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Maria T Schwabe
Washington University School of Medicine in St. Louis

John C Clohisy
Washington University School of Medicine in St. Louis

Abby L Cheng
Washington University School of Medicine in St. Louis

Cecilia Pascual-Garrido
Washington University School of Medicine in St. Louis

Marcie Harris-Hayes
Washington University School of Medicine in St. Louis

See next page for additional authors

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Authors
Maria T Schwabe, John C Clohisy, Abby L Cheng, Cecilia Pascual-Garrido, Marcie Harris-Hayes, Devyani M Hunt, Michael D Harris, Heidi Prather, and Jeffrey J Nepple

Short-term Clinical Outcomes of Hip Arthroscopy Versus Physical Therapy in Patients With Femoroacetabular Impingement

A Systematic Review and Meta-analysis of Randomized Controlled Trials

Maria T. Schwabe,* MD, John C. Clohisy,* MD, Abby L. Cheng,* MD, Cecilia Pascual-Garrido,* MD, PhD, Marcie Harris-Hayes,† PT, DPT, OCS, Devyani M. Hunt,* MD, Michael D. Harris,† PhD, Heidi Prather,* DO, and Jeffrey J. Nepple,*‡ MD

Investigation performed at Washington University School of Medicine, St Louis, Missouri, USA

Background: Both physical therapy (PT) and surgery are effective in treating femoroacetabular impingement (FAI), but their relative efficacy has not been well established until recently. Several randomized controlled trials (RCTs) comparing the early clinical outcomes of these treatments have been published, with contradictory results.

Purpose/Hypothesis: The purpose of this study was to perform a meta-analysis of RCTs that compared early patient-reported outcomes (PROs) of hip arthroscopy versus PT in patients with symptomatic FAI. The hypothesis was that surgical treatment of FAI leads to better short-term outcomes than PT.

Study Design: Systematic review; Level of evidence, 1.

Methods: In March 2019, a systematic review was performed to identify RCTs comparing hip arthroscopy and PT in patients with symptomatic FAI. A total of 819 studies were found among 6 databases; of these, 3 RCTs met eligibility (Griffin et al, 2018; Mansell et al, 2018; and Palmer et al, 2019). All 3 RCTs reported international Hip Outcome Tool–33 (iHOT-33) scores, and 2 reported Hip Outcome Score (HOS)–Activities of Daily Living (ADL) and HOS-Sport results. In a random-effects meta-analysis, between-group differences in postintervention scores were assessed according to intention-to-treat and as-treated approaches. Quality was assessed with CONSORT, CERT, TiDieR, and the Cochrane Collaboration tool.

Results: The 3 RCTs included 650 patients with FAI; the mean follow-up ranged from 8 to 24 months. All studies reported PRO improvement from baseline to follow-up for both PT and surgery. The quality of the Griffin and Palmer studies was good, with minimal bias. In the Mansell study, a 70% crossover rate from PT to surgery increased the risk of bias. The meta-analysis demonstrated improved iHOT-33 outcomes with surgery compared with PT for intention-to-treat (mean difference [MD], 11.3; $P = .046$) and as-treated (MD, 12.6; $P = .007$) analyses. The as-treated meta-analysis of HOS-ADL scores favored surgery (MD, 12.0; $P < .001$), whereas the intention-to-treat analysis demonstrated no significant difference between groups for HOS-ADL (MD, 3.9; $P = .571$).

Conclusion: In patients with FAI, the combined results of 3 RCTs demonstrated superior short-term outcomes for surgery versus PT. However, PT did result in improved outcomes and did not appear to compromise the surgical outcomes of patients for whom therapy failed and who progressed to surgery.

Keywords: randomized controlled trials; femoroacetabular impingement; hip arthroscopy; physical therapy

Femoroacetabular impingement (FAI) syndrome is increasingly recognized and treated in adolescent and young adult patients.[2] A number of surgical studies have demonstrated patient improvements after surgical treatment of FAI.

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However, some patients have suboptimal outcomes, with 18% to 34% not reaching minimal clinically important difference (MCID) thresholds for patient-reported outcomes (PROs).[16] Physical therapy (PT) that emphasizes strengthening, motor control, and movement patterns, rather than range of motion, appears to relieve pain in some patients with FAI.[27] The success rates of nonoperative treatment for FAI have ranged from 39% to 82%.[13,20] Rigorous comparative research between outcomes of PT and FAI surgery has been previously lacking. The National Institutes of Health–sponsored American Academy of Orthopaedic Surgeons/Orthopaedic Research Society (AAOS/ORS) FAI Research Symposium of international leaders in 2012 concluded, "an urgent need exists for a randomized clinical trial that could compare the surgical and nonsurgical management of symptomatic FAI to justify definitively the need for surgical intervention in these patients."[3]

Several randomized controlled trials (RCTs) have recently been completed and published on this topic; however, the results are contradictory. It is important to systematically assess the findings and quality of these RCTs in order to reach a conclusion on the best evidence on this topic. The purpose of the current study was to perform a systematic review and meta-analysis of RCTs that directly compared the short-term outcomes of PT and surgery in patients with symptomatic FAI. The study hypothesis was that surgical treatment of FAI leads to better short-term outcomes, as measured by the international Hip Outcome Tool-33 (iHOT-33), compared with PT.

METHODS

A systematic review and meta-analysis of RCTs comparing PT and surgery in patients with FAI was performed using the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. The question inquired was, "Is there a difference in patient-reported outcomes of patients with femoroacetabular dysplasia impingement who have surgery versus conservative management with physical therapy?"

Eligibility Criteria

The inclusion criteria consisted of RCTs comparing the surgical and nonsurgical management of patients with FAI. Exclusion criteria included studies that did not assess FAI, were not randomized, did not compare surgical and nonsurgical interventions, and did not assess human patients. Additional exclusion criteria were studies in a language other than English, duplicates, protocol/feasibility studies, abstracts, and reviews/case studies/commentaries.

Search Strategy

A search of the literature was performed with the assistance of a medical librarian with extensive experience in systematic reviews and included the search terms "femoroacetabular impingement" and "randomized controlled trials," with similar keywords; an RCT filter was used. The databases searched were Ovid Medline 1946-, Embase 1947-, Scopus 1960-, Cochrane Central Register of Controlled Trials, Cochrane Database of Systematic Reviews, and ClinicalTrials.gov. These databases were employed to ensure that a broad and exhaustive search was performed. In total, 819 results were exported and 340 duplicates were removed, resulting in 479 final citations for review. The search was performed on March 1, 2019; complete search strategies are contained in Appendix 1.

Study Selection and Data Collection

Two reviewers (M.T.S. and A.L.C.) were blinded and independently reviewed all abstracts and relevant articles, and discrepancies regarding eligibility were resolved by discussion between the 2 reviewers. Then, each reviewer independently performed the data extraction, of which the variables included author, year, setting, patient characteristics, number of surgeons and therapists, type of surgery and therapy, expertise, randomization method, percentage receiving allocating treatment, crossover, and PROs. The CONSORT (Consolidated Standards of Reporting Trials) checklist[22] was used to ensure that each study met the evidence-based, minimum set of requirements. Overall risk of bias among the studies was assessed using the Cochrane Collaboration tool.[11] To assess the reporting of the PT and surgical treatment, the TIDieR (Template for Intervention Description and Replication) checklist[12] was utilized. Additionally, for PT we used the CERT (Consensus on Exercise Reporting Template) guidelines[23] specifically to assist in scoring items 4 (what: procedures) and 8 (when and how

‡Address correspondence to Jeffrey J. Nepple, MD, Department of Orthopaedic Surgery, Washington University School of Medicine, St Louis, MO 63110, USA (email: nepplej@wustl.edu).

*Department of Orthopaedic Surgery, Washington University School of Medicine, St Louis, Missouri, USA.

†Department of Physical Therapy, Washington University School of Medicine, St Louis, Missouri, USA.

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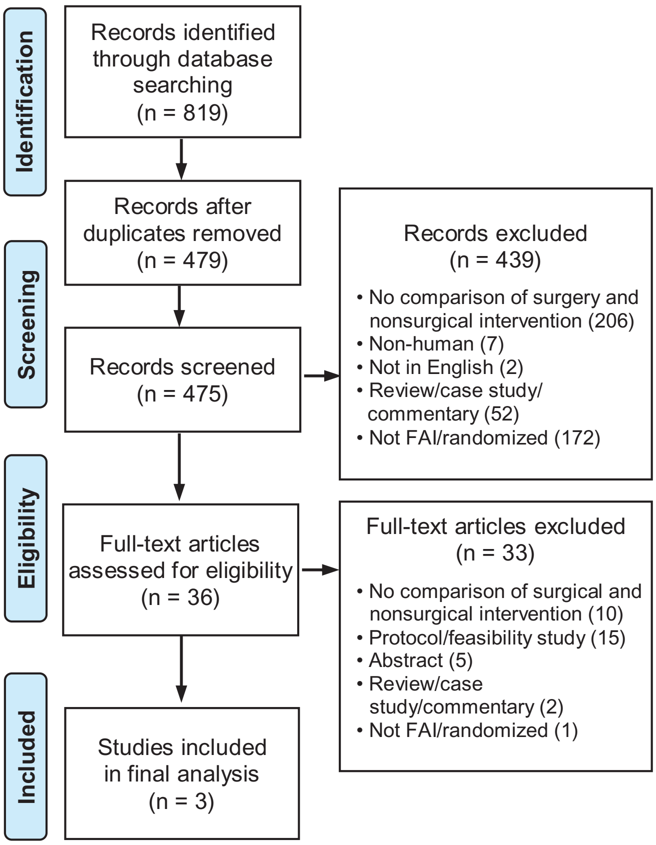

Figure 1. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow diagram of included studies. FAI, femoroacetabular impingement.

much) in the TIDieR checklist. See Appendix 2 for further methodological details.

A total of 3 studies (Griffin et al [2018],[8] Mansell et al [2018],[15] and Palmer et al [2019][19]) met all eligibility criteria, as summarized in Figure 1. The published protocols (all 3 studies) and feasibility publications (Griffin and Palmer studies) were assessed for additional details not present in the primary papers.[7,9,14,17,18] As the effect size and standard deviation of iHOT-33 noted in the Palmer study did not appear to be possible as reported, the authors of the Palmer study were contacted and the correct data were provided (Sion Glyn-Jones, personal communication, 2019). The previously reported iHOT-33 effect size of 2.0 (95% CI, 1.3-2.8) was corrected to the actual result of 20 (95% CI, 13-28) and utilized in the analysis.

Outcome Measures and Analysis

Similar PROs across the studies included the iHOT-33 (all studies[8,15,19]), Hip Outcome Score (HOS)–Activities of Daily Living (ADL) subscale (2 studies[15,19]), and HOS-Sport subscale (2 studies[15,19]) and were utilized for meta-analysis. The iHOT-33 was used as the primary outcome because all 3 studies included this value, and the HOS was used as a secondary outcome. Follow-up was based on time from randomization to final outcome, not when treatment (surgery or PT) was actually received. All studies reported the difference in final scores between the 2 treatment groups at follow-up. To determine significant clinical improvement, the 3 studies used the MCID. Only the Palmer study used the Patient Acceptable Symptomatic State (PASS), and no studies used the substantial clinical benefit. A pre- to posttreatment effect size of PT and surgery could not be measured with the available data from the publications; thus, a similar baseline score was assumed given randomization, and the final posttreatment score was the primary outcome.

A meta-analysis was performed across the 3 RCTs after detailed assessments of each study. A Cochrane Q and I^2 were calculated to assess statistical heterogeneity. Each meta-analysis had high heterogeneity, as seen by the I^2 values, likely from the variability in PT protocol, patient population, and crossover bias. Because of the heterogeneity in patient populations, all assessments were done with a random-effects model, and a standardized mean difference (MD) was obtained. While some differences in patient population, PT intervention, and surgical intervention were present across studies, our multidisciplinary team judged them to be adequately representative of the current treatment of FAI to allow meta-analysis.

Given the large crossover rate present in 1 study[15] (70% crossover PT to surgery), which may significantly bias intention-to-treat analyses, both intention-to-treat and as-treated analyses were performed. Data for as-treated analyses were available for 2 studies.[8,15] No as-treated analysis data were available for the Palmer[19] study, but given the low rate of crossover present in this study, intention-to-treat data from the Palmer study were combined into the as-treated meta-analysis.

RESULTS

A total of 650 patients were included in the 3 RCTs evaluated in the meta-analysis.[8,15,19] The Palmer[19] and Griffin[8] studies were multicenter trials, while the Mansell[15] study was a single-institution trial. The 3 studies differed in their calculated sample size to achieve appropriate power (Table 1). The Mansell study was performed in a US military population (1 surgeon, 80 patients), while the Griffin and Palmer studies were performed in civilian UK population (27 surgeons, 348 patients; and 10 surgeons, 222 patients, respectively) (Tables 1 and 2). The Griffin study included patients who had received PT before enrollment, while the Mansell study included patients who had participated in a self-management program before enrollment. The percentage of eligible patients enrolled was 63% for the Palmer study, 54% for the Griffin study, and 77% for the Mansell study. Each study used a computer-generated randomization method (1:1 allocation for the Palmer and Griffin studies, blocks of 2 or 4, with a 1:1 ratio for the Mansell study). All studies designated intention-to-treat analyses as the primary outcome, but Griffin and Mansell also reported as-treated analyses. Overall, follow-up was good for each study, ranging from 85% to 93% (78% reaching the 2-year time point for the Mansell study) (Table 2).

TABLE 1
Study Characteristics[a]

Study	Setting	Sample Size	Surgeons/PTs, n	PT Visits
Palmer et al (2019)[19]	7 centers in the United Kingdom	222	10/2	8 sessions over 20 weeks
Griffin et al (2018)[8]	23 centers in the United Kingdom	348	27/47	6-10 sessions over 12-24 weeks
Mansell et al (2018)[15]	Army medical center in the United States	80	1/1	12 sessions over 6 weeks

[a]PT, physical therapy.

TABLE 2
Study Methods and Patient Characteristics[a]

Study	Male Sex, n (%)	Age, y, Mean ± SD	Analysis	Follow-up Length	Follow-up, %	% Receiving Allocated Treatment	PT Visits	Surgery Details: %
Palmer et al (2019)[19]	75 (34)	36.2 ± 9.7	ITT	8 mo	85	PT—83 Surgery—88	8 sessions over 20 wk	Labral repair: 70 Labral debridement: 25 No labral treatment: 4 Femoral osteoplasty: 86 Acetabular rim trimming: 25 Acetabular microfracture: 9
Griffin et al (2018)[8]	213 (61)	35.3 ± 9.6	ITT	1 y	92	PT—95 Surgery—84	6-10 sessions over 12-24 wk	Labral repair: 25 Labral debridement: 60 Labral resection: 5 Femoral osteoplasty: 92 Acetabular rim trimming: 24 Acetabular microfracture: 15 Acetabular chondroplasty: 27
Mansell et al (2018)[15]	47 (59)	30.1 ± 7.4	ITT	2 y[b]	93	PT—28 Surgery—95	12 sessions over 6 wk	Surgical details not provided

[a]ITT, intention to treat; PT, physical therapy.
[b]A total of 78% with available 2-year patient-reported outcome.

Risk of Bias

The quality of 2 RCTs (Griffin and Palmer studies) was assessed as good, with minimal bias, while in the third RCT (Mansell study), several study characteristics increased the risk of bias (Table 3). First, an extremely high crossover rate may have affected interpretability of the Mansell study results (70% crossover from PT to surgery). The mean time to surgery was only 71.4 days longer in patients crossing over (compared with randomization to surgery) in this study. This resulted in the comparison of groups receiving surgery (95% vs 70%) in the intention-to-treat analyses for the Mansell study, which results in large differences between the intention-to-treat and as-treated analyses for HOS-ADL for this study. Additional risks of bias in the Mansell study included the single-center design, unique (military) population, notably different PT protocol compared with the other 2 studies (including exercises that moved the hip into an impingement position), and a smaller sample size compared with the other 2 studies.

The other 2 studies had low crossover rates from PT to surgery (Griffin[8] study, 8%; Palmer[19] study, 5%). Surgery was completed in 84% (Griffin study), 88% (Palmer study), and 95% (Mansell[15] study) of patients allocated to the surgery group. In the Palmer study, 9% of patients received incomplete surgical treatment (labral treatment only without bony correction because of advanced osteoarthritis) because they would be at higher risk for a poor outcome. All studies had significant wait times from randomization to actual surgery, with most patients obtaining surgery at about 3 months postrandomization, while short-term outcomes were still assessed relative to time of randomization. Last, all studies were unable to blind participants and personnel to the intervention type because no sham procedures were performed.

Qualitative Assessment

The assessment of TIDieR and CERT for each study is provided in Appendix 2.

Physical Therapy. Based on our review, no trial achieved 100% reporting PT details based on TIDieR. The Griffin[8] study scored the highest, with 67%, while the Palmer[19] and Mansell[15] studies each scored 33%. All studies used a multimodal approach to physical therapist–led intervention. Intervention described in all 3 studies was based on a systematic review[26] or consensus of an expert panel. The Mansell study described their intervention as standard of care.

TABLE 3
Cochrane Collaboration Tool for Assessing Risk of Bias

	Random Sequence Generation (Selection Bias)	Allocation Concealment (Selection Bias)	Blinding of Participants and Personnel (Performance Bias)	Blinding of Outcome Assessment (Detection Bias)	Incomplete Outcome Data (Attrition Bias)	Selective Reporting (Reporting Bias)	Other Bias
Palmer et al (2019)[19]	Low	Low	High	Low	Low	Low	Low
Griffin et al (2018)[8]	Low	Low	High	Low	Low	Low	Low
Mansell et al (2018)[15]	Low	Low	High	Low	High	Low	High

The studies utilized 1 to 47 physical therapists (Table 1). Despite referencing the same evidence, the PT interventions used across studies were quite varied. All studies used both supervised sessions in a PT clinic and a home exercise program that included core components of hip muscle strengthening and neuromuscular control exercises. Two of the 3 studies (by reported protocol) included the following core components: flexibility,[7,14] core stability,[7,17] and education to avoid the impingement position.[7,17] Additional core components included hip joint mobilization,[14] lumbar mobility,[14] and instruction in activity modification and physical activity.[7] All studies allowed for individualization based on pain and movement impairments. Across studies, the planned PT treatment dosage varied: 8 visits over 5 months,[19] 6 to 10 visits over 6 months,[8] and 12 visits over 6 weeks.[15]

FAI Surgery. FAI surgery was performed via hip arthroscopy in all studies. The number of surgeons included 1,[15] 10,[19] and 27[8] surgeons, all with some level of expertise in hip arthroscopy (performed at least 100 arthroscopies annually or at least had "extensive experience"). Hip arthroscopy for each study also included bony correction or labral treatments as deemed appropriate. Preoperative radiographic definitions of FAI morphology were present (cam, pincer, and mixed), and clinical examination helped support the findings. No studies included data regarding the adequacy of bony correction. Only the Griffin[8] study utilized a panel of experts to assess the quality of surgical care (87% deemed high fidelity, 13% inadequate). Postoperative PT was utilized in all studies, with similar limitations in the level of detail to the nonsurgical treatment PT arm described above.

Complications and Reoperations

Based on intention to treat, the surgery group's complication rate in the Mansell[15] study was 2.5% (1 heterotopic ossification) and the reoperation rate was 2.6% (1 hip arthroplasty), compared with a 2.5% complication rate (1 fracture after crossover to surgery) and 12.5% reoperation rate (5 revision hip surgeries) for the PT group. According to as-treated analysis, the complication rate of surgery was 3.0% (1 heterotopic ossification, 1 hip fracture) and the reoperation rate was 9.2% (1 hip arthroplasty). The Palmer[19] study reported a 3% rate of nonserious complications (0% serious complications), including a superficial wound infection treated with oral antibiotics and temporary lateral femoral cutaneous neurapraxia. The Palmer study reported no reoperations, but the study had a short-term follow-up. The Griffin[8] study reported minor complications of surgery in 7.9% (9 superficial wound infection, 2 thigh numbness), while serious complications were present in 0.7% (1 hip infection leading to total hip arthroplasty). To allow comparability across studies, we did not include some complications in this comparison (that were noted in the studies), including contralateral hip surgery (Mansell study intention-to-treat/as-treated: 0/6 surgery, 6/0 PT), hip osteoarthritis without reoperation (Mansell study intention-to-treat/as-treated: 5/7 surgery, 3/1 PT), muscle soreness or spasms (Griffin study: 58 surgery, 70 PT), hip pain or stiffness (Griffin study: 13 surgery, 8 PT), unscheduled hospital appointments (Griffin study: 13 surgery, 6 PT), or other miscellaneous issues noted in the publications as a complication (Griffin study: 41 surgery, 0 PT).

Meta-analysis

All 3 RCTs reported improvement from baseline to follow-up for both PT and surgery. Two studies (Griffin[8] and Palmer[19]) concluded that there were statistically significant superior outcomes with surgery, while 1 study (Mansell[15]) concluded that there was no difference in outcome between surgery and PT. For the primary outcome, differences in postintervention iHOT-33 scores were reported in all 3 studies, and meta-analysis of the intention-to-treat data demonstrated that the surgical group achieved a significantly greater postintervention outcome compared with the PT group (MD, 11.3; 95% CI, 1.9-20.7; $P = .046$; $I^2 = 76.7\%$) (Figure 2). The as-treated analysis also demonstrated greater postintervention outcomes in the surgery group, with a slightly higher effect size (MD, 12.6; 95% CI, 3.4-21.9; $P = .007$; $I^2 = 69.3\%$) (Figure 2).

For the secondary outcome, in the intention-to-treat meta-analysis of the 2 studies (Palmer[19] and Mansell[15] studies) reporting HOS-ADL and HOS-Sport, between-group postintervention scores were not significantly different, although favoring surgery over PT (HOS-ADL: MD, 3.9; 95% CI, –9.6 to 17.3; $P = .571$; $I^2 = 85.1\%$; HOS-Sport: MD, 6.2; 95% CI, –6.8 to 19.2; $P = .347$; $I^2 = 71.1\%$) (Figure 3). In the as-treated meta-analysis, the HOS-ADL showed a statistically

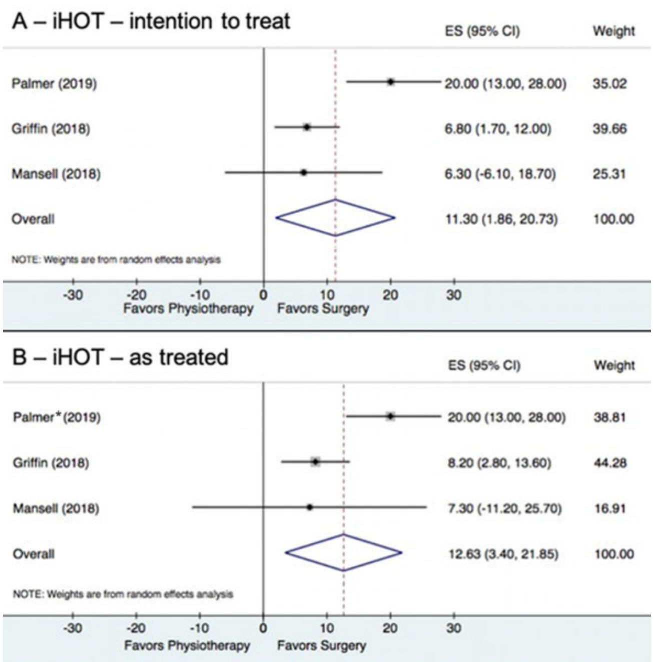

Figure 2. (A) Intention-to-treat meta-analysis of studies reporting iHOT-33 (P = .046). (B) As-treated meta-analysis of studies reporting iHOT-33 (P = .007). *Palmer[19] did not have as-treated data but provided the low crossover rate; intention-to-treat was used in this analysis. ES, effect size; iHOT-33, international Hip Outcome Tool–33.

significant result of favoring surgery over PT (MD, 12.0; 95% CI, 7.5-16.5; $P < .001$; $I^2 = 0\%$) (Figure 3). Adequate data for as-treated analysis of HOS-Sport were not available. Additionally, adequate data for comparing the percentage achieving MCID were also not available.

DISCUSSION

In this meta-analysis of 3 RCTs including 650 patients with FAI, surgical treatment resulted in significantly better PROs than PT as assessed by iHOT-33 and HOS-ADL, with the difference exceeding MCID values for each outcome. This conclusion is consistent with the results of the 2 higher-quality, larger RCTs included in the current review (Palmer[19] and Griffin[8] studies). The total cohort of 650 FAI patients also allows for improved power relative to individual studies that may have been underpowered. While the Mansell[15] study concluded that no significant difference in outcomes was present between surgery and PT, the results of this RCT were influenced by several issues that may have introduced bias. The most important of these issues is a 70% crossover from PT to surgery, which resulted in the intention-to-treat analysis comparing 2 groups in which the majority of both groups had surgical intervention. In the current meta-analysis, combining the intention-to-treat analysis data for the iHOT-33 still demonstrated a significant difference favoring surgery (despite the smallest effect

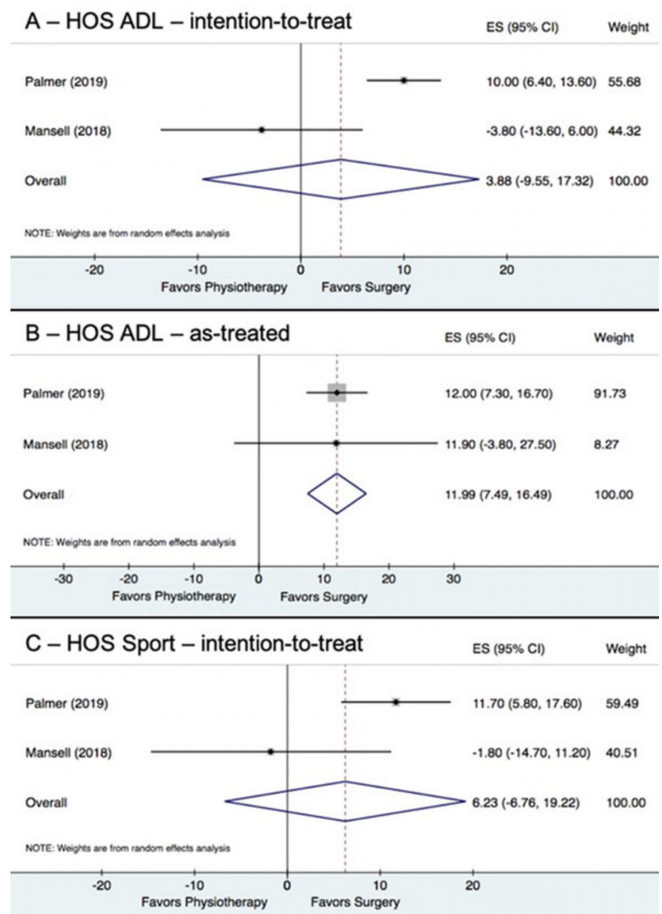

Figure 3. (A) Intention-to-treat meta-analysis of studies reporting HOS-ADL (P = .571). (B) As-treated meta-analysis of studies reporting HOS-ADL ($P < .001$). (C) Intention-to-treat meta-analysis of studies reporting HOS-Sport (P = .347). ADL, Activities of Daily Living; ES, effect size; HOS, Hip Outcome Score.

size present for the Mansell study). The as-treated analysis of the HOS-ADL results demonstrated a statistically significant effect size, with the effect size being very similar between the Mansell and Palmer studies (not available for the Griffin study). It was not possible to report surgery-specific or PT-specific effect sizes because the pre- to post-intervention change was not reported in any of the studies, only the difference in final PRO.

The collective results of these 3 research studies (all evidence level 1) support the efficacy of surgical intervention for FAI. However, the general difference between surgery and PT was just slightly greater than established MCID thresholds. MCID data were not routinely available across all studies and, in some cases, used different values. Nwachukwu et al[16] defined the MCIDs for HOS-ADL, HOS-Sport, and iHOT-33 to be 8.3, 14.5, and 12.1, respectively. The Palmer[19] study used an MCID of 9 for HOS-ADL, while the Mansell[15] study used MCIDs of 6 to 8, 8 to 9, and 12 for HOS-ADL, HOS-Sport, and iHOT-33, respectively. On the contrary, the Griffin[8] study used an MCID of 6.1 for iHOT-33.

The Palmer study reported that 51% of patients undergoing surgery and 32% of those undergoing PT reached the MCID for iHOT-33 (MCID defined as 12 points). The studies also clearly demonstrated variability in surgical outcomes between studies and within studies. The Mansell study concluded that "most patients perceived no improvement at 2 years." On the contrary, the Palmer study concluded that "blinded clinical assessments revealed a greater improvement in range of hip flexion and discomfort in patients allocated to arthroscopic surgery . . . patient reported outcome measured also indicated superior outcomes in patients randomized to arthroscopic surgery." Surgical procedures were variable across studies and differed in some ways from the currently accepted standards of most surgeons treating FAI. The Palmer study reported a 70% rate of labral repair, while the Griffin study reported a 25% rate of labral repair. The need for different components of the surgical procedure was assessed preoperatively as well as intraoperatively at the surgeon's discretion, which contributed to some of the variability. None of the studies appeared to utilize capsular closure, which is now commonly utilized by most surgeons and appears to improve outcomes. Frank et al[6] showed earlier recovery and return to sport in patients with complete capsular closure compared with partial closure at 2 years, with 13% and 0% revision rates in the partial and complete closure groups, respectively.

It should also be noted that patients enrolled in 2 of the studies[8,15] may have received some form of nonsurgical care before study enrollment, which may have affected the success of PT but does represent common clinical practice. Additionally, some patients appeared to similarly improve with PT. The Mansell[15] study can be viewed from an intention-to-treat perspective, but given the high crossover rate, this can be somewhat misleading. In this military population, 70% of patients in the PT arm were unsatisfied enough to cross over to surgery. At final follow-up, the outcomes of these patients appeared to be similar to those of patients who pursued surgery from the onset, although reoperation was much more common in the patients crossing over from PT to surgery (12.5% vs 2.5%). Additionally, as expected, the complication rate was generally higher in all 3 studies in the surgical group, although the major complication rate was still low. This supports the general concept that equivalent outcomes of FAI surgery can be achieved after a 3- to 6-month trial of nonoperative treatment.

Despite the findings of this meta-analysis, it is essential to continue investigation into both surgical and nonsurgical FAI management to better understand which patients are most likely to improve enough with PT to avoid surgery. Future research to understand which patients fail to benefit from surgical intervention will also be important, for this was not explicitly described or stratified in these 3 studies. It is possible that some patients may not improve with either PT or surgical intervention. Identification of these patients' characteristics would allow for further understanding and reevaluation of the source of pain in these patients. It is also imperative that both treatment strategies are assessed over long-term follow-up, as one of the fundamental goals of intervention for symptomatic FAI is to delay the lifelong progression of secondary hip osteoarthritis, which will require long-term follow-up.

Research efforts to determine the best evidence-based nonsurgical management for patients with FAI are ongoing. The use of a systematic review and consensus panel to determine current best practice for the conservative management offered in these RCTs is helpful, but it highlights the need for more research rather than expert opinion to guide management.[5] Components of PT, which have recently yielded positive outcomes, include task- and sport-specific activity modification training,[20] movement pattern training,[10] and trunk stabilization.[1] Emerging evidence suggests that nonsurgical FAI management also needs to address coexisting sleep and behavioral health impairments. Young hip patients report more insomnia and anxiety than age-matched controls,[21] and baseline psychological impairment is associated with worse postoperative outcomes.[25] Extra-articular myofascial-based therapies such as manual release, dry needling, and trigger point injections[4,24] may be useful adjuncts to facilitate progress with strengthening, movement pattern normalization, and long-term functional improvement. The variability in PT-led intervention highlights the need for better systematic research into the nonsurgical treatment protocols for FAI. The role of activity level also deserves further attention in future research. Pennock et al[20] found an 82% success rate of a nonsurgical treatment protocol when alterations in activity level were accepted by the patient (41% maintaining same sport and level).

There are several limitations to the current review in addition to those previously mentioned. First, even though RCTs minimize bias and provide the strongest level of evidence, many patients with FAI choose not to enroll in RCTs. The differences between patients enrolling and declining RCT participation are not well established but may play a role in the generalizability of these results. Second, because of the variety of PROs used in the studies, we were only able to perform meta-analysis on 3 outcome measures, and only the iHOT-33 could be compared across all 3 studies. This highlights the importance of including several PROs in RCTs, as otherwise no meta-analysis would be feasible. Third, we were only able to perform meta-analysis of the data presented in the published literature. In 1 case, we were able to clarify an important error in the treatment effect that would have affected the meta-analysis of the data. It was not possible to compare the preintervention with the postintervention mean differences to better investigate the variability of the treatment effect of surgery and PT across studies. Additionally, patients in some studies had exposure to PT before the study, which could potentially have increased the selection of patients who were unlikely to improve with PT. Last, based on the limitations of the literature, only 3 studies were included in this meta-analysis. However, 650 patients were included in this study, improving the power and overall generalizability and making it suitable for meta-analysis, which clarifies the contradictory results between these studies.

CONCLUSION

This meta-analysis of 3 RCTs that compared short-term outcomes of surgery versus PT in patients with FAI demonstrated that surgery resulted in superior outcomes compared with PT based on iHOT-33 and HOS-ADL. However, PT also resulted in clinically meaningful improvements in patients and did not appear to compromise surgical outcomes.

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APPENDIX 1
SEARCH STRATEGY

The databases included Ovid Medline 1946-, Embase 1947-, Scopus 1960-, Cochrane Central Register of Controlled Trials, Cochrane Database of Systematic Reviews, and ClinicalTrials.gov, and a randomized controlled trial filter was used. In total, 819 results were exported and 340 duplicates were removed, resulting in 479 final citations for review.

Ovid Medline
87 results on March 15, 2019

Exp Femoracetabular impingement/ OR "femoral acetabular".mp. OR "femoro acetabular".mp. OR "femoral acetabular".mp. OR femoracetabular.mp. OR femoroacetabular.mp.

OR (cam adj1 impingement).mp. OR (pincer adj1 impingement) .mp. OR (hip adj3 impingement).mp.

AND

(randomized controlled trial.pt. or double-blind method/ or controlled clinical trials as topic/ or randomized controlled trials as topic/ or early termination of clinical trials as topic/ or (randomized adj7 trial*).mp. or (randomised adj7 trial*).mp. or (controlled adj3 trial*).mp. OR (double-blind adj1 method).mp. or ((single or doubl* or tripl* or treb*) and (blind* or mask*)).ti,ab,kw. or 4 arm.ti,ab,kw. or four arm.ti,ab,kw.)

Embase

380 results on March 15, 2019

('Femoracetabular impingement'/exp OR 'femoral acetabular':ti,ab,kw,de OR 'femoro acetabular':ti,ab,kw,de OR 'femoral acetabular':ti,ab,kw,de OR femoracetabular:ti,ab,kw,de OR femoroacetabular:ti,ab,kw,de OR (cam NEAR/1 impingement):ti,ab,kw,de OR (pincer NEAR/1 impingement):ti,ab,kw,de OR (hip* near/3 impingement):ti,ab,kw,de)

AND

('randomized controlled trial'/exp OR (control near/3 group*):ti,ab,kw,de or ((patient or healthy or volunteer or volunteers) NEAR/3 control*):ti,ab,kw,de or 'controlled clinical trial':ti,ab,kw,de or 'randomized controlled trial':-ti,ab,kw,de or 'double-blind method'/exp or 'controlled clinical trials as topic'/exp or 'randomized controlled trials as topic'/exp or 'early termination of clinical trials as topic'/exp or (randomi?ed NEAR/7 trial*):ti,ab,kw,de or (double-blind NEAR/1 method):ti,ab,kw,de or (controlled NEAR/3 trial*):ti,ab,kw,de or ((single or doubl* or tripl* or treb*) and (blind* or mask*)):ti,ab,kw,de or '4 arm':ti,ab,kw,de or 'four arm':ti,ab,kw,de)

Scopus

238 results on March 15, 2019

((TITLE-ABS-KEY ("femoral acetabular")) OR (TITLE-ABS-KEY ("femoro acetabular")) OR (TITLE-ABS-KEY ("femoral acetabular")) OR (TITLE-ABS-KEY (femoracetabular)) OR (TITLE-ABS-KEY (femoroacetabular)) OR (TITLE-ABS-KEY ((cam w/1 impingement)) OR (TITLE-ABS-KEY (pincer w/1 impingement)) OR (TITLE-ABS-KEY (hip w/3 impingement)))

AND ((TITLE-ABS-KEY ((patient OR healthy OR volunteer OR volunteers) W/3 control*)) OR (TITLE-ABS-KEY ("controlled clinical trial")) OR (TITLE-ABS-KEY ("randomized controlled trial")) OR (TITLE-ABS-KEY (randomi?ed W/7 trial*)) OR (TITLE-ABS-KEY ("double-blind" W/1 method)) OR (TITLE-ABS-KEY (controlled W/3 trial*)) OR (TITLE-ABS-KEY ((single OR doubl* OR tripl* OR treb*) W/4 (blind* OR mask*))) OR (TITLE-ABS-KEY ("4 arm")) OR (TITLE-ABS-KEY ("four arm")))

Cochrane

Cochrane Database of Systematic Review—1 result on March 15, 2019

Cochrane Central Register of Controlled Trials—102 results on March 15, 2019

([mh "Femoracetabular impingement"] OR (("femoro acetabular" OR "femoral acetabular" OR Femoracetabular OR Femoroacetabular OR cam OR pincer OR hip) near/1 impingement*):ti,ab,kw)

AND

(control*:ti,ab,kw OR trial*:ti,ab,kw OR blind*:ti,ab,kw OR mask*:ti,ab,kw OR "double-blind":ti,ab,kw OR "4 arm":ti,ab,kw OR "four arm":ti,ab,kw)

ClinicalTrials.gov

11 results on March 15, 2019

physical therapy AND surgery AND femoracetabular impingement [DISEASE]

APPENDIX 2
METHODOLOGICAL DETAILS

Two of the 3 studies included the following core components: flexibility,[8,15] core stability,[8,19] and education to avoid the impingement position.[8,19] Additional core components include hip joint mobilization,[15] lumbar mobility,[15] and instruction in activity modification and physical activity.[8] All studies allowed for individualization based on pain and movement impairments. Additional nonoperative treatments allowed included medications (nonsteroidal anti-inflammatory medications) or corticosteroid injection,[8] orthotics or taping,[8] lumbar joint mobilization,[15] and manual therapy, including joint and soft tissue mobilization.[8] Only 1 study[8] specified items that were not allowed; Griffin et al[8] excluded interventions such as forceful manual techniques into restricted range of motion, painful stretches that had a hard end feel, acupuncture, electrotherapy, and hydrotherapy. In contrast, a number of exercises included in the treatment described by Mansell et al[15] placed the involved hip into the position of impingement. Patient adherence to treatment session attendance was not reported in 2 studies,[15,19] and no studies reported patient adherence to the home exercise program. In the Griffin study, 30% of the patients received treatment that was judged as low fidelity.

We used the CERT (Consensus on Exercise Reporting Template) guidelines specifically to assist in scoring items 4 (what: procedures) and 8 (when and how much) in the TIDieR (Template for Intervention Description and Replication) checklist. Two authors (M.T.S. and A.L.C.) independently scored each item as "yes" or "no." A "no" response indicated that there was insufficient information provided that would allow for replication. Disagreements were resolved through discussion. Our assessments were based on the information published in the article reporting trial results, as well as all associated articles reporting the study protocol, feasibility of the trial, and feasibility of the

TABLE A1
TIDiER Checklist[a]

Study	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10	Item 11	Item 12	Total[b]
Physical therapy													
Palmer et al (2019)[19]	+	+	–	–	–	+	+	–	–	–	–	–	4
Griffin et al (2018)[8]	+	+	–	–	+	+	+	–	–	+	+	+	8
Mansell et al (2018)[15]	+	+	–	–	–	+	+	–	–	–	–	–	4
Surgery													
Palmer et al (2019)[19]	+	+	–	–	+	+	+	+	+	–	–	+	8
Griffin et al (2018)[8]	+	+	+	+	+	+	+	+	+	–	+	+	11
Mansell et al (2018)[15]	+	+	+	+	+	+	+	+	+	–	–	+	10

[a]Items: 1 = name; 2 = rationale; 3 = materials; 4 = procedures; 5 = providers; 6 = mode of delivery; 7 = setting; 8 = dose; 9 = tailoring/progression; 10 = modifications; 11 = planned fidelity; 12 = actual fidelity. Consensus on Exercise Reporting Template (CERT) guidelines were used to assist in scoring items 4 and 8. +, yes; –, no.

[b]The maximum score = 12. Higher scores are more favorable.

physical therapist–led treatment.[26] Similarly, the same guidelines were used to describe reporting of the surgical treatments. The "yes" responses were summed to provide a descriptive total representing the completeness of reporting for each article (Table A1).

TIDieR/CERT Assessment

Based on our review, no trial achieved 100% reporting of the physical therapist–led treatment, unlike the surgical treatment, which achieved near 67% to 92% (Table A1). Griffin et al[8] scored the highest with 67%, and Palmer et al[19] and Mansell et al[15] each scored 33%. None of the studies (or published protocols) reported sufficient detail for the materials provided for the patient treatment and physical therapist training, details about the procedures included in treatment (exercise description, progression of exercise, home exercise prescription, adherence), dosage of the interventions (intensity, frequency, session time, duration), or specific guidelines for tailoring the interventions to patients. Similarly, the quality of reporting of surgical treatment details was also assessed, with each study achieving 67% or greater.