

A comprehensive three-phase opiate sparing multimodal pain protocol for hip arthroscopy: a retrospective review

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ABSTRACT

The aim of this study is to assess the efficacy of a three-phase, multimodal, perioperative pain protocol for primary hip arthroscopy based on pain scores, narcotic use, time to discharge, hospital admission and complications. A retrospective study of patients undergoing primary hip arthroscopy over a 48-month time period was conducted. Patients were separated into a multimodal group consisting of non-narcotic medication, local analgesia and a peripheral nerve block (PNB) versus patients receiving only a PNB. Differences in post-anesthesia care unit (PACU) visual analog scores, PACU time to discharge, PACU opioid consumption, hospital admission and complications between protocols were recorded and analyzed. There were 422 patients who underwent 484 surgeries, with 15 patients crossing over pain protocol groups for surgery on the contralateral hip. One hundred and ninety-six patients underwent 213 procedures in the multimodal group and 241 patients underwent 271 procedures in the PNB group. No differences in baseline characteristics were appreciated between groups. Mean time to discharge was significantly shorter in the multimodal group (137.4 ± 49.3 min versus 176.3 ± 6.5 min; $P < 0.001$) which also had less post-operative admissions (0 versus 9; $P = 0.006$) than the PNB group. In patients who crossed over protocol groups, a statistically shorter time to discharge was appreciated with the multimodal protocol compared with the PNB protocol (119.9 ± 32.1 min versus 187.9 ± 9.2 ; $P = 0.012$). The three-phase, multimodal pain protocol led to significantly faster discharge times and fewer hospital admissions when compared with isolated PNB in patients undergoing primary hip arthroscopy.

INTRODUCTION

Hip arthroscopy has become a common and increasingly popular treatment for patients with intra-articular hip pathology, increasing in frequency by 117% from 2007 to 2014 [1]. Despite its minimally invasive nature and performance as primarily an outpatient procedure, pain control continues to be a challenge [2–6]. This challenge is likely due to the combination of the surgery itself and the complex

innervation of the hip joint [3, 7]. Inadequate pain control following hip arthroscopy has been shown to lead to prolonged discharge times, unexpected hospital admission, and higher consumption of opioid narcotics [3]. As a result, perioperative pain regimens have been developed to improve pain control following hip arthroscopy, utilizing a combination of non-narcotic medications, peripheral nerve blocks and local injection analgesia [3, 4]. The goal of

these regimens is to decrease pain and opioid consumption, allowing early mobilization, and timely discharge following arthroscopic hip surgery. However, the ideal combination of multimodal interventions remains unknown.

The utilization of an effective and safe multimodal perioperative pain protocol is imperative to ensure successful outcomes while ensuring patient satisfaction. In an effort to establish a standard protocol for the successful treatment of post-operative pain following primary hip arthroscopy, we implemented a novel three-phase, opiate sparing pain protocol for perioperative pain control following arthroscopic hip surgery beginning on 1 January 2018. In order to compare the efficacy of this protocol, we compared outcomes against our prior protocol utilizing an isolated preoperative peripheral nerve block (PNB) in the form of a fascia iliaca compartment block (FICB) or lumbar plexus nerve block (LPB). This PNB was performed using ultrasound guidance, 22-gauge stimuplex needle and 0.5% Bupivacaine with 1 in 200 000 epinephrine by the attending anesthesiologist. No intra-operative local injection analgesia or pre-operative non-narcotic pain medication was utilized in patients receiving the PNB. The purpose of this investigation was to retrospectively review patients undergoing primary hip arthroscopy using each pain protocol to better understand the effect of implementing a multimodal, opiate sparing pain protocol. Specifically, we sought to analyze the differences in protocols based on: (i) post-operative pain scores based on post-operative care unit (PACU) visual analog scores (VAS), (ii) time to discharge (in minutes), (iii) PACU opioid consumption (based on morphine equivalents [Meq]), (iv) unexpected hospital admission and (v) incidence of post-operative complications. The authors hypothesize that patients receiving the multimodal, opiate sparing pain protocol would possess decreased post-operative pain scores, time to discharge, opioid consumption, unexpected hospital admission and complications following primary hip arthroscopy.

MATERIALS AND METHODS

Following institutional review board approval, the electronic medical records of patients undergoing primary hip arthroscopy with osteoplasty and labral repair for symptomatic femoral acetabular impingement (FAI) treated between 1 January 2016 and 31 December 2019 were identified using Current Procedural Terminology codes 29914, 29915, and 29916. In our practice, patients that underwent primary hip arthroscopy from 1 January 2016 to 31 December 2017 were treated preoperatively using only a FICB and LPB, while patients undergoing surgery from 1 January

2018 to 31 December 2019 were treated in the preoperative period using a multimodal pain regimen. Patients of all ages at the time of surgery were included in this study. Additional procedures performed in conjunction with osteoplasty and labral repair were also included in analysis. Patients undergoing revision hip arthroscopy and those with incomplete medical records were excluded. In patients undergoing bilateral procedures treated utilizing both pain protocols, both surgeries were included for data analysis within the appropriate group based on protocol utilized. Demographic data such as patient age, sex, laterality of operative hip were recorded in addition to PACU VAS scores, time from PACU admission to discharge, opioid consumption in PACU, incidence of unexpected hospital admission and complications such as residual numbness, nausea and vomiting from pain medication, motor weakness or side effects of anesthesia during the perioperative period. Opioid consumption was calculated by converting dosing to Meq using a published conversion calculator [8]. A student's *t*-test was used to determine differences between continuous variables. A Fisher Exact Test was used for discrete variable analysis. A *P* value of <0.05 was used to determine statistical significance. All statistical analyses were performed using Microsoft Excel v.16.38 software (Redmond, WA, USA).

Three-Phase, multimodal pain regimen

Our multimodal pain regimen consists of patients first receiving a one-time dose of three oral medications preoperatively: (i) acetaminophen 975 mg or 15 mg/kg if <65 kg (unless patients were using oxycodone-acetaminophen post-operatively); (ii) gabapentin 300 mg (max dose of 10 mg/kg); (iii) celecoxib 200 mg (unless patients possess sulfa allergy or history of coronary artery disease, congestive heart failure, cerebrovascular accident, chronic renal insufficiency, active peptic ulcer diseases or aspirin sensitive asthma). Patients then receive a transversalis fascial plane (TFP) nerve block, also referred to as a Quadratus Lumborum (QL) block under ultrasound [9, 10] by a board-certified anesthesiologist with an area of expertise in regional anesthesia and nerve blocks. Patients are first positioned in the lateral position facing the operator where the anterolateral abdominal wall between the costal margin and the iliac crest is scanned using a high frequency, linear probe. The three layers of the abdominal wall are identified, namely the external oblique, the internal oblique and the transversus abdominis; and are traced posteriorly to identify the quadratus lumborum muscle and the reflection of the peritoneum [10]. Using an in-plane technique, 30 cc of 0.5% Bupivacaine or Ropivacaine with Epinephrine (1 in 200 000) and dexamethasone

(4 mg) is injected deep to the tapered end of the transverse abdominis muscle. The point of injection is close to the iliac crest where the perinephric fat is prominent and the local anesthetic spreads to the lateral surface of the quadratus lumborum muscle and pushes this perinephric fat downwards [10]. This is a pure sensory block which results in no motor weakness and eliminates the major fall risk reported in previous studies utilizing peripheral nerve blocks [11].

Intraoperatively, following anesthetic induction, patients receive an intravenous injection of methocarbamol (1 g or 15 mg/kg if <65 kg) for prophylaxis against muscle spasms. Intravenous ketorolac (30 mg) may be administered if celecoxib was not given preoperatively. Following surgery, 4–5 mg of Morphine is injected intraarticularly into the hip capsule, as well as 10 cc of 0.25% Marcaine with epinephrine equally into each portal site.

Post-operatively, patients receive 1–2 doses of intravenous hydromorphone 0.5 mg in PACU and 1–2 tabs of 5 mg oral oxycodone as needed for breakthrough pain every 4 h.

RESULTS

Four hundred and twenty-two patients underwent 484 cases of primary hip arthroscopy for FAI over the 48 months study period. There were 196 patients who underwent 213 procedures in the multimodal pain protocol group and 241 patients undergoing 271 procedures in the PNB group. (Table I) The multimodal group consisted of 64% females, while the PNB group was composed 65% females. Overall mean age at time of surgery was 28.8 ± 12.2 years, with no significant differences between groups ($P=0.12$). No significant differences between groups was appreciated based on patient sex ($P=0.92$) or surgical laterality ($P=0.35$). Sixty-two patients underwent staged bilateral procedures, with 15 patients ($n=5$ males;

$n=10$ females) crossing over pain protocol groups for their subsequent contralateral surgery. A total of 21 patients who underwent additional procedures in addition to osteoplasty and labral repair. Thirteen patients in the multimodal group and eight patients in the PNB group underwent additional procedures (Table II).

The mean overall time from admission to PACU discharge was 159.6 ± 65.0 min and was significantly shorter in the multimodal pain group ($P < 0.001$) (Table III). No significant difference was appreciated between groups based on mean PACU VAS ($P=0.83$) or PACU opioid consumption based on Meq ($P=0.29$). Patients in the multimodal pain protocol were significantly less likely to experience an unexpected hospital admission ($P=0.006$), while no significant difference in the incidence of post-operative complications was found between groups ($P=0.76$) (Table IV).

In patients undergoing staged bilateral surgeries with crossover between pain protocols, patients receiving the multimodal protocol had a significantly shorter time to

Table II. Concomitant procedures performed

| Multimodal protocol ($n=13$) | Peripheral nerve block ($n=8$) |
|---|--|
| ORIF acetabular rim fracture ($n=1$) | ORIF acetabular rim fracture ($n=1$) |
| Synovectomy ($n=1$) | Microfracture ($n=7$) |
| Greater trochanteric bursectomy ($n=5$) | |
| Iliopsoas lengthening ($n=2$) | |
| Microfracture ($n=3$) | |
| Microfracture and greater trochanteric bursectomy ($n=1$) | |

Table I. Demographic data

| | Multimodal protocol ($n=196$) | Peripheral nerve block protocol ($n=241$) | P-value |
|-------------|---------------------------------|---|---------|
| Cases | 213 | 271 | — |
| Age (years) | 27.8 ± 12.3 | 30 ± 12.1 | 0.12 |
| Sex | M, 77 F, 136 | M, 96 F, 175 | 0.92 |
| Laterality | R, 132 L, 81 | R, 156 L, 115 | 0.35 |

Legend: y, years; R, right; L, left; M, male; F, female.

Table III. Outcome measures between post-operative protocol groups

| | <i>Multimodal protocol</i> (n = 213 cases) | <i>Peripheral nerve block protocol</i> (n = 271 cases) | P-value |
|--------------------------|---|---|--------------------|
| PACU time to D/C (m) | 137.4 ± 49.3 | 176.3 ± 67.5 | <0.001a |
| PACU VAS | 4.0 ± 2.0 | 4.0 ± 2.1 | 0.83 |
| Opioid Consumption (Meq) | 12.4 ± 7.9 | 13.3 ± 11.5 | 0.29 |
| Hospital Admissions | 0 | 9 | 0.006 ^a |
| Complications | 5 | 5 | 0.76 |

Legend: m, minutes; PACU, post-anesthesia care unit; D/C, discharge; VAS, visual analog score; Meq, morphine equivalents.

^aStatistical significance.

Table IV. Complications based on treatment group

| <i>Multimodal protocol</i> | <i>Peripheral nerve block protocol</i> |
|--|--|
| Nausea and vomiting (n = 2) | Residual numbness (n = 3) |
| Vomiting, pain and foot numbness (n = 1) | Dizziness and blurriness (n = 1) |
| Nausea and constipation (n = 1) | Constipation (n = 1) |
| Swollen tongue (n = 1) | |

PACU discharge when compared with use of the isolated PNB protocol ($P = 0.012$) (Table V). No significant differences in PACU VAS scores ($P = 0.86$), PACU opioid consumption based on Meq ($P = 0.94$), unplanned hospital admissions ($P = 1.0$), or complication incidence ($P = 0.48$) were appreciated. No patients who underwent staged bilateral procedures had a history of preoperative narcotic use, and only three patients had a documented history of anxiety depression. There was no significant difference in preoperative duration of symptoms ($P = 0.37$), preoperative VAS score ($P = 0.61$) or grade of preoperative hip arthritis (Tonnis Stage) ($P = 1$) (Table VI).

DISCUSSION

The main findings from this study were that when compared to a preoperative PNB only protocol, implementation of a three-phase, multimodal, opiate-sparing pain protocol resulted in a significantly shorter time from PACU admission to discharge and significantly lower incidence of unexpected hospital admissions in patients undergoing primary hip arthroscopy. No significant difference in mean PACU VAS, PACU opioid consumptions or incidence of post-operative complications were appreciated.

Moreover, in patients undergoing staged, bilateral primary hip arthroscopy treated with both pain protocols, treatment with the multimodal pain protocol led to significant shorter PACU discharge times.

No significant difference in post-operative pain after primary hip arthroscopy based on PACU VAS scores was appreciated between groups. Recent literature has supported the use of a QL block in the setting of arthroscopic hip surgery to control perioperative pain. McCrum et al. demonstrated in their cohort of patients who received a QL block had improved post-operative VAS scores versus those who received multimodal oral/intravenous medication [12]. Yuan et al. also found that subjects who received a QL block had lower VAS pain scores in the PACU and within the first 24 h post-operatively when compared with a control group [13]. In this study, mean overall PACU VAS score (4.0 ± 2.0) in patients treated using our multimodal pain protocol was lower when compared with a recent systematic review examining 17 studies reporting on perioperative pain control following hip arthroscopy, which reported a mean PACU VAS score of 4.79 ± 2.04 [3]. In the retrospective review by Childs et al., the authors reported a mean VAS score of 4.28 in 88 patients undergoing primary hip arthroscopy who received only local analgesia into the portal sites [14]. Similarly, two recent randomized control trials examined VAS scores in patients who received only preoperative celecoxib; Zhang et al. reported that VAS scores remained elevated in the recovery room (VAS, 7.23), 12 h (VAS, 7.65) and even 24 h (VAS, 5.13) post-operatively, while Kahlenberg et al. reported a VAS of 4.11 at 2 h post-op [15, 16]. As such, when compared with previous published techniques, utilization of our three-phase, multimodal pain protocol demonstrates improved pain control based on PACU VAS scores.

Control of pain following hip arthroscopy has a pivotal role in the timely discharge of patients from the recovery

Table V. Outcomes of 15 subjects treated using both protocols during staged surgery

| | <i>Multimodal protocol</i> | <i>Peripheral nerve block protocol</i> | <i>P-value</i> |
|--------------------------|----------------------------|--|--------------------|
| PACU time to D/C (m) | 119.9 ± 32.1 | 187.9 ± 90.2 | 0.012 ^a |
| PACU VAS | 4.1 ± 2.3 | 4.2 ± 2.6 | 0.86 |
| Opioid consumption (Meq) | 13.8 ± 6.2 | 14.2 ± 15.5 | 0.94 |
| Hospital admissions | 0 | 1 | 1 |
| Complications | 2 | 0 | 0.48 |

Legend: m, minutes; PACU, post-anesthesia care unit; D/C, discharge; VAS, visual analog score; Meq, morphine equivalents.

^aStatistical significance.

Table VI. Preoperative characteristics of 15 subjects treated using both protocols during staged surgery

| | <i>Multimodal protocol</i> | <i>Peripheral nerve block protocol</i> | <i>P-value</i> |
|--|-----------------------------|--|----------------|
| Preoperative narcotic use | <i>n</i> = 0 | <i>n</i> = 0 | 1 |
| Preoperative diagnosis of anxiety/depression | <i>n</i> = 3 | <i>n</i> = 3 | 1 |
| Preoperative duration of symptoms (mos) | 10.0 ± 7.99 | 14.7 ± 14.6 | 0.37 |
| Preoperative VAS | 6.79 ± 2.06 | 7.23 ± 1.71 | 0.61 |
| Tonnis grade of Hip OA | Stage 0 = 14 Stage 1 = 1 | Stage 0 = 14 Stage 1 = 1 | 1 |

Legend: mos, months; VAS, visual analog score; OA, osteoarthritis.

^aStatistical significance.

room, while preventing unplanned admissions. Our study found significantly shortened discharge times from PACU in subjects who received the three-phase, multimodal pain protocol compared with the isolated preoperative PNB. In addition, none of the patients in the multimodal group were admitted for uncontrolled pain post-operatively, while nine patients were admitted in the PNB group for uncontrolled pain post-operatively. While mean time to discharge following hip arthroscopy has been reported to range from 48 to 240 min, mean overall time in our multimodal group was 137.4 ± 49.3 min [17]. The study by Ward et al. reported a mean discharge time of 178 min following hip arthroscopy in patients who received only post-operative femoral nerve blocks (FNB) [5]. Another retrospective review noted an average discharge time of 240 min in their group of patients receiving both preoperative LPB and intraoperative intracapsular morphine [18]. In addition, two other studies reported longer discharge times in patients receiving isolated preoperative LBP [19] or FNB [20]. Cogan et al. reported an average discharge time of 161 min in patients receiving preoperative celecoxib and

acetaminophen in addition to intraoperative intracapsular morphine and clonidine [2]. In another retrospective study, patients who received extracapsular bupivacaine were discharged from the recovery room at an average of 151 min, however the authors noted that a post-operative nerve block was administered in a select number of patients [21]. While it is difficult to compare discharge timing between studies due to the heterogeneity of pain protocols, none of the above studies included patients who received preoperative, intraoperative and post-operative pain control interventions. To determine effective pain control resulting in shorter discharge times from PACU, further interventions examining pain management in all three phases of the perioperative period following primary hip arthroscopy is warranted.

In the setting of the current opioid crisis, achieving appropriate pain control while limiting post-operative opioid consumption is critical following arthroscopic hip surgery. Patients using the senior authors opiate sparing pain protocol used an average of ~4 Meq of opioids in the recovery room, which correlates to less than one 5 mg oxycodone

tablet or about a 0.5 mg of IV hydromorphone. Recent systematic reviews have reported that the average opioid consumption in the recovery room ranges from 0 to 32.53 Meq in patients receiving non-narcotic interventions for perioperative pain control [3, 4, 17]. Compared to the current multimodal pain regimen, greater opioid consumption has been reported in studies utilizing the following modalities: PNB and preoperative non-narcotic medications [6, 22], PNB and intraoperative local injection analgesia [16, 23], pre-operative non-narcotic medications and local injection analgesia [2], and preoperative non-narcotic medications, intraoperative local injection analgesia with optional PNB post-operatively [21]. Furthermore, two recent studies have shown decreased total post-operative Meq in patients who have received a QL peripheral nerve block when compared to control group receiving traditional post-operative PO and IV pain medication [12, 13]. These findings further emphasize the need for a pain control protocol that involves treatment during all three phases of care in the perioperative period in order to minimize post-operative opioid consumption.

Our multimodal pain regimen resulted in no significant differences in the incidence of complications when compared with the PNB only protocol. Neither protocol resulted in any post-operative falls, which are of concern due to post-operative motor weakness and have the potential to result in femoral neck fractures due the amount of bone resection needed to produce adequate clinical results [24, 25]. When examining previously utilized nerve blocks, Childs et al. found that in 105 subjects receiving a FNB, 18% of patients sustained falls due to quadriceps weakness [14]. In addition, Berhands et al. reported an 11% incidence of falls in patients receiving a FICB [23]. In addition to the potential for falls, Yadea et al. and Wolff et al. reported one case each of neuraxial spread leading to urinary retention and a short seizure following LPB [19, 26]. The TFP/QL block utilized in our multimodal protocol provides adequate analgesic effect without subsequent muscle weakness or neuraxial spread.

This study is not without limitation. The retrospective nature of this investigation prevented patients from being randomized to a single pain protocol. This study only includes data from the immediate perioperative period and thus the effects of long-term opioid use or complication incidence following patient discharge were not analyzed. This is a single institution study with the collection of patients from a single surgeon, as such differences in post-operative pain control and outcomes cannot be inferred beyond the results obtained from this single surgeon series. The authors do note that since this is a cohort of patients from a single surgeon well into his professional practice, it

is possible that patient selection has improved which may have affected the analyzed outcome scores. However, after analyzing preoperative variables there was no difference between treatment groups in those patients who underwent staged bilateral procedures; and thus, inclusion of patients only within the 48-month time period could have lessened the effect. Lastly, this study only included patients over a 48-month period of time and not from the beginning of the senior author's practice, as hip arthroscopy has been shown to be a demanding procedure with a prolonged learning curve that has an effect on outcomes [27–29]. Therefore, given the prolonged learning curve and skill needed for hip arthroscopy, the authors believe that by including the most recent two years prior switching to a standard pain protocol would minimize potential confounding factors from the steep learning curve inherent to hip arthroscopy.

In conclusion, when compared with a prior PNB only pain protocol, implementation of a multimodal, three-phase, opiate-sparing pain protocol was found to result in significantly shorter time to PACU discharge and decrease in unexpected hospital admissions. No significant difference in mean PACU VAS scores, PACU opioid consumption or incidence of complications was appreciated between pain protocol groups. Further high quality, randomized investigations are needed in order to establish the optimal perioperative pain regimen to minimize post-operative opioid use, allowing for early effective pain control and discharge while decreasing the risk of unexpected admission and complications post-operatively.

DATA AVAILABILITY STATEMENT

The data included in this study and used for analysis is available from the corresponding author, upon request.

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CONFLICT OF INTEREST STATEMENT

None declared.

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