RESEARCH ARTICLE

Preoperative Temporal Summation is Associated with Impaired Recovery Following Hip Arthroscopy for Femoroacetabular Impingement Syndrome

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Abstract

Objectives: Chronic pain is a risk factor for worse outcomes following hip arthroscopy for femoroacetabular impingement syndrome (FAIS). Pain sensitization involves the central nervous system perceiving previously innocuous stimuli as noxious. Temporal summation can provide a surrogate measure of sensitization, and may be a clinical tool to identify patients at a higher risk for poor post-hip arthroscopy outcomes. Therefore, we aimed to 1) identify the prevalence of temporal summation in patients undergoing hip arthroscopy for FAIS, 2) determine if there a difference in postoperative improvement between individuals with and without preoperative temporal summation, and 3) examine preoperative predictors of poor postoperative recovery.

Methods: 51 participants undergoing hip arthroscopy for FAIS underwent preoperative temporal summation testing. Three months postoperatively, 38 participants completed the 12-item International Hip Outcome Tool (iHOT-12) and reported their overall symptomatic improvement (0% to 100%, with 100% being normal). Participants were categorized on the presence (Δ Numeric Pain Rating Scale; NPRS ≥ 2) or absence (Δ NPRS < 2) of temporal summation. A Mann-Whitney U test was used to determine the difference in improvement between groups (temporal summation: temporal summation (TS), no temporal summation (NTS), and a linear regression was used to explore predictors of improvement.

Results: 23 (45.1%) of 51 participants displayed preoperative temporal summation. In participants with postoperative data, those with temporal summation reported less improvement than those without (TS: 62.8% ± 29.7%; NTS: 82.7% ± 13.9%; p = 0.01; Cohen's d = -0.86). Temporal summation (Beta = -0.48; 95% CI -36.6, -8.7) and mental health disorder (Beta = -0.30; 95% CI -28.0, -0.48) predicted 28.1% of the variance in postoperative improvement (p = 0.002).

Conclusion: The presence of preoperative temporal summation is common and related to worse postoperative recovery after hip arthroscopy for FAIS.

Level of evidence: IV

Keywords: Hip preservation, Pre-arthritic hip, Quantitative sensory testing

Introduction

Outcomes, including pain, function, and physical activity, following hip arthroscopy for femoroacetabular impingement syndrome (FAIS) are variable,[1–5] with a recent 2024 study reporting that less than half of patients reach the patient-acceptable symptomatic state for activities of daily living five years following hip arthroscopy.[6] Previous literature suggests that multiple factors may predict poor postoperative

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outcomes, including female sex, age greater than 45 years, presence of osteoarthritis (OA), elevated body mass index, and longer symptom duration.[7–9] Chronic pain (i.e., a symptom duration greater than three to six months[10]) contributes to maladaptive signaling mechanisms, including pain hypersensitivity, which may be an important contributing factor to poor clinical recovery after hip arthroscopy. One previous article examined central sensitization using the Central Sensitization Inventory (CSI) (a self-reported measure of central sensitization) and found that CSI scores were associated with pain at baseline and three months following hip arthroscopy for FAIS.[11] However, the CSI is more related with psychological health factors (e.g., depression, anxiety, pain catastrophizing, kinesiophobia) than response to nociception, thereby leaving our current understanding of pain processing in patients with FAIS incomplete.[12]

Quantitative sensory testing can be used to measure temporal summation, or pain wind-up, which is a hypothesized maladaptation which occurs in patients with chronic pain. In temporal summation, previously harmless stimuli progressively become perceived as noxious by nociceptors and perceived as pain by the brain. Both central and peripheral sensitization pathways play a role,[13,14] and while we cannot tease out peripheral and central mechanisms in a clinical setting, we can test for temporal summation of pain. Previous work has identified temporal summation of pain in a variety of other chronic conditions including osteoarthritis.[15] As it is not uncommon for patients with FAIS to have a symptom duration of greater than two years prior to hip arthroscopy,[7,16,17] it is reasonable to hypothesize that temporal summation may be prevalent, providing a treatment target to improve post-operative outcomes. By better understanding the prevalence and clinical impact of temporal summation in patients undergoing hip arthroscopy for FAIS, musculoskeletal rehabilitation clinicians and orthopaedic surgeons will be able to improve and personalize pre- and postoperative management.

Poor postoperative recovery has long-term implications for a patients' quality of life.[6] Proper identification and individualization of preoperative risk factors will allow clinicians to tailor preoperative management to patients' specific needs. To that end, this study aimed to 1) identify the prevalence of temporal summation in patients undergoing hip arthroscopy for FAIS, 2) determine if there is a difference in postoperative improvement between individuals with and without preoperative temporal summation, and 3) examine preoperative predictors of poor postoperative recovery. We hypothesize that preoperative temporal summation will be common, patients with temporal summation will report less symptomatic improvement following hip arthroscopy, and the presence of preoperative temporal summation will account for a significant portion of the variance in postoperative improvement.

Materials and Methods

Following approval from the University of Kentucky Institutional Review Board (IRB approval #14-0019-P6J), 82 patients were enrolled in this observational study. The primary results of the study were previously published.[16] This paper includes a secondary exploratory analysis of quantitative sensory testing data which was not previously reported. Of the 82 patients that were enrolled, 51 completed preoperative temporal summation testing.

Participants

All participants were undergoing hip arthroscopy for FAIS.[18] A single fellowship trained orthopaedic surgeon (surgical experience >1,200 hip arthroscopies) clinically evaluated all participants and performed all hip arthroscopies. Patients with worker's compensation cases, fibromyalgia or complex regional pain syndrome were excluded from the study. Prior to surgery all patients must have failed to improve (measured via patient-reported symptoms) with non-operative treatments including intra-articular cortisone injections, rehabilitation, and/or activity modification. Following informed consent, participants completed a survey which included self-reported mental health disorder (e.g., anxiety, depression) as a yes/no question and hip symptom duration (months). Alpha angle (Cam morphology) and lateral center edge angle (Pincer morphology) were measured from preoperative radiographs (anteroposterior pelvis and frog leg lateral views).

Pain Visual Analog Scale (VAS)

The Pain VAS for hip pain at rest was completed preoperatively and three months postoperatively. The Pain VAS is a valid and reliable patient-reported outcome tool in patients with chronic pain which asks participants to rate their hip pain on a scale from 0 (*no pain at all*) to 10 (*worst pain imaginable*).[19]

12-item International Hip Outcome Tool (iHOT-12)

The iHOT-12 is a valid and reliable patient-reported outcome tool in patients with FAIS which measures patients perceived hip function and quality of life.[20] The iHOT-12 is scored on a scale from 0 (*worst patient-reported hip function*) to 100 (*best self-reported function*), and a change of 13 points on the iHOT-12 is clinically meaningful.[21] Participants completed the iHOT-12 three months postoperatively.

Postoperative Improvement

Three months following hip arthroscopy participants were asked to rate their overall improvement in symptoms by answering, "How much did you improve following your hip arthroscopy on a scale from 0% to 100%, with 100% being normal?".[22]

Temporal Summation Testing

Preoperatively, a Von Frey (VF) monofilament (10g) was used to apply a single cutaneous stimulus to each participant's contralateral (side opposite their painful hip) dorsal middle phalanx of the third finger. Participants rated their pain on a verbal Numeric Pain Rating Scale (NPRS) of 0 (no pain at all) to 10 (worst pain imaginable). For the following 30 seconds, a mechanical stimulus was applied to the same position at one second intervals.[13,23] At the end of 30 seconds, participants were asked to rate their pain on the same verbal NPRS. As with previous work,[13,23] increased pain in response to repeated mechanical stimulation was considered indicative of temporal summation of pain.

Specifically, we considered a change of two (the minimal clinically important difference for the NPRS[24]) or greater to indicate temporal summation of pain. All VF monofilament testing was performed by a single author (KNJ).

Statistical Analysis

Descriptive statistics (mean, standard deviation, frequency, percentage) were used to summarize demographic, Pain VAS, and iHOT-12 scores. The number and percent of participants with preoperative temporal summation was reported and patient-specific factors were described and compared between groups (with temporal summation: TS, those with no temporal summation NTS) using Mann-Whitney U tests and Chi Square tests. Following this, we addressed the secondary aim of this paper, to determine the difference in postoperative improvement three months post-hip arthroscopy for FAIS between participants with and without preoperative temporal summation using a Mann-Whitney U test.

We also explored predictors of postoperative improvement using a linear regression with forward variable entry. In the first block, age, sex (M/F), BMI, and revision (yes/no) were added and in the second block mental health disorder (yes/no), temporal summation (yes/no) and preoperative Pain VAS were added as independent variables in the linear regression. All statistical analyses were made using IBM SPSS Statistics (Version 28). Significance level was set as $\alpha \leq 0.05$ and 95% confidence intervals are reported throughout the results. Effect sizes are reported and used to interpret all findings.

Results

Of the 82 participants enrolled, temporal summation data was available on 51 participants (62.2%). Three-month postoperative patient-reported improvement data was available for 38 of these 51 participants (74.5%). In 51 participants, 23 (45.1%) had preoperative temporal summation. Participants undergoing revision hip arthroscopy (N=6) did not differ from participants undergoing primary hip arthroscopy in terms of any baseline patient-specific factors ($P \geq 0.10$) [Table 1]. Of the 38 participants with postoperative data, 15 (39.5%) had preoperative temporal summation, and those with preoperative temporal summation reported less improvement three months following hip arthroscopy than those without preoperative temporal summation (TS: 62.8% ± 29.7%; NTS: 82.7% ± 13.9%; $P = 0.01$; Cohen's d = -0.86) [Table 2]. Participants with preoperative temporal summation were younger (TS: 34.1 ± 12.8 years; NTS: 40.3 ± 10.2 years; $P = 0.03$). However, no other patient-specific factors differed between groups ($P \geq 0.38$).

The final forward linear regression model included temporal summation (Beta = -0.48; 95% CI -36.6, -8.7; $P = 0.002$) and self-reported mental health disorder (Beta = -0.30; 95% CI -28.0, -0.48; p = 0.04) as significant predictors of three-month postoperative improvement ($P = 0.002$). These two variables accounted for 28.1% of the variance in three-month postoperative improvement.

Table 1. Baseline patient characteristics between participants undergoing primary and revision hip arthroscopy

Patient characteristics	Revision (N=6)	Primary (N=45)	*P* -value
Sex	5F/1M	36F/9M	0.85
Age (years)	35.2 ± 10.1	37.8 ± 12.0	0.51
BMI (kg/m²)	26.4 ± 5.5	26.5 ± 4.8	0.95
Self-reported mental health disorder	4N/2Y (33.3%)	26N/19Y (42.2%)	0.68
Alpha angle	65.0° ± 11.7°	60.0° ± 10.7°	0.42
LCEA	29.3° ± 5.4°	31.0° ± 4.2°	0.41
Symptom duration (months)	11.8 ± 7.6	29.5 ± 32.5	0.19
PRE VAS hip pain at rest	5.8 ± 2.5	3.9 ± 2.2	0.10
PRE VF NPRS change score	1.0 ± 1.3	1.8 ± 1.6	0.22

* Indicates statistically significant at P < 0.05

Body Mass Index (BMI), Lateral Center Edge Angle (LCEA), Preoperative (PRE), Visual Analog Scale (VAS), Von Frey Monofilament Testing (VF), Numeric Pain Rating Scale (NPRS)

Table 2. Patient characteristics between participants with (TS) and without (NTS) preoperative temporal summation

Patient characteristics	Total (N=51)	TS (N=23)	NTS (N=28)	*P*-value
Sex	41F/10M	20F/3M	21F/7M	0.48
Age (years)	37.5 ± 11.7	34.1 ± 12.8	40.3 ± 10.2	0.03*
BMI (kg/m²)	26.5 ± 4.8	25.9 ± 4.3	27.0 ± 5.2	0.50
Revision	N=6	N=2	N=4	0.68

Table 2. Continued				
Self-reported mental health disorder	30N/21Y (41.2%)	12N/11Y (47.8%)	18N/10Y (35.7%)	0.41
Alpha angle	60.6° ± 10.8°	60.5° ± 11.6°	60.8° ± 10.4°	0.76
LCEA	30.8° ± 4.3°	29.9° ± 4.6°	31.4° ± 4.1°	0.38
Symptom duration (months)	27.4 ± 31.1	31.2 ± 34.8	24.4 ± 28.0	0.86
PRE VAS hip pain at rest	4.2 ± 2.3	4.4 ± 2.2	4.0 ± 2.4	0.50
PRE VF NPRS change score	1.7 ± 1.6	3.1 ± 0.98	0.48 ± 0.76	<0.001*
POST iHOT-12	54.2 ± 21.7	47.3 ± 23.1	58.8 ± 19.9	0.17
POST VAS hip pain at rest	1.7 ± 1.7	1.8 ± 1.9	1.5 ± 1.6	0.44
POST improvement	74.9% ± 23.3%	62.8% ± 29.7%	82.7% ± 13.9%	0.01*

* Indicates statistically significant at P < 0.05

Body Mass Index (BMI), Lateral Center Edge Angle (LCEA), Preoperative (PRE), Visual Analog Scale (VAS), Von Frey Monofilament Testing (VF), Numeric Pain Rating Scale (NPRS), Post-operative (POST), 12-item International Hip Outcome Tool (iHOT-12)

Post-hoc Power Analysis

This study was powered for the original analysis and outcome measures.[16] However, using G*Power 3.1 a post-hoc power analysis was conducted using postoperative improvement data presented in the current study. Using a Mann-Whitney U test, alpha set to 0.05, the Cohen's d effect size of -0.86 for the variable of interest (postoperative improvement compared between TS and NTS groups) [Table 2], it was determined we had 79.9% power.

Discussion

In this study we reported the prevalence of preoperative temporal summation in patients undergoing hip arthroscopy for FAIS. We also compared postoperative symptomatic improvement three months after hip arthroscopy between individuals with and without preoperative temporal summation and explored preoperative predictors of postoperative improvement. We found that preoperative temporal summation was common, present in nearly half of patients (45.1%; 23/51). Individuals with preoperative temporal summation reported significantly less improvement three months following hip arthroscopy for FAIS. Additionally, preoperative temporal summation and self-reported mental health disorders predicted over a quarter (26.1%) of the variance in postoperative improvement.

Many risk factors for poor post-hip arthroscopy outcomes have been identified, including older age[25] and an extended duration of symptoms. Though older age has been identified as a predictor of worse outcomes following hip arthroscopy, this is usually paired with the presence of worse joint disease osteoarthritis (OA) which becomes more common throughout the lifespan. Interestingly, in the current study, there was a significant age difference between the TS and NTS groups, with the TS group being younger and reporting less improvement following hip arthroscopy. An extended duration of symptoms is common in patients with FAIS[7,8] and an important contributor to the development of pain sensitization. At baseline, the clinical presentation of patients with FAIS may be predisposing a significant number to temporal summation of pain. The findings of this study support this, with nearly half of patients presenting with temporal summation of pain preoperatively. In our cohort of participants, individuals with preoperative temporal summation reported less overall improvement postoperatively (TS: 62.6% improvement vs. NTS: 82.7% improvement) [Table 2]. However, postoperative pain at rest (TS: 1.8 vs. NTS: 1.5) and iHOT-12 scores (TS: 47.3 vs. NTS: 58.8) did not statistically differ between individuals with and without preoperative temporal summation [Table 2]. Although the iHOT-12 scores did not differ between groups, the difference of 11.5 points may be clinically meaningful as it is approaching the minimal clinically important difference of 13.[21] Collectively, these findings suggest pain senitiszation should be investigated as a risk factor for poor hip arthroscopy outcomes and a future treatment target.

In addition to pain sensitization, psychological health factors must be considered when discussing post-hip arthroscopy outcomes. A 2021 study by Bech et al identified an association between preoperative CSI scores – symptoms associated with central pain sensitization – and Pain Catastrophizing Scale (PCS) scores – an exaggerated, negative mental response to pain.[11] They found that both CSI and PCS scores were associated with hip pain three-months following hip arthroscopy.[11] The current study builds on this to identify that preoperative temporal summation and self-reported mental health disorders predicted over a quarter of the variance in patient-reported improvement three-months following hip arthroscopy. Together, these findings highlight the impact of a patient's pain-related thoughts and feelings on their pain experience and underscore the importance of adopting a biopsychosocial approach to evaluation and treatment when treating patients with FAIS.

The current study adds to a larger body of literature describing the association between preoperative temporal summation and poorer patient-reported outcomes following orthopaedic surgeries for chronic musculoskeletal pain conditions. In a recent 2023 study, Aoyagi et al found that

preoperative temporal summation was associated with worse patient-reported pain after total knee arthroplasty for OA.[15] Specific to the hip joint, a 2017 study by Izumi et al found similarly that preoperative temporal summation was associated with worse pain following total hip arthroplasty.[26] Importantly, non-arthritic hip disorders, such as FAIS, are precursors to OA.[27,28] As we demonstrated in this study, preoperative temporal summation was associated with less patient-perceived improvement three-months following hip arthroscopy. These data suggest that, like in OA, treatment outcomes for other chronic musculoskeletal diseases including FAIS may be significantly impacted by pain sensitization. Two recent systematic review and meta-analyses concluded that exercise and manual therapy may produce small but significant reductions in temporal summation for patients with chronic musculoskeletal conditions.[29,30] These data provide direction towards developing effective interventions for treating temporal summation. Given the intricate link between pain sensitivity and psychological health factors, future intervention studies should explore the effect of mind-body or psychologically informed rehabilitation interventions to improve pain sensitivity in patients with chronic musculoskeletal pain.

Limitations

There are several limitations of this study. First, since it is impossible to directly measure pain sensitization in humans, temporal summation was used as a correlate of sensitization. These findings should be interpreted with the acknowledgement that temporal summation of pain is an imperfect and indirect quantitative sensory measurement and may be best described as "pain hypersensitivity" in human subjects. This study enrolled significantly more female participants than males. This limitation is particularly important to recognize given that pain profiles and pain processing differs between sexes.[31] The question regarding post-operative improvement asked patients to rate their improvement on a scale from 0% to 100%, with 100% being normal. It is possible that some patients did not know how to interpret "normal" or had difficulty remembering their "normal" given the duration of their hip pain. Of the initial 82 participants enrolled, [31] did not complete preoperative VF monofilament testing because they elected out of the testing at the time of enrollment, and an additional 13 participants did not complete the postoperative perceived improvement survey. We do not know why participants did not complete their postoperative survey; however, follow-up calls and emails were made in an attempt to collect this data. Additionally, we cannot assume whether postoperative improvement was associated with likelihood of follow-up. Nonetheless, it is important to replicate this study in a larger cohort, and to consider this missing data when interpreting these findings. Six participants underwent revision hip arthroscopy. The odds of having preoperative temporal summation were not greater for participants undergoing revision hip arthroscopy (P = 0.68) [Table 1]. However, this heterogeneity should be considered when interpreting these data. Lastly, though the vast majority of symptomatic improvement occurs within the first three months following hip arthroscopy,[32,33,34] this follow-up should be acknowledged when interpreting these results and future studies should examine the effect of preoperative temporal summation on longer-term hip arthroscopy outcomes.

Conclusion

This study demonstrates that the presence of preoperative temporal summation is common and related to worse postoperative recovery after hip arthroscopy for FAIS. These findings may help musculoskeletal rehabilitation clinicians and orthopaedic surgeons to tailor pre and postoperative management (patient-centered education and psychologically informed rehabilitation) to improve postoperative outcomes for patients with temporal summation.

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Authors Contribution:

Collected the data: KNJ, CAJ
Contributed data or analysis tools: STD
Performed the analysis: KNJ, JVW
Wrote the paper: KNJ, EK, JVW, BN, MAS, STD, CGM, CAJ
All authors critically revised the article and approved the final version.

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Declaration of Informed Consent:

All participants provided written and verbal consent to participate.

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References

1. Chen AW, Craig MJ, Yuen LC, Ortiz-Declet V, Maldonado DR, Domb BG. Five-Year Outcomes and Return to Sport of Runners Undergoing Hip Arthroscopy for Labral Tears With or Without Femoroacetabular Impingement. Am J Sports Med. 2019; 47(6):1459-1466. doi:10.1177/0363546519836429.
2. Jack RA, Sochacki KR, Hirase T, Vickery JW, Harris JD. Performance and Return to Sport After Hip Arthroscopy for Femoroacetabular Impingement in Professional Athletes Differs Between Sports. Arthrosc J Arthrosc Relat Surg. 2019; 35(5):1422-1428. doi:10.1016/j.arthro.2018.10.153.
3. Jones DM, Crossley KM, Ackerman IN, et al. Physical Activity Following Hip Arthroscopy in Young and Middle-Aged Adults: A Systematic Review. Sports Med Open. 2020; 6(1):7. doi: 10.1186/s40798-020-0234-8.
4. Kyin C, Maldonado DR, Go CC, Shapira J, Lall AC, Domb BG. Mid- to Long-Term Outcomes of Hip Arthroscopy: A Systematic Review. Arthrosc J Arthrosc Relat Surg. 2021; 37(3):1011-1025. doi:10.1016/j.arthro.2020.10.001.
5. Levy DM, Kuhns BD, Chahal J, Philippon MJ, Kelly BT, Nho SJ. Hip Arthroscopy Outcomes With Respect to Patient Acceptable Symptomatic State and Minimal Clinically Important Difference. Arthroscopy. 2016; 32(9):1877-1886. doi:10.1016/j.arthro.2016.05.014.
6. Richter C, Ishøi L, Kraemer O, Hölmich P, Thorborg K. Association of 5-Year Hip Arthroscopy Outcomes with Hip Morphology and Cartilage Status at Time of Surgery: A National Registry Study With HAGOS Outcomes in 281 Patients With Femoroacetabular Impingement Syndrome. Orthop J Sports Med. 2024; 12(3):23259671241238742. doi:10.1177/23259671241238742.
7. Basques BA, Waterman BR, Ukwuani G, et al. Preoperative symptom duration is associated with outcomes after hip arthroscopy. Am J Sports Med. 2019; 47(1):131-137. doi: 10.1177/0363546518808046.
8. Kim DNW, Lee MS, Mahatme RJ, et al. Short Symptom Duration Is Associated With Superior Outcomes in Patients Undergoing Primary Hip Arthroscopy: A Systematic Review. Arthrosc J Arthrosc Relat Surg. 2023; 39(2):498-509. doi:10.1016/j.arthro.2022.11.009.
9. Minkara AA, Westermann RW, Rosneck J, Lynch TS. Systematic Review and Meta-analysis of Outcomes after Hip Arthroscopy in Femoroacetabular Impingement. Am J Sports Med. 2019;47(2):488-500. doi:10.1177/0363546517749475.
10. Treede RD, Rief W, Barke A, et al. A classification of chronic pain for ICD-11. PAIN. 2015; 156(6):1003. doi:10.1097/j.pain.0000000000000160.
11. Bech NH, Sierevelt IN, de Rooij A, Kerkhoffs GMMJ, Haverkamp D. The influence of pain catastrophizing and central sensitization on the reported pain after hip arthroscopy. Knee Surg Sports Traumatol Arthrosc. 2021; 29(9):2837-2842. doi:10.1007/s00167-021-06658-w.
12. Adams GR, Gandhi W, Harrison R, et al. Do "central sensitization" questionnaires reflect measures of nociceptive sensitization or psychological constructs? A systematic review and meta-analyses. PAIN. 2023; 164(6):1222. doi:10.1097/j.pain.0000000000002830.
13. Neogi T, Frey-Law L, Scholz J, et al. Sensitivity and sensitisation in relation to pain severity in knee osteoarthritis: trait or state? Ann Rheum Dis. 2015; 74(4):682-688. doi:10.1136/annrheumdis-2013-204191.
14. Woolf CJ. Central sensitization: Implications for the diagnosis and treatment of pain. PAIN. 2011; 152(3, Supplement):S2-S15. doi:10.1016/j.pain.2010.09.030.
15. Aoyagi K, Law LF, Carlesso L, et al. Post-surgical contributors to persistent knee pain following knee replacement: The Multicenter Osteoarthritis Study (MOST). Osteoarthr Cartil Open. 2023; 5(1):100335. doi:10.1016/j.ocarto.2023.100335.
16. Jochimsen KN, Noehren B, Mattacola CG, Di Stasi S, Duncan ST, Jacobs C. Preoperative Psychosocial Factors and Short-term Pain and Functional Recovery After Hip Arthroscopy for Femoroacetabular Impingement Syndrome. J Athl Train. 2021; 56(10):1064-1071. doi: 10.4085/1062-6050-139-20.
17. Kunze KN, Nwachukwu BU, Beck EC, et al. Preoperative Duration of Symptoms Is Associated With Outcomes 5 Years After Hip Arthroscopy for Femoroacetabular Impingement Syndrome. Arthrosc J Arthrosc Relat Surg. 2020; 36(4):1022-1029. doi:10.1016/j.arthro.2019.08.032.
18. Griffin DR, Dickenson EJ, O'donnell J, et al. The Warwick Agreement on femoroacetabular impingement syndrome (FAI syndrome): an international consensus statement. Br J Sports Med.2016; 50(19):1169-76. doi: 10.1136/bjsports-2016-096743.
19. Euasobhon P, Atisook R, Bumrungchatudom K, Zinboonyahgoon N, Saisavoey N, Jensen MP. Reliability and responsivity of pain intensity scales in individuals with chronic pain. PAIN. 2022; 163(12):e1184. doi:10.1097/j.pain.0000000000002692.
20. Griffin DR, Parsons N, Mohtadi NGH, Safran MR, Network MA of the HOR. A short version of the International Hip Outcome Tool (iHOT-12) for use in routine clinical practice. Arthroscopy. 2012; 28(5):611-6; quiz 616-8. doi: 10.1016/j.arthro.2012.02.027.
21. Nwachukwu BU, Chang B, Beck EC, et al. How Should We Define Clinically Significant Outcome Improvement on the iHOT-12? HSS J. 2019; 15(2):103-108. doi: 10.1007/s11420-018-9646-0.
22. Jochimsen KN, Doorley JD, Vranceanu AM, Noehren B, Duncan ST, Jacobs CA. Postoperative Psychological Factors Are Associated With Perceived Improvement Following Hip Arthroscopy. Int J Athl Ther Train. 2022; 28(1):46-51. doi:10.1123/ijatt.2021-0076.
23. Neogi T, Guermazi A, Roemer F, et al. Association of Joint Inflammation With Pain Sensitization in Knee Osteoarthritis: The Multicenter Osteoarthritis Study. Arthritis Rheumatol. 2016; 68(3):654-661. doi:10.1002/art.39488.
24. Farrar JT, Young JP, LaMoreaux L, Werth JL, Poole RM. Clinical importance of changes in chronic pain intensity measured on

an 11-point numerical pain rating scale. PAIN. 2001; 94(2):149-158. doi:10.1016/S0304-3959(01)00349-9.
25. Zimmerer A, Ramoser A, Streit M, et al. Osteoarthrosis, Femoroacetabular Impingement Syndrome: Case Series with Minimum 10-Year Follow-Up. Arthroscopy. 2021; 37(6):1822-1828.e1. doi:10.1016/j.arthro.2021.01.024.
26. Izumi M, Petersen KK, Laursen MB, Arendt-Nielsen L, Graven-Nielsen T. Facilitated temporal summation of pain correlates with clinical pain intensity after hip arthroplasty. Pain. 2017; 158(2):323-332. doi:10.1097/j.pain.0000000000000764.
27. Beck M, Kalhor M, Leunig M, Ganz R. Hip morphology influences the pattern of damage to the acetabular cartilage: femoroacetabular impingement as a cause of early osteoarthritis of the hip. J Bone Joint Surg Br. 2005; 87(7):1012-8. doi: 10.1302/0301-620X.87B7.15203.
28. Ganz R, Parvizi J, Beck M, Leunig M, Nötzli H, Siebenrock KA. Femoroacetabular impingement: a cause for osteoarthritis of the hip. Clin Orthop Relat Res.2003 :(417):112-20. doi: 10.1097/01.blo.0000096804.78689.c2.
29. Arribas-Romano A, Fernández-Carnero J, Molina-Rueda F, Angulo-Diaz-Parreño S, Navarro-Santana MJ. Efficacy of Physical Therapy on Nociceptive Pain Processing Alterations in Patients with Chronic Musculoskeletal Pain: A Systematic Review and Meta-analysis. Pain Med. 2020; 21(10):2502-2517. doi:10.1093/pm/pnz366.
30. Martínez-Pozas O, Sánchez-Romero EA, Beltran-Alacreu H, et al. Effects of Orthopedic Manual Therapy on Pain Sensitization in Patients With Chronic Musculoskeletal Pain: An Umbrella Review With Meta-Meta-analysis. Am J Phys Med Rehabil. 2023; 102(10):879. doi:10.1097/PHM.0000000000002239.
31. Mogil JS. Qualitative sex differences in pain processing: emerging evidence of a biased literature. Nat Rev Neurosci. 2020; 21(7):353-365. doi:10.1038/s41583-020-0310-6.
32. Flores SE, Sheridan JR, Borak KR, Zhang AL. When do patients improve after hip arthroscopy for femoroacetabular impingement? A prospective cohort analysis. Am J Sports Med. 2018; 46(13):3111-3118. doi: 10.1177/0363546518795696.
33. Tuncay I, Ucan V, Agir M, Anwar W, Elmali N. Is Only Peripheral Hip Arthroscopy Enough for Selected Patients with Femoroacetabular Impingement Syndrome?. Archives of Bone and Joint Surgery. 2022 Dec;10(12):1044. doi: 10.22038/abjs.2022.53954.2698
34. Shahpari O, Mortazavi J, Ebrahimzadeh MH, Bagheri F, Mousavian A. Role of hip arthroscopy in the treatment of avascular necrosis of the hip: a systematic review. Archives of Bone and Joint Surgery. 2022 Jun;10(6):480. doi: 10.22038/abjs.2021.58534.2894
Advanced Age, and Female Sex Are Risk Factors for Inferior Outcomes after Hip Arthroscopy and Labral Debridement for