Use of Air Arthrograms to Aid in Joint Distraction During Hip Arthroscopic Surgery Decreases Postoperative Pain and Opioid Requirements

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Background: Positive-pressure air arthrography and venting of the hip capsule are techniques used to decrease the traction forces needed for joint distraction during hip arthroscopic surgery. Little is known about the effects that these techniques have on postoperative pain.

Hypothesis: Positive-pressure air arthrography and venting during hip arthroscopic surgery will decrease patient-reported pain and narcotic requirements in the acute postoperative setting.

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

Methods: A retrospective cohort analysis was conducted to analyze 35 patients who underwent positive-pressure air arthrography and venting to aid joint distraction during hip arthroscopic surgery versus a group with similar demographics, pathologies, and treatments who did not undergo air arthrography. Numeric pain rating scale (NPRS) scores and medication administration including narcotic and nonnarcotic analgesia in the postanesthesia care unit (PACU) were tracked and compared.

Results: The maximum (7.17 vs 4.97, respectively), minimum (2.43 vs 1.09, respectively), and mean (5.15 vs 3.11, respectively) NPRS scores were all higher in the control group compared with the air arthrogram group (P < .001, P = .007, and P < .001, respectively). The administration of oral morphine equivalents (OMEs) during the PACU stay was significantly lower in the air arthrogram group, with a mean of 36.75 ± 11.37 OMEs, compared with 44.53 ± 16.06 OMEs in the control group (P = .023). There was no difference in postoperative nonopioid medications, such as ketorolac or acetaminophen, given between groups.

Conclusion: Patients undergoing hip arthroscopic surgery with air arthrography and venting used to aid distraction had significantly less postoperative pain and required a lower total dosage of opioids during their PACU stay when compared with patients who underwent hip arthroscopic surgery without air arthrography.

Keywords: hip arthroscopic surgery; venting; pain; narcotics
The purpose of this study was to assess if using a positive-pressure air arthrogram decreases postoperative pain and analgesia requirements. To determine this, a matched-cohort analysis comparing numeric pain rating scale (NPRS) scores and opioid use in the postanesthesia care unit (PACU) in patients undergoing hip arthroscopic surgery for FAI with and without the use of an air arthrogram was performed. We hypothesized that the use of an air arthrogram will decrease postoperative pain as well as opioid use.

METHODS

Patients undergoing hip arthroscopic surgery by a sports medicine fellowship–trained orthopaedic surgeon with a focus on hip preservation (A.L.Z.) at a single academic institution were prospectively enrolled in a secure database. Database records were retrospectively reviewed, and 2 groups were established. Thirty-five patients undergoing primary hip arthroscopic surgery for FAI with the use of an air arthrogram during hip distraction were matched by age, sex, body mass index (BMI), and abnormality to 35 patients who did not receive an air arthrogram during similar procedures. The appropriate institutional review board approved the study protocol, and all patients provided written consent before enrollment.

Inclusion criteria included patients with symptomatic FAI with failure of conservative management and physical therapy who consented to participate in the study and underwent surgery within a 15-month time period. All patients had undergone a minimum of 6 weeks of conservative management before the surgical intervention. Exclusion criteria included patients with osteoarthritis (Tennis grade \( \geq 2 \)), hypermobility (Beighton score \( \geq 4 \)), and age older than 65 years. The primary outcomes evaluated were traction-related perioperative complications; maximum, minimum, and mean NPRS scores; and opioid medications administered in the PACU. Secondary outcomes included nonnarcotic analgesia administration and time from admission to discharge.

Patient demographics, including sex, age, and BMI, as well as radiographic findings were recorded along with intraoperative variables, complications, and medications administered. All patients underwent a preoperative radiographic evaluation, which included radiographs of the pelvis in the supine anteroposterior view and Dunn lateral 45° view, in addition to magnetic resonance imaging of the affected side. Radiographic measurements including the alpha angle and lateral center-edge angle were collected. Intraoperative variables recorded included procedures performed, cartilage condition, time spent in traction, and total procedure time. Intraoperative pain medications given by anesthesia were standardized for both groups.

To compare opioid administration between patients in the setting of multiple different narcotics and administration routes, a standardized calculation was used to convert all PACU narcotics administered into oral morphine equivalents (OMEs). All opioid administration data were recorded by PACU nursing staff and documented in the electronic medical record. Narcotic analgesia was administered for a pain score greater than 5 or for tachycardia, hypertension, or visible discomfort in patients not yet awake enough to report their pain score.

Surgical Technique

General anesthesia was used in all cases, and intraoperative medications were standardized across all patients. All patients underwent hip arthroscopic surgery on a standard hip distractor attachment table. The uninjured leg and operative leg were appropriately padded and placed into traction boots, and a well-padded perineal post was used. The hip was positioned in neutral without flexion or extension and without internal or external rotation. Gentle gross traction was performed to remove any slack from the knee joint so that the leg was suspended with the knee in extension but without any distraction of the hip joint.

After sterile preparation and draping, the hip capsule was entered anteriorly through the anterolateral portal with a sterile 17-gauge hip-length spinal needle under fluoroscopic guidance (Figure 1). Entry was away from the labrum and weightbearing articular cartilage to avoid iatrogenic injuries to these structures.

Air Arthrogram Group. After localization, 25 mL of air was then injected into the joint with a sterile syringe to provide positive pressure, breaking the negative suction seal of the hip joint. Fluoroscopy was used to confirm the intra-articular position by identifying an appropriate air arthrogram site, after which the syringe was removed from the needle, allowing pressure neutralization or “venting” to occur. Fine traction was then placed on the hip, with 10 turns typically needed for adequate joint distraction before dilators and arthroscopic instruments were used for standard hip arthroscopic entry through the anterolateral and midanterior portals.

Control Group. Gross traction using the distractor and padded post was placed on the operative hip before sterile preparation and draping, followed by fine traction as needed (typically 25-30 turns) until a visible/audible pop occurred, indicating hip joint distraction. Fluoroscopy was used to evaluate the joint for adequate distraction, after
which the spinal needle was used to enter the joint and a similar process of instrumentation performed.

At the end of the procedure, patients from both groups were given a 10-mL injection of 0.2% ropivacaine intra-articularly before portal closure.

**Statistical Analysis**

An unpaired Student t test was used to calculate the statistical significance between the 2 groups for mean values such as age, traction time, and medication administration. The Pearson chi-square test was used for categorical values such as sex and affected hip laterality. A $P$ value $<.05$ was considered statistically significant. All statistical computations were conducted in StatPlus:mac (v 6; AnalystSoft). An a priori power analysis was performed based on the results of previous literature on pain scores after hip arthroscopic surgery. It was determined that a minimum of 26 patients per group was required to power the study to $1 - \beta = 0.80$, and therefore, groups of 35 patients each were selected to ensure adequate power. A post hoc power analysis conducted for the postoperative pain scores between the 2 groups resulted in a power value of 100%.

**RESULTS**

The demographics and intraoperative findings for the control and air arthrogram groups are shown in Table 1. There was no statistical difference between groups in demographics, including sex, laterality, age, or BMI. No statistical difference was present with regard to preoperative radiographic measurements, including the alpha angle or lateral center-edge angle. Intraoperative findings, including mean traction time (63.6 ± 19.1 vs 63.2 ± 21.2 minutes, respectively; $P = .939$) and mean procedure time (110.8 ± 23.7 vs 103.3 ± 24.3 minutes, respectively; $P = .197$) were also similar between the control and air arthrogram groups. Thirty-four of 35 (97.14%) patients in the control group and 35 of 35 (100.00%) patients in the air arthrogram group had labral tears identified at the time of arthroscopic surgery. In the control group, 8 of the 35 patients (22.86%) were on short-acting narcotic analgesia preoperatively, compared with 7 of 35 patients (20.00%) in the air arthrogram group ($P = .771$). No patients in either group were on long-acting narcotic medications before surgery.
The primary goal of this study was to evaluate the effects of a positive-pressure air arthrogram on patient-reported pain scores after hip arthroscopic surgery. The elimination of the negative pressure seal of the hip joint using venting without air arthrography has been studied and is known to provide increased joint distraction at equal traction forces.\textsuperscript{11} This study adds to the literature by assessing the effect of the air arthrogram technique in addition to venting on postoperative pain and narcotic requirements. We hypothesized that not only will an air arthrogram vent the joint, but a positive-pressure application of air into the joint will also help to further decrease surface tension and facilitate distraction. In performing this matched-cohort analysis, we found that patients undergoing hip arthroscopic surgery with air arthrography had significantly less postoperative pain and required a lower total dosage of opioids during their PACU stay when compared with patients who underwent hip arthroscopic surgery without air arthrography during distraction.

The 2 groups in this study were matched by abnormalities, procedures, and demographics. There was no significant difference with regard to their nonnarcotic analgesia. The between-group differences in NPRS scores were most notable regarding maximum pain (2.20) and mean pain (2.04) but were slightly less with respect to minimum pain (1.34). All of these, however, were greater than the minimal clinically important difference for acute pain in the hospital setting (1.3) as established by Bijur et al.\textsuperscript{9} The difference in OMEs between groups was 7.78, equivalent to approximately 5 mg of oral oxycodone or nearly 0.5 mg of hydro-morphone less in the air arthrogram group.\textsuperscript{10} Decreased opioid use in the PACU may be associated with decreased opioid use after discharge, which is important in battling the current opioid epidemic.\textsuperscript{13}

Techniques to decrease postoperative pain in hip arthroscopic surgery are imperative. Unlike shoulder, elbow, knee, and ankle arthroscopic surgery, there is little benefit to standard regional nerve blocks.\textsuperscript{4} The joint also requires greater forces to distract because of its thick capsule. Prolonged and greater traction is associated with an increased risk of pudendal nerve palsy\textsuperscript{17,18} and should therefore be limited. Furthermore, prolonged postoperative narcotic use has been tied to worse outcomes after hip arthroscopic surgery.\textsuperscript{1} Other valuable techniques have also been described, including hip arthroscopic surgery without a perineal post,\textsuperscript{17,18} which may work well in conjunction with the air arthrography technique. It is important for surgeons to continue to develop safe and reliable techniques to minimize postoperative pain and traction-related complications after hip arthroscopic surgery.\textsuperscript{2,12,13}

The use of air arthrography or “venting” has been described as a technical pearl to aid in distraction of the hip joint.\textsuperscript{10,21} The strength and thickness of the hip capsule, combined with a patient population that tends to be young, healthy, and active, make distraction of the joint difficult. It is likely that by breaking the native vacuum suction seal of the hip joint with positive pressure, the hip distractes more easily, with less force on the soft tissue and surrounding musculature. Additionally, there is less force exerted in the perineal region as a result of decreased pressure against the perineal post. In contrast, manually distracting the joint with gross and fine traction may require increased force on the hip musculature as well as perineal area to overcome a tight negative suction seal on the hip. Therefore, using an air arthrogram may produce the effects of decreased immediate postoperative pain and narcotic requirements because of the reduced force needed on the leg to achieve adequate joint distraction.

This study is not without limitations. It was a single-surgeon, single-institution study, and because it was a retrospective review of a prospectively collected database, there was no randomization of patients. There was no group for whom venting alone was tested against positive-pressure air arthrography, and thus, the two can only be compared as a single combined strategy against traction without countermeasures to eliminate the suction seal of the hip. In addition, there is not a reliable record of patient narcotic or nonnarcotic analgesia requirements after discharge from the PACU. However, the goal of this study was...
to evaluate the immediate postoperative effects of using the air arthrography technique during hip arthroscopic surgery. Longer term outcomes after discharge from the PACU may be related to other factors, such as rehabilitation, that are more difficult to control for, but it is a goal of future studies to better examine this aspect. Future areas of research may also include larger multicenter studies to evaluate the effect of air arthrography on pudendal nerve palsy rates, as they are typically too infrequent to adequately power for an analysis at a single institution.

CONCLUSION

Patients undergoing hip arthroscopic surgery with air arthrography and venting used to aid distraction had significantly less self-reported postoperative pain and required a lower total dosage of opioids during their PACU stay when compared with patients who underwent hip arthroscopic surgery without air arthrography.

REFERENCES

1. Anciano Granadillo V, Cancienne JM, Gwathmey FW, Werner BC. Perioperative opioid analgesics and hip arthroscopy: trends, risk factors for prolonged use, and complications. Arthroscopy. 2018;34(8):2359-2367.

2. Baker JF, Byrne DP, Hunter K, Mulhall KJ. Post-operative opiate requirements after hip arthroscopy. Knee Surg Sports Traumatol Arthrosoc. 2011;19:1399-1402.

3. 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):1012-1018.

4. Behrends M, Yap EN, Zhang AL, et al. Preoperative fascia iliaca block does not improve analgesia after arthroscopic hip surgery, but causes quadriceps muscles weakness: a randomized, double-blind trial. Anesthesiology. 2018;129(3):536-543.

5. Bijur PE, Latimer CT, Gallagher EJ. Validation of a verbally administered numerical rating scale of acute pain for use in the emergency department. Acad Emerg Med. 2003;10(4):390-392.

6. Bonazza N, Liu G, Leslie D, Dhanw A. Surgical trends in arthroscopic hip surgery using a large national database. Orthop J Sports Med. 2017;5(suppl 6):232567117500406.

7. Boykin RE, Patterson D, Briggs KK, Dee A, Philippon MJ. Results of arthroscopic labral reconstruction of the hip in elite athletes. Am J Sports Med. 2013;41:2296-2301.

8. Bozic KJ, Chan V, Valone FH, Feeley BT, Vail TP. Trends in hip arthroscopy utilization in the United States. J Arthroplasty. 2013;28(suppl 8):140-143.

9. Byrd JWT. Femoroacetabular impingement in athletes: current concepts. Am J Sports Med. 2014;42:737-751.

10. Childs S, Pyne S, Nandra K, Bakhsh W, Mustafa SA, Giordano BD. The effect of intra-articular cocktail versus femoral nerve block for patients undergoing hip arthroscopy. Arthroscopy. 2017;33(12):2170-2176.

11. Dienst M, Seil R, Godde S, et al. Effects of traction, distension, and joint position on distraction of the hip joint: an experimental study in cadavers. Arthroscopy. 2002;18(8):865-871.

12. Frandsen L, Lund B, Gronbech Nielsen T, Lind M. Traction-related problems after hip arthroscopy. J Hip Preserv Surg. 2017;4(1):54-59.

13. Luo J, Min S. Postoperative pain management in the postanesthesia care unit: an update. J Pain Res. 2017;10:2687-2698.

14. Mannava S, Howse EA, Stone AV, Stubbs AJ. Basic hip arthroscopy: supine patient positioning and dynamic fluoroscopic evaluation. Arthrosc Tech. 2015;4(4):e391-e396.

15. Maradit Kremers H, Schilz SR, Van Houten HK, et al. Trends in utilization and outcomes of hip arthroscopy in the United States between 2005 and 2013. J Arthroplasty. 2017;32:750-755.

16. Matsuda DK, Gupta N, Hanami D. Hip arthroscopy for challenging deformities: global pincer femoroacetabular impingement. Arthrosc Tech. 2014;3(2):e197-e204.

17. Mei-Dan O, Kraeutler MJ, Garabekyan T, Goodrich JA, Young DA. Hip distraction without a perineal post: a prospective study of 1000 hip arthroscopy patients. Am J Sports Med. 2018;46(3):632-641.

18. Merrell G, Medvecky M, Daigneault J, Jokl P. Hip arthroscopy without a perineal post: a safer technique for hip distraction. Arthroscopy. 2007;23(1):107.

19. Neilsen S, Degenhardt L, Hoban B, Gisev N. A synthesis of oral morphine equivalents (OME) for opioid utilization studies. Pharma-coepidemiol Drug Saf. 2016;25:733-737.

20. Pfirrmann CWA, Mengiardi B, Dora C, Kalberer F, Zanetti M, Hodler J. Cam and pincer femoroacetabular impingement: characteristic MR arthographic findings in 50 patients. Radiology. 2006;240(3):778-785.

21. Thomas J, Ross JR, Salata MJ, Bancroft R, Bedi A. Synovial-based disorders. In: Wiesel SW, ed. Operative Techniques in Orthopedics. 2nd ed. Philadelphia: Wolters-Kluwer; 2016:264-275.