pain                                                                  | 1                 | 57     | ARTHROSCOPIC              |
| Chaharbakhsi, E. O. [34]       | 2019 | III               | USA          | Retrospective  | 47³       | n   | 107          | HOS (SS), iHOT-12, mHHS, NAHS, VAS pain, VAS satisfaction                      | 4                 | 66     | ARTHROSCOPIC              |
| Chahla, J. [36]                | 2019 | III               | USA          | Retrospective  | 27.8      | n   | 634          | HOS (ADL + SS), mHHS, VAS pain, VAS satisfaction                               | 2                 | 33     | ARTHROSCOPIC              |
| Chahla, J. [37]                | 2019 | III               | USA          | Retrospective  | 24        | n   | 600          | HOS (ADL + SS), mHHS, VAS pain, VAS satisfaction                               | 2                 | 36     | ARTHROSCOPIC              |
| Chahla, J. [35]                | 2019 | III               | USA          | Prospective    | 12        | n   | 153          | HOS (ADL + SS), HPSES, mHHS, VAS pain, VAS satisfaction                       | 3                 | 29     | ARTHROSCOPIC              |
| Chambers, C. C. [38]           | 2019 | IV                | USA          | Retrospective  | 24        | n   | 142          | HOOS, mHHS, SF-12, VAS pain                                                   | 2                 | 51     | ARTHROSCOPIC              |
| Chiron, P. [39]                | 2012 | IV                | France       | Prospective    | 26.4      | y   | 108          | HHS, MOS, NAHS, SF-36, satisfaction (1–5), VAS pain, WOMAC                    | 3                 | 85     | MINIMALLY INVASIVE APPROACH |
| Chladek, P. [40]               | 2015 | III               | Czech Republic | Retrospective  | 40        | n   | 100          | NAHS, WOMAC                                                                    | 2                 | x      | MINIMALLY INVASIVE SURGERY AND OPEN |
| Cho, S. H. [41]                | 2015 | IV                | Korea        | Retrospective  | 24        | n   | 11           | mHHS, UCLA                                                                     | 1                 | 36     | ANTERIOR MINI-OPEN (AMO) AND OPEN |
| Author                  | Year | Level of evidence | Country    | Study type | Follow-up | RTS | Participants | Included PROMs                                                                 | Hip specific PROMs | Merit % | Surgery                      |
|-------------------------|------|-------------------|------------|------------|-----------|-----|--------------|--------------------------------------------------------------------------------|-------------------|---------|------------------------------|
| Christensen, J. C. [43] | 2019 | III               | USA        | Retrospective | 24        | n   | 173          | iHOT-12                                                                         | 1                 | 0       | ARTHROSCOPIC                 |
| Cappa, I. M. [44]       | 2020 | III               | USA        | Prospective  | 199       | n   | 85           | HOS (ADL + SS), mHHS, iHOT-12, PCS, TSK, VAS pain, VAS satisfaction            | 3                 | 25      | ARTHROSCOPIC                 |
| Claßen, T. [45]         | 2016 | II                | Germany    | Prospective  | 6         | n   | 177          | NAHS, WOMAC                                                                   | 2                 | 46      | ARTHROSCOPIC                 |
| Comba, F. [47]          | 2016 | IV                | Argentina  | Prospective  | 91        | n   | 42           | mHHS, WOMAC                                                                   | 2                 | 64      | ARTHROSCOPIC                 |
| Cunningham, D. J. [48]  | 2017 | III               | USA        | Prospective  | 1.5       | n   | 62           | iHOT-12, PCS, PHQ, VAS pain                                                  | 1                 | 33      | ARTHROSCOPIC                 |
| Cvetanovich, G. L. [49] | 2017 | III               | USA        | Retrospective | 31.2      | n   | 348          | HOS (ADL + SS), mHHS, VAS pain, VAS satisfaction                              | 2                 | 42      | ARTHROSCOPIC                 |
| Cvetanovich, G. L. [50] | 2018 | IV                | USA        | Prospective  | 24        | n   | 386          | HOS (ADL + SS), mHHS, VAS pain                                                | 2                 | 39      | ARTHROSCOPIC                 |
| Di Benedetto, P. [51]   | 2016 | II                | Italy      | Prospective  | 12        | n   | 65           | mHHS, MHOT                                                                     | 2                 | x       | ARTHROSCOPIC                 |
| Domb, B. G. [52]        | 2018 | III               | USA        | Retrospective | 50        | n   | 130          | HOS (SS), mHHS, NAHS, VAS pain, VAS satisfaction                              | 3                 | 28      | ARTHROSCOPIC                 |
| Domb, B. G. [53]        | 2018 | III               | USA        | Retrospective | 24        | n   | 148          | HOS (SS), iHOT-12, mHHS, NAHS, SF-12, VAS pain, VAS satisfaction, VR-12        | 4                 | 41      | ARTHROSCOPIC                 |
| Dragé, T. [56]          | 2020 | III               | USA        | Retrospective | 12        | n   | 346          | HOS (ADL + SS), iHOT-12, mHHS, VAS pain, VAS satisfaction                      | 3                 | 28      | ARTHROSCOPIC                 |
| Ellis, S. H. [57]       | 2020 | III               | Australia  | Retrospective | 12        | n   | 79           | iHOT-33                                                                       | 1                 | 42      | ARTHROSCOPIC                 |
| Ernat, J. J. [59]       | 2019 | IV                | USA        | Retrospective | 12        | n   | 182          | mHHS, SANE, satisfaction score, VAS pain, VR-12, WOMAC                       | 2                 | 74      | MINI-OPEN ARTHROSCOPIC ASSISTED            |
| Ernat, J. J. [58]       | 2015 | IV                | USA        | Retrospective | 43.2      | n   | 93           | mHHS, SANE, satisfaction, VAS pain, VR-12, WOMAC                             | 2                 | 70      | MINI-OPEN ARTHROSCOPIC ASSISTED            |
| Espinosa, N. [60]       | 2007 | III               | Switzerland| Retrospective | 24        | n   | 52           | The Merle d’Aubigne–Postel score                                              | 1                 | x       | OPEN                         |
| Essildie, A. A. [61]    | 2020 | II                | USA        | Prospective  | 24        | n   | 126          | mHHS, NAHS                                                                     | 2                 | 67      | ARTHROSCOPIC                 |
| Fabbricant, P. D. [62]  | 2015 | III               | USA        | Retrospective | 21        | n   | 243          | HOS (ADL + SS), iHOT-33, mHHS                                                | 3                 | 49      | ARTHROSCOPIC                 |
| Fero, F. P. [63]        | 2015 | IV                | USA        | Retrospective | 30        | n   | 184          | mHHS, SF-12, WOMAC                                                            | 2                 | x       | ARTHROSCOPIC                 |
| Fiorentino, G. [64]     | 2015 | IV                | Italy      | Retrospective | 36        | n   | 38           | mHHS, patient satisfaction                                                   | 1                 | 59      | ARTHROSCOPIC                 |
| Author          | Year | Level of evidence | Country | Study type | Follow-up | RTS | Participants | Included PROMs                                                                 | Hip specific PROMS | Men% | Surgery     |
|----------------|------|-------------------|---------|------------|-----------|-----|--------------|--------------------------------------------------------------------------------|-------------------|------|-------------|
| Flores, S. E.  | 2018 | II                | USA     | Prospective| 12        | n   | 58           | HOOS, mHHS, SF-12, VAS pain                                                   | 2                 | 53   | ARTHROSCOPIC|
| Flores, S. E.  | 2020 | II                | USA     | Prospective| 24        | n   | 131          | HOOS, mHHS, SF-12, VAS pain                                                   | 2                 | 45   | ARTHROSCOPIC|
| Flores, S. E.  | 2018 | II                | USA     | Prospective| 12        | n   | 122          | HOOS, mHHS, SF-12, VAS pain                                                   | 2                 | 47   | ARTHROSCOPIC|
| Foreman, S.C.  | 2020 | II                | USA     | Prospective| 12        | n   | 42           | HOOS                                                                           | 1                 | 64   | ARTHROSCOPIC|
| Frank, R. M.   | 2019 | III               | USA     | Retrospective| 31.2      | y   | 330          | HOSS (ADL + SS), mHHS, VAS pain, VAS satisfaction                              | 2                 | 100  | ARTHROSCOPIC|
| Frank, R. M.   | 2018 | IV                | USA     | Retrospective| 31.1      | y   | 59           | HOSS (ADL + SS), mHHS, VAS pain, VAS satisfaction                              | 2                 | 38   | ARTHROSCOPIC|
| Fukui, K.      | 2016 | II                | USA     | Prospective| 33.6      | n   | 150          | HOSS (ADL + SS), mHHS, VAS satisfaction                                       | 2                 | 50   | ARTHROSCOPIC|
| Fukui, K.      | 2015 | IV                | USA     | Retrospective| 42        | n   | 28           | HOSS (ADL + SS), mHHS, SF-12, VAS satisfaction, WOMAC                        | 3                 | 57   | ARTHROSCOPIC|
| Fukui, K.      | 2015 | IV                | USA     | Retrospective| 40        | n   | 100          | HOSS (ADL + SS), mHHS, SF-12, VAS satisfaction, WOMAC, VAS satisfaction       | 3                 | 50   | ARTHROSCOPIC|
| Gao, F.        | 2020 | IV                | China   | Prospective| 24        | n   | 27           | iHOT-12, mHHS, VAS pain                                                      | 2                 | 56   | ARTHROSCOPIC|
| Gicquel, T.    | 2014 | IV                | France  | Prospective| 55.2      | n   | 58           | WOMAC satisfaction (1–4)                                                      | 1                 | 63   | ARTHROSCOPIC|
| Gigi, R.       | 2016 | III               | Israel  | Retrospective| 30.4      | n   | 106          | HOSS (ADL), mHHS                                                              | 2                 | 65   | ARTHROSCOPIC|
| Grace, T.      | 2018 | IV                | USA     | Prospective| X         | n   | 43           | HOOS                                                                           | 1                 | 58   | ARTHROSCOPIC|
| Grace, T.      | 2018 | II                | USA     | Prospective| X         | n   | 46           | HOOS, VAS pain                                                                | 1                 | 59   | ARTHROSCOPIC|
| Grant, L. F.   | 2017 | I                 | England | RCT        | 3         | n   | 18           | EQ-SD, NAHS                                                                   | 1                 | 33   | ARTHROSCOPIC|
| Graves, M. L.  | 2009 | IV                | USA     | Retrospective| 38        | n   | 46           | The Merle d’Aubigne’-Postel score                                             | 1                 | 54   | OPEN        |
| Griffin, D. R. | 2018 | IV                | England | RCT        | 12        | n   | 213          | EQ-SD, iHOT-33, SF12, UCLA                                                    | 1                 | 58   | ARTHROSCOPIC|
| Gupta, A.      | 2014 | IV                | USA     | Prospective| 28.3      |     |              | EQ-SD, iHOT-33, SF12, UCLA                                                    | 1                 | 60   | ARTHROSCOPIC|
| Gupta, A.      | 2015 | III               | USA     | Retrospective| 23.1      |     | 680          | HOSS (ADL + SS), mHHS, NAHS, VAS pain, VAS satisfaction                       | 3                 | 33   | ARTHROSCOPIC|
| Ha, Y. C.      | 2020 | IV                | Korea   | Retrospective| 24        | n   | 62           | mHHS, UCLA, VAS pain, VAS satisfaction                                        | 1                 | 90   | ARTHROSCOPIC|
| Hamula, M. J.  | 2020 | III               | USA     | Retrospective| 31.6      |     | 226          | mHHS, NAHS                                                                    | 2                 | 39   | ARTHROSCOPIC|
| Haskel, J. D.  | 2020 | III               | USA     | Retrospective| 24        | n   | 149          | mHHS, NAHS                                                                    | 2                 | 25   | ARTHROSCOPIC|
| Hassebrock, J. D. | 2019 | III               | USA     | Retrospective| 24        | n   | 133          | HOSS (SS), iHOT-12, mHHS, NAHS, VAS pain, VAS satisfaction                   | 4                 | 47   | ARTHROSCOPIC|
| Herrmann, S. J. | 2016 | IV                | Germany | Retrospective| 32        |     | 79           | HOSS (ADL + SS)                                                               | 1                 | 62   | ARTHROSCOPIC|
Table 1 (continued)

| Author                | Year | Level of evidence | Country    | Study type  | Follow-up | RTS | Participants Included PROMs | Hip specific PROMS | Men (%) | Surgery     |
|-----------------------|------|-------------------|------------|-------------|-----------|-----|----------------------------|-------------------|---------|-------------|
| Horisberger, M. [92]  | 2010 | IV                | Switzerland| Prospective | 36        | n   | 20                          | NAHS, VAS pain    | 1       | 80          | ARTHROSCOPIC |
| Hwang, J. M. [94]     | 2019 | IV                | Korea      | Retrospective| 43.6      | n   | 9                           | HOS (ADL), mHHS, VAS pain | 2       | 75          | ARTHROSCOPIC |
| Ilizaliturri, V. M. [95]| 2008 | IV                | Mexico     | Prospective | 24        | n   | 19                          | WOMAC             | 1       | 58          | ARTHROSCOPIC |
| Inan, U. [96]         | 2016 | IV                | Turkey     | Retrospective| 48        | n   | 21                          | HHS               | 1       | 33          | OPEN         |
| Ishai, L. [97]        | 2018 | III               | Denmark    | Retrospective| 33.1      | y   | 189                         | HAGOS             | 1       | 51          | ARTHROSCOPIC |
| Ishai, L. [98]        | 2019 | III               | Denmark    | Retrospective| 33.1      | y   | 184                         | HAGOS             | 1       | 50          | ARTHROSCOPIC |
| Javed, A. [99]        | 2011 | IV                | England    | Retrospective| 30        | n   | 40                          | mHHS, NAHS, satisfaction y/n | 2       | 65          | ARTHROSCOPIC |
| Jochimsen, K. N. [100]| 2019 | III               | USA        | Retrospective| X         | n   | 127                         | HOOS              | 1       | 26          | ARTHROSCOPIC |
| Jäger, M. [101]       | 2011 | IV                | Germany    | Prospective | 12        | n   | 22                          | HHS               | 1       | 32          | OPEN         |
| Kaldau, N. C. [102]   | 2018 | IV                | Denmark    | Retrospective| 82.9²⁵| n  | 84                          | EQ-5D, HAGOS, HSAS | 2       | 54          | ARTHROSCOPIC |
| Kaplan, D. J. [103]   | 2020 | IV                | USA        | Retrospective| 76.5      | n   | 103                         | HHS, mHHS, NAHS   | 3       | 32          | ARTHROSCOPIC |
| Keating, T. C. [104]  | 2019 | IV                | USA        | Retrospective| 24        | y   | 22                          | HOS (ADL + SS), mHHS, VAS pain, VAS satisfaction | 2       | 0           | ARTHROSCOPIC |
| Kekatpure, A. L. [105]| 2017 | III               | Korea      | Retrospective| 25.4      | n   | 83                          | mHHS, NAHS, WOMAC | 3       | 66          | ARTHROSCOPIC |
| Kierkegaard, S. [107] | 2020 | III               | Denmark    | Prospective | 12        | y   | 60                          | HAGOS             | 1       | 37          | ARTHROSCOPIC |
| Kierkegaard, S. [108] | 2019 | III               | Denmark    | Prospective | 12        | n   | 60                          | HAGOS             | 1       | 40          | ARTHROSCOPIC |
| Kockara, N. [109]     | 2018 | IV                | Turkey     | Retrospective| 72        | n   | 33                          | HHS               | 1       | 58          | OPEN         |
| Kouk, S. [110]        | 2020 | III               | USA        | Retrospective| 24        | n   | 62                          | mHHS, NAHS        | 2       | 44          | ARTHROSCOPIC |
| Krishnamoorthy, V. P. [112]| 2019 | III               | USA        | Retrospective| 24        | n   | 830                         | HOS (ADL + SS), iHOT-12, mHHS, VAS pain, VAS satisfaction | 3       | 31          | ARTHROSCOPIC |
| Krishnamoorthy, V. P. [111]| 2019 | III               | USA        | Retrospective| 36.8      | n   | 743                         | HOS (ADL + SS), mHHS, VAS pain, VAS satisfaction | 2       | 32          | ARTHROSCOPIC |
| Krych, A. J. [113]    | 2016 | III               | USA        | Retrospective| 24        | n   | 104                         | HOS (ADL + SS), mHHS | 2       | 38          | ARTHROSCOPIC |
| Krych, A. J. [114]    | 2013 | I                 | USA        | RCT         | 32        | n   | 36                          | HOS (ADL + SS)    | 1       | 0           | ARTHROSCOPIC |
| Kunze, K. N. [115]    | 2019 | III               | USA        | Retrospective| 24        | n   | 1094                         | HOS (ADL + SS), iHOT-12, mHHS, VAS pain, VAS satisfaction | 3       | 34          | ARTHROSCOPIC |
| Author               | Year | Level of evidence | Country  | Study type       | Follow-up | RTS | Participants | Included PROMs                                                                 | Hip specific PROMs | Men% | Surgery                      |
|---------------------|------|-------------------|----------|------------------|-----------|-----|--------------|--------------------------------------------------------------------------------|-------------------|------|------------------------------|
| Kunze, K. N. [116]  | 2019 | III               | USA      | Retrospective    | 24        | n   | 306          | HOS (ADL + SS), mHHS, VAS pain, VAS satisfaction                                | 2                 | 42   | ARTHROSCOPIC                 |
| Kunze, K. N. [117]  | 2019 | IV                | USA      | Prospective      | 6         | n   | 52           | HOS (ADL + SS), iHOT-12, mHHS, PSQI, VAS pain                                  | 3                 | 37   | ARTHROSCOPIC                 |
| Lall, A. C. [118]   | 2020 | III               | USA      | Retrospective    | 549       | n   | 84           | HOS (SS), iHOT-12, mHHS, NAHS, SF-12, VAS pain, VR-12                          | 4                 | 36   | ARTHROSCOPIC                 |
| Lansdown, D. A. [120]| 2018 | IV                | USA      | Retrospective    | 24        | n   | 707          | HOS (ADL + SS), mHHS, VAS pain, VAS satisfaction                               | 2                 | 36   | ARTHROSCOPIC                 |
| Lansdown, D. A. [121]| 2018 | III               | USA      | Retrospective    | 24        | n   | 301          | HOS (ADL + SS), mHHS, VAS pain, VAS satisfaction                               | 2                 | 36   | ARTHROSCOPIC                 |
| Lee, S. [122]       | 2015 | IV                | USA      | Retrospective    | 21        | n   | 131          | mHHS, VAS satisfaction                                                        | 1                 | 56   | ARTHROSCOPIC                 |
| Lerch, S. [123]     | 2015 | IV                | Germany  | Prospective      | 3.3       | n   | 40           | HOOS, WOMAC                                                                  | 2                 | x    | ARTHROSCOPIC                 |
| Levy, D. M. [124]   | 2017 | III               | USA      | Retrospective    | 24        | n   | 84           | HOS (ADL + SS), mHHS, VAS pain, VAS satisfaction                               | 2                 | 36   | ARTHROSCOPIC                 |
| Lindman, I. [125]   | 2020 | IV                | Sweden   | Prospective      | 60        | n   | 64           | HAGOS, HSAS, iHOT-12, VAS hip function, EQ-5D, EQ VAS, satisfaction y/n       | 3                 | 81   | ARTHROSCOPIC                 |
| Malagelada, F. [127]| 2015 | IV                | Spain    | Prospective      | 12        | y   | 14           | LISOH, VAS pain                                                               | 1                 | 64   | MINI-OPEN TECHNIQUE          |
| Maldonado, D. R. [128]| 2020 | III               | USA      | Retrospective    | 24        | n   | 145          | HOS (SS), iHOT-12, mHHS, NAHS, SF-12, VAS pain, VAS satisfaction              | 4                 | 12   | ARTHROSCOPIC                 |
| Malloy, P. [129]    | 2019 | IV                | USA      | Retrospective    | 26.4      | n   | 50           | HOS (ADL + SS), iHOT-12, mHHS, VAS pain, VAS satisfaction                     | 3                 | 36   | ARTHROSCOPIC                 |
| Mannion, A. F. [130]| 2013 | II                | Switzerland| Prospective    | 12        | n   | 86           | GTO, ORS, NASS                                                                | 2                 | 44   | MINI-OPEN AND ARTHROSCOPIC   |
| Marsell, N. S. [131]| 2018 | I                 | USA      | RCT              | 12        | n   | 40           | GRC, HOUS, iHOT-12, PCS, Self-motivation inventory score, VAS pain            | 2                 | 53   | ARTHROSCOPIC                 |
| Mardones, R. [132]  | 2016 | IV                | Chile    | Retrospective    | 52.8      | n   | 23           | mHHS, VAS pain                                                               | 1                 | 22   | ARTHROSCOPIC                 |
| Mardones, R. [133]  | 2016 | IV                | Chile    | Retrospective    | 48        | n   | 15           | mHHS, VAS pain, VHS                                                         | 2                 | 27   | ARTHROSCOPIC                 |
| Martinez, D. [135]  | 2015 | IV                | Colombia | Prospective      | 23.8      | n   | 179          | WOMAC                                                                        | 1                 | 35   | ARTHROSCOPIC                 |
| Mas Martinez, J. [136]| 2020 | IV                | Spain    | Retrospective    | 24        | y   | 185          | HOS (ADL + SS), iHOT-12 mHHS                                                 | 3                 | 77   | ARTHROSCOPIC                 |
| Matsuda, D. K. [137]| 2013 | III               | USA      | Retrospective    | 30        | n   | 54           | NAHS, satisfaction scale                                                    | 1                 | 59   | ARTHROSCOPIC                 |
### Table 1 (continued)

| Author                  | Year | Level of evidence | Country | Study type         | Follow-up | RTS | Participants Included PROMs | Hip specific PROMs | Men% | Surgery                |
|-------------------------|------|-------------------|---------|--------------------|-----------|-----|-----------------------------|-------------------|------|------------------------|
| Matsuda, D.K. [138]     | 2017 | III               | USA     | Retrospective      | 12        | n   | 77 NAHS, satisfaction (1–5) | 1                 | 52   | ARTHROSCOPIC           |
| Matsuda, D.K. [139]     | 2019 | III               | USA     | Retrospective      | 24        | n   | 437 iHOT-12                 | 1                 | 67   | ARTHROSCOPIC           |
| Menge, T.J. [140]       | 2017 | III               | USA     | Retrospective      | 120       | n   | 154 HOS (ADL + SS), mHHS, SF-12, VAS satisfaction | 2                 | 52   | ARTHROSCOPIC           |
| Mladenović, D. [141]    | 2014 | IV                | Serbia  | Retrospective      | 12        | n   | 21 WOMAC                    | 1                 | 23   | OPEN                   |
| Naal, F.D. [144]        | 2017 | III               | Switzerland | Retrospective | 444       | n   | 232 EQ-5D, EQ-VAS, OHS, satisfaction scale (1–5), UCLA | 1                 | 49   | INCLUDING BOTH         |
| Nabavi, A. [145]        | 2015 | III               | Australia | Retrospective | 12        | n   | 253 mHHS, NAHS              | 2                 | 50   | ARTHROSCOPIC           |
| Nakashima, H. [146]     | 2019 | III               | Japan   | Retrospective      | 341       | n   | 97 mHHS, NAHS               | 2                 | 44   | ARTHROSCOPIC           |
| Nawabi, D.H. [147]      | 2016 | III               | USA     | Retrospective      | 24        | n   | 177 HOS (ADL + SS), iHOT-33, mHHS | 3                 | 46   | ARTHROSCOPIC           |
| Nepple, J.J. [148]      | 2015 | IV                | USA     | Prospective        | X         | n   | 50 mHHS, SF-12              | 1                 | 64   | ARTHROSCOPIC AND LIMITED OPEN OSTEOCARTILAGE RESECTION |
| Nepple, J.J. [149]      | 2009 | III               | USA     | Retrospective      | 24\(^1\)  | n   | 48 mHHS                     | 1                 | 60   | ARTHROSCOPIC           |
| Nho, S.J. [150]         | 2019 | III               | USA     | Retrospective      | 27.8      | n   | 933 HOS (ADL + SS), iHOT-12, mHHS, VAS pain, VAS satisfaction | 3                 | 37   | ARTHROSCOPIC           |
| Nwachukwu, B.U. [151]   | 2020 | III               | USA     | Retrospective      | 24        | n   | 898 HOS (ADL + SS), mHHS, VAS pain, VAS satisfaction | 2                 | 35   | ARTHROSCOPIC           |
| Nwachukwu, B.U. [152]   | 2018 | III               | USA     | Retrospective      | 24        | n   | 719 HOS (ADL + SS), iHOT-33, mHHS | 3                 | 47   | ARTHROSCOPIC           |
| Nwachukwu, B.U. [153]   | 2017 | III               | USA     | Retrospective      | 12        | n   | 364 HOS (ADL + SS), iHOT-33, mHHS | 3                 | 43   | ARTHROSCOPIC           |
| Palmer, A.J.R. [156]    | 2019 | I                 | England | RCT                | 8         | n   | 112 EQ-5D, EQ-VAS, HADS (anxiety + depression), HAGOS, HOS (ADL + SS), iHOT-33, NAHS, OHS, Pain detect score, UCLA | 5                 | 34   | ARTHROSCOPIC           |
| Park, M.S. [157]        | 2014 | IV                | Korea   | Retrospective      | 28.2      | n   | 197 mHHS, VAS satisfaction | 1                 | 49   | ARTHROSCOPIC           |
| Peeters, I. [160]       | 2019 | III               | USA     | Retrospective      | 60        | n   | 52 HOS (SS), iHOT-12, mHHS, NAHS, VAS pain, VAS satisfaction | 4                 | 72   | ARTHROSCOPIC           |
| Peeters, I. [161]       | 2018 | III               | USA     | Retrospective      | 71        | n   | 148 HOS (SS), mHHS, NAHS, VAS pain, VAS satisfaction | 3                 | 39   | ARTHROSCOPIC           |
| Author            | Year | Level of evidence | Country | Study type | Follow-up | RTS | Participants | Included PROMs                                                                 | Hip specific PROMS | Mer% | Surgery            |
|-------------------|------|-------------------|---------|------------|-----------|-----|--------------|--------------------------------------------------------------------------------|-------------------|------|--------------------|
| Perets, I. [159]  | 2018 | IV                | USA     | Retrospective | 60        | n    | 94           | HOS (SS), mHHS, NAHS, VAS pain, VAS satisfaction                               | 3                 | 45   | ARTHROSCOPIC       |
| Philippon, M. J.  | 2010 | IV                | USA     | Retrospective | 24        | y    | 28           | mHHS, VAS satisfaction                                                        | 1                 | 100  | ARTHROSCOPIC       |
| Philippon, M. J.  | 2009 | IV                | USA     | Prospective  | 27.6      | n    | 112          | HOS (ADL + SS), mHHS, NAHS, VAS satisfaction                                  | 3                 | 45   | ARTHROSCOPIC       |
| Philippon, M. J.  | 2012 | IV                | USA     | Prospective  | 35.7      | n    | 153          | HOS (ADL + SS), mHHS, SF-12, VAS satisfaction                                 | 2                 | 47   | ARTHROSCOPIC       |
| Polesello, G. C.  | 2012 | IV                | Brazil  | Retrospective | 34.3      | y    | 47           | mHHS, satisfaction                                                           | 1                 | 43   | ARTHROSCOPIC       |
| Polesello, G. C.  | 2009 | IV                | Brazil  | Retrospective | 27        | n    | 28           | HHS                                                                         | 1                 | 67   | ARTHROSCOPIC       |
| Potter, M. Q.     | 2014 | II                | USA     | Prospective  | X         | n    | 147          | HOS (ADL + SS), mHHS, Modified zung depression scale, MSPQ                    | 2                 | 37   | ARTHROSCOPIC       |
| Przybyl, M.       | 2018 | III               | Poland  | Retrospective | 24        | y    | 129          | mHHS, NAHS                                                                    | 2                 | 100  | ARTHROSCOPIC       |
| Ragab, R.         | 2018 | IV                | Egypt   | Prospective  | 12.5      | n    | 40           | iHOT-12, mHHS                                                                 | 2                 | 50   | ARTHROSCOPIC       |
| Ramos, N.         | 2020 |III               | USA     | Retrospective | 12        | n    | 70           | mHHS                                                                        | 1                 | 47   | ARTHROSCOPIC       |
| Ramos, N.         | 2020 |IV                | USA     | Retrospective | 19.2      | y    | 10           | mHHS, satisfaction                                                            | 1                 | 100  | ARTHROSCOPIC       |
| Redmond, J. M.    | 2015 | III               | USA     | Retrospective | 24        | n    | 190          | HOS (ADL + SS), mHHS, NAHS, VAS pain, VAS satisfaction                        | 3                 | 37   | ARTHROSCOPIC       |
| Rego, P.A.        | 2018 | III               | Portugal| Retrospective | 59        | y    | 198          | NAHS                                                                        | 1                 | 56   | INCLUDING BOTH    |
| Ribas, M.         | 2007 | IV                | Spain   | Retrospective | 29.2      | y    | 32           | The Merle d’Aubigné–Postel score, WOMAC                                      | 2                 | 72   | MINI-OPEN-TECHNIQUE|
| Riff, A. J.       | 2018 | IV                | USA     | Retrospective | 24        | y    | 32           | HOS (ADL + SS), mHHS, VAS pain, VAS satisfaction                              | 2                 | 40   | ARTHROSCOPIC       |
| Rivera, E.        | 2020 |III               | Spain   | Retrospective | 24        | n    | 80           | iHOT-33, mHHS, VAS pain                                                      | 2                 | 66   | ARTHROSCOPIC       |
| Roos, B. D.       | 2017 | III               | Brazil  | Retrospective | 36⁰      | n    | 56           | mHHS, NAHS                                                                    | 2                 | 84   | INCLUDING BOTH    |
| Roos, B. D.       | 2015 | IV                | Brazil  | Retrospective | 29.1      | n    | 40           | mHHS, NAHS                                                                    | 2                 | 87   | ARTHROSCOPIC       |
| Rylander, J. H.   | 2011 | IV                | USA     | Prospective  | 12        | n    | 11           | Tegner                                                                       | 0                 | 73   | ARTHROSCOPIC       |
| Saltzman, B. M.   | 2017 | III               | USA     | Retrospective | 31.2      | n    | 381          | HOS (ADL + SS), mHHS, VAS pain, VAS satisfaction                              | 2                 | 39   | ARTHROSCOPIC       |
| Samaan, M. A.     | 2020 | II                | USA     | Prospective  | 7         | n    | 10           | HOOS                                                                         | 1                 | 80   | ARTHROSCOPIC       |
Table 1 (continued)

| Author                  | Year  | Level of evidence | Country | Study type     | Follow-up | RTS | Participants | Included PROMs                                                                                      | Hip specific PROMS | Men% | Surgery                           |
|-------------------------|-------|-------------------|---------|----------------|-----------|-----|--------------|---------------------------------------------------------------------------------------------------|-------------------|------|-----------------------------------|
| Sanders, T. L. [184]    | 2017  | IV                | USA     | Retrospective  | 30 y      | 46  | ADL, iHOT, mHHS, sport score, subjective level of function (1–4) | 2                  | 33   | ARTHROSCOPIC                      |
| Sansone, M. [186]       | 2015  | IV                | Sweden  | Prospective    | 12.3 n    | 85  | EQ-5D, HAGOS, HSAS, iHOT-12, VAS overall hip function, satisfaction y/n | 3                  | 80   | ARTHROSCOPIC                      |
| Sansone, M. [187]       | 2016  | IV                | Sweden  | Prospective    | 26 n      | 75  | EQ-5D, HAGOS, HSAS, iHOT-12, VAS overall hip function, satisfaction y/n | 3                  | 77   | ARTHROSCOPIC                      |
| Sansone, M. [188]       | 2017  | IV                | Sweden  | Prospective    | 25.4 n    | 289 | EQ-5D, HAGOS, HSAS, iHOT-12, VAS overall hip function, satisfaction y/n | 3                  | 66   | ARTHROSCOPIC                      |
| Sariali, E. [189]       | 2018  | IV                | France  | Prospective    | 396 n     | 47  | HHS, OHS                                             | 2                  | x    | ARTHROSCOPIC                      |
| Scannaliato, J. P. [190]| 2018  | III               | USA     | Retrospective  | 24 n      | 152 | iHOT-12, mHHS, SF-12, VAS pain, VAS satisfaction      | 2                  | 42   | ARTHROSCOPIC                      |
| Shaw, K. A. [191]       | 2017  | IV                | USA     | Prospective    | 6 n       | 11  | HOS, mHHS                                             | 2                  | 73   | ARTHROSCOPIC                      |
| Shibata, K. R. [192]    | 2017  | III               | USA     | Retrospective  | 189 y     | 98  | HSAS, iHOT-33, mHHS                                  | 3                  | 50   | ARTHROSCOPIC                      |
| Skendzel, J. G. [194]   | 2014  | III               | USA     | Retrospective  | 73 n      | 559 | HOS (ADL + SS), mHHS, SF-12, VAS satisfaction, WOMAC | 3                  | 44   | ARTHROSCOPIC                      |
| Skowronek, P. [195]     | 2017  | IV                | Poland  | Retrospective  | 45 y      | 39  | HHS, SF-36, VAS pain                                 | 1                  | 64   | MIN-OPEN DIRECT ANTERIOR APPROACH (DDA)          |
| Sochacki, K. R. [198]   | 2018  | III               | USA     | Retrospective  | X n       | 212 | HOS (ADL + SS), iHOT-12, SF-36                      | 2                  | 44   | ARTHROSCOPIC                      |
| Sochacki, K. R. [197]   | 2018  | III               | USA     | Retrospective  | 12 n      | 77  | BDI-2, HOS (ADL + SS), iHOT-33                       | 2                  | 27   | ARTHROSCOPIC                      |
| Spencer-Gardner, L. [199]| 2017  | III               | Australia| Retrospective | 19 n      | 36  | mHHS, NAHS                                           | 2                  | 42   | ARTHROSCOPIC                      |
| Srinivasan, S. C. [200] | 2013  | IV                | England | Retrospective  | 223 n     | 26  | NAHS, UCLA, VAS pain                                 | 2                  | 42   | COMBINED ARTHROSCOPIC AND OPEN       |
| Stone, A. V. [201]      | 2019  | IV                | USA     | Retrospective  | 24 n      | 626 | HOS (SS), VAS pain, VAS satisfaction                | 1                  | 31   | ARTHROSCOPIC                      |
| Stone, A. V. [202]      | 2019  | III               | USA     | Retrospective  | 24 n      | 688 | HOS (ADL + SS), iHOT-12, mHHS, VAS pain, VAS satisfaction | 3                  | 35   | ARTHROSCOPIC                      |
| Stähelin, L. [203]      | 2008  | IV                | Switzerland| Prospective  | 6 n       | 22  | NAHS, VAS pain                                       | 1                  | 68   | ARTHROSCOPIC                      |
| Thomas, D. D. [204]     | 2017  | IV                | USA     | Retrospective  | 30 n      | 469 | SANE, VAS pain                                       | 0                  | 66   | ARTHROSCOPIC                      |
Table 1 (continued)

| Author       | Year | Level of evidence | Country | Study type         | Follow-up | RTS | Participants | Included PROMs                                           | Hip specific PROMS | Merits | Surgery                           |
|--------------|------|-------------------|---------|--------------------|-----------|-----|--------------|----------------------------------------------------------|-------------------|--------|------------------------------------|
| Tjong, V. K. | 2016 | IV                | USA     | Prospective        | 24        | y   | 23           | HOS (SS), iHOT-12, mHHS, VAS pain, VAS satisfaction       | 3                 | 35     | ARTHROSCOPIC                      |
| Vahedi, H.   | 2019 | III               | USA     | Retrospective      | 49.9      | n   | 601          | mHHS, SF-36                                             | 1                 | 54     | ARTHROSCOPIC                      |
| Wadhawan, J. | 2018 | IV                | Spain   | Retrospective      | 12        | n   | 105          | mHHS                                                    | 1                 | 50     | ARTHROSCOPIC                      |
| Westermann, R. W. | 2018 | III              | USA     | Retrospective      | X         | n   | 321          | HOOS (pain + physical function), UCLA, VR-12             | 1                 | 31     | ARTHROSCOPIC                      |
| Wu, C. T.    | 2019 | IV                | Taiwan  | Retrospective      | 44        | n   | 36           | HHS, VAS pain                                          | 1                 | 56     | MINI-OPEN ARTHROSCOPIC-ASSISTED   |
| Wörner, T.   | 2019 | III               | Sweden  | Retrospective      | 8.1       | y   | 33           | HAGOS, HSAS                                             | 2                 | 88     | ARTHROSCOPIC                      |
| Yoo, J. I.   | 2017 | IV                | Korea   | Retrospective      | 24        | n   | 40           | mHHS, UCLA, VAS pain                                   | 1                 | 63     | ARTHROSCOPIC                      |
| Yun, H. H.   | 2009 | IV                | Korea   | Retrospective      | 27.6      | n   | 16           | HHS                                                    | 1                 | 86     | OPEN                              |
| Zhu, X.      | 2020 | I                 | China   | RCT                | 3         | n   | 100          | HHS, PGA, VAS pain                                      | 1                 | 51     | ARTHROSCOPIC                      |
| Zimmerer, A. | 2018 | II                | Germany | Prospective        | 24.4      | n   | 43           | HOOS, WOMAC                                             | 2                 | 72     | ARTHROSCOPIC                      |
| Zusmanovich, M. | 2020 | III             | USA     | Retrospective      | 25.2      | n   | 34           | mHHS, NAHS, VAS pain                                    | 2                 | 41     | ARTHROSCOPIC                      |
| Öhlin, A.    | 2017 | IV                | Sweden  | Prospective        | 24        | n   | 198          | iHOT-12, satisfaction y/h                               | 1                 | 62     | ARTHROSCOPIC                      |

Abbreviations: n no, PROM Patient-reported Outcome Measures, RCT randomized control trial, RTS Return to sport, y = yes. For abbreviations of PROMs, see Appendix, Table 3

a combined mean value was calculated

b median value
Discussion
The most important finding in this systematic review was the expected growth in the number of studies published over the years, where over 70% of the included studies were published between 2016–2020. Although the literature review included studies from 1999–2020, the first study meeting the inclusion criteria was published in 2004.

A total of 39 different PROMs were used among the studies, of which 15 were hip specific. The most common non-hip specific outcome was satisfaction, found in 40% of the studies. Previous studies have reported that satisfaction is the most frequently used non-hip specific outcome tool, although there is a variability how satisfaction is reported [175, 193]. The discrepancy in the use of different PROMs has previously been noted and the reason for this is unknown. The routinely use of a specific PROM, the difficulty in changing PROMs once norms have been established and the inevitable retention of the same PROMs to be able to follow a cohort and evaluate long-term outcomes are possible explanations for the divergence in use of PROMs [175].

After the Warwick agreement in 2016, three patient-reported outcome measures were considered suitable for the target population of FAIS and were recommended
to use when evaluating surgery for FAIS [82], 65% of the included studies in this systematic review used at least one of the recommended PROMs (HAGOS, iHOT-12 or iHOT-33 and HOS (ADL + SS)). Nonetheless, the mHHS remains being the most commonly used PROM, even though there is a well-known ceiling effect of mHHS described for young active patients [206]. It could be seen as both surprising and concerning that mHHS still is the most used PROM in studies on FAIS as its outcome's validity for young and active patients is considered low. Thorborg et al. [206] found HAGOS to be the best suited PROM for patients with FAIS, which only was used in 7% of the studies. This finding can guide future healthcare providers and researchers in using hip specific PROMs valid for the target population and diagnosis. Furthermore, there is a need for adoption of new validated scores, translated into the patients’ native language.

Only 13% of the included studies reported RTS specifically by using a clear definition. There is a current challenge in sports science regarding the definition of RTS, and the most optimal evaluation of RTS has not yet been decided. Activity scores such as the HOS (SS), Tegner activity scale or HSAS, with the purpose to evaluate the patients’ activity level or issues in sport specific activities, are not the best tools to evaluate the RTS. Mainly because these scores do not include training load or performance compared with preinjury status. This could possibly generate a ceiling effect if the patients rate the PROMs higher, yet still not being capable to fully return to their preinjury level of sport. Furthermore, the definition of RTS has been proposed to differ between elite and recreational athletes [42]. Athletes undergoing hip arthroscopic surgery for FAIS usually have a major interest whether they can RTS again, thus, a reliable method to determine RTS is thus needed.

The majority of the studies were published in USA or in Europe. This has previously been reported [106, 213]. Although USA and Europe have been in the front line of hip arthroscopic surgery and research, a small number of studies included in this systematic review were from Korea and China, indirectly indicating an upcoming trend in performed surgeries for FAIS in Asia. Moreover, only studies in the English language were included in this systematic review, which partly might explain the high percentage of studies from USA and Europe.

Although a few RCT:s have been published, retrospective studies are still the most common. Over the years, patient registries have facilitated prospective evaluation of FAIS and yielded important insight on PROMs [126, 185]. Öhlin et al. [155] assessed the methodological quality of prospective studies over a 5-year time period and found no improvement in the quality of the methods despite an increase in the number of published studies. With the dramatic increase seen in the number of published studies in this systematic review, it is of importance to also improve the quality of observational studies. New consensus meetings to enhance adoption of suitable PROMs and education of researchers and clinicians could benefit future research in the outcome of FAIS.

Strengths and limitations
The strength of this study is the methodological rigor using PRISMA guidelines, focus on an important topic and the longitudinal analysis of a 20-year time horizon.

This systematic review is not without limitations. One of the a-priori set exclusion criteria was age, excluding studies with patients < 18 years old, though the focus was on the adult population as validation of PROMs in the pediatric population is still emerging. Moreover, only publications in the English language were included and there is a risk of missing publications in non-English speaking countries. Due to the heterogeneity of the included studies no statistical meta-analysis was conducted.

Conclusion
There has been a continuous increase in the number of published studies regarding FAIS with the majority evaluating arthroscopic surgery. The mHHS remains being the most commonly used PROM.
## Appendix

### Table 2  Search strategy: pubmed

| Search | Query | Results |
|--------|-------|---------|
| #27    | Search: #19 NOT #22 Filters: English Sort by: Most Recent | 2,085 |
| #23    | Search: #19 NOT #22 Sort by: Most Recent | 2,172 |
| #22    | Search: #20 OR #21 Sort by: Most Recent | 5,073,653 |
| #21    | Search: animal(ti) OR animals(ti) OR rat(ti) OR rats(ti) OR mouse(ti) OR mice(ti) OR rodent(ti) OR rodents(ti) OR dog(ti) OR dogs(ti) OR cat(ti) OR cats(ti) OR koala(ti) OR hamster(ti) OR hamsters(ti) OR rabbit(ti) OR rabbits(ti) OR swine(ti) OR murine(ti) Sort by: Most Recent | 1,886,518 |
| #20    | Search: (animals(mh) NOT (animals(mh) AND humans(mh))) Sort by: Most Recent | 4,731,731 |
| #19    | Search: #5 AND #18 Sort by: Most Recent | 2,177 |
| #18    | Search: #6 OR #7 OR #17 Sort by: Most Recent | 2,006,557 |
| #17    | Search: surgery(tiab) OR surgical(tiab) OR operative(tiab) OR minimally invasive(tiab) Sort by: Most Recent | 1,989,360 |
| #7     | Search: arthroscop*[tiab] Sort by: Most Recent | 31,803 |
| #6     | Search: "Arthroscopy"[Mesh] Sort by: Most Recent | 23,951 |
| #5     | Search: #2 OR #3 OR #4 Sort by: Most Recent | 4,313 |
| #4     | Search: hip impingement(tiab) OR cam impingement(tiab) OR pincer impingement(tiab) OR FAI(tiab) OR FAIS(tiab) Sort by: Most Recent | 2,865 |
| #3     | Search: (femoroacetabular(tiab) OR femoracetabular(tiab) OR femoral acetabular(tiab) OR femoro-acetabular(tiab)) AND impingement(tiab) Sort by: Most Recent | 2,738 |
| #2     | Search: "Femoracetabular Impingement"[Mesh] Sort by: Most Recent | 1,702 |

* Date of search: 7th of September 2020. Results: 2085 studies
| PROM            | Name                                                      | Hip specific |
|-----------------|-----------------------------------------------------------|--------------|
| BDI-2           | Beck Depression Inventory                                 | No           |
| EQ-5D           | European Quality of life index version 5D                 | No           |
| FAA             | Functional Activity Assessment                            | No           |
| GRC             | Global Rating of Change                                  | No           |
| GTO             | Global Treatment Outcome                                 | No           |
| HADS            | Hospital Anxiety and Depression Scale                    | No           |
| HAGOS           | The Copenhagen Hip and Groin Outcome Score               | Yes          |
| HHS             | Harris Hip Score                                          | Yes          |
| HOOS            | Hip Disability and Osteoarthritis Outcome Score           | Yes          |
| HOS (ADL + SS)  | Hip Outcome Score (Activities of Daily Living + Sport Specific) | Yes         |
| HPSES           | Hip Preservation Surgery Expectations Survey             | Yes          |
| iHOT-12         | The international Hip Outcome Tool-12                    | Yes          |
| iHOT-33         | The international Hip Outcome Tool-33                    | Yes          |
| LISHO           | Lequesne Functional Index for Hip Osteoarthritis          | Yes          |
| Merle d'Aubigne and Postel scale |  | Yes          |
| mHHS            | modified Harris Hip Score                                | Yes          |
| MHOT            | Mahorn Hip Outcome Tool                                  | Yes          |
| MSPQ            | Modified Somatic Perception Questionnaire                | Yes          |
| Modified zung depression scale |  | No           |
| NASS            | North American Spine Society Lumbar Spine Questionnaire   | No           |
| MOS             | Mean Opinion Score                                        | No           |
| NAHS            | Non-Arthritic Hip Score                                  | Yes          |
| OHS             | Oxford Hip Score                                          | Yes          |
| Pain detect score |  | No           |
| PCS             | Pain Catastrophizing Scale                               | No           |
| PGA             | Patient Global Assessment                                | No           |
| PHQ             | Patient Health Questionnaire                              | No           |
| PSQI            | Pittsburgh Sleep Quality Index                            | No           |
| SANE            | Single Assessment Numeric Evaluation                     | No           |
| Satisfaction    |  | No           |
| SF-12           | 12-item Short-Form Health Survey                         | No           |
| SF-36           | The Short Form 36 Health Survey                          | No           |
| Tegner          |  | No           |
| TSK             | Tampa Scale of Kinesiophobia                             | No           |
| UCLA            | University of California Los Angeles activity scores.    | No           |
| VAS pain        | Visual analogue scale                                     | No           |
| VHS             | Vail Hip score                                            | Yes          |
| VR-12           | The Veterans RAND 12 Item Health Survey                   | No           |
| WOMAC           | Western Ontario and MacMaster Universities Osteoarthritis Index | Yes         |
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OA declare a potential conflict of interest as a non-financial arrangement of “Speakers Bureau of Conmed”. Other authors have no competing interest to declare.

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