Prospective Single-Blinded Randomized Controlled Trial Comparing Pericapsular Injection Versus Lumbar Plexus Peripheral Nerve Block for Hip Arthroscopy

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Background: Hip arthroscopy has become the standard for the operative treatment of symptomatic femoroacetabular impingement. Given the high levels of postoperative pain associated with hip arthroscopy, optimal analgesia is critical to ensure patient comfort and safety after discharge.

Purpose/Hypothesis: Our purpose was to perform a single-blinded randomized controlled trial comparing the use of pericapsular injection versus lumbar plexus blockade for postoperative pain control after arthroscopic surgery on the hip. We hypothesized that pericapsular injection would provide equivalent pain relief to that of lumbar plexus blockade while minimizing adverse effects and alleviating the dependence on a qualified individual to administer.

Study Design: Randomized controlled trial; Level of evidence, 1.

Methods: A total of 64 consecutive patients undergoing hip arthroscopy were prospectively assessed over a 6-month period between 2017 and 2018. Patients were randomly allocated to 1 of 2 groups: 32 patients received a lumbar plexus blockade by a single anesthesiologist, while 32 patients received a pericapsular injection of 30 mL of ropivacaine and 12 mg of morphine. Postoperative pain in the postanesthesia care unit (PACU) as measured using the numeric rating scale, time to discharge, PACU morphine equivalents, and adverse effects were collected by PACU staff. Postoperative day 1 and 2 narcotic use was obtained through a telephone call with the patient on postoperative day 3.

Results: We found no statistically significant difference in PACU pain scores at all time points, although there was a trend toward lower pain for patients receiving a pericapsular injection. PACU and short-term narcotic demand did not vary across the 2 arms. Time to discharge from the PACU did not differ. There were no major adverse events reported for either intervention.

Conclusion: Pericapsular injection provides equivalent analgesia when compared with lumbar plexus blockade. It is a safe intervention that allows for efficient postoperative analgesia for patients undergoing hip arthroscopy.

Registration: ClinicalTrials.gov ID: NCT03244631.

Keywords: hip arthroscopy; pericapsular injection; lumbar plexus blockade; labral reconstruction
to administer. In a previous retrospective review, researchers from our group found lumbar plexus blockade to be superior to fascia iliaca blockade as well as general anesthesia alone. However, lumbar plexus blockade continues to present several concerns, including but not limited to dependence on the experience and comfort level of the administering anesthesiologist, concomitant postoperative motor blockade, postoperative fall risk, and the risk of epidural or intravascular injection. As a result of these concerns, we continued to investigate alternative methods for obtaining optimal postoperative pain control after hip arthroscopy.

The purpose of this prospective single-blinded randomized controlled trial was to compare pericapsular anesthetic injection with lumbar plexus blockade to determine if there exists a difference in pain control in the immediate and short-term postoperative setting. Secondary outcome measures included postoperative morphine equivalents taken by the patient and adverse outcomes in the PACU. We hypothesized that pericapsular injection would provide equivalent pain relief to that of lumbar plexus blockade while minimizing adverse effects and alleviating the dependence on a qualified individual to administer.

METHODS

The study was approved by the Western Institutional Review Board and registered on ClinicalTrials.gov (ID: NCT03244631). All study participants provided informed consent before study inclusion. All patients at our study location who were indicated for hip arthroscopy were assessed for eligibility. The inclusion criteria were age >16 or <50 years and a clinical indication for hip arthroscopy. To be eligible (Figure 1). Of the 35 excluded patients, 12 had preoperative narcotic use for hip pain, 3 had a known allergy to morphine or morphine, a primary language other than English, pregnancy in women, preoperative narcotic use for hip pain, and/or a preexisting chronic pain disorder. A total of 115 patients were screened, and 80 were determined to be eligible (Figure 1). Of these 80 patients, 64 patients (64 hips) who agreed to participate in the study were enrolled (Table 1). Patients were randomly allocated (with simple randomization) to 1 of 2 groups according to the randomization plan, which was developed before study initiation. Randomization was 1:1. The list resulting from this process was accessible by the operative surgeon (A.B.W.) and the anesthesiologist (P.S.G.). The patient and the PACU staff member responsible for recording the patient’s postoperative pain and medications administered were blinded to the intervention.

Surgical Technique

The same surgeon treated all patients enrolled in this study. Surgical techniques performed are outlined in Table 1. The algorithm for surgical decision making with regard to intrarticular interventions has been described. All reconstructions that were performed were circumferential. No segmental reconstructions were performed. There was no statistically significant difference among the procedures performed across the 2 groups.

Interventions

Both interventions were performed after the induction of general anesthesia to ensure that patients could not identify which intervention they received.

Lumbar Plexus Block

All lumbar plexus blocks were performed by the single anesthesiologist. The patient was placed supine on the operative table (Pivot Guardian; Stryker Sports Medicine) with a bump placed under the operative hip. The iliac crest, spinous processes at the midline, and posterior superior iliac spine were used as landmarks. The needle was inserted perpendicular to the skin at an entrance point is located at the junction of the lateral one-third and medial two-thirds of a line connecting the spinous process of L4 and a line parallel to the spinal column passing through the posterior superior iliac spine (PSIS). A nerve stimulator was then used to incite visible or palpable quadriceps contraction at 0.5 to 1.0 mA. After confirmation of proper positioning, 40 mL of 0.375% ropivacaine with 4 mg of preservative-free dexmedetomidine was slowly injected using repetitive aspirations.

Pericapsular Injection

The patient was placed supine on the operative table (Pivot Guardian; Stryker Sports Medicine). After the induction of general anesthesia and the application of initial traction but before final traction, 3 injection points were identified and used approximately 1 cm proximal to the capsule.
Anteromedially: the needle was placed under the anterior inferior iliac spine (AIIS) and advanced medially and slightly posteriorly (Figure 2).

Directly lateral: The injection started directly lateral and proceeded anteriorly above the acetabulum and posteriorly (Figure 3).

Posteriorly: The injection was performed along the posterior aspect of the acetabulum (Figure 4).

A total of 30 mL of ropivacaine and 12 mg of morphine was used.

After the lumbar plexus block or periarticular injection, a bandage was placed over the site of the lumbar plexus block to blind patients and nursing providers to the type of intervention used. The PACU nurse directly responsible for the patient’s care was informed which intervention was being performed.

### TABLE 1
Patient Characteristics and Surgical Procedures Performed

<table>
<thead>
<tr>
<th></th>
<th>Pericapsular Injection</th>
<th>Lumbar Plexus Blockade</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients</td>
<td>32</td>
<td>32</td>
<td>.43</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>15</td>
<td>12</td>
<td>.43</td>
</tr>
<tr>
<td>Female</td>
<td>17</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Age on date of surgery, y</td>
<td>37.9 (4.4)</td>
<td>38.6 (3.6)</td>
<td>.38</td>
</tr>
<tr>
<td>BMI at time of surgery</td>
<td>27.03 (6.7)</td>
<td>29.93 (10.1)</td>
<td>.22</td>
</tr>
<tr>
<td>Preoperative hip pain (VAS)</td>
<td>4.77 (1.57)</td>
<td>5.10 (1.22)</td>
<td>.19</td>
</tr>
<tr>
<td>Procedures</td>
<td></td>
<td></td>
<td>.99</td>
</tr>
<tr>
<td>Labral repair</td>
<td>10</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Labral reconstruction</td>
<td>22</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>Femoroplasty</td>
<td>32</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>Preoperative alpha angle, deg</td>
<td>65.5 (4.1)</td>
<td>67.8 (5.3)</td>
<td>.814</td>
</tr>
</tbody>
</table>

aData presented as No. or mean (SD). BMI, body mass index; VAS, visual analog scale.

![Figure 1. CONSORT (Consolidated Standards of Reporting Trials) flowchart.](image-url)
Postoperatively, all patients were taken to the PACU. In the PACU, the postoperative data collection was performed by a member of the PACU nursing staff who was not providing or responsible for the patient’s care but was blinded to the intervention that the patient received. All data from Appendix 1 (available in the online version of this article) were recorded and provided to the research team in a linked manner. A member of the research team called the patients on postoperative day 3 to record the remaining information on Appendix 1. The treating surgeon and anesthesiologist were blinded to the data recorded on Appendix 1, while the nursing staff obtaining the data recorded on Appendix 1 and the patients themselves were blinded to the intervention received. After postoperative day 3, the blinding ended, and patients were told which intervention they received.

**Rehabilitation**

Both groups followed the same rehabilitation protocol, and there was no difference between the treatment arms with regard to postoperative care. Postoperatively, patients
are permitted to be range of motion and weightbearing as tolerated but are strictly instructed to use crutches for at least 1 month and to avoid painful positions or activities for the duration of their recovery. We did not use bracing or a continuous passive motion machine. Activities were permitted in a graduated fashion depending on concomitant procedures performed (ie, slower for chondral restoration procedures or gluteal repair procedures), discomfort, and time from surgery. Typically, bicycling with resistance was permitted at 1 month, jogging at 3 months, and full unrestricted activity at 6 months.

Outcomes

The primary outcome measure was pain, as measured by the pain numeric rating scale. Secondary outcomes included time to discharge from the PACU, morphine equivalents received in the PACU, 10 mg immediate-release oxycodone (or 10 mg immediate-release oxycodone equivalents) taken by the patient in the first 48 hours, patient satisfaction with postoperative analgesia, and adverse effects.

Statistical Analysis

The power analysis was performed with the G*Power program (v 3.1; Heinrich-Heine-Universitat Dusseldorf). Pain as determined by the numeric rating scale was used as the primary outcome measure. With a power of 0.8, an effect size of 0.8, and a significance level of .05, a total of 28 patients were required for each group to detect a 30% difference between the groups. Oversampling of patients in each group was performed because of potential withdrawals and losses to follow-up. All data are reported as mean and standard deviation. Patient pain was compared between treatment arms using an independent t test. Chi-square test was used for categorical data.

RESULTS

A total of 64 of 64 (100%) patients were available for follow-up. Patient descriptive data are shown in Table 1. Preoperative patient age, body mass index, and pain did not vary between treatment arms. Pain at all time points in the PACU and time to discharge from the PACU did not vary between treatment arms (Table 2). Home analgesia during the first 48 hours, as measured by morphine equivalent dose, did not vary between treatment arms. The percentage of patients satisfied with their pain control did not vary between treatment arms.

DISCUSSION

The purpose of this single-blinded randomized controlled trial was to compare postoperative pain after hip arthroscopy for 2 discrete interventions: a lumbar plexus blockade and a pericapsular injection. Overall, postoperative pain levels, time to discharge from the PACU, complications, and postoperative narcotic use by patients did not differ between the treatment arms. As a result of our findings, our hypothesis was supported.

There are various sources of pain after hip arthroscopy, which can lead to substantial postoperative pain levels. Tan et al identified ≥80 mm Hg of pump pressure, femoral osteochondroplasty, and labral repair as intraoperative factors associated with greater postoperative pain. Despite ongoing research, there exists no identifiable gold standard with regard to the optimal method for management of postoperative pain after hip arthroscopy. Interventional modalities used by surgeons are numerous and include lumbar plexus blockade, peripheral nerve blockade, field

### Table 2

<table>
<thead>
<tr>
<th></th>
<th>Pericapsular Injection (n = 32)</th>
<th>Lumbar Plexus Blockade (n = 32)</th>
<th>Difference</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Postoperative pain, NRS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 min</td>
<td>1.13 (0.34)</td>
<td>2.36 (0.25)</td>
<td>–1.23</td>
<td>.09</td>
</tr>
<tr>
<td>30 min</td>
<td>2.31 (0.46)</td>
<td>3.25 (0.53)</td>
<td>–0.94</td>
<td>.21</td>
</tr>
<tr>
<td>60 min</td>
<td>1.76 (0.22)</td>
<td>2.77 (0.19)</td>
<td>–1.01</td>
<td>.10</td>
</tr>
<tr>
<td>90 min</td>
<td>0.81 (0.15)</td>
<td>0.9 (0.17)</td>
<td>–0.09</td>
<td>.14</td>
</tr>
<tr>
<td>PACU</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Morphine equivalents in</td>
<td>8.72 (1.34)</td>
<td>11.11 (1.86)</td>
<td>–2.39</td>
<td>.39</td>
</tr>
<tr>
<td>Time to discharge from, min</td>
<td>137.37 (15.13)</td>
<td>124.39 (12.44)</td>
<td>12.98</td>
<td>.43</td>
</tr>
<tr>
<td>Presence of nausea in, No.</td>
<td>10</td>
<td>7</td>
<td>3</td>
<td>.44</td>
</tr>
<tr>
<td>Patients satisfied with pain control at discharge, %</td>
<td>94.29</td>
<td>91.44</td>
<td>2.85</td>
<td>.65</td>
</tr>
<tr>
<td>No. of oxycodone (or equivalents) taken*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>POD 1</td>
<td>2.05 (1.56)</td>
<td>2.08 (1.74)</td>
<td>–0.03</td>
<td>.96</td>
</tr>
<tr>
<td>POD 2</td>
<td>1.22 (1.65)</td>
<td>1.36 (1.35)</td>
<td>–0.14</td>
<td>.75</td>
</tr>
</tbody>
</table>

*Data presented as mean (SD) unless noted otherwise. NRS, numeric rating scale; PACU, postanesthesia care unit; POD, postoperative day. Oxycodone is 10-mg immediate release formulation.
block, or intra- or pericapsular injection. Various pharmacologic interventions have been investigated as well.⁸

Lumbar plexus blocks have been used to provide anesthesia and postoperative analgesia for a variety of lower extremity surgical procedures. In a prospective randomized controlled trial, YaDeau et al²⁷ found that when compared with control, patients receiving a lumbar plexus blockade had lower postoperative pain scores while in the PACU. Another study found that patients receiving a lumbar plexus block had improved postoperative pain levels, decreased peri- and postoperative opioid consumption, and less postoperative nausea and emesis.¹⁸ While many studies have demonstrated the efficacy of lumbar plexus blockade on postoperative pain, this intervention is not without risk.²⁷ Epidural spread occurs anywhere from 3% to 27% of the time, which can result in falls, urinary retention, or bilateral spread.⁶,¹² Intravascular injection has been reported as well.²⁵ In addition, the procedure is dependent on administration by an experienced anesthesia provider. As a result of the risks and limitations of lumbar plexus blockade, there is ongoing investigation of various administrative methods and pharmacologic cocktails to use in intra- or pericapsular injections. In a retrospective study, Philippie et al¹³ found that patients receiving extracapsular local analgesia infiltration had lower requirement of rescue postoperative nerve blocks. Morgenthaler et al¹¹ found that patients receiving a postoperative intra-articular injection of 0.25% bupivacaine had lower postoperative pain while moving the operative limb, although pain at rest did not differ; as a result, the authors postulated that intra-articular injection may facilitate earlier, less painful range of motion. In a recently published level 1 evidence study, Garner et al⁷ found that patients who received local anesthetic infiltration had lower postoperative pain and narcotic consumption when compared with patients who received fascia iliaca blockade. Cogan et al⁵ in a retrospective cohort study, found that patients who received an intra-articular cocktail of 10-mg morphine and 100-μg clonidine had lower postoperative pain in the PACU. Shlaifer et al²⁴ compared intra-articular versus pericapsular infiltration of 20 mL of 0.5% bupivacaine and found that patients who received a pericapsular infiltration had lower pain scores at 30 minutes and 18 hours postoperatively. Baker et al⁴ compared the analgesic effect of intra-articular 0.25% bupivacaine versus portal site injection; they found that, overall, patients who received an intra-articular injection required fewer rescue narcotics in the PACU. However, at 6 hours postoperatively, the portal injection group reported significantly lower visual analog scale scores.

We found no difference in postoperative pain, narcotic consumption, time to discharge from the PACU, and satisfaction with analgesia when comparing lumbar plexus blockade with pericapsular injection. While we did not encounter any major adverse events during our trial, there is a theoretically increased risk with lumbar plexus blockade when compared with pericapsular injection. As a result, we postulate that there are many benefits to pericapsular injection versus other analgesic modalities. The technique does not require anesthesia staff assistance to administer, which could lead to decreased operative time and increased operating room efficiency. We found pain relief to be equivalent to that of lumbar plexus blockade. Finally, patient satisfaction with this modality was high, and no major adverse events were reported.

Limitations

A potential limitation of this study is that outside of data collected in the PACU, postoperative outcomes were self-reported. It is possible that patients incorrectly recorded the amount of medication consumed. In addition, we did not record the amount of NSAIDs (nonsteroidal anti-inflammatory drugs) consumed by patients in the postoperative period. While these are prescribed as a scheduled medication and are not intended to be taken on an as-needed basis, there exists the possibility that NSAID consumption differed and had an unforeseen effect on postoperative pain.

CONCLUSION

Pericapsular injection provides equivalent analgesia when compared with lumbar plexus blockade. It is a safe intervention that allows for efficient postoperative analgesia for patients undergoing hip arthroscopy.

ACKNOWLEDGMENT

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