



# Local Infiltration Analgesia for Postoperative Pain Control following Skin Crease “Bikini Incision” Anterior Total Hip Arthroplasty for Neglected Femoral Neck Fractures: A Double-Blinded Randomized Control Trial

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## ABSTRACT

**Background.** The incidence of femoral neck fractures continues to increase along with the rise of the elderly population, and in the Philippines, a significant number have become neglected. Total hip arthroplasty (THA) is the treatment of choice for previously healthy and active patients. Local infiltration analgesia is a known adjunct for postoperative pain control, but its effects for THA via the “bikini incision” anterior approach are yet to be established.

**Objective.** The study primarily aims to determine the effectiveness of local infiltration anesthesia using bupivacaine (as compared to placebo) in reducing acute post-operative pain in adult patients who have undergone THA for a neglected femoral neck fracture via the skin crease “bikini incision” anterior approach.

**Methodology.** Forty-two patients (21 per treatment arm) aged 50–80 who underwent THA via the said approach were included in a double-blinded randomized control trial (RCT). Modified d’Aubigné-Postel score, pain control on the first two postoperative days, and length of hospital stay were the measured outcomes. Independent Sample T-test, Mann-Whitney U test, and Fisher’s exact/Chi-square test were used to determine the differences in mean, rank, and frequency, respectively, between the two groups. Null hypotheses were rejected at 0.05  $\alpha$ -level of significance.

**Result.** On postoperative day one, the local infiltration anesthesia group had a higher Modified d’Aubigné-Postel median score compared to the placebo group (14 vs. 12,  $p = 0.026$ ). Day one median NRS was also slightly lower versus the placebo group (3 vs. 4,  $p = 0.032$ ). On day two, NRS scores decreased for both groups, and the difference between the groups was not statistically significant (1 vs. 2,  $p = 0.203$ ). The number of rescue doses on both days and the length of hospital stay were not significantly different for both groups. No adverse effects were recorded.

**Conclusion.** Statistically, local infiltration anesthesia reduces pain only on day one after THA via the anterior “bikini incision” approach for neglected femoral neck fractures. However, clinically, no significant differences in functional and pain scores were observed between the groups. Therefore, local infiltration anesthesia cannot be routinely recommended for post-operative pain management in this population.

**Keywords.** bikini incision, direct anterior approach, total hip arthroplasty, neglected femoral neck fracture, local infiltration analgesia, bupivacaine

## INTRODUCTION

### Incidence of femoral neck fractures

In the coming years, with the increasing number of the elderly population, the number of fragility fractures is also expected to rise. Globally, the population of people aged 60 and above is expected to almost double from 12% in 2015 to 20% in 2050. The lifetime risk for fragility fractures is especially high among Asians at 40%, similar to that of coronary heart disease. Of particular interest, hip fracture cases are projected to increase to as many as 6.26 million cases by 2050.<sup>1</sup>

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Femoral neck fractures in the elderly should be treated urgently, ideally within 48 hours of admission, to prevent major complications. According to Roshan et al., the odds ratio of mortality increased by 1.27 for a 24-hour delay in surgery.<sup>2,3</sup>

However, given the socioeconomic status of patients seen in a Philippine tertiary government institution and the lingering effects of the global COVID-19 pandemic, a significant number of femoral neck fractures became neglected.

### Neglected femoral neck fractures

Literature is scarce because developed countries can treat neglected femoral neck fractures in a more timely and ideal setting. Developing countries like the Philippines, on the other hand, have more patients who receive delayed management for different reasons—financial, geographic, poor health-seeking behaviors, or simply a lack of information regarding these injuries.

An acceptable definition was proposed by Jain in 2015, describing a “neglected femoral neck fracture” as a femoral neck fracture for which 30 days or more have elapsed from the time of injury to the time of first medical consultation.<sup>4</sup> These patients present with shortened, severely externally rotated lower extremities, superiorly displaced greater trochanters, with varying amounts of soft tissue contracture. Main complications include avascular necrosis (AVN) of the femoral head, non-union, and even increased mortality rates. Given their non-ambulatory status, a significant number of these patients also experience functional decline secondary to generalized deconditioning. The treatment of choice for these neglected femoral neck fractures in the previously active, independent elderly patient with good pre-injury status is still total hip arthroplasty (THA).<sup>4</sup>

### Local data: Total Hip Arthroplasty (THA) in the Philippine Orthopedic Center (POC)

In the POC, femoral neck fractures constitute 43–46% of patients who underwent primary THA in the adult orthopedic service from 2018–2020, even at the onset of the COVID-19 pandemic (Figure 1). In 2018 alone, 58 cases of

neglected femoral neck fractures were treated with primary THA; in 2020, despite difficulties with lockdown restrictions and temporary cessation of elective surgeries, 27 cases were treated and still comprised the majority of THA cases. Following in 2<sup>nd</sup> and 3<sup>rd</sup> were cases of degenerative osteoarthritis secondary to dysplastic hip and AVN, respectively.

### Anterior approach THA: skin crease “bikini incision”

Given the need to perform THA for neglected femoral neck fractures in the active elderly population, various approaches have been done through the years. Gaining attention in the field of hip arthroplasty is the skin crease or “bikini incision” for the anterior approach THA. The technique was pioneered by Leunig et al in 2012, and the results of their initial study showed better aesthetic appearance (shorter, narrower scars) and decreased risk of dislocation (3.1% vs. 6.9% in the posterior approach).<sup>5</sup> Moreover, functional scores (WOMAC, Oxford hip, and UCLA activity scale scores), the incidence of lateral femoral cutaneous nerve (LFCN) hypoesthesia, operating time, blood loss, and average cup inclination were all comparable with that of the standard anterior approach.

### Local Infiltration Analgesia (LIA) as an adjunct for post-operative pain management in THA

Treatment does not end after prosthesis implantation. Control of postoperative pain expedites recovery and improves outcomes.<sup>6</sup> Inadequate pain control has translated to delayed mobilization and rehabilitation, sleep disruption, cognitive dysfunction, increased patient anxiety, increased length of stay, and decreased overall patient satisfaction. The current standard of care usually includes a combination of opioids and non-steroidal anti-inflammatory drugs (NSAIDs) as recommended by Anesthesiology, coupled with an early Rehabilitation protocol. Aside from these, however, there is no universal protocol for adjunctive treatment.

In a meta-analysis of 27 articles, Zhao et al showed that multimodal pain management is effective in post-THA and post-total knee arthroplasty (TKA) patients. One of the modalities highlighted was local infiltration analgesia (LIA),

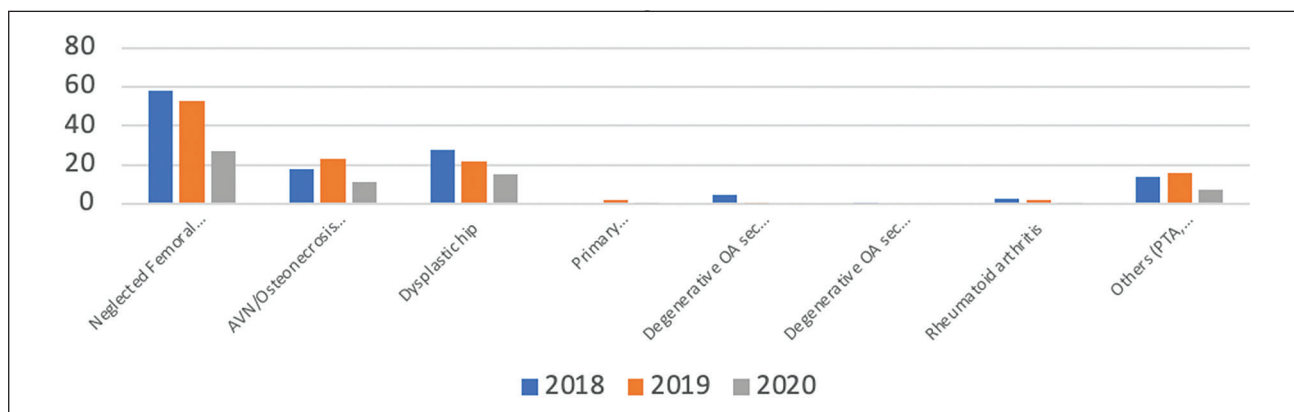


Figure 1. Indications for Primary THA in the POC Adult Orthopedics Service, 2018-2020.

which relieves pain, improves range of motion (ROM), shortens the length of stay, decreases opioid consumption, and promotes early mobilization.<sup>6</sup>

LIA as an adjunct therapy for hip and knee arthroplasty was first reported by Kerr in 2008, in a case series of 325 post-THA/TKA/hip resurfacing patients. The original mixture for LIA comprised ropivacaine (Naropin) 2.0 mg/mL, ketorolac (Toradol) 30 mg, and epinephrine 10 ug/mL.<sup>7</sup> The concoction was diluted with 0.9% normal saline to achieve a volume of 150 to 200 mL (depending on the weight). The solution was equally distributed in three different locations during surgery, namely: 1) around the acetabular rim after insertion of the acetabular component; 2) into the external rotators, gluteus tendon, and iliotibial band after insertion of the femoral component; and 3) into the subcutaneous tissues under the wound before skin closure.

No adverse events were seen attributable to the LIA, and pain scores were generally at 0 to 3/10 at rest and while walking. Moreover, no patients required morphine after day one and all patients were discharged after a single overnight stay, suggesting that LIA can potentially be used as an adjunct to achieve adequate postoperative pain control.<sup>7</sup>

More than a decade later, Tan published a randomized control trial (RCT) which used LIA for patients who underwent THA using the anterior approach. They used ropivacaine alone and distributed the anesthetic (or the 0.9% saline for the placebo group) in two planes.<sup>8</sup>

Results of their study showed no statistically or clinically significant difference in the median quality of recovery score on day one post-op, no significant difference in worst pain scores, opioid consumption, and time to mobilization, and there were no local anesthetic toxicity complications for either group.<sup>8</sup> They concluded that perhaps anterior THA was an inherently less painful procedure compared to the other approaches, hence the short-acting effect of pure ropivacaine was not detectable. It is unclear, however, what the results would have been if the LIA was prepared as described by Kerr.

### Local anesthetics: general information, additives, toxicity

Local anesthetics cause anesthesia and analgesia by blocking pain sensation along the nerve fibers. This is achieved by targeting voltage-gated Na<sup>+</sup> channels, and their effect can be increased by epinephrine, opioids, and alpha 2-adrenergic agonists. Epinephrine is a vasoconstrictor that prolongs the local anesthetic block in a dose-dependent manner, increases the intensity of the block, and decreases systemic absorption. Opioids work through synergistic analgesia, which also enhances and prolongs the local anesthetic block.<sup>9</sup>

The rate of systemic absorption and peak plasma level are directly proportional to the dose of local anesthetic in a nearly linear relationship. Treatment options for systemic

effects are generally supportive, starting with oxygenation and ventilation, followed by anti-seizure medications (for neurologic complications), and lastly, intravenous infusion of lipid emulsion (for cardiovascular events).<sup>9</sup>

### Local anesthetics: bupivacaine vs. ropivacaine

While ropivacaine has been widely used, bupivacaine has not been reported for LIA. Ropivacaine is not readily available in our tertiary government hospital in the Philippines, but a similar drug in its class, bupivacaine, is a staple in most pharmacies along with lidocaine.

According to Barash et al., bupivacaine and ropivacaine have the same potency on peripheral nerves (3.6). Both local anesthetics also have a fast onset of action and comparable durations (2–8 hours for bupivacaine vs. 2–6 hours for ropivacaine). Bupivacaine, however, has a slightly higher relative potency for central nervous system toxicity (4.0 vs. 2.9 in ropivacaine), which can be avoided by administering appropriate weight-based doses. In adults, the recommended maximum single dose for bupivacaine is 175 mg but increases to 225 mg with epinephrine, while the maximum single dose for ropivacaine is 200 mg.<sup>9</sup>

Jacob et al. tested lidocaine, bupivacaine, and ropivacaine in terms of efficacy for pain control and their effects on chondrocytes. While analgesic effects were equal, ropivacaine was the least toxic to chondrocytes. This is perhaps another reason why previous studies opted for ropivacaine for LIA.<sup>10</sup>

### Functional outcome: Modified d'Aubigné-Postel Score

Lastly, to measure the functional outcomes of post-operative patients in the study, the Modified d'Aubigné-Postel Score was assessed 24 hours postoperatively (Table 1). The original scale was developed in 1954 for post-hip arthroplasty patients, and it was modified in 1986. The scores from each parameter (pain, ambulation, and range of motion) are added to provide an overall score, with the clinical interpretation as follows: *18 Excellent, 15–17 Good, 12–14 Fair, and 3–11 Poor*. Aside from its simplicity, this score was also chosen because it focused on the key goals of arthroplasty—pain relief, improved mobility, and walking ability.<sup>11</sup>

**Table 1.** The Modified d'Aubigné-Postel Score

Score	Pain	Ambulation	Range of motion (%)
6	No pain	Normal	95–100
5	Slight or intermittent	No cane, but slight limp	80–94
4	Pain after ambulation, but disappears	Long distances with cane or crutch	60–79
3	Moderately severe, permits ambulation	Limited, even with support	40–59
2	Severe with ambulation	Very limited	20–39
1	Severe, prevents ambulation	Bedridden	0–19

## Relevance/Rationale

With the increasing prevalence of femoral neck fractures brought about by the growing population of active elderly patients, the number of total hip arthroplasties will continue to rise. In a government tertiary hospital in the Philippines, a significant number of these cases will inevitably be neglected. As arthroplasty surgeons aim to bring these patients back to their pre-injury status, total hip arthroplasties will be chosen more often. In line with this, adequate post-operative pain control helps patients mobilize earlier and recover faster.

Moreover, there are currently no studies on alternative local anesthesia agents, particularly bupivacaine, which is more readily available. The outcomes and differences with ropivacaine, if there are any, would contribute new information in this field as well.

## OBJECTIVES

### General objective

The study primarily aimed to determine the effectiveness of LIA (as compared to placebo) in reducing acute postoperative pain in adult patients who underwent THA for a neglected femoral neck fracture via the skin crease “bikini incision” anterior approach.

### Specific objectives

Specifically, the study aimed to determine the relationship between the use of intraoperative LIA in skin crease “bikini incision” anterior THA for neglected femoral neck fractures and the following:

1. Modified d'Aubigné-Postel scores – measured on day one post-operative<sup>7,8</sup>
2. Pain control on day one post-operative (measured with the NRS and number of rescue doses of pain meds)
3. Pain control on day two post-operative (measured with the NRS and number of rescue doses of pain meds)
4. Length of hospital stay (number of days from the end of surgery to discharge)

## METHODOLOGY

### Research design and sampling method

The study was a double-blinded randomized control trial (RCT) following the CONSORT 2010 checklist and flow-chart, in which neither the patient nor the primary surgeon/surgical team were informed regarding the group the patient was randomized into. The patients aged 50–80 years old, weighing more than 50 kg, who underwent unilateral THA via the skin crease anterior approach by a single surgeon for a neglected femoral neck fracture (defined as a femoral neck fracture for which surgery was done 30 days or more from the time of injury) were included in the study. All surgeries were done by a single surgeon assisted by an arthroplasty fellow and several orthopaedic residents. Convenience sampling was

done as patients were consecutively recruited as they were seen in the Adult Orthopedics Outpatient Department. The study underwent review and was approved by the institution's Ethics Review Board (ERB) before data was gathered.

### Definition of exposure and outcome

The treatment (exposure) group received LIA (3 ampules of bupivacaine isobaric 50 mg/amp, 1 ampule of ketorolac 30 mg/amp, and 1 ampule of epinephrine 1 mg/amp diluted with 170 mL of 0.9% saline). All formulations were safely within the maximum dose of bupivacaine (225 mg with epinephrine). The placebo (control) group was given 200 mL of 0.9% saline only. The outcome measures were as follows:

1. Modified d'Aubigné-Postel scores – measured on day one (24 hours postoperatively)
2. Pain control on postoperative day one – measured using the numerical rating scale (NRS) and number of rescue doses of pain meds taken within the first day
3. Pain control on postoperative day two – measured with the NRS and number of rescue doses of pain meds taken within the second day
4. Length of hospital stay – defined as the number of days from the end of surgery to discharge

### Inclusion and exclusion criteria

All patients aged 50–80 years old, weighing more than 50 kg, who underwent unilateral total hip arthroplasty (THA) via the skin crease “bikini incision” anterior approach for neglected femoral neck fractures, and who were active and mobile pre-injury (independent community ambulators with or without assistive devices) were included in the study. Exclusion criteria were the following: history of prior hip surgery on the ipsilateral hip, ipsilateral knee and/or spine pathology (e.g., arthrodesis), patients who had limited ambulation pre-injury, major medical comorbidity with high-risk for intra- or postoperative complications (e.g. cardiovascular disease, chronic liver disease, or chronic kidney disease), patients who needed to undergo peripheral nerve blocks pre- and post-operatively, patients with known allergies to bupivacaine and/or NSAIDs, and patients diagnosed with chronic regional pain syndrome (CRPS).

### Data gathering and sample size computation

#### Sample size computation

Using G\*Power 3.1.9.2, a computed minimum sample size of 42 patients were required for this study based on the desired large (0.90) effect size between patients under LIA and placebo in terms of any of the study outcomes. This computation also accounted for a 5% level of significance and 80% power. Participants were equally allocated for both the treatment group and placebo group, with 21 patients in each arm.

At the time of calculating the sample size, no existing studies compared LIA with placebo in terms of Modified d'Aubigné-Postel scores, pain control, and length of hospital

stay. Given this limitation, the statistician and author made an informed assumption for the effect size (0.90) based on clinical experience and analogous studies in similar contexts. This estimate was intended to be as close as possible to what is observed in actual clinical practice.

The choice of an effect size of 0.90 and a power of 80% was a pragmatic decision, balancing the need for statistical accuracy with the practicalities of the study design. While the sample size of 42 may appear small, it was determined based on the best available estimates at the time, recognizing the need for further research to validate these findings on a larger scale.

### Pre-operative

Data was gathered via the convenience sampling method. Patients seen at the Adult Orthopedics Outpatient Department who met the inclusion criteria were recruited for the study and were informed that the study would be double-blinded. Informed consent was secured by either the researcher or the doctor-in-charge (DIC). Patients were admitted one to two days before surgery upon fulfillment of standard pre-operative requirements (e.g., cardiopulmonary and other necessary medical clearances, COVID testing, etc.). Pre-operative orders were standardized for all patients, which included the following medications:

1. Omeprazole 40 mg IV once on *nil per orem* (NPO)
2. Tranexamic acid 1 g IV every 12 hours for 3 doses starting 12 MN
3. Paracetamol 1 g IV every 6 hours

Medications needed for either the LIA or the placebo were ordered for all patients at the ward, so that they could be randomly allocated into either group upon arrival at the OR. Anesthesia service was also informed regarding the patient's participation and were blinded to the assigned treatment. The pre-induction medications were also standardized among all patients, as discussed with the anesthesia service. Lastly, a blank Data Collection Form was then attached to all participants' charts upon admission.

### Intraoperative

The following standard pre-induction medications (weight-dependent doses) were given upon arrival at the OR and after assessment of the initial vital signs:

1. Midazolam 0.5–1 mg IV, and
2. Fentanyl 0.25–50 mcg IV

The standard anesthesia for THA patients was neuraxial-spinal anesthesia (weight-dependent doses) with either of the following local anesthetics:

1. Bupivacaine 0.5% Heavy 16–18 mg, or
2. Bupivacaine 0.5% Isobaric 16–18 mg

The following adjuncts were also given alongside the spinal anesthesia:

1. Fentanyl 12.5–25 mcg and
2. Epinephrine 0.1–0.2 mg

Once the patient was induced at the OR, the following medications were given:

1. Cefazolin 2 g IV loading dose
2. Dexamethasone 4 mg IV

Before the surgery, the patient was assigned to either the LIA group or the placebo group using a table of random numbers from 01 to 42—if the patient was assigned to an even number, he/she was assigned to the LIA group; on the other hand, the patient was enrolled in the placebo group if an odd number was drawn. This information was disclosed only to the circulating nurse, scrub nurse, and the section chief resident (if the researcher was not physically present at the OR). The primary surgeon, the rest of the surgical team, as well as the anesthesiologists, were not informed about the patient's assignment. The patient's assignment was recorded by the researcher on a separate list and was not written on the data collection form to avoid bias from the doctor-in-charge upon data gathering at the ward.

The circulating and scrub nurses then prepared the appropriate solution. For the LIA group, the exact concoction used was a modification of Kerr's original treatment:<sup>7</sup>

1. Bupivacaine 0.5% isobaric 50 mg/amp, 3 ampules (total of 150 mg)
2. Ketorolac 30 mg/amp, 1 amp
3. Epinephrine 1 mg/amp, 1 amp

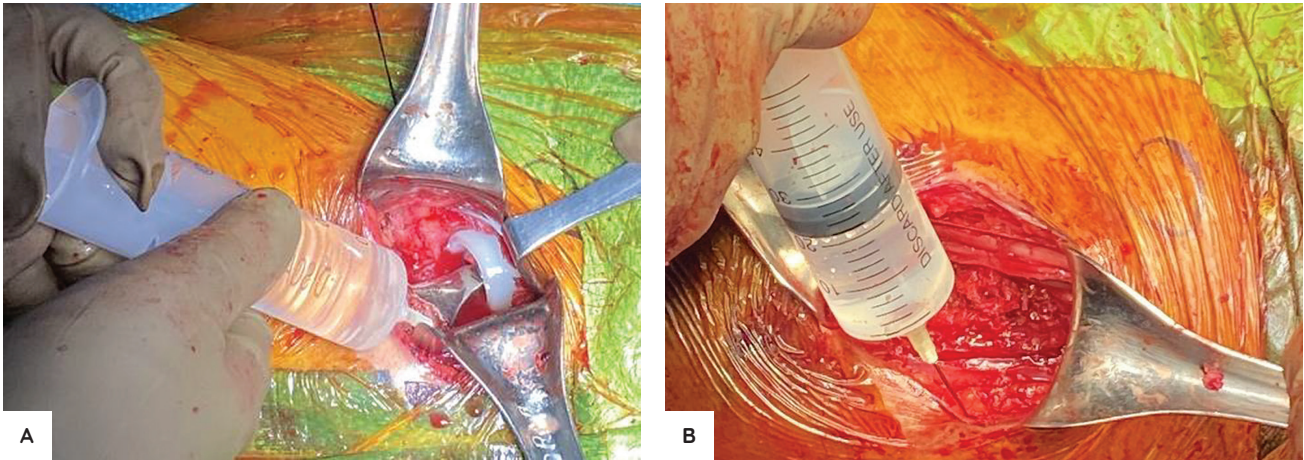
These components were then diluted with 0.9% saline to complete 200 mL in a kidney basin. On the other hand, for the placebo group, 200 mL of plain 0.9% saline was prepared. The infiltrate was prepared by the scrub nurse under the supervision of the researcher, section chief resident, and/or the circulating nurse, without disclosing the contents to the rest of the surgical team. Another circulating nurse confirmed the contents of the solution prepared by checking the ampules opened.

All surgeries then proceeded as in the routine fashion via the skin crease “bikini incision” anterior approach. After prosthesis implantation and with deep retractors still applied, the main surgeon requested the solution. Using a 50 cc syringe, a gauge 19 needle, and slow incremental injection with aspiration, half of the prepared solution (100 mL) was injected into muscles in the subfascial plane (tensor fascia lata, anterior border of gluteus medius, upper anterior border of the vastus lateralis, medially into adductors along the medial margin of the acetabulum, and rectus femoris) (Figure 2). The remaining half (100 mL) was infiltrated with multiple passes into the subcutaneous tissues after deep fascia closure. Routine closure of subcutaneous layers and skin with absorbable sutures and sterile staples, respectively, was done.<sup>8</sup>

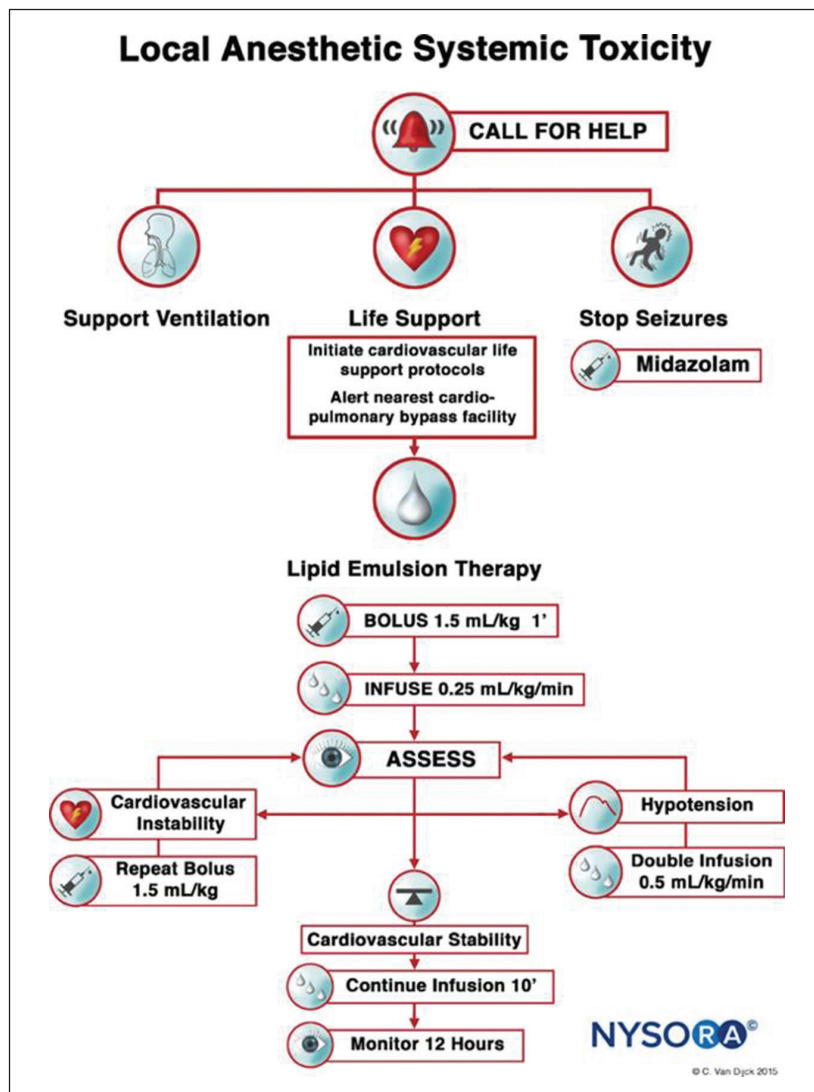
The New York School of Regional Anesthesia (NYSORA) treatment algorithm is the standard of care to treat local anesthetic systemic toxicity (LAST) detected intra-operatively (e.g., lightheadedness, tinnitus, oral numbness, seizures, unconsciousness, decreased sensorium, or cardio-respiratory depression/arrest as evidenced by unstable vital signs).

Adequate oxygenation, seizure cessation, and lipid emulsion therapy are the cornerstones of management.<sup>12</sup> In case of toxicity, the surgery would be suspended while treatment was being administered and continued once deemed safe by

the anesthesiologist, and monitoring would continue up to 24 hours postoperatively. The patient would also be referred to the cardiology and/or neurology services (depending on the patient's symptoms) (Figure 3).



**Figure 2.** Intraoperative images: infiltrating 100 mL of the solution into the subfascial plane (A), and the remaining 100 mL into the subcutaneous plane (B) before closure.



**Figure 3.** Algorithm for management of local anesthetic systemic toxicity.<sup>12</sup>

### Post-operative

Post-operative medications in the recovery room were standardized across all patients:

1. Cefazolin 1 g IV every 6 hours for 4 doses, then shift to co-amoxiclav 625 mg/cap, 1 cap every 8 hours for 14 days
2. Ketorolac 30 mg IV every 8 hours for 3 doses
3. Tramadol 50 mg IV every 6 hours for 3 doses
4. Paracetamol 1 g IV every 8 hours for the first 24 hours
5. Ondansetron 4 mg IV every 8 hours for nausea/vomiting

The standard opioid rescue medication for breakthrough post-operative pain was:

1. Tramadol 50 mg IV every 4–6 hours as needed for severe pain (pain scale/numerical rating score (NRS)  $\geq 4/10$ ) with a maximum dose of 400 mg/day, to be given within 15 minutes of the patient’s verbalization of severe pain

All patients were instructed on precautions to prevent anterior hip dislocation. In the post-anesthesia care unit (PACU), vital signs were monitored, the post-op site was inspected, and ambulation was initiated. Numerical rating score (NRS) was recorded by the nurses as part of the standard vital signs monitoring for all post-operative patients (every 15 minutes for 2–3 hours, then every 30 minutes for 1–2 hours, then every hour until the postoperative 24<sup>th</sup> hour). Any adverse reactions or symptoms of LAST were also monitored. Any allergic reactions were treated with antihistamines (Cetirizine 10 mg/tab, 1 tab PO) or Epinephrine 0.5 mg IM.

The Data Collection Form was filled up by the resident doctor-in-charge at the ward. The Modified d’Aubigné-Postel and NRS scores (average of the hourly NRS score for the first 24 hours) and the number of rescue doses received by the patient for breakthrough pain (i.e., Tramadol 50 mg IV, as detailed above) were recorded 24 hours postoperatively. The NRS score and number of rescue doses for breakthrough pain were again recorded on postoperative day two (postoperative 48<sup>th</sup> hour).

Lastly, the length of stay was recorded for each patient, defined as the number of days spent at the hospital from the end of the surgery until the time of discharge. Take-home medications were also standardized for all patients, as follows:

1. Co-amoxiclav 625 mg/cap 1 cap every 8 hours for 2 weeks
2. Paracetamol 500 mg/tab 2 tabs every 6 hours round-the-clock (RTC)
3. Tramadol 50 mg/tab 1 tab every 8 hours RTC
4. Etoricoxib 120 mg/cap 1 cap once a day as needed for breakthrough pain
5. Omeprazole 40 mg/tab 1 tab

Regular follow-ups were standardized at 1 week, 2 weeks, 1 month, 3 months, 6 months, and yearly post-operatively. No other data was collected during these follow-up visits to the Outpatient Department.

### Statistical tools

Descriptive statistics were used to summarize the demographic and clinical characteristics of the patients. Frequency and

proportion were used for categorical variables, median and interquartile range (IQR) for non-normally distributed continuous variables and mean and SD for normally distributed continuous variables. Independent Sample T-test, Mann-Whitney U test, and Fisher’s exact/Chi-square test were used to determine the difference of mean, rank, and frequency, respectively, between the LIA and Placebo groups. All statistical tests were two-tailed tests. Shapiro-Wilk test was used to test the normality of the continuous variables. Missing values were neither replaced nor estimated. Null hypotheses were rejected at 0.05  $\alpha$ -level of significance. STATA 13.1 was used for data analysis.

### RESULT

A total of 42 participants were included in the study, with a mean age of  $71.33 \pm 6.01$  years. Among the participants, 39 (92.86%) were female and 24 (57.14%) sustained a neglected femoral neck fracture on the left side. Among the demographic variables, no significant difference was noted between the two groups (Table 2). As for the medical and surgical profile of the patients, the majority of patients were hypertensive (71.43%) and 40.48% were diabetics. The majority of the patients had been operated on within 6 months of their injury (88.1%), and all implants were cementless total hip arthroplasty implants. Lastly, the surgeries lasted for a mean duration of  $82.67 \pm 6.79$  minutes. There was no significant difference between the two groups in terms of medical and surgical parameters ( $p > 0.05$ ) (Table 3).

In terms of the post-operative parameters, the main variables of interest were the Modified d’Aubigné-Postel score, NRS, and the number of rescue doses received by the patients on postoperative days one and two. Across both groups, the median Modified d’Aubigné-Postel score was 12 (IQR 11–14) out of the highest possible score of 18, which is interpreted as *Fair*.

While the median NRS differed by one point between the two groups (placebo NRS 4 vs LIA NRS 3), several participants under the placebo group had a higher average NRS on the first postoperative day (placebo IQR 3–6 vs. LIA IQR 2–4), and the  $p$ -value for the said variable was significant at 0.032, implying a significant difference between the two groups (Table 4).

Regardless of the treatment group, most patients (31) received 0–1 rescue doses of Tramadol within the first postoperative day. While 12 LIA patients received at least one rescue dose compared to 16 patients from the placebo group, there was no significant difference between the two groups ( $p = 0.582$ ) (Table 4).

On the second postoperative day, the NRS scores were generally lower compared to the previous day. The LIA group’s NRS score was still one point lower, but there was no significant difference between the two groups ( $p = 0.203$ ). The number of rescue doses requested on the second day also decreased. While two patients from the LIA group required

**Table 2.** Demographic and clinical profile of the patients

	Total (n = 42)	LIA (n = 21)	Placebo (n = 21)	P-value
	Frequency (%); Mean ± SD			
<b>Age, years</b>	71.33 ± 6.01	72.33 ± 5.85	70.33 ± 6.15	0.287
<b>Sex</b>				0.232
Male	3 (7.14)	3 (14.29)	0	
Female	39 (92.86)	18 (85.71)	21 (100)	
<b>Civil status</b>				1.000
Single	6 (14.29)	3 (14.29)	3 (14.29)	
Married	22 (52.38)	11 (52.38)	11 (52.38)	
Separated	1 (2.38)	0	1 (4.76)	
Widowed	13 (30.95)	7 (33.33)	6 (28.57)	
<b>Neglected femoral neck fracture</b>				1.000
Left	24 (57.14)	12 (57.14)	12 (57.14)	
Right	18 (42.86)	9 (42.86)	9 (42.86)	

**Table 3.** Medical and surgical profile of the patients

	Total (n = 42)	LIA (n = 21)	Placebo (n = 21)	P-value
	Frequency (%); Mean ± SD			
<b>Comorbidities</b>				
Hypertension	30 (71.43)	15 (71.43)	15 (71.43)	1.000
Diabetes mellitus	17 (40.48)	11 (52.38)	6 (28.57)	0.208
Dyslipidemia	10 (23.81)	5 (23.81)	5 (23.81)	1.000
Stroke/ CVA	4 (9.52)	3 (14.29)	1 (4.76)	0.606
<b>Time between injury to surgery</b>				1.000
≤6 months	37 (88.1)	18 (85.71)	19 (90.48)	
>6 months	5 (11.9)	3 (14.29)	2 (9.52)	
<b>Type of Anterior THA done</b>				1.000
Cementless	42 (100)	21 (100)	21 (100)	
Cemented	0	0	0	
<b>Duration of surgery, minutes</b>	82.67 ± 6.79	83.38 ± 7.06	81.95 ± 6.60	0.502

at least two rescue doses and no patient in the placebo group needed rescue doses on the second day, there was no significant difference between the groups ( $p = 0.855$ ) (Table 4).

All patients were discharged within three days after surgery with the majority being discharged after two days (57.14%) with no significant difference between the two groups ( $p = 0.729$ ) (Table 5). There was one report of a patient under the LIA group who had lightheadedness on postoperative day two. This patient had a total of six rescue doses of Tramadol within the admission, which is known to cause nausea/ dizziness/ lightheadedness in excessive doses. After discontinuing tramadol, the patient’s symptoms resolved. No adverse effect attributable to LIA was recorded throughout the study period.

## DISCUSSION

The demographic of our population was typical of patients who sustain femoral neck fractures. Females were also noted to comprise the majority of the participants (92.86%), reflecting the increased risk of osteopenia and fragility fractures in women as they become menopausal. The majority of patients also had other comorbidities such as hypertension and type 2 diabetes mellitus, which was not significantly different across both groups.

A minority of our patients ( $n = 5$ ) were operated on more than six months from the time of injury. This could be

attributed to the increasing accessibility of surgery across the country as COVID restrictions were lifted in 2023.

The study was able to determine the effectiveness of LIA (as compared to placebo) in reducing acute post-operative pain in adult patients who have undergone THA for a neglected femoral neck fracture via the skin crease “bikini incision” anterior approach.

In terms of functional scoring (Modified d’Aubigné-Postel score), patients in the LIA group had higher scores (14 vs. 12,  $p = 0.026$ ) compared to the placebo group. While statistically significant, clinically, both median scores are classified as *Fair*.<sup>11</sup> It is difficult to see whether an improvement of one parameter is directly attributable to the use of LIA. Other factors that may affect the functional score include the individual patient’s physiological age, pain tolerance, and time between injury and operation (Table 4).

In terms of the NRS or pain control on the first postoperative day, there was also a statistically significant difference between the LIA and placebo group, with the LIA group having a *lower* rating compared to the placebo group (3 vs. 4,  $p = 0.032$ ). This difference is also clinically not as significant since the NRS scores are close. Corollary to that, the number of rescue doses is similar between the two groups. Regardless of which group they were in, the majority of patients still did not need a rescue dose of Tramadol, showing that having LIA does not necessarily translate to decreased breakthrough

pain. In fact, two patients from the LIA group needed at least two rescue doses; no patients in the placebo group requested more than one rescue dose (Table 5). These findings were also consistent with the conclusions of Kerr and Tan.<sup>7,8</sup>

Across both groups, there was also a noticeable decrease in the NRS from day one to two. Several reasons are postulated for this gradual reduction in pain as a function of time. First, it is possible that the anesthetic effect of LIA was only effective for the first 24 hours, since bupivacaine as a standalone infiltrate is known to have a fast onset of action but a duration of only 2–8 hours (ropivacaine, on the other hand, lasts only 2–6 hours). Epinephrine is known to extend the local anesthetic block of most local anesthesia by counteracting its intrinsic ability to vasodilate vessels. Combined with bupivacaine, systemic absorption is reduced by 10–20%. Interestingly, most studies do not support the routine use of epinephrine with ropivacaine, which is the local anesthetic of choice for LIA in most literature.<sup>9</sup>

Second, all participants in the study (regardless of the group they belong to) typically start physical therapy several hours after surgery and are generally expected to stand and ambulate with a walker. Early initiation of physical therapy (PT) within the first few hours post-operatively is known to decrease post-operative pain and aid in earlier recovery. In a study by Kirkness et al, patients enrolled in an early start PT program (<9 weeks postoperatively) had significantly better pain scores and functional outcomes compared to their

late start (>9 weeks) counterparts.<sup>13</sup> Since the postoperative protocol was standardized for both groups, the PT sessions could have been a major contributor to the general decrease in NRS for both groups.

Third, the reduction in pain might be attributable to the direct anterior approach itself. In a retrospective cohort study by Seah et al, the direct anterior approach was associated with the least amount of post-operative opioid consumption in patients who underwent primary THA for osteoarthritis compared to the standard lateral (21% more opioid use) and posterior approaches (18.7% more opioid use). This was attributed to the anterior approach being a muscle-sparing approach, in which less inflammatory cytokines are released since no muscle groups are surgically disrupted and no tendons are detached. Repair of muscles or tendons associated with the posterior and lateral approaches also causes further post-operative pain as these structures are placed in tension once patients start physical therapy.<sup>14</sup>

Lastly, the study conducted a comparative analysis rather than an association study, hence, testing for confounders was not part of the original analysis plan. However, the researcher acknowledges that certain factors, such as individual pain tolerance, psychological variables, duration from injury to surgery, access to rescue doses, and early postoperative rehabilitation protocol for both groups could have potentially influenced the outcomes. While these factors are challenging to quantify and were not explicitly controlled for in this study,

**Table 4.** Post-operative parameters of the patients

	Total (n = 42)	LIA (n = 21)	Placebo (n = 21)	P-value
	Frequency (%); Median (IQR)			
<b>Day 1 Post-operative</b>				
<i>Modified d'Aubigné-Postel score</i>	12 (11 to 14)	14 (12 to 14)	12 (10 to 13)	0.026
<i>NRS</i>	4 (3 to 5)	3 (2 to 4)	4 (3 to 6)	0.032
<i>Number of rescue doses</i>				0.582
None	15 (35.71)	9 (42.86)	6 (28.57)	
1 rescue dose	16 (38.1)	6 (28.57)	10 (47.62)	
2 rescue doses	8 (19.05)	4 (19.05)	4 (19.05)	
3 rescue doses	3 (7.14)	2 (9.52)	1 (4.76)	
<b>Day 2 Post-operative</b>				
<i>NRS</i>	2 (1 to 3)	1 (1 to 2)	2 (1 to 4)	0.203
<i>Number of rescue doses</i>				0.855
None	30 (71.43)	14 (66.67)	16 (76.19)	
1 rescue dose	10 (23.81)	5 (23.81)	5 (23.81)	
2 rescue doses	1 (2.38)	1 (4.76)	0	
3 rescue doses	1 (2.38)	1 (4.76)	0	

**Table 5.** Clinical outcomes of the patients

	Total (n = 42)	LIA (n = 21)	Placebo (n = 21)	P-value
	Frequency (%)			
<b>Length of hospital stay, days</b>				
1	4 (9.52)	1 (4.76)	3 (14.29)	0.729
2	24 (57.14)	13 (61.9)	11 (52.38)	
3	14 (33.33)	7 (33.33)	7 (33.33)	
<b>Adverse effects</b>				
Neurologic	1 (2.38)	1 (4.76)	0	1.000
Cardiovascular	0	0	0	-
Respiratory	0	0	0	-
Allergic	0	0	0	-
Others	0	0	0	-

they are important clinical considerations in the evaluation of LIA.

As for the safety profile of bupivacaine, no adverse effects were noted in any of the participants of the study. One case of lightheadedness was reported, however, in a participant from the LIA group (Table 5). On further analysis, the symptoms could be attributed to the fact that the patient had a total of six rescue doses of Tramadol, which is known to have nausea as an adverse reaction. The specific reason behind the high number of rescue doses was not elucidated. The rest of the participants in the LIA group did not report any adverse effects, which could help support bupivacaine as an effective and safe alternative to ropivacaine.<sup>10</sup>

For all participants in the study, discharge criteria included good pain control, the ability to stand and ambulate with a walker, restoration of hip range of motion, and a dry, well-coaptated wound with no signs of infection. Length of hospital stay was not significantly different in both groups, which shows that the use of LIA does not necessarily translate to a shorter hospital stay. NRS was not the sole factor for discharge; the reduction of pain from day zero to the day of discharge was more important than the actual NRS on the day of discharge itself. Unstable medical issues and wound healing concerns usually influence the decision to discharge patients, but such factors were not observed.

The study is not without several limitations. First, a larger sample size would be better to provide a more generalizable picture of the effects of LIA on patients who undergo skin crease “bikini incision” direct anterior total hip arthroplasty. Second, the population of acute hip trauma patients (ideally within 48 hours to 1 week of injury) should be considered as these injuries tend to be more acutely painful. Third, the population with degenerative osteoarthritis or non-traumatic etiologies would help determine if LIA would also be effective for different pain generators. Fourth, in terms of methodology, it would be ideal if a single data collector is available to eliminate all potential inconsistencies or biases during data gathering.

Lastly, for future studies, it would be recommended to include the assessment of pain control at 6–8 hours post-operatively to consider the effect of LIA and the advantages of the direct anterior approach and to consider the number of post-operative hours that have elapsed before a rescue dose is administered. Moreover, it would be prudent to add additional outcomes such as standing and sitting tolerance, distance walked after surgery, or even the ability to do activities of daily living (ADLs).

## CONCLUSION

From a statistical standpoint, LIA was effective in reducing pain only on postoperative day one in adult patients who underwent THA for a neglected femoral neck fracture via the skin crease “bikini incision” anterior approach. Patients

in the LIA group had statistically significant higher Modified d’Aubigné-Postel scores and lower median NRS scores on postoperative day one. Pain control on day two and length of hospital stay were not statistically significant between the two groups, suggesting that the benefits of using LIA do not go beyond 24 hours. In the clinical setting, however, there was no significant difference in functional and pain scores between the two groups. Therefore, LIA as an additional method for post-operative pain management in this population cannot be routinely recommended at this time.

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## STATEMENT OF AUTHORSHIP

All authors certified fulfillment of ICMJE authorship criteria.

## CREDIT AUTHOR STATEMENT

**AGML:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Resources, Data Curation, Writing – original draft preparation, Writing – review and editing, Visualization, Supervision, Project administration; **JVB:** Methodology, Investigation, Resources, Writing – review and editing, Supervision

## AUTHOR DISCLOSURE

The authors declared no conflict of interest.

## DATA AVAILABILITY STATEMENT

The Data Collection Form is available upon request from the corresponding author.

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None.

## REFERENCES

1. Falaschi P, David M, editors. Orthogeriatrics: the management of older patients with fragility fractures [Internet]. 2nd ed. Cham (CH): Springer; 2021. PMID: 33347100 Bookshelf ID: NBK565581 DOI: 10.1007/978-3-030-48126-1
2. Roshan A, Ram S. The neglected femoral neck fracture in young adults: review of a challenging problem. *Clin Med Res.* 2008;6(1): 33-9. PMID: 18591377 PMCID: PMC2442029 DOI: 10.3121/cm.2008.752
3. Court-Brown CM, Heckman JD, McQueen MM, Ricci WM, Tornetta P III, McKee MD. Rockwood and Green’s: fractures in adults, 8th ed. Lippincott Williams & Wilkins; 2015. <https://orthopaedics.lwwhealthlibrary.com/book.aspx?bookid=952&sectionid=0>
4. Jain AK, Mukunth R, Srivastava A. Treatment of neglected femoral neck fracture. *Indian J Orthop.* 2015;49(1):17-27. PMID: 25593354 PMCID: PMC4292324 DOI: 10.4103/0019-5413.143909

5. Leunig M, Faas M, von Knoch F, Naal FD. Skin crease ‘bikini’ incision for anterior approach total hip arthroplasty: surgical technique and preliminary results. *Clin Orthop Relat Res.* 2013;471(7):2245-52. PMID: 23412730 PMCID: PMC3676627 DOI: 10.1007/s11999-013-2806-0
6. Zhao J, Davis SP. An integrative review of multimodal pain management on patient recovery after total hip and knee arthroplasty. *Int J Nurs Stud.* 2019;98:94-106. PMID: 31352132 DOI: 10.1016/j.ijnurstu.2019.06.010
7. Kerr DR, Kohan L. Local infiltration analgesia: a technique for the control of acute postoperative pain following knee and hip surgery: a case study of 325 patients. *Acta Orthop.* 2008;79(2):174-83. PMID: 18484242 DOI: 10.1080/17453670710014950
8. Tan NL, Gotmaker R, Barrington MJ. Impact of local infiltration analgesia on the quality of recovery after anterior total hip arthroplasty: a randomized, triple-blind, placebo-controlled trial. *Anesth Analg.* 2019;129(6):1715-22. PMID: 31743193 DOI: 10.1213/ANE.0000000000004255
9. Barash PG, Cullen BF, Stoelting RK, et al. *Clinical anesthesia*, 8e. Lippincott Williams & Wilkins, a Wolters Kluwer business; 2017. <https://anesthesiology.lwwhealthlibrary.com/book.aspx?bookid=2137&sectionid=0>
10. Jacob B, Zippelius T, Kloss N, et al. Local anesthetics’ toxicity toward human cultured chondrocytes: a comparative study between lidocaine, bupivacaine, and ropivacaine. *Cartilage.* 2019;10(3):364-9. PMID: 29468902 PMCID: PMC6585294 DOI: 10.1177/1947603518758436
11. Øvre S, Sandvik L, Madsen JE, Røise O. Comparison of distribution, agreement and correlation between the original and modified Merle d’Aubigné-Postel Score and the Harris Hip Score after acetabular fracture treatment: moderate agreement, high ceiling effect and excellent correlation in 450 patients. *Acta Orthop.* 2005;76(6):796-802. PMID: 16470432 DOI: 10.1080/17453670510045390
12. Raeder J, Spreng U. Intra-articular and periarticular infiltration: local anesthetics. NYSORA: The New York School of Regional Anesthesia. Accessed May 17, 2023. Available from: <https://www.nysora.com/topics/regional-anesthesia-for-specific-surgical-procedures/lower-extremity-regional-anesthesia-for-specific-surgical-procedures/anesthesia-and-analgesia-for-hip-procedures/intra-articular-periarticular-infiltration-local-anesthetics/>
13. Kirkness CS, Fritz JM. Translating research into clinical practice: functional recovery post total hip arthroplasty using outcomes gathered in the usual physical therapy practice setting. *Health Outcomes Res Med.* 2011;2(2):e119-27. PMID: 32288908 PMCID: PMC7102721 DOI: 10.1016/j.ehrm.2011.04.001
14. Seah S, Quinn M, Tirosh O, Tran P. Postoperative opioid consumption after total hip arthroplasty: a comparison of three surgical approaches. *J Arthroplasty.* 2019;34(11):2676-80. PMID: 31311666 DOI: 10.1016/j.arth.2019.05.057

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