

Extracapsular local infiltration analgesia in hip arthroscopy patients: a randomized, prospective study

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Submitted 16 February 2018; Revised 4 June 2018; revised version accepted 8 July 2018

ABSTRACT

Hip arthroscopy patients can experience significant post-operative pain. Many strategies to combat this pain have been explored including nerve blocks, which can be costly. An alternative option for pain management is local infiltration analgesia (LIA) which has been studied in hip and knee arthroplasty, but its ability to decrease pain in the setting of hip arthroscopy remains uncertain. A prospective randomized controlled trial of 74 patients who underwent hip arthroscopy at a single medical center was performed. Thirty-seven patients received a 20-ml extracapsular injection of 0.25% bupivacaine-epinephrine under direct arthroscopic visualization after capsular closure while 37 from the control group received no injection. Primary outcome measures were both maximum and discharge numeric rating scale (NRS) pain scores while in the post-anesthesia care unit (PACU). The LIA group had a statistically significant decrease in the maximum PACU NRS score (6.16 versus 7.35, $P = 0.009$), however this did not reach the level of minimal clinically important difference of 1.5. There was an insignificant difference in discharge PACU pain scores. This is the first randomized controlled trial studying extracapsular LIA in hip arthroscopy. While LIA offers an uncomplicated and low-cost approach to post-operative pain management, this specific technique did not reduce pain to a clinically significant level.

INTRODUCTION

Hip arthroscopy is a growing field in orthopedic surgery that has gained momentum in recent years as a treatment for an array of hip pathologies with a low rate of complications [1, 2]. Longitudinal studies have demonstrated favorable outcomes in the treatment of femoroacetabular impingement, borderline hip dysplasia and labral tears [3, 4]. However, many patients experience significant pain post-operatively [5, 6]. Acute pain after surgical procedures can hinder patient outcomes as brief periods of pain can induce neuronal remodeling and sensitization precipitating chronic pain and psychological distress [7–9].

Many injection strategies to combat pain associated with hip arthroscopy have been explored. These include femoral nerve blocks, fascia iliaca compartment blocks (FICBs) and

paravertebral blocks. Nerve blocks have been shown to decrease post-operative pain and opioid use [5, 6, 10, 11]; however, they can be costly as they frequently require separate procedural and equipment fees billed by the anesthesiologist. Furthermore, nerve blocks have been shown to increase the rate of patient falls. Rarely, they can also carry the risk of residual paresthesias and permanent nerve damage [12–15].

One way to circumvent these limitations is local infiltration analgesia (LIA), a technique that has been described for post-operative pain management in orthopedic modalities like knee arthroscopy, total knee arthroplasty (TKA) and total hip arthroplasty (THA) [16–25]. LIA has been studied to a limited extent in the setting of hip arthroscopy [26–30]; however, its efficacy is unclear due to variable described LIA injection sites and limited study designs.

This study utilizes an extracapsular LIA technique which localizes analgesic to the hip capsule following hip arthroscopy. The capsule was targeted as it is known to have a high concentration of nociceptive nerve fibers which are traumatized during hip arthroscopic procedures and may contribute to post-operative pain [31–33]. The extracapsular LIA technique was researched previously by the authors of the present study in a case-control study which found that hip arthroscopy patients who received an extracapsular LIA injection had a significantly decreased rate of post-operative nerve blocks (56–35%) as compared with the control group ($P=0.027$) [34]. These results motivated the current prospective study.

The purpose of this randomized controlled study is to compare the efficacy of an extracapsular LIA in reducing immediate postoperative pain. Secondary outcome measures include post-anesthesia care unit (PACU) opioid consumption and data from patient recorded pain dairies. We hypothesize that the LIA group will have lower maximum pain scores in the immediate postoperative period and lower pain scores at the time of discharge.

MATERIALS AND METHODS

This was a single-center prospective randomized controlled study. The participants, anesthesiologists and PACU ancillary staff were blinded to group assignments. The surgeon administering the LIA was not blinded. Participants were randomized to the LIA or non-LIA group and stratified by current use of narcotic pain medication. Patients were invited to participate in the study if they were undergoing any unilateral hip arthroscopy procedure during the study period. Patients undergoing bilateral hip procedures were excluded. All surgeries were performed by the senior author (SKA).

After receiving approval from the institutional review board, eligible patients were recruited either at preoperative clinic appointments or in the preoperative area on the day of surgery. A total of 74 patients were enrolled in the study; one was excluded due to incorrect pain documentation in the PACU. Thirty-six patients were assigned to the intervention group while 37 patients were assigned to the control group (Fig. 1).

In the LIA group, once the interportal capsulotomy was fully closed, a spinal needle was arthroscopically placed in the space just anterior to the capsule (Fig. 2). Excess saline was then suctioned out of the pericapsular space and all portals were closed. After portal closure, 20 ml of 0.25% bupivacaine-epinephrine (1:200 000) was injected into the extracapsular space. Participants in the control group did not receive any injection into the extracapsular space.

To quantify patients' subjective pain, a numeric rating scale (NRS) of pain (0–10 scale) was used. As soon as the patient was awake, aware and responsive following surgery, the PACU nursing staff documented the patient's NRS pain score. The nursing staff was asked to chart pain scores with each of their interactions with the patient, at the time of administration of opioids, after the opioids were perceived to have taken effect and at the time of discharge from the facility.

PACU opioid use was documented by the nursing staff and total post-operative consumption was calculated based on morphine milligram equivalents (MME) described by the Centers for Disease Control and Prevention [35, 36].

Patients were sent home with a pain diary with entries for the first 7 days post-operatively, and one entry at the end of each of the following 3 weeks. The daily entries included an average daily NRS pain score, opioid use and satisfaction with pain control using a Likert-type scale (very unsatisfied, somewhat unsatisfied, neutral, somewhat satisfied and very satisfied). The weekly entries included overall weekly NRS pain score and satisfaction with pain control. Diaries were returned to the study team via self-addressed envelopes or in person during post-operative follow-up appointments.

Patients were also asked to document if they perceived a distinct increase in pain during the first 48 h postoperatively. If a distinct increase in pain was experienced, the patients were asked to give an NRS pain rating both before and after the increase in pain occurred. Patients were instructed to document this in their pain diary at the time the rebound pain occurred in order to minimize recall bias.

Based on the available literature, the minimal clinically important difference (MCID) for the NRS was estimated to be 1.5 points [37–40]. To detect a 1.5-point difference between our LIA and non-LIA arms with 80% power at a 0.05 significance level, we would need 68 participants using a pooled standard deviation of 2.2, which was estimated from the Xing *et al.* study of femoral nerve blocks in hip arthroscopy patients [41]. This calculation was based on a two-tailed *z*-test incorporating one interim and one final look at the data using the O'Brien and Fleming method [42].

Demographics, rate of rebound pain, PACU pain scores, opioid consumption and time-to-discharge were compared between intervention and control groups. Continuous variables were compared using a *t*-test or Wilcoxon–Mann–Whitney test. Categorical variables were described in frequency and percentage, and were compared using a chi-square test. The data collected from the pain dairies were analysed using generalized linear mixed effect model which tested for a difference in NRS pain scores,

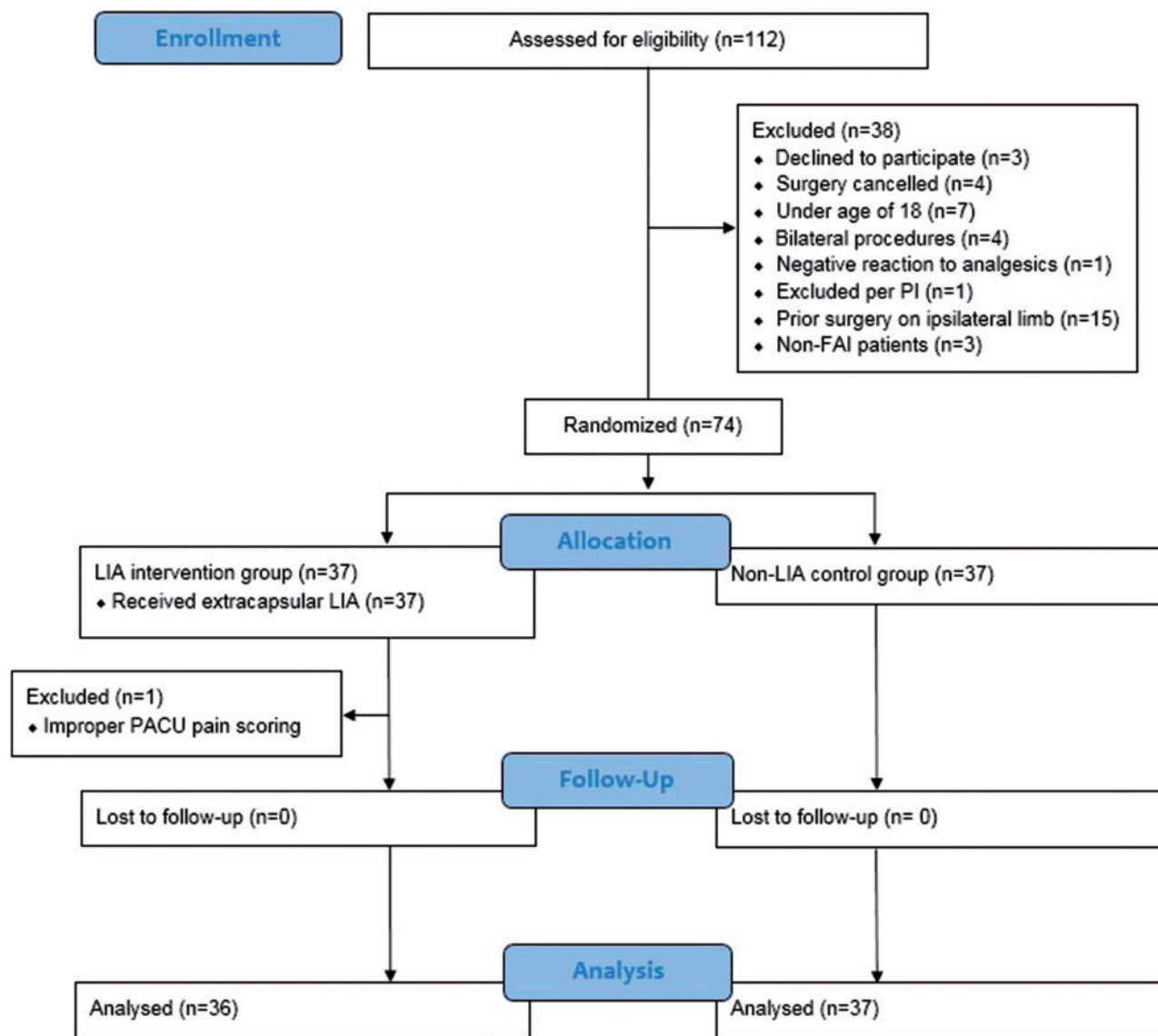


Fig. 1. CONSORT flow diagram of the progress of patients in the study from enrollment to analysis.

satisfaction scores and daily opioid consumption between LIA vs non-LIA groups at baseline and over time. All statistical analysis was performed using SAS 9.4 (SAS Institute Inc., Cary, NC, USA).

RESULTS

There were no significant differences in sex, age, BMI or laterality of surgery between LIA and control groups. Demographic characteristics can be found in Table I. The distribution of surgical procedures were very similar between the two groups (LIA/control): 19/19 patients underwent primary femoral osteochondroplasty with labral repair, 9/8 patients underwent femoracetabuloplasty, 6/6

patients underwent femoral osteochondroplasty without labral repair and 2/4 patients underwent revision femoral osteochondroplasty. All patients underwent complete capsular repair.

There was a statistically significant decrease in the maximum PACU NRS score in the LIA group versus the non-LIA group (6.16 versus 7.35, $P = 0.009$). There was no significant difference in discharge PACU NRS pain scores. While our study was not powered specifically to measure secondary outcomes, the non-LIA group did have a longer median PACU duration (97 min versus 118 min, $P = 0.09$) and higher median PACU opioid consumption (10 MME versus 14 MME, $P = 0.09$); these factors may have been

influential in the similar mean PACU discharge pain score (3.36 versus 3.86 $P = 0.18$). Rebound pain, and other pain diary variables of interest also showed no difference between groups. Results can be found in [Tables II and III](#).

DISCUSSION

The findings of this study support our hypothesis that administration of extracapsular LIA would decrease PACU pain scores in hip arthroscopy patients, although the decrease did not reach the MCID for the NRS score for pain in previously reported literature [39, 41].

LIA has been used in a diverse array of surgical settings; however, there has been limited research into the efficacy of LIA in hip arthroscopy. In 2007, Morgenthaler *et al.*

published findings from a randomized controlled trial of a small cohort of 26 hip arthroscopy patients in which 13 received an intra-articular 20 ml 0.25% bupivacaine and 13 received placebo normal saline. Visual analogue scale (VAS) pain scores were recorded at 0.5, 4, 12, 16 and 20 h post-operatively. The mean of these scores was found to be 17.5 in the LIA group and 27.5 in the control group ($P = 0.05$) [30].

There has been concern regarding intra-articular LIA injections due to the potential chondrotoxicity of analgesic medicine [43]. Consequently, Baker *et al.* compared intra-articular injection with portal injection of 10 ml of 0.25% bupivacaine in a 2011 study. The analgesic efficacy of these two LIA strategies was shown to be similar; the only significant differences between groups were that the portal group required more rescue analgesia initially after surgery, but had lower VAS scores at 6 h after surgery [26]. However, the lack of control group limits the ability to characterize the analgesic effect of LIA.

In 2017, Garner *et al.* carried out further research into portal LIA in the setting of hip arthroscopy, this time comparing the analgesic effect of 40 ml of 0.125% levobupivacaine LIA to the FICB. They found that LIA group had significantly less pain in the 1st hour postoperatively and consumed less opioids than patients who had received FICB [27]. While FICB has been shown to significantly reduce pain in hip arthroscopy patients [44], and is therefore a valuable comparison for LIA, the lack of a control group makes it difficult to quantify the analgesic effect of LIA.

Also in 2017, Shlaifer *et al.* published research comparing intra-articular to periacetabular LIA injection in hip arthroscopy patients. At the early stages of the hip arthroscopy procedure, one group received a 20 ml intra-articular

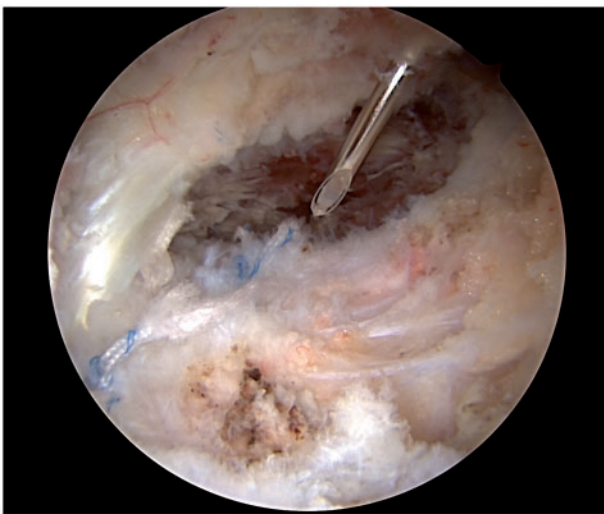


Fig. 2. LIA administration via spinal needle placed just anterior to the hip capsule.

Table I. Patient demographics (N = 73)

	Total	LIA (N = 36)	Non-LIA (N = 37)	P-values
Sex, n (%)				
Male	21 (28.8)	11 (30.6)	10 (27.0)	0.739 ^a
Female	52 (71.2)	25 (69.4)	27 (73.0)	
Age at surgery, mean (SD)	34.7 (10.0) (range 19–58)	36.3 (10.9) (range 19–58)	33.3 (8.9) (range 19–54)	0.085 ^b
BMI, mean (SD)	25.6 (5.1) (range 18.0–41.2)	24.7 (4.5) (range 19.0–39.6)	26.4 (5.6) (range 18.0–41.2)	0.141 ^b
Side of surgery, n (%)				
Left	35 (47.9)	17 (47.2)	18 (48.6)	0.903 ^a
Right	38 (52.1)	19 (52.8)	19 (51.4)	

^aChi-square test.

^bTwo sample t test.

Table II. Clinical characteristics comparison between LIA versus non-LIA groups (N = 73)

Variables	LIA (N = 36)	Non-LIA (N = 37)	P-value
Maximum PACU NRS score, mean (SD)	6.19 (1.97)	7.35 (1.69)	0.009 ^a
Median (IQR)	6.50 (5.00, 7.50)	7.00 (6.00, 8.00)	
Discharge PACU NRS score, mean (SD)	3.36 (1.61)	3.86 (1.57)	0.18 ^a
Median (IQR)	4.00 (2.50, 4.50)	4.00 (3.00, 5.00)	
PACU opioid use (MME), mean (SD)	11.91 (8.50)	15.11 (9.92)	
Median (IQR)	10.00 (5.00, 18.30)	15.00 (7.50, 21.70)	0.19 ^b
Total opioid use (MME), Mean (SD)	37.86 (13.37)	42.67 (17.27)	0.19 ^a
Median (IQR)	38.00 (28.35, 48.30)	40.00 (30.80, 56.70)	
Total PACU time, mean (SD)	124.47 (67.01)	136.78 (52.48)	
Median (IQR)	97.00 (86.00, 142.00)	118.00 (101.00, 182.00)	0.09 ^b
Perceived postoperative increase in pain, <i>n</i> (%)			0.58 ^c
Yes	15 (45.45)	14 (38.89)	
No	18 (54.55)	22 (61.11)	
NRS score prior to perceived increase in pain, mean (SD)	3.67 (1.95)	4.57 (2.21)	0.25 ^a
Median (IQR)	3.00 (2.00, 5.00)	4.00 (3.00, 7.00)	
NRS score after perceived increase in pain, mean (SD)	6.13 (1.46)	7.57 (1.65)	0.019 ^a
Median (IQR)	6.00 (5.00, 7.00)	7.50 (7.00, 9.00)	

¹Two sample *t*-test.²Wilcoxon–Mann–Whitney test.³Chi-square test.**Table III. Comparison between LIA and non-LIA at baseline and over time from generalized linear mixed effect models**

Outcomes	Regression used	Comparison between LIA vs n-LIA		
		Estimate (95% CI) at baseline	P-value at baseline	P-value over time
NRS	Linear mixed effect model	Coefficient = -0.31, 95% CI = (-1.35, 0.73)	0.56	0.98
Satisfaction (very satisfied versus other)	Logistic mixed effect model	Odds ratio = 0.93, 95% CI = (0.26, 3.37)	0.97	0.97
Opioid consumption	Negative binomial mixed effect model	Coefficient = 0.77, 95% CI = (0.42, 1.43)	0.41	0.53

injection of 0.5% bupivacaine while the other group received a 20 ml periacetabular injection of 0.5% bupivacaine. During the closing stages, both groups received an additional 20 ml intra-articular injection of 0.5%

bupivacaine. The two different LIA groups had similar post-operative pain with the periacetabular group having improved pain at 30 min and 18 h compared with the intra-articular group [29]. The analgesic effect of

intra-articular or periacetabular LIA is difficult to quantify as no control group was included in the study design.

The authors of the present study published a retrospective case-control study in 2018, which compared the rate of post-operative femoral nerve blocks in hip arthroscopy patients who received an extracapsular LIA versus those with no injection. The LIA group had a 22% decrease in the rate of nerve blocks compared with controls ($P = 0.027$). This study was limited by its retrospective design and the lack of pain score data.

The limited study design of the previous research, as well as the variability in LIA technique employed, spurred the current prospective study of postoperative pain scores in hip arthroscopy patients who received extracapsular LIA. The findings of this study are concurrent with previous research suggesting that LIA reduces post-operative pain in hip arthroscopy patients.

The challenges and limitations of this study characterize some of the difficulties in using patient-reported pain as a primary outcome measure. Pain itself is multidimensional in nature. While the NRS 0-10 scale is useful in quantifying pain, it only measures a single dimension of pain and consequently may be an inadequate tool for fully characterizing and measuring patients' pain [9]. The measurement of this pain was carried out by many different members of the PACU staff leaving the data subject to measurement bias. Additionally, patients must be below a certain threshold of pain before meeting PACU discharge criteria; the incentive to have patients report pain below the discharge threshold to facilitate discharge may influence how pain measurements are reported by patients or gathered and recorded by clinicians. Other limitations include the surgeon being unblinded to the administration of LIA. Lastly, patients in the study were cared for by different anesthesiologists, creating further potential for variability in intraoperative and perioperative pain management.

This is the first randomized controlled trial studying extracapsular LIA versus no injection in hip arthroscopy. In this study, an injection of 20-ml of bupivacaine-epinephrine demonstrated improvements in patient reported PACU pain scores ($P = 0.009$), shorter PACU stays ($P = 0.09$) and less PACU opioid use ($P = 0.09$). While LIA offers an uncomplicated and low-cost approach to post-operative pain management, the clinical improvements regarding the MCID could be questioned and requires further scientific investigation.

ACKNOWLEDGEMENTS

This investigation was supported by the University of Utah Study Design and Biostatistics Center, with funding in part

from the National Center for Research Resources and the National Center for Advancing Translational Sciences, National Institutes of Health, through Grant 8UL1TR000105 (formerly UL1RR025764).

FUNDING

This work was supported by the LS Peery Foundation through grant [90371].

CONFLICT OF INTEREST STATEMENT

SKA is a consultant for Stryker Medical. TGM is a consultant for Arthrex.

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