# Effect of Cigarette Smoking on Patient-Reported Outcomes in Hip Arthroscopic Surgery

## A Matched-Pair Controlled Study With a Minimum 2-Year Follow-up

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**Background:** The rate of hip arthroscopic surgery has recently increased; however, there is limited literature examining patient-reported outcomes (PROs) in cigarette smokers.

**Purpose/Hypothesis:** The purpose of this study was to evaluate whether smoking status for patients undergoing hip arthroscopic surgery affects clinical findings and PRO scores. We hypothesized that patients who smoke and undergo primary hip arthroscopic surgery will have similar clinical examination findings and preoperative and postoperative PRO scores compared with nonsmoking patients.

**Study Design:** Cohort study; Level of evidence, 3.

**Methods:** Data were collected on all patients who underwent primary hip arthroscopic surgery from February 2008 to July 2015. A retrospective analysis of the data was then conducted to identify patients who reported cigarette use at the time of the index procedure. Patients were matched 1:2 (smoking:nonsmoking) based on sex, age within 5 years, labral treatment (repair vs reconstruction vs debridement), workers' compensation status, and body mass index within 5 kg/m$^2$. All patients were assessed preoperatively and postoperatively using 4 PRO measures: the modified Harris Hip Score (mHHS), Non-Arthritic Hip Score (NAHS), Hip Outcome Score–Sport-Specific Subscale (HOS-SSS), and International Hip Outcome Tool–12 (iHOT-12). Pain was estimated using a visual analog scale. Satisfaction was measured on a scale from 0 to 10. Significance was set at $P < .05$.

**Results:** A total of 75 hips were included in the smoking group, and 150 hips were included in the control group. Preoperatively, the smoking group had significantly lower PRO scores compared with the control group for the mHHS, NAHS, and HOS-SSS. Both groups demonstrated significant improvement from preoperative levels. A minimum 2-year follow-up was achieved, with a mean of 42.5 months for the smoking group and 47.6 months for the control group ($P = .07$). At the latest follow-up, the smoking group reported inferior results for all outcome measures compared with controls. The improvement in PRO scores and rates of treatment failure, revision arthroscopic surgery, and complications was not statistically different between the groups.

**Conclusion:** Patients who smoke had lower PRO scores preoperatively and at the latest follow-up compared with nonsmokers. Both groups demonstrated significant improvement in all PRO scores. These results show that while hip arthroscopic surgery may still yield clinical benefit in smokers, these patients may ultimately achieve an inferior functional status. To optimize results, physicians should advise patients to cease smoking before undergoing hip arthroscopic surgery.

**Keywords:** hip; labrum; arthroscopic outcomes; PROs; outcome study

Smoking is a major cause of morbidity and mortality among patients worldwide. The relationship between smoking and systemic conditions such as cardiovascular and pulmonary diseases has been well established in the literature.[32] Further research with musculoskeletal studies has shown higher rates of fractures, decreased bone density, and longer healing times among patients who are smokers.[26,32,38] In addition, studies have shown increased rates of postoperative complications such as infections, component failure, and revision surgery in smokers compared with nonsmokers.[13,28,30,31,40] Several studies have explored the effects of smoking on arthroscopic procedures of the shoulder and

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knee, demonstrating that smoking has a negative effect on patient-reported outcomes (PROs) as well as a higher failure rate.[1,5,8,25] However, to our knowledge, no studies have directly examined the effects of smoking on clinical findings and PRO scores after hip arthroscopic surgery for femoroacetabular impingement (FAI).

The purpose of this study was to evaluate whether smoking status for patients undergoing hip arthroscopic surgery affects clinical findings and PRO scores. Our null hypothesis was that patients who smoke and undergo primary hip arthroscopic surgery will have similar clinical examination findings and preoperative and postoperative PRO scores compared with nonsmoking patients.

## METHODS

Between February 2008 and July 2015, a total of 2705 patients underwent primary hip arthroscopic surgery at our institution. Data were collected prospectively and were retrospectively reviewed. Inclusion criteria were patients undergoing primary hip arthroscopic surgery during the study period with a minimum of 2-year follow-up, age >18 years, and preoperative PRO scores. Exclusion criteria were Tönnis grade >1, previous hip conditions such as Legg-Calvé-Perthes disease, avascular necrosis, and prior surgical intervention in the ipsilateral hip. The PRO measures used included the modified Harris Hip Score (mHHS), the International Hip Outcome Tool–12 (iHOT-12), the Non-Arthritic Hip Score (NAHS), and the Hip Outcome Score–Sport-Specific Subscale (HOS-SSS). Scores were collected during the preoperative and annual postoperative follow-up visits. Pain was estimated on a visual analog scale (VAS) from 0 to 10 (10 being the worst), and satisfaction with surgery was rated on a scale from 0 to 10 (10 being the best).

At our institution, radiographic data on all patients undergoing hip arthroscopic surgery are recorded preoperatively by hip preservation fellows. The measurements are taken by multiple readers; however, we have previously shown interobserver reliability among the readers at our institution.[12] Using the anteroposterior pelvis view, the lateral center-edge angle (LCEA), acetabular inclination, acetabular crossover, and femoral neck shaft angle were measured. When a crossover sign was present, we estimated the percentage of crossover by dividing the distance from the superior acetabulum to the point of intersection of the anterior and posterior walls by the entire length of the posterior wall. This was done to gauge the amount of acetabular retroversion. A 45° Dunn view was used to measure the alpha angle.[10] A false-profile view was used to measure the anterior center-edge angle (ACEA).

Groups were created based on the patients' smoking status obtained at the preoperative visit and were classified as either nonsmokers or smokers. The study group (smokers) was then matched to the control group (nonsmokers) at a 1:2 ratio based on patient sex, age within 5 years, labral treatment (repair vs reconstruction vs debridement), workers' compensation status, and body mass index (BMI) within 5 kg/m$^2$. If a patient underwent bilateral procedures, each hip was matched independently to a control in the database.

### Participation in the American Hip Institute Hip Preservation Registry

While the present study represents a unique analysis, data on some patients in this study may have been reported in other studies. All data collection received institutional review board approval.

### Surgical Technique

All hip arthroscopic procedures were performed in a tertiary referral setting dedicated to hip preservation. The surgical procedures were performed in the modified supine position using a minimum of 2 portals (standard anterolateral and midanterior) according to previously described surgical techniques from the literature.[7,22] Diagnostic arthroscopic surgery was performed after the establishment of portals and capsulotomy.

Bony abnormalities were corrected with the use of fluoroscopic guidance. Acetabuloplasty was performed for pincer impingement, and femoral neck osteoplasty was performed for cam impingement. Labral tears were managed with selective debridement to a stable rim or repaired when indicated. Labral reconstruction was performed if native tissue was of poor quality and degenerative in nature. If full-thickness cartilage damage was present,

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Ethical approval for this study was obtained from the Advocate Health Care Institutional Review Board (ID: 5276).

TABLE 1
Patient Demographics[a]

| Characteristic | Smokers (n = 75 Hips) | Nonsmokers (n = 150 Hips) | P |
|---|---|---|---|
| Sex, male:female, n | 42:33 | 84:66 | >.99 |
| Laterality, right:left, n | 47:28 | 78:72 | .16 |
| Age at surgery, y | 41.7 ± 11.1 (18.8-66.9) | 41.7 ± 11.1 (18.9-68.7) | .94 |
| Body mass index, kg/m$^2$ | 27.6 ± 5.0 (19.2-42.8) | 27.3 ± 4.9 (17.7-41.9) | .75 |
| Workers' compensation, n | 4 | 8 | >.99 |
| Follow-up time, mo | 42.5 ± 18.6 (24.0-88.6) | 47.6 ± 19.5 (24.0-96.1) | .07 |

[a]Data are shown as mean ± SD (range) unless otherwise indicated.

microfracture was performed according to the technique of Crawford et al[11] technique.

### Rehabilitation Protocol

During the first 2 weeks after surgery, patients were placed in a hip brace that restricted range of motion from 0° to 90° of flexion at all times. In addition, patients were placed on a 20-lb flat-foot restriction for the operative side for a minimum of 2 weeks if labral debridement or repair was performed. Alternatively, if labral reconstruction, gluteus medius repair, or capsular plication in the setting of borderline dysplasia was performed, the weightbearing restriction was extended for a total of 6 weeks. After microfracture for an articular cartilage injury, the weightbearing restriction was further extended to 8 weeks. All patients began physical therapy on the first postoperative day to initiate range of motion, which was accomplished via a continuous passive motion device 4 hours daily or a stationary bicycle 2 hours daily.

### Endpoints

An endpoint was defined as the occurrence of total hip arthroplasty (THA), hip resurfacing procedure, or revision hip arthroscopic surgery during the study period.

### Statistical Analysis

According to a previously published study, a clinically significant difference between groups for the mHHS would be 6.0 with a standard deviation of 8.0.[27] An a priori analysis was performed to obtain a power of ≥0.80 with a match ratio of 1:2 (smoker:nonsmoker); we would need a minimum of 44 hips in the control group and 22 hips in the study group. A 2-tailed paired $t$ test was used to assess differences between preoperative and postoperative scores for both the smoking and the nonsmoking groups. An independent $t$ test was used to compare the mean change in PRO scores (change from preoperative to postoperative) between the smoker and nonsmoker groups. A chi-square analysis was conducted for categorical data, and $P < .05$ was considered significant. Statistical analysis was conducted with Excel 2007 (Microsoft).

TABLE 2
Preoperative Physical Examination Findings[a]

| Finding | Smokers | Nonsmokers | P |
|---|---|---|---|
| Range of motion, deg | | | |
| Internal rotation | 20.8 | 21.5 | .73 |
| External rotation | 42.5 | 43.3 | .72 |
| Flexion | 115.7 | 117.6 | .26 |
| Abduction | 39.5 | 41.8 | .16 |
| Snapping hip, n (%) | | | |
| Internal | 11 (14.7) | 29 (19.3) | .46 |
| External | 1 (1.3) | 4 (2.7) | .67 |

[a]Data are shown as mean unless otherwise indicated.

## RESULTS

### Demographics

Among patients who met our inclusion criteria during the study period and who were eligible for 2-year follow-up, 106 were identified as smokers and 851 as nonsmokers. Follow-up data were obtained on 86 smokers (81.1%). After applying our matching criteria at a 1:2 ratio (smoker:nonsmoker), there were 75 hips in 72 patients in the smoking group and 150 hips in 140 patients in the control group. Overall, there were slightly more hips from male patients (56%) compared with female patients. The mean age was 41.7 years (range, 18.8-66.9 years) in the smoking group and 41.7 years (range, 18.9-68.7 years) in the control group ($P = .94$). The mean BMI in the smoking group was 27.6 kg/m$^2$ and 27.3 kg/m$^2$ in the control group ($P = .75$). There were 4 patients with workers' compensation status in the smoking group and 8 patients in the control group ($P > .99$). Table 1 presents the demographics for both groups.

### Physical Examination Findings

There were no statistically significant differences between study groups with regard to internal rotation, external rotation, flexion, or abduction ($P > .05$). There were no differences between groups for the presence of an internal snapping hip or external snapping hip ($P > .05$). Table 2 presents the preoperative physical examination findings.

TABLE 3
Preoperative Radiographic Findings[a]

| Finding | Smokers | Nonsmokers | *P* |
|---|---|---|---|
| Tönnis osteoarthritis grade, n (%) | | | |
| 0 | 65 (86.7) | 117 (78.0) | — |
| 1 | 10 (13.3) | 33 (22.0) | — |
| Alpha angle, deg | 64.8 ± 12.2 (38.0-89.0) | 63.1 ± 18.7 (0.0-101.0) | .36 |
| Lateral center-edge angle, deg | 27.8 ± 6.6 (13.0-47.0) | 30.7 ± 6.2 (13.0-44.0) | <.05 |
| Anterior center-edge angle, deg | 29.2 ± 7.4 (16.0-44.0) | 31.2 ± 7.1 (11.0-46.0) | .07 |

[a]Data are shown as mean ± SD (range) unless otherwise indicated.

TABLE 4
Concomitant Hip Procedures Performed[a]

| Procedure | Smokers | Nonsmokers | *P* |
|---|---|---|---|
| Labral repair | | | |
| Simple and base repair | 48 (64.0) | 96 (64.0) | >.99 |
| Reconstruction | 2 (2.7) | 4 (2.7) | >.99 |
| Debridement | 24 (32.0) | 50 (33.3) | >.99 |
| Acetabular microfracture | 12 (16.0) | 16 (10.7) | .29 |
| Capsular treatment | | | |
| Release | 40 (53.3) | 87 (58.0) | .57 |
| Plication | 35 (46.7) | 63 (42.0) | .57 |
| Ligamentum teres debridement | 17 (22.7) | 49 (32.7) | .16 |
| Isolated femoroplasty | 28 (37.3) | 32 (21.3) | <.05 |
| Isolated acetabuloplasty | 1 (1.3) | 13 (8.7) | <.05 |
| Combined acetabuloplasty and femoroplasty | 43 (57.3) | 97 (64.7) | .31 |
| Iliopsoas fractional lengthening | 27 (36.0) | 48 (32.0) | .55 |
| Synovectomy | 11 (14.7) | 11 (7.3) | .10 |
| Notchplasty | 8 (10.7) | 10 (6.7) | .31 |

[a]Data are shown as n (%).

TABLE 5
PRO Scores Preoperatively and at Latest Follow-up[a]

| PRO Measure | Smokers | Nonsmokers | *P* |
|---|---|---|---|
| Preoperative | | | |
| mHHS | 55.5 ± 16.3 | 63.0 ± 15.6 | <.05 |
| NAHS | 52.5 ± 18.1 | 60.8 ± 16.5 | <.05 |
| HOS-SSS | 30.5 ± 22.7 | 41.5 ± 22.7 | <.05 |
| VAS | 5.8 ± 2.3 | 5.3 ± 2.2 | .15 |
| Follow-up | | | |
| mHHS | 76.3 ± 20.5 | 83.4 ± 16.1 | <.05 |
| NAHS | 77.0 ± 19.9 | 83.5 ± 16.8 | <.05 |
| HOS-SSS | 60.8 ± 28.8 | 69.6 ± 26.7 | .08 |
| iHOT-12 | 62.5 ± 26.7 | 73.1 ± 25.0 | <.05 |
| VAS | 3.1 ± 2.7 | 2.3 ± 2.2 | .14 |
| Patient satisfaction | 7.9 ± 2.2 | 8.0 ± 2.5 | .87 |

[a]Data are shown as mean ± SD. HOS-SSS, Hip Outcome Score–Sport-Specific Subscale; iHOT-12, International Hip Outcome Tool–12; mHHS, modified Harris Hip Score; NAHS, Non-Arthritic Hip Score; PRO, patient-reported outcome; VAS, visual analog scale.

## Radiographic Findings

There were no significant differences between the study groups with regard to the preoperative radiographic measurements for alpha angle, Tönnis grade, and ACEA ($P > .05$). The mean LCEA was 27.8° for the smoking group and 30.7° for the control group ($P < .05$). Preoperative radiographic measurements of both groups are presented in Table 3.

## Concomitant Procedures

Concomitant procedures for the smoking and control groups are presented in Table 4. Based on the 1:2 matching criteria described above, there were statistically higher rates of isolated femoroplasty in the smoking group (37.3%) compared with the control group (21.3%) ($P < .05$) and lower rates of isolated acetabuloplasty in the smoking group (1.3%) compared with the control group (8.7%) ($P < .05$). There were no other statistically significant differences in procedures performed between groups.

## Clinical Outcomes

For the 150 hips in the control group and 75 hips in the smoking group, follow-up was obtained at 47.6 months and 42.5 months, respectively ($P = .07$). The mean pre- and postoperative PRO scores for both groups are shown in Table 5. The preoperative scores were significantly lower for the smoking group compared with the control group on the mHHS, NAHS, and HOS-SSS ($P < .05$). As the iHOT-12 was a new survey implemented at our institution, a preoperative comparison was not available. In the smoking group, the improvement in scores from preoperatively to the latest follow-up was 55.5 to 76.3 for the mHHS, 52.5 to 77.0 for the NAHS, and 30.5 to 60.8 for the HOS-SSS (Table 5). In the control group, the improvement in scores from preoperatively to the latest follow-up was 63.0 to 83.4 for the mHHS, 60.8 to 83.5 for the NAHS, and 41.5 to 69.6 for the HOS-SSS. Statistically significant improvements on all 4 PRO measures ($P < .05$ for all) were seen in both groups. When comparing the amount of improvement in PRO scores (delta) from preoperatively to the latest follow-up, there was no statistical difference between the smoking and control groups (Table 6).

TABLE 6
Improvement in PRO Scores[a]

| PRO Measure | Smokers | Nonsmokers | *P* |
|---|---|---|---|
| mHHS | 20.8 ± 21.3 | 20.4 ± 20.0 | .10 |
| NAHS | 24.5 ± 19.2 | 22.7 ± 19.4 | .63 |
| HOS-SSS | 30.3 ± 28.5 | 28.1 ± 31.6 | .69 |
| VAS | −2.7 ± 3.0 | −3.0 ± 2.8 | .29 |

[a]Data are shown as mean ± SD. HOS-SSS, Hip Outcome Score–Sport-Specific Subscale; mHHS, modified Harris Hip Score; NAHS, Non-Arthritic Hip Score; PRO, patient-reported outcome; VAS, visual analog scale.

There was no significant difference in preoperative VAS scores between groups; however, at the latest follow-up, patients in the smoking group reported a VAS score of 3.1 compared with 2.3 for the control group ($P = .05$). Both groups had a significant improvement from preoperative VAS scores at the latest follow-up visit ($P < .05$). Postoperative patient satisfaction at the latest follow-up was 8.0 for the smoking group and 7.9 for the control group, which was not significantly different.

### Complications

There were 7 hips in the control group and 3 hips in the smoking group that had superficial infections, which resolved with oral antibiotics. Four hips in the control group and 3 hips in the smoking group reported numbness. In both groups, the areas of numbness were the dorsum of the foot, leg, and anterior thigh. All cases of numbness resolved.

### Endpoints

There were 5 hips in the smoking group and 5 hips in the control group that converted to THA during the study period, with rates of 6.7% and 3.3%, respectively ($P = .31$) (Table 7). The mean time to THA conversion was 44.2 months for the smoking group and 39.6 months for the control group ($P = .74$). During the study period, 5 hips in the smoking group and 15 hips in the control group underwent revision hip arthroscopic surgery, with rates of 6.7% and 10.0%, respectively ($P = .47$). The mean time to revision was 16.5 months for the smoking group and 23.5 months for the control group ($P = .83$).

In the smoking group, 3 of the 5 revisions were for intra-articular issues such as retearing of the labrum. Two of these revisions were treated by labral debridement and 1 by base repair. One of the 5 revisions was second-look arthroscopic surgery to assess cartilage repair, and the remaining revisions were for excision of heterotopic ossification. In the control group, 7 of the 15 revisions were performed because of associated intra-articular issues; of these, 4 were treated by labral debridement and 3 by labral reconstruction. Four of the 15 revisions were for excision of heterotopic ossification, 3 for injuries sustained from falls, and 1 for an injury sustained after a car accident.

## DISCUSSION

In the present study, we compared preoperative clinical examination findings, imaging results, and PRO scores in addition to the latest follow-up PROs between patients who smoke and a control group. We attempted to control for confounding variables by matching on a 1:2 basis (smoking:nonsmoking) for patient sex, age within 5 years, labral treatment (repair vs reconstruction vs debridement), workers' compensation status, and BMI within 5 kg/m$^2$. Between the 2 groups, differences in demographics and preoperative clinical examination findings were not statistically significant. Preoperative imaging results only showed a statistical between-group difference in the LCEA; however, neither group was considered dysplastic. The results of this study show that patients who smoke have statistically significant lower preoperative and latest follow-up PROs compared with nonsmokers when undergoing hip arthroscopic surgery; however, the PRO scores still show a statistically similar improvement from preoperatively.

Many factors have been documented to affect the outcomes of hip arthroscopic surgery, including surgeon experience, portal placement, and traction time.[41] In addition, several patient factors that affect patient outcomes have been identified, such as BMI, age, and presence of osteoarthritis.[14,29,34] In a prospective cohort study, Westermann et al[42] evaluated 373 patients undergoing hip arthroscopic surgery. They conducted a multivariate analysis comparing numerous patient and operative factors to identify predictors of hip pain and dysfunction in patients with FAI. In their study, lower preoperative scores and higher pain were associated with mental health, female sex, smoking status, education, and activity level.[42] However, these authors only looked at preoperative scores and did not look at preoperative clinical examination findings, preoperative imaging results, postoperative outcome scores, or workers' compensation status. Kamath et al[19] conducted a univariate binary analysis for a variety of patient factors and found that patients who smoke are less likely to achieve a good or excellent outcome (defined as an mHHS score of $\geq$80) at the latest follow-up. However, the clinical distinction between groups is unclear because of the use of a binary endpoint and failure to present absolute differences in outcomes between groups.[19] In addition, the study did not compare or control for preoperative score differences, clinical examination differences, imaging differences, and workers' compensation status. Potter et al[33] studied psychological distress on preoperative scores in patients with FAI and found that a lower baseline Hip Outcome Score–Activities of Daily Living score could be attributed to smoking. To the best of our knowledge, ours is the first study comparing preoperative clinical examination findings, preoperative imaging results, preoperative PRO scores, and latest follow-up PROs for smokers undergoing hip arthroscopic surgery, matched to a control group of nonsmokers.

Smoking is the most preventable cause of morbidity and mortality in the United States and has been shown to adversely affect bone mineral density, lumbar disk health,

TABLE 7
Endpoints[a]

| Endpoint | Smokers | Nonsmokers | *P* |
|---|---|---|---|
| Revision arthroscopic surgery, n (%) | 5 (6.7) | 15 (10.0) | .47 |
| Time to revision, mo | 16.5 ± 7.7 (3.7-22.0) | 23.5 ± 18.3 (4.1-63.6) | .83 |
| Conversion to THA, n (%) | 5 (6.7) | 5 (3.3) | .31 |
| Time to THA, mo | 44.2 ± 23.9 (17.3-79.6) | 39.6 ± 14.3 (24.0-58.1) | .74 |

[a]Data are shown as mean ± SD (range) unless otherwise indicated. THA, total hip arthroplasty.

the relative risk of sustaining fractures, and the dynamics of bone and wound healing.[26,32,38] Each cigarette contains approximately 2 to 3 mg of nicotine and 20 to 30 mL of carbon monoxide depending on the brand and tar content.[16] The components of cigarette smoke circulate in the bloodstream and affect mesenchymal stem cells, fibroblasts, acute-phase proteins, and growth factors that are crucial mediators of wound repair. Nicotine has been shown to increase platelet aggregation, decrease microvascular prostacyclin levels, and inhibit the function of fibroblasts, red blood cells, and macrophages.[3] In addition, nicotine has been shown to cause peripheral vasoconstriction, especially in the digits, and microcirculation.[37] Carbon monoxide has a stronger affinity for hemoglobin than oxygen, resulting in the displacement of oxygen from hemoglobin and thus lower oxygen tension and hypoxia. Ten minutes of smoking has been shown to reduce oxygen tension in tissues for 1 hour. Therefore, a pack-per-day smoker is hypoxic for 20 hours each day.[39] Patients who smoke have been advised by their surgeon to refrain from doing so perioperatively, not only to improve lung and cardiovascular function but also to optimize the healing process after surgery.

In orthopaedic surgery, smoking has been associated with adverse effects for open procedures.[31] Increased rates of complication such as aseptic loosening, infections, and all-cause revisions have been well described when comparing smokers with nonsmokers in arthroplasty for the knee, hip, and shoulder.[13,15,28,35,40] Similar results have been seen with arthroscopic procedures of the knee, ankle, and shoulder. However, no study has thoroughly examined preoperative differences and postoperative patient outcomes after hip arthroscopic surgery in patients who smoke. During anterior cruciate ligament reconstruction, lower subjective and objective outcomes have been reported in smokers when compared with nonsmokers.[20,23,24] Clement et al[9] used 3 large databases to study 595,083 patients undergoing knee arthroscopic surgery and identified smoking as a risk factor for postoperative infections. In addition, lower functional outcomes have been documented after knee microfracture and increased rates of early meniscus repair failure after knee arthroscopic surgery in smokers.[2,3,5] Studies in ankle arthroscopic surgery have shown higher fusion times for smokers undergoing elective arthroscopic fusion of the talus to the distal tibia.[17]

Shoulder arthroscopic surgery is probably considered the most similar to hip arthroscopic surgery, and the effects of smoking are well documented, with larger rotator cuff tear sizes and inferior outcomes in smokers.[1,4,8,25] In a systematic review, Santiago-Torres et al[36] found smoking to have a negative effect on clinical outcomes of rotator cuff repair, associated with decreased healing in small- and medium-sized tears. Our study aimed to better understand the well-documented effects of smoking in arthroscopic procedures of the hip, and our results demonstrate similar effects as seen in the knee, ankle, and shoulder.

While hip arthroscopic surgery has increased in prevalence for the surgical management of pain associated with FAI and labral and capsular lesions, the effect of smoking has not been thoroughly examined or documented. Hip arthroscopic surgery is aimed at reducing bony impingement and restoration of the anatomic location and function of the labrum. The acetabular labrum is a triangular soft tissue structure that lines the acetabulum, serving as a suction seal to maintain intra-articular fluid for joint lubrication and load distribution.[6] The labrum has been described to receive its blood supply from the periacetabular vascular ring.[18] Kelly et al[21] evaluated the labral cross-sectional anatomy and found a relatively avascular labrum with increased vascular density along the capsular periphery (zone 1), similar to vascular zones within the meniscus of the knee. This microvascular milieu of the acetabular labrum may affect the healing potential. Likewise, the well-known detrimental effects of smoking on tissue perfusion may be related to the decreased PRO scores after hip arthroscopic surgery.

The strengths of our study are that this is the first study comparing smokers with nonsmokers who underwent hip arthroscopic surgery with a minimum 2-year follow-up. The study has a matched-pair controlled design with sufficient statistical power using prospectively collected data in a cohort comparison. This study used 4 different PRO tools to assess patient outcomes, addressing the psychometric evidence that no single PRO measure is adequate in hip arthroscopic surgery.[27]

There are several limitations of this study. Weaknesses include a limited sample size and short-term follow-up. We would expect true labral dysfunction to become evident after many years and to be accelerated by smoking. Future studies should focus on a longer term follow-up and larger cohort. Additionally, we did not stratify based on patient smoking factors such as pack-years or packs per day, as these data were not available for the cohort. A detailed smoking history could provide more insight regarding outcomes based on subgroup classification. In addition, multiple procedures were performed in all cases, such that the differences in PRO scores cannot be specifically attributed

solely to smoking. While no 2 patients are exactly alike, and perfect matching is not possible, the matched-pair controlled study design helps control for confounding variables. No preoperative difference was seen between groups in demographics, clinical examination findings, and imaging results. Further study at our institution will focus on the longer term outcomes of these procedures and more specific patient factors.

## CONCLUSION

Our study demonstrated inferior absolute PRO scores both preoperatively and at the latest follow-up for patients who smoke when compared with patients who do not smoke. The 2 groups were matched on a 1:2 basis (smoking:nonsmoking) with respect to patient sex, age within 5 years, labral treatment (repair vs reconstruction vs debridement), workers' compensation status, and BMI within 5 $kg/m^2$. Both groups demonstrated statistically significant improvement in all PRO scores compared with preoperatively, and the improvements were similar between groups. These results show that while hip arthroscopic surgery may still yield clinical benefit in smokers, patients who smoke may ultimately achieve an inferior functional status, and expectations should be adjusted accordingly. To optimize results, physicians should advise patients to cease smoking before undergoing hip arthroscopic surgery.

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