

General

A Novel Approach to Improving Post-Operative Pain and Minimizing Opioid Consumption After a Hip Arthroscopy

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Background

There have been many different approaches to controlling pain in patients undergoing hip arthroscopy. These include medications, nerve blocks, and intra-articular injections among many others. We introduced a combination of a pre-operative pericapsular nerve group (PENG) block, and intra-operative pericapsular injection of BKK (bupivacaine, ketamine, and ketorolac).

Methods

Patients undergoing primary hip arthroscopy were identified. There were three patient cohorts based on type of anesthesia: general anesthesia only (GA), general anesthesia and a pericapsular Marcaine injection (GA/Marcaine), or GA with pre-operative PENG block and an intraoperative BKK pericapsular injection (GA+PENG/BKK). Data collected included post-operative pain scores in the PACU (Post-Anesthesia Care Unit), time spent in the PACU, inpatient opioid consumption (both PACU and inpatient), and outpatient opioid prescriptions filled.

Results

20 patients received GA, 11 patients received GA/Marcaine, and 20 patients received GA+PENG/BKK. The GA+PENG/BKK group had average PACU pain score of 3.9 out of 10 compared to 7.7 in the GA group ($p < .001$) and 6.6 in the GA/Marcaine injection group ($p = .048$). The GA+PENG/BKK group had shorter mean PACU times than either other group ($p < .001$). The GA+PENG/BKK also consumed less opioids than the GA or GA/Marcaine groups in the PACU ($p < .001$), and in the total inpatient stay ($p = .002$, $p = .003$), as well as outpatient ($p = .019$, $p = .040$).

Conclusion

In patients undergoing a hip arthroscopy, performing a pre-operative PENG block and intra-operative BKK pericapsular injection will result in decreased postoperative pain, PACU time, and inpatient and outpatient opioids compared to general anesthesia only and general anesthesia with intracapsular Marcaine.

INTRODUCTION

The number of arthroscopic hip procedures completed each year has drastically increased in the last decade.¹ As this procedure has gained popularity, there has been an increased need for an optimal regimen for postoperative pain control. When surveyed, a majority of orthopedic surgeons cite relying on opiate medications postoperatively for pain control.² In the midst of the current opiate crisis, there has been a large push in the field to reduce the reliance on postoperative narcotic medications.³ Although there have been many proposed multimodal pain management regimens, there is not one standardized technique.⁴ Many pro-

posed multimodal pain protocols include the use of systemic medications, nerve blocks, and periarticular injection anesthetics.² There has been increased usage of local periarticular injections, with many studies showing effective reduction in postoperative pain, even when compared to nerve blocks.⁵ However, there is still controversy regarding which multimodal protocol provides the optimal combination of safety and pain control.

Recently at our institution, there have been two separate protocols introduced: one included a Marcaine pericapsular injection and the other included a pericapsular nerve group (PENG) block with a pericapsular injection of a premixed bupivacaine, ketamine, and ketorolac (BKK) injection.⁵⁻⁷ This study aims to analyze the quality of pain control be-

tween these interventions compared to general anesthesia alone. Additional outcomes include time spent in the post-anesthesia care unit (PACU), opiate administration in the PACU as well as the rest of their inpatient stay, and amount of outpatient opioids prescribed.

The hypothesis of this study is that GA combined with a pre-operative PENG block and an intra-operative pericapsular BKK injection will lower postoperative pain scores, decrease time spent in the PACU, and decreased both inpatient and outpatient opiate consumption.

METHODS

STUDY DESIGN

This is a retrospective cohort study at a single academic institution with IRB approval (HM20024272). Patient charts were accessed through the electronic medical health record (EMR) system and were identified by Current Procedural Terminology (CPT) codes search. Included patients underwent a primary hip arthroscopy with procedures including a combination of labral repair versus labral debridement (CPT code 29916), femoroplasty (CPT code 29914), and acetabuloplasty (CPT code 29915). Patients were subdivided into three groups based on the intervention they received: general anesthesia only (GA group), general anesthesia with an intraoperative pericapsular Marcaine injection (20 mL) (GA/Marcaine group), and general anesthesia with a pre-operative PENG (pericapsular nerve group) block using ropivacaine (2mg/mL) and intra-operative pericapsular BKK (50mL bupivacaine, ketamine, ketorolac combination) injection (GA+PENG/BKK group). This anesthetic protocol including BKK injection and PENG block was developed to combine the benefits of intraarticular injections and nerve blockade to optimize regional anesthesia. PENG block, first described in 2018, was chosen due to its lack of motor impairment and documented efficacy in the anatomic region.⁷⁻¹⁰ The BKK mixture is injected into the pericapsular space after the capsule has been repaired at the end of the procedure [Figure 1]. The PENG blocks were all performed by an anesthesia provider using standard protocol and technique.¹¹ The Marcaine and BKK intra-operative injections were performed by two sports fellowship trained orthopedic surgeons. Patient demographics, including age, sex, and BMI were collected.

Using our EMR, postoperative pain score in the PACU, time spent in the PACU, opioid consumption in the PACU and inpatient, and outpatient opioid prescriptions were collected. Outpatient prescriptions filled at their pharmacy were collected for the first two weeks after their surgery.

DATA SOURCE

Information was gathered from patient charts within the electronic medical health record at Virginia Commonwealth University. For outpatient opioid prescriptions filled, data was collected from the PMP (prescription monitoring program) that is accessible in the electronic medical record system.

INCLUSION AND EXCLUSION CRITERIA

Patients included in this study underwent primary hip arthroscopy between the years 2020 and 2022. CPT codes utilized to identify patients included 29914, 29915, and 29916, which correspond to hip arthroscopy with femoroplasty, acetabuloplasty, and labral repair respectively. On chart review, patients with revision procedure or labral reconstruction included in the procedure were excluded. Individuals with a history of chronic pain, fibromyalgia, prior trauma, or opiate use disorder were excluded from the study to avoid confounding factors such as higher baseline pain or prior opiate exposure that could impact results. Individuals that received spinal anesthesia were also excluded for comparability.

DATA EXTRACTION

Two individuals (JW, JS) chose participants by examining the last 67 hip arthroscopy procedures completed at our institution, located by CPT code search, of which 51 met inclusion criteria, and 16 were excluded. Ten patients were excluded because they received spinal anesthesia, with an additional 4 for being revision procedures, and 2 excluded for chronic pain/fibromyalgia. Individuals were grouped based on the anesthesia/pain regimen they received. Included in the study were 20 patients that received GA, 11 patients that received GA/Marcaine, and 20 patients that received GA with a preoperative PENG block and pericapsular BKK injection.

Data collected included the PACU postoperative pain scores, time spent in the PACU, total milligram morphine equivalents (MMEs) of opiates consumed in the PACU, inpatient opiate consumption after PACU discharge measured in total MMEs, as well as opioids prescribed in the first 2 weeks after surgery. Postoperative pain was scored on a 0 to 10 visual analogue scale (VAS). PACU time was measured from the time that the patient left the operative room, to the time they were discharged from the PACU.

STATISTICAL ANALYSIS

The outcomes measured included postoperative pain score, time spent in the PACU, opiates consumed in the PACU, opiates consumed while in the hospital after being discharged from the PACU, and opiates prescribed in the first 2 weeks after surgery. Independent two-sided t-tests were completed for each of the variables (IBM SPSS 28). These t-tests were used to determine the difference between each of the cohort means, with alpha set at 0.05. One-way ANOVA testing was used to assess group demographic differences.

RESULTS

A total of 52 individuals were included in this study: 20 patients in the GA group, 12 in the GA/Marcaine group, and 20 in GA+PENG/BKK group. The average age of patients in each group was 33±11, 27±10), and 30±10 years respectively (p=.304), and there were no significant differences in sex distribution among groups.

POST-OP PAIN SCORES IN THE PACU

The mean VAS pain scores were significantly lower in the GA+PENG/BKK group (3.9, range 0-10) compared to, the GA group (7.7, range 4-10) ($p<.001$) as well as the GA/Marcaine group (6.6, range 3-10) ($p=.048$).

PACU TIME

The GA group had an average PACU time of 99 ± 40 minutes, and the GA/Marcaine group was not significantly different at 129 ± 59 minutes, ($p=.106$). The GA+PENG/BKK group had an average PACU time of 47 ± 44 minutes, 53% less time than the GA group ($p<.001$), and a 64% decrease from the GA/Marcaine group ($p<.001$).

PACU OPIOIDS

The GA+PENG/BKK group consumed only 4.1 MME in the PACU, which is an 84% decrease from the GA group (26.3 MME) and an 85% decrease from the GA/Marcaine group (28.1 MME) ($p<.001$).

INPATIENT, POST PACU OPIOIDS

After leaving the PACU, but while still in the hospital, there were no significant differences in opiates consumed by any group. The GA group averaged 19.0 MME, while the GA/Marcaine group averaged 23.2 MME and GA+PENG/BKK group averaged 13.5 MME during this period.

TOTAL INPATIENT OPIOIDS

With regards to total postoperative inpatient opiate consumption, GA+PENG/BKK group averaged 17.6 ± 15.7 MME which is 61% less than the GA group (45.3 ± 34.6 MME) ($p=.002$) and 66% less than the GA/Marcaine group (51.3 ± 40.8 MME) ($p=.003$).

OUTPATIENT OPIOIDS, 0-2 WEEKS

The GA+PENG/BKK group was prescribed an average of 264 MME over the first 2 weeks after surgery (18.9 MME/day), which was significantly less than the GA group (335 MME, 23.9 MME/day) ($p=0.019$) and the GA/Marcaine group (387 MME, 27.7 MME/day) ($p=0.040$). All results are further detailed in [Table 1](#).

DISCUSSION

Our study shows that the combination of a preoperative PENG block and an intraoperative BKK injection in hip arthroscopy patients resulted in significant decreases in post-operative pain scores, time spent in the PACU, and opioids received in the PACU, as well as total opioids during hospital stay and opioids prescribed in the first 2 weeks after surgery compared to patients receiving general anesthesia alone or those receiving an intraoperative Marcaine injection.

There is no standard perioperative pain control method for hip arthroscopy, although multiple potential strategies have been discussed through the literature. Fascia-iliaca blocks have been shown to make no statistical difference in postoperative pain scores at any time point, including immediately postoperatively.^{12,13} Femoral nerve blocks can be effective in lowering pain scores in the first 6 hours post-operatively, but the intervention carries the risks of motor weakness and associated falls.¹⁴ The PENG block carries a decreased risk of motor weakness which potentially makes it a safer option than a femoral nerve block from a fall risk perspective.⁹ The combination shown in this study of using both the PENG block and BKK injection decreased the average pain score in the PACU by 49% from the GA group pain score of 7.7. This is improved from the difference made by local infiltration of bupivacaine with epinephrine in the study by Philippi et al. which showed an improvement of 16% compared to a score of 7.35 in their general anesthesia only cohort.⁸

The PENG block combined with BKK injection significantly decreased PACU times by 53% compared to general anesthesia alone. In the study by Dold et al. evaluating peripheral nerve blocks in conjunction with general anesthesia for hip arthroscopy, it was found that they were not associated with a decrease in time spent in the PACU compared to those receiving general anesthesia alone.¹⁵ Systemic ketorolac administration has also been shown to not significantly decrease PACU length of stay.¹⁶ Neuraxial anesthesia has proven to be beneficial for PACU length of stay, with a 23% reduction compared to general anesthesia. The GA+PENG/BKK group in our study experienced an average of 53% reduction in length of stay in the PACU. This intervention represents the best improvement in time spent in the PACU we are aware of in the literature and avoids potential complications related to neuraxial anesthesia.

It is important, when possible, to minimize and ultimately decrease perioperative opioid use. In the review of the literature in 2019, Kolaczko et al. noted no statistically significant differences between any nerve block or nerve block paired with periarticular injection in terms of opioid consumption in the PACU.¹⁷ In a more recent study, neuraxial anesthesia showed a remarkable 42% decrease in opioid consumption in the PACU.¹⁸ However, our study we show an 84% decrease in opioids administered in the PACU with PENG block and BKK injection. There was minimal difference between the GA group and the GA/Marcaine group raising the possibility that the larger effect seen in our results is due to the PENG block as opposed to the periarticular BKK injection. Similarly to our study, Jaffe et al. showed a large decrease in PACU opioids consumed by patients with a combination lumbar plexus and sciatic nerve block, but there was no significant decrease in opioid use at 24 hours.¹⁹ This suggests that patients who received the intervention “caught up” in the amount of opioids needed in that period after the PACU. Our study showed similar results in the PACU, but differed from the results of Jaffe et al, as the cumulative opioids consumed in the hospital were

Table 1. Detailed table of study results by cohort

	GA Average	GA Std. Dev.	GA/Marcaine Average	GA/Marcaine Std. Dev.	GA+PENG/BKK	GA+PENG/BKK Std. Dev.
Postoperative VAS Pain Score (0-10)	7.7	2.1	6.6	2.3	3.9	3.7
PACU Time (minutes)	99	40	129	59	47	44
PACU Opioids (MME)	26.3	18.3	28.1	19.3	4.1	5.7
Inpatient, Post-PACU Opioids (MME)	19.0	26.6	23.2	29.1	13.5	13.9
Total Inpatient Opioids (MME)	45.3	34.6	51.3	40.8	17.6	15.7
Outpatient Opioids, 0-2 weeks (Total MME)	335	68	387	205	264	110

significantly different as well between the GA group and the GA+PENG/BKK group.

A study by Cogan et al. showed no significant difference in opioid consumption after release from the hospital in patients treated with an intra-articular injection of morphine and clonidine in hip arthroscopy patients compared to a control group receiving only preoperative celecoxib and acetaminophen in addition to general anesthesia at any time point including 14 days.²⁰ Our study showed a significant difference in the amount of opioids that were prescribed in the first 14 days after surgery. While we cannot compare this data to prospective trials in the literature where accurate pill counts are obtained, it suggests that the BKK injection and PENG block combination may be effective at reducing the longer-term opioid use after hip arthroscopy.

Limitations of this study include small sample size, as well as possible misclassification bias that is more likely to occur in all retrospective reviews. Additionally, we were unable to perform a postoperative pill count, and were not able to fully screen participants for previous opioid exposure levels or chronic pain conditions. The lack of patient reported outcome scores makes it difficult to determine if there are any long-term clinical differences with regards to the perioperative pain control strategies. Retrospective reviews also make it more difficult to assess for confounding factors. This study used smaller cohorts to demonstrate promising pilot data with the intention to build on these current results in future prospective studies. The small sample size of this study leaves this study vulnerable to type II error in the metrics that were not noted to be significantly different, so these metrics should be included for further evaluation in those future studies. Furthermore, as a retrospective review, it is difficult to ascertain which intervention is the most beneficial. It is difficult to assess whether the preoperative PENG block, intraoperative BKK injection, or both used in conjunction are the true cause of this improved outcome. Despite these limitations, there is

still strong evidence that the combination of a PENG block and BKK injection has strong positive clinical implications.

We plan to use the results of this retrospective review to set the stage for future prospective studies. Future studies will help differentiate exactly which interventions including the preoperative PENG block and intraoperative BKK pericapsular injection are the most effective. This will help find the most specific, effective pain management regimen in hip arthroplasty.

CONCLUSION

In patients undergoing primary hip arthroscopy, GA combined with preoperative PENG block and an intraoperative BKK pericapsular injection led to decreased PACU time, post-operative pain scores, and both inpatient and outpatient opiate consumption when compared to those receiving GA only or GA combined with pericapsular Marcaine injection. The findings of this study support the need for future prospective studies to determine which aspects of the intervention, either pre-operative PENG block or intraoperative BKK pericapsular injection, were most effective.

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AUTHOR CONTRIBUTIONS

Jonathan R. Widmeyer – Data collection, statistical analysis, main manuscript authorship

James Satalich MD – Data management, manuscript writing

Omar Protzuk MD – Project coordination, manuscript writing

Hailey Hampton - Manuscript writing and organization

Matthew Torre DO – Anesthesia expertise, manuscript editing

Iliia Brusilovsky MD - Anesthesia expertise, manuscript editing

Alexander Vap MD – Project oversight, manuscript editing

DISCLOSURES

Robert O’Connell MD – Primary Investigator, project oversight, manuscript authorship and editing,

None.

FURTHER INFORMATION

N/A.

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