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Peri-operative pain management in hip arthroscopy: a systematic review of the literature

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ABSTRACT

The purpose of this article was to review current literature on peri-operative pain management in hip arthroscopy. A systematic review of the literature on pain control in hip arthroscopy published January 2008 to December 2018 was performed. Inclusion criteria consisted of English language or articles with English translations, subjects undergoing hip arthroscopy with documented peri-operative pain control protocols in studies reporting Level I to IV evidence. Exclusion criteria were non-English articles, animal studies, prior systematic review or meta-analyses, studies not reporting peri-operative pain control protocols, studies documenting only pediatric (<18 years of age) patients, studies with Level V evidence and studies including less than five subjects. Statistical analysis was performed to assess pain protocols on narcotic consumption in PACU, VAS score on discharge, time to discharge from PACU and incidence of complications. Seventeen studies were included, comprising 1674 patients. Nerve blocks were administered in 50% of patients ($n = 838$ of 1674), of which 88% ($n = 740$ of 838) received a pre-operative block while 12% ($n = 98$ of 838) post-operative block. Sixty-eight complications were recorded: falls (54%, $n = 37$), peripheral neuritis (41%, $n = 28$), seizure (1.5%, $n = 1$), oxygen desaturation and nausea (1.5%, $n = 1$) and epidural spread resulting in urinary retention (1.5%, $n = 1$). No significant differences in narcotic consumption, VAS score at discharge, time until discharge or incidence of complication was found based on pain control modality utilized. No statistically significant difference in PACU narcotic utilization, VAS pain scores at discharge, time to discharge or incidence of complications was found between peri-operative pain regimens in hip arthroscopy.

INTRODUCTION

The use of hip arthroscopy for the treatment of patients with hip pathology has increased during the last two decades, with majority performed as outpatient procedures [1, 2]. While minimally invasive in nature, many patients report post-operative pain despite steady narcotic consumption [3–5]. Higher post-operative pain scores are associated with prolonged discharge times [6, 7] and unexpected hospital admission [8], resulting in increasing costs incurred by the patient and hospital [9]. Post-operative pain in the peri-operative period is of particularly concern as orthopedic procedures have the highest rate of unexpected hospital admissions and incidence of postoperative pain among surgical subspecialties in the setting of ambulatory surgery [5]. To date, the ideal peri-operative pain management protocol to effectively decrease pain scores, increase patient satisfaction, allow early mobilization and discharge following arthroscopic hip surgery remains largely unknown [1].

In the setting of the current opioid crisis, the use of multimodal pain control regimens has become an increasing focus in orthopedic procedures, including hip arthroscopy, to decrease post-operative narcotic consumption [10]. The causes of pain following hip arthroscopy are multifactorial and related to a combination of traction on the operative leg, capsulotomy, labral repair and osteochondroplasty [2, 6, 11, 12]. Moreover, the complex innervation of the hip joint and surrounding musculature make effective pain control difficult [13]. Current studies have examined the efficacy of peripheral nerve block administration, local injection analgesia, and use of adjunct medications in decreasing post-operative pain and narcotic consumption, while facilitating early discharge following hip arthroscopy [1, 2, 8, 12, 14–18]. However, no study has evaluated reported post-operative pain outcomes based on pain control regimen. The purpose of this investigation is to provide a comprehensive systematic review of the current literature on peri-operative pain management protocols in patients undergoing arthroscopic hip surgery. The authors hypothesized no significant differences in narcotic consumption, Visual Analog Scale (VAS) score at discharge or incidence of complication depending on pain regimen utilized.

MATERIALS AND METHODS

A systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines using a PRISMA checklist [19]. All literature pertaining to studies reporting on patients undergoing arthroscopic hip surgery with documented peri-operative pain management regimens published between January 2008 and December 2018 was identified. Two reviewers (J.G.K., D.M.K.) independently conducted a literature search in December 2018 using the following database: Biosis Previews, SPORTdiscus, PEDRO and EMBASE. Each search included the following terms: hip AND arthroscopy AND pain AND management AND nerve block AND analgesia AND outcomes.

Inclusion criteria consisted of English language or articles with English translations, subjects undergoing arthroscopic hip surgery with documented peri-operative pain control protocols in studies reporting Level I to IV evidence. Exclusion criteria were non-English articles, animal studies, prior systematic review or meta-analyses, studies not reporting peri-operative pain control protocols, studies documenting only pediatric (<18 years of age) patients, studies with Level V evidence and studies with less than five subject participants.

Following the 2 independent authors search of the literature a total of 180 citations were identified. The search process is shown in the flow diagram (Fig. 1). Following title and abstract evaluation, a total of 28 articles were selected for further evaluation. Of these studies, 11 studies were excluded due to systematic reviews ($n = 3$ studies), reporting on only pediatric patients ($n = 1$ study), studies not documenting pain control regimens ($n = 5$ studies), studies with <5 participants ($n = 2$). Following application of the inclusion/exclusion criteria, a total of 17 studies were identified for further analysis. To ensure that all available studies were identified, references cited in the included articles were cross-referenced for inclusion if they were overlooked during the initial search.

Patient sex and age at the time of surgery, pain management regimens, time from arrival to discharge from post-anesthesia care unit (PACU), VAS pain score at the time of discharge from PACU, and any complications occurring secondary to pain control interventions or medication were recorded. Narcotic consumption in the PACU was calculated based on morphine equivalents [20]. Unexpected hospital admissions due to poorly controlled pain in the immediate post-operative period were also documented. The impact on time to discharge from PACU, VAS score on discharge, PACU narcotic consumption and incidence of complications related to pain regimen was analysed based on: (i) performance of nerve block versus no nerve block, (ii) performance of pre-operative versus post-operative nerve block, (iii) site of nerve block (femoral nerve versus lumbar plexus versus fascia iliac compartment), (iv) performance of isolated nerve block versus nerve block + local analgesic injection versus isolated local injection versus use of only oral or intravenous narcotics. Due to the small size of included studies, Fischer's exact test was used to determine differences between two variables while a one-way analysis of variance was performed when three or more variables were analysed. A *P* values of <0.05 was used to determine statistical significance. All statistical analyses were performed using SPSS (Version 25.0, IBM, Armonk, NY, USA) software.

QUALITY ASSESSMENT OF INCLUDED EVIDENCE

The JADAD quality evaluation scale [21] was used to assess the quality of included randomized controlled trials. Studies were assigned a score based on the presence of certain domains (0 = not present, 1 = present and adequate, −1 = present but inadequate). Studies were graded as low quality if they scored 0–1 points, fair quality for 2–3 points or high-quality if they scored 4–5 points. The methodological index for non-randomized studies (MINORS) score [22] was used for non-randomized control trial studies which consists of 12 categories (non-comparative studies use only the first 8). Each category is scored out of two points for reported domains (0 = not reported, 1 = reported but inadequate, 2 = reported and adequate).

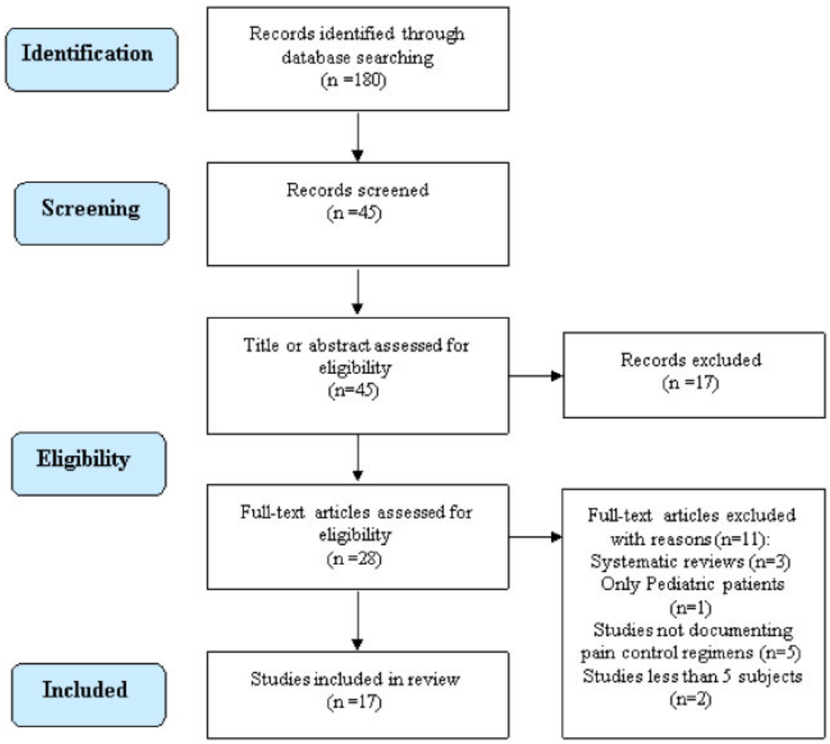

Fig. 1. Preferred reporting items for systematic reviews and meta-analyses (PRISMA) flowchart.

The max score therefore is 16 for non-comparative studies and 24 for comparative studies. An inter-class correlation coefficient was calculated between two authors (J.G.K., D.M.K.) to evaluate agreement between authors using quality appraisal scores. If a score discrepancy was greater than one point between the two authors, the study was evaluated and scored by the senior author (M.J.S.).

RESULTS

The current study includes a combination of blinded randomized control trials and retrospective/prospective cohort studies. In total, 17 articles were included in the present study: 8 randomized controlled trials [2, 11, 23, 24, 25, 27, 29, 30], 7 retrospective [8–10, 12, 14, 26, 28] and 2 prospective cohort studies [4, 16]. Level 1 evidence made up 47% ($n = 8$ of 17) of the included studies, Level 2 evidence comprised 6% ($n = 1$ of 17) of studies, Level 3 41% ($n = 7$ of 17) and Level 4 6% ($n = 1$ of 17). The mean JADAD score was 4.1 ± 0.6.and the mean MINORS Score was 17.6 ± 3.2 (Table I) The ICC between the two authors was 0.96, indicating excellent inter-observer agreement, while no study required consultation with the senior author due to score discrepancy of greater than one point.

The 17 studies meeting inclusion/exclusion criteria consisted of 1674 patients undergoing arthroscopic hip surgery (Table II). Mean patient age at the time of surgery was 34.7 ± 3.9 years. Males comprised 37% ($n = 617$) of patients, while patient sex was not reported in one study [12]. Mean PACU VAS pain scores at the time of discharge was 4.79 ± 2.04, while VAS scores were not reported in 14 studies [2, 8, 9, 11, 12, 14, 16, 23–29]. Mean time from arrival to discharge from the PACU was 143.6 ± 57.6 min and not reported in four studies [10, 11, 14, 16]. Mean reported post-operative narcotic utilization following surgery while in PACU was 10.9 ± 10.3 mg, while narcotic consumption was not reported in three studies [2, 16, 30].

Nerve blocks were performed in 50% of patients ($n = 838$ of 1674), of which 88% ($n = 740$ of 838) received a pre-operative block while 12% ($n = 98$ of 838) were administered following surgery. Blocks were administered to the: fascia iliaca compartment (29%, $n = 245$ of 838) [4, 9, 11, 16, 24, 28], femoral nerve (28%, $n = 233$ of 838) [2, 8, 10, 26], lumbar plexus (26%, $n = 219$ of 838) [12, 28, 29] and lumbar plexus + sciatic nerve (17%, $n = 141$ of 838) [14]. Blocks were performed either under ultrasound guidance or with the use of a nerve stimulator, with block localization not reported in two studies [14, 26]. Seven studies reported use of local injection analgesia

Table I. ***Methodology assessment scores of articles***

Study	*Assessment score #1*	*Assessment score #2*
Philippi *et al.* [26]	MINORS score: 13/24	MINORS score: 13/24
Purcell *et al.* [9]	MINORS score: 18/24	MINORS score: 18/24
Wolff *et al.* [28]	MINORS score: 16/24	MINORS score: 16/24
Baker *et al.* [23]	JADAD score: 4/5	JADAD score: 4/5
Childs *et al.* [10]	MINORS score: 20/24	MINORS score: 20/24
Dold *et al.* [8]	MINORS score: 17/24	MINORS score: 17/24
Kahlenberg *et al.* [25]	JADAD score: 4/5	JADAD score: 4/5
Schroeder *et al.* [12]	MINORS score: 18/24	MINORS score: 18/24
Jaffe *et al.* [14]	MINORS score: 18/24	MINORS score: 18/24
Krych *et al.* [16]	MINORS score: 12/16	MINORS score: 12/16
Shlaifer *et al.* [27]	JADAD score: 4/5	JADAD score: 4/5
Xing *et al.* [2]	JADAD score: 5/5	JADAD score: 5/5
Behrends *et al.* [24]	JADAD score: 4/5	JADAD score: 4/5
Zhang *et al.* [30]	JADAD score: 3/5	JADAD score: 3/5
Potter *et al.* [4]	MINORS score: 22/24	MINORS score: 22/24
Garner *et al.* [11]	JADAD score: 4.5/5	JADAD score: 4.5/5
YaDeua *et al.* [29]	JADAD score: 4/5	JADAD score: 4/5

intra-operatively, with injections provided to the intracapsular space ($n = 5$ studies) [10, 12, 23, 24, 27], extracapsular space ($n = 3$ studies) [11, 23, 26], or both intra-and extracapsular spaces ($n = 1$ study) [27]. Statistical analysis found no significant difference in consumption of narcotic pain medication in PACU, time until PACU discharge, VAS scores on discharge, or the incidence of complications based on pain control regimen (Table III). Time from PACU arrival to discharge was not significantly different in patients provided with femoral nerve blocks (mean, 166 min) compared with those receiving fascia iliac compartment (mean, 111 min) or lumbar plexus blocks (mean 189 min) ($P = 0.21$).

A total of 68 complications related to post-operative pain management interventions were reported in 5 studies. Reported complications included: falls (54%, $n = 37$ patients) [2, 10, 24, 29], peripheral neuritis (41%, $n = 28$ patients) [10], seizure (1.5%, $n = 1$ patient) [28], oxygen desaturation and nausea (1.5%, $n = 1$ patient) [29], and epidural spread resulting in urinary retention (1.5%, $n = 1$ patient) [29]. Eighty-four percent ($n = 31$ of 37) of falls occurred in patients receiving a peripheral nerve block, of which 81% ($n = 25$ of 31) of fall patients received a femoral nerve block [2, 10]. No reported falls required further operative intervention. A total of six patients were admitted following surgery due to poorly controlled post-operative pain [4, 8, 29]. No significant difference was appreciated between patients admitted for poorly controlled pain compared with patients discharged on the day of surgery based on patient age ($P = 0.60$), narcotic consumption in PACU ($P = 0.86$) or time from PACU arrival to discharge ($P = 0.57$).

DISCUSSION

A total of 50% of patients undergoing arthroscopic hip surgery received a peripheral nerve block, with the majority of patients undergoing pre-operative nerve blocks. No significant difference in narcotic consumption in PACU, time until PACU discharge, VAS score on discharge or incidence of complications related to peri-operative pain management was appreciated based on pain control regimen. Patients treated with femoral nerve blocks had higher rate of falls post-operatively compared with fascia iliaca compartment blocks or lumbar plexus blocks. To our knowledge, this investigation represents the largest collection of studies evaluating the impact of peri-operative pain control regimens on outcomes following arthroscopic hip surgery (Table IV).

Nerve blocks were utilized as part of the pain control regimen in 50% of patients undergoing hip arthroscopy. The use of selective nerve blocks have demonstrated good efficacy in controlling pain following hip fracture fixation, as well as total knee arthroplasty [31, 32]. One retrospective review found that patients who underwent pre-operative femoral nerve blocks prior to hip arthroscopy reported significantly lower pain scores 1 h following PACU arrival, required lower PACU morphine equivalent doses, and experienced no unexpected admissions due to poorly controlled pain compared with control patients not receiving femoral nerve blocks [8]. Another retrospective review found that patients who received a pre-operative lumbar plexus block in addition to standard intra-articular injection of morphine reported significantly reduced immediate and peak postoperative recovery pain scores, as well as decreased narcotic consumption post-operatively when compared with control patients [12]. As such, the utilization of selective nerve blocks has become increasingly common for the control of post-operative pain following hip

Table II. Summary of studies included in review

Author	*Journal*	*Level of evidence*	*Number of patients*	*Age (mean years)*	*Sex*	*Pre-operative block*	*Intra-operative local injection*	*Post-operative block*	*PACU morphine equivalents (mg)*	*Time until discharge (Min)*	*Post-operative pain at discharge (VAS)*	*Complications*	*Pre- versus post-procedure local injection analgesia*	*Localization for block*	*Procedures performed*
Philippi *et al.* [26]	*J Hip Preserv Surg* (2018)	3	50	25.47	14M 36F	NR	Extracapsular 20 ml 0.25% bupivacaine-epinephrine (1:200 000)	n=17 (FNB)	14.51	151.2	NR	NR	Post-procedure	NR	NR
			50	25.09	18M 32F	NR	None	n=28 (FNB)	14.08	139.8	NR	NR			
Purcell *et al.* [9]	*Knee Surg Sports Traumatol Arthrosc* (2018)	3	34	34.7	23M 11F	FICB 40 cc 0.25% plain Bupivacaine	NR	NR	32.53	110.6	NR	None	NA	US	NR
			34	32.4	15M 19F	FICB 266 mg liposomal bupivacaine+20 cc 0.5% plain bupivacaine	NR	NR	29.46	108.6	NR	None			
Wolff *et al.* [28]	*J Hip Preserv Surg* (2016)	3	55	34.51	18M 37F	None	NR	NR	7.02	108.6	NR	None	NA	US (FNB, LPB)+nerve stimulator for (LBP)	NR
			30	30.57	11M 19F	FICB 40 ml, 0.375% ropivacaine, 4 mg dexamethasone	NR	NR	8.8	112.2	NR	None			
			60	35.45	19M 41F	LPB 0.375% ropivacaine, 4 mg dexamethasone	NR	NR	7.16	111.5	NR	Seizure (n=1)			
Baker *et al.* [23]	*Hip Int* (2011)	1	40	37.8	26M 14F	NR	Intracapsular 10 ml of 0.25% bupivacaine	NR	0.57	48	NR	NR	Post-procedure	NA	Labral/chondral tissue debridement; MFX/osteoplasty
			33	38.8	17M 16F	NR	Extracapsular 10 ml of 0.25% bupivacaine	NR	2.33	48	NR	NR			
Childs *et al.* [10]	*Arthroscopy* (2017)	3	105	33.4	38M 67F	FNB 0.5% bupivacaine with 1:200 000 epinephrine	None	NR	10.425	NR	3.55	Peripheral Neuritis (n=26) Falls (n=19)	Post-procedure	US	Labral debridement/repair/reconstruction; synovectomy; femoral osteochondroplasty
			88	31.3	27M 61F	None	Intracapsular 300 mg ropivicaine (0.5%) with epinephrine, 30 mg ketorolac, and 5 mg morphine	NR	12.525	NR	4.28	Peripheral neuritis (n=2) Falls (n=5)			

(continued)

Table II. (continued)

Author	Journal	Level of evidence	Number of patients	Age (mean years)	Sex	Pre-operative block	Intra-operative local injection	Post-operative block	PACU morphine equivalents (mg)	Time until discharge (Min)	Post-operative pain at discharge (VAS)	Complications	Pre- versus post-procedure local injection analgesia	Localization for block	Procedures performed
Dold *et al.* [8]	*Am J Sports Med* (2014)	3	40	34.2	22M 18F	None	NR	NR	4	81.53	NR	Admission for pain (n=2)	NA	US	Femoral osteochondroplastyloose body removal; labral debridement
			56	33.1	37M 19F	FNB 15–25 ml, 0.33–0.75% ropivacaine	NR	NR	2.04	85.96	NR	None			
Kahlenberg *et al.* [25]	*Arthroscopy* (2017)	1	50	34.2	24M 26F	None	NR	NR	15.326	152.96	NR	None	NA	NA	Labral repair/debridement/reconstruction alone; revision labral repair; Labral repair with acetabular osteoplasty/chondroplasty; labral repair with femoral head chondroplasty
			48	35.8	19M 29F	None	NR	NR	15.419	172.96	NR	None			
Schroeder *et al.* [12]	*Hip Int* (2013)	3	118	41.1	NR	LPB 20–30 ml, 0.5% ropivacaine, 3 μg ml^{-1} epinephrine	Intracapsular 4 mg of morphine	NR	5	240	NR	NR	Post-procedure	Nerve stimulator	NR
			118	38.7	NR	None	Intracapsular 4 mg of morphine	NR	6.7	217.5	NR	NR			
Jaffe *et al.* [14]	*J Pain Palliat Care Pharmacother* (2017)	3	141	32.4	42M 99F	LPB+sciatic block	NR	NR	0	NR	NR	NR	NA	NR	NR
			36	38.2	8M 28F	None	NR	NR	40.05	NR	NR	NR			
Krych *et al.* [16]	*Knee Surg Sports Traumatol Arthrosc* (2014)	2	30	34	7M 23F	FICB 40 ml 0.25 % bupivacaine with 1:200 000 epinephrine	NR	NR	NR	NR	NR	None	NA	US	Labral repair; femoral osteochondroplasty; pincer resection
Shlaifer *et al.* [27]	*Arthroscopy* (2017)	1	21	39.6	14M 7F	None	Extracapsular 20 ml of bupivacaine 0.5% Intracapsular 20 ml of bupivacaine 0.5%	NR	3.15	123	NR	None	Pre- and post-procedure	NA	Labral repair/reconstruction; femoral/acetabular osteoplasty
			21	36	11M 10F	None	Intracapsular 20 ml of bupivacaine 0.5%	NR	7.23	213	NR	None			

(continued)

Table II. (continued)

Author	*Journal*	*Level of evidence*	*Number of patients*	*Age (mean years)*	*Sex*	*Pre-operative block*	*Intra-operative local injection*	*Post-operative block*	*PACU morphine equivalents (mg)*	*Time until discharge (Min)*	*Post-operative pain at discharge (VAS)*	*Complications*	*Pre- versus post-procedure local injection analgesia*	*Localization for block*	*Procedures performed*
Xing *et al.* [2]	*Am J Sports Med* (2015)	1	27	32	21M 6F	FNB 20 ml, 0.5% ropivacaine, 2.5 μg ml^{-1} epinephrine	NR	None	NR	246	NR	Falls (n=6)	NA	US	Labral repair; osteochondroplasty
			23	31	14M 9F	None	NR	None	NR	252.5	NR	None			
Behrends *et al.* [24]	*Anesthesiology* (2018)	1	38	35	23M 15F	FICB 40 ml ropivacaine 0.2%	Intracapsular 10 ml of 0.2% ropivacaine	NR	15	123	NR	Falls (n=4)	Post-procedure	US	Osteochondroplast; labral repair; loose body removal; screw removal; MFX; debridement
			40	32	17M 23F	None	Intracapsular 10 ml of 0.2% ropivacaine	NR	16	128	NR	Fall (n=1)			
Zhang *et al.* [30]	*Eur J Orthop Surg Traumatol* (2013)	1	27	41	11M 13F	None	NR	NR	NR	147	7.23	NR	NA	NA	NR
			26	43.5	14M 15F	None	NR	NR	NR	152	7.46	NR			
Potter *et al.* [4]	*Arthroscopy* (2014)	4	53	37.1	15M 38F	NR	NR	FICB 30 ml 0.25% bupivacaine with 5 mg ml^{-1} of epinephrine	4.4	102	2.8	Admission for pain (n=3)	NA	US	Femoral osteoplasty; labral repair; capsular repair; unlisted additional repair
			54	34.9	26M 28F	NR	NR	None	4.4	97	3.4	None			
Garner *et al.* [11]	*Arthroscopy* (2017)	1	20	33.6	14M 6F	None	Extracapsular 40 ml of 0.125% of levobupivacaine	NR	2.4	NR	NR	None	Post-procedure	US	Excision of CAM lesion; labral debridement/repair; removal of loose bodies; chondroplasty; MFX
			26	31.9	11M 15F	FICB 40 ml, 0.125% levobupivacaine	None	NR	5.5	NR	NR	None			
YaDeua *et al.* [29]	*Anesth Analg* (2012)	1	41	37	21M 20F	None	None	NR	29	187	NR	Oxygen desaturation (n=1) Admission for pain (n=1)	NA	Nerve stimulator	Labral debridement; labral/capsular repair; synovectomy; cam decompression; osteochondroplasty; pincer debridement; subspine decompression; rim decompression; psoas release; loose body removal
			41	33	20M 21F	LPB 30 ml, 0.25% bupivacaine, 5 μg ml^{-1} epinephrine	None	NR	2	216	NR	Epidural spread with urinary retention (n=1) Falls (n=2)			

GA, general anesthesia; FICB, fascia iliac compartment block; LPB, lumbar plexus block; FNB, femoral nerve block; LIA, local injection analgesia; CSE, continuous spinal epidural; PA, periacetabular; IA, intra-articular; NR, not reported; PACU, post-anesthesia care unit; VAS, visual analog score; NRS, numeric rating scale; SDCU, surgical day care unit; Min, minutes; mg, milligrams; MFX, microfracture; US, Ultrasound; NR, Not reported; NA, Not applicable.

Table III. Fischer's exact test and analysis of variables based on pain control modality

Pain control modality	P-*value*			
	Time admission to PACU discharge (min)	*PACU narcotic utilization (Meq)*	*VAS at PACU discharge*	*Complications*
Nerve block only versus no nerve block	0.89	0.75	0.1	0.3
Pre-operative nerve block versus post-operative nerve block	–	–	–	–
Nerve block only versus nerve block + LIA	0.58	0.85	–	–
LIA pre and post versus LIA post-procedure	0.62	0.28	–	0.24
LIA only versus LIA + nerve block	0.53	0.6	–	–
FNB versus LPB versus FICB block	0.21	0.16	–	0.17
Nerve block only versus nerve block + LIA versus LIA only	0.64	0.53	–	0.86
Nerve block only versus nerve block +LIA versus LIA only versus narcotics only	0.74	0.35	–	0.75

LIA, local injection analgesia; FNB, femoral nerve block; LPB, lumbar plexus nerve block; FICB, fascia iliac compartment block; Meq, narcotic use based on calculated morphine equivalents; VAS, visual analog score; PACU, post-anesthesia care unit.

*Statistical significance.

arthroscopy. The current investigation found that patients treated with FICB (mean 111 min) experienced shorter times to discharge when compared with FNB (mean 166 min) and LPB (mean 189 min). While not statistically significant, the shorter PACU stay times for FICB blocks could result in decrease hospital costs. A recent analysis on operating room and PACU cost found that PACU operations were ∼$12.14 per minute for services offered [33]. Thus, hospital costs could be theoretically decreased with shorter PACU stays based on the type of nerve block provided. However, in order to delineate these cost savings and benefits, future studies examining different outcome variables based on types of nerve blocks performed for hip arthroscopy are warranted.

Local analgesia alone or when administered with nerve blocks was not found to significantly change post-operative pain outcomes. Local injections are generally provided to effectively control localized pain and supplement the anatomical areas missed by peripheral nerve blocks, specifically the hip capsule. Difficulty in controlling pain from the hip capsule occurs as a result of its complex innervation from the network of surrounding nerves: the anterior and medial capsule being innervated by the femoral and obturator nerves while the posterior and lateral capsule are innervated by the sciatic, superior gluteal and nerve to quadratus femoris [13]. One randomized control trial reported that patients treated with local analgesia to the hip capsule versus FICB nerve blocks had significantly lower PACU pain scores, hypothesizing that the innervation provided by the sciatic, superior gluteal and nerve to quadratus femoris to the hip capsule were not treated using an FICB block [11]. The same study also proposed that local analgesia injections diffuse outside the portal tracts, thereby more completely anesthetizing the hip capsule/joint [11]. Moreover, the concentration of diffused local anesthetic effectively block the fibers responsible for pain, lacking the potency to block motor fibers, decreasing fall risks [11]. Other investigations have similarly reported that FICB as well as FNB do not affect nerves from the sacral plexus innervating the hip capsule, leading to continued hip pain with the potential for admission for pain control [4, 9, 28]. When compared with extra-capsular injection, one study reported that intra-capsular injections have been shown to result in significantly lower morphine requirements in the immediate post-operative period [23]. The authors further hypothesized that a combination of intra-articular and portal local injection analgesia to be optimal for post-operative pain control [23].

While no differences in the incidence of complications were reported based on pain regimen, peripheral nerve

Table IV. Mean values based on pain control modality utilized

Pain control modality	*Mean time admission to PACU discharge (min)*	*Mean PACU narcotic utilization (Meq)*	*Mean VAS at PACU discharge*	*Mean number of complications*
Nerve block only	137	11.7	3.18	5
No nerve block	142	11.6	5.59	0.75
Nerve block (FNB, LBP or FICB)	146	10.2	3.18	4.92
Pre-operative nerve block	150	10.7	3.55	5.34
Post-operative nerve block+	102	4.4	2.80	0
Nerve block + LIA	181.5	10	–	4
LIA post-procedure	137	8.75	3.92	9.5
LIA pre- and post-procedure	168	5.19	–	0
LIA only	130	6.36	4.28	1.60
FNB	166	6.23	3.55	17
LBP	189	3.54	–	2
FICB	111	15.9	2.8	0.57
Narcotics only	150	16.5	6.03	0.14

LIA, local injection analgesia; FNB, femoral nerve block; LPB, lumbar plexus nerve block; FICB, fascia iliaca compartment block; Meq, narcotic use based on calculated morphine equivalents; VAS, visual analog score; PACU, post-anesthesia care unit; +, denotes single study.
*Statistical significance.

blocks and local anesthesia injections each carry the potential for complications. Falls remains a significant area of concern following peripheral nerve blocks in hip surgery due to muscle weakness and neuraxial spread [10, 24, 29]. One retrospective review reported that patients receiving femoral nerve blocks had over 3× the fall risk and 14× the risk for post-operative neuropathy when compared with local injection anesthesia [10]. Meanwhile, intra-articular injections possess the potential for chondrotoxic effects, with one study reporting that a single intra articular injection of bupivacaine into the knees of rat subjects resulted in a 50% decrease in chondrocyte density compared with saline-injected rat knees after 6 months [34]. As such, post-operative precautions must be taken into consideration in patients undergoing utilization of nerve blocks for pain control following hip arthroscopy.

The current study is not without limitations. Due to the heterogeneity and variability of data reporting post-operative pain regimen, the authors utilized surrogate metrics to standardize data to allow for pooled analysis. Moreover, there remains a lack of a standardized reporting measures to evaluate post-operative pain outcomes following arthroscopic hip surgery. Due to limited reported data, the authors were unable to determine differences in outcomes based on the performance of pre-operative versus post-operative nerve blocks or outcomes based on pre-procedural versus post-procedural intra-operative local injection analgesia. As the arthroscopic procedures performed within the hip were not regularly reported nor were outcomes based on procedures performed explicitly reported, the authors were unable to conduct any sub-analysis based on the number and type of arthroscopic procedures performed within the hip. Patients who underwent revision surgeries and those with a history of chronic opiate or narcotic abuse/use were not explicitly excluded in all of the chosen articles, which may alter post-operative outcome scores when compared with primary surgery patients and opiate naive patients. In addition, due to heterogeneity of the reported data, the authors were unable to perform any meaningful statistical analysis on pre-operative non-narcotic medication regimens.

In moving forward, the treatment of peri-operative pain following hip arthroscopy will require further investigation using a multiple modal pain control protocol given the complex innervation of the hip capsule and surrounding tissue. Determining the optimal pain protocol will involve providing appropriate sensory anesthesia for pain control while preserving motor function to prevent the incidence of falls and other associated injuries in the acute postoperative period. The senior author's institution has implemented a novel opiate sparing pain protocol for peri-operative pain control following arthroscopic hip surgery that includes non-narcotic preoperative pain medications (acetaminophen, celecoxib, neurontin); preoperative ultrasound-guided pure sensory transversalis fascia plane block performed by a fellowship-trained anesthesiologist; the use of both intra capsular and portal site local injection analgesia; muscle relaxer to combat spasms; and the use of anti-inflammatory postoperative pain medication with minimal postoperative narcotics utilization. Further prospective studies utilizing a combination of peripheral nerve block, peri-operative and postoperative pain control with minimal use of narcotics are necessary to help better understand the best methods of treating the complex series of pain generators activated following hip arthroscopy.

In conclusion, no statistically significant difference in PACU narcotic utilization, time to discharge, VAS pain scores at discharge or incidence of complications was appreciated when comparing different peri-operative pain regimens following hip arthroscopy in the present study. Further research and standardization of pain control regimens is required to determine the best protocol for the treatment of postoperative pain during the peri-operative period to optimize patient satisfaction, allow early mobilization and decease number of pain-related complications.

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CONFLICT OF INTEREST STATEMENT

None declared.

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