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Clinical Evaluation for Effectiveness and Safety of Lidocaine and Bupivacaine Combination Epidural Infusion for the Management of Post-Total Hip Replacement Pain

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Abstract

BACKGROUND: The management of post-operative pain is critical for both the patient and the surgical outcome. Although epidural analgesia is valuable method, optimal local anesthetic selection and combination could improve its effectiveness.

AIM: This study was conducted to evaluate the effectiveness and safety of bupivacaine and lidocaine combination bolus epidural analgesia for post-total hip arthroplasty pain management.

METHODS: Sixty-five records of patients who underwent total hip arthroplasty and received bolus epidural analgesia with bupivacaine and lidocaine were evaluated retrospectively. The numerical pain score for 48 h, drug adverse effects, hospital stay, and opioid intake were analyzed statistically to determine the effectiveness and safety of epidural analgesia.

RESULTS: The numerical pain score showed mild pain perception through the first 48 h postoperatively. There was no significant difference ($p \geq 0.005$) between the first score data collected at 6 h and the last score at 48 h. Postoperatively, patients had lower incidence of hypotension and headache with acceptable mobility. Opioid rescue analgesia was used for 11 (16.9%) of patients.

CONCLUSIONS: For patients who have undergone total hip replacement surgery, epidural analgesia with a bolus epidural infusion of lidocaine and bupivacaine delivers an effective and safe pain control method for 48 h. This method was effective in opioid sparing.

Introduction

So far, surgeons and patients have been quite concerned about post-operative discomfort. Patients' satisfaction and anxiety are affected by severe-to-moderate pain after surgery, which has an impact on the operation's outcome [1], [2]. Patients with poor pain management risk major complications such as cardiac, respiratory, and mobility problems [3].

Through various pain control strategies, health practitioners hardly attempted to alleviate patients' discomfort. However, more could be done to reduce stress. Opioids are remaining the most commonly prescribed medication. Nonetheless, they are accompanied by a number of negative side effects that limit their usefulness. Opioids taken during and after surgery predispose patients to gastrointestinal issues, as well as dependency and respiratory center depression [4].

Regarding total hip arthroplasty, patients experience severe pain that lasts up to 5 post-operative days [5]. Therefore, well-controlled pain management with minimum adverse effects is essential. Epidural analgesia offers site-specific analgesia, which reduces opioid doses and provides safe and better pain control, which, in turn, enhances patients' mobility and reduces hospitalization days [6].

Epidural analgesia attained through the insertion of a catheter in to the epidural space where local anesthetic drugs, with or without adjuvants, are administered by bolus or continuous infusion. The process proves its competence in the management of acute post-operative pain after gynecological, thoracic, and other surgical procedures [7], [8]. Bupivacaine is an amide local anesthetic commonly used in epidural analgesia and anesthesia. In spite of its efficiency, bupivacaine has a slow onset of action and a high tendency to block sensory and motor nerve fibers. Consequently, post-operative hypotension and impedance of patients' early mobilization could happen [9]. Fortunately, efforts are advancing to improve epidural analgesia through proper patient management and the selection of safe and effective local anesthetic agents [10].

Lidocaine is a well-known safe local anesthetic drug, believed to be a good alternative or additive to bupivacaine [11]. Lidocaine has an intermediate duration and a rapid onset of action. With the use of both local anesthetics, a rapid effect with a lower dose could be achieved. However, the available evidence from well-organized clinical trials is still insufficient to prove that, especially for post-total hip arthroplasty pain management. In our institution, expert anesthesiologists tried to advance epidural techniques through using different combinations for the best practice results.

To evaluate safety and effectiveness of epidural analgesia with lidocaine and bupivacaine combination, the following study was conducted retrospectively for patients who underwent total hip arthroplasty.

Patients and Methods

A retrospective study conducted at Al-Salaam Private Hospital in Hilla City, Iraq, under the approval of the hospital ethical committee. Records of patients between December 2020 and June 2021 who underwent total hip replacement under general anesthesia with epidural analgesia were investigated.

Patients

Seventy patients' records of both sexes and different age groups (Table 1) evaluated according to the following: The patients underwent total hip replacement under general anesthesia and received epidural analgesia, complete information of the numeric pain scale for 48 h postoperatively at a 6 h interval, and epidural analgesia performed by bupivacaine 5% plus lidocaine 2% bolus infusion. Patients with a history of opioids, other anesthetics, and anticoagulant drugs were excluded from the study.

Table 1: Demographic data

Variables	Patients (n = 65)	p value
Age	58.921 ± 13.99	0.71
Sex		0.457
Male	36 (55.4%)	
Female	29 (44.6%)	
Cause of operation		
A vascular necrosis of femoral head	18 (27.7%)	0.000*
Fracture neck femur	34 (52%)	
Fracture acetabulum	3 (4.6%)	
Fracture neck femur (pathological)	3 (4.6%)	
Developmental dysplasia of the hip (DDH)	1 (1.5%)	
Osteoarthritis (OA)	6 (9.2%)	

*p ≤ 0.05. Values expressed by mean ± standard deviation, the numbers in parenthesis represent percentages.

Treatments

The patients underwent total hip replacement surgery under general anesthesia, in standard procedure.

General anesthesia and operative notes

Anesthesia induced with thiopental 4 mg/kg, then muscle relaxant delivered, they use either atracurium 0.6 mg/kg or cisatracurium 0.2 mg/kg to facilitate intubation. For the maintenance of anesthesia, inhalation anesthesia delivered with isoflurane (MAC is 2.5–3). Additional drugs administered during surgical procedure were paracetamol or morphine at the last ½ h of operation for analgesia. At the end of operation, atropine and neostigmine administered as antidote for muscle relaxant.

Patients were positioned laterally with anterior and posterior pillows, a lateral transgluteal approach with cementless (Johnson and Johnson) prosthesis was utilized, two suction drains inserted, finally, wound closed in layers after checking stability. The procedure took roughly 90 minutes.

Epidural analgesia technique

Epidural analgesia approved and applied in the hospital according to the published guidelines.

An expert anesthesiologist prepared patients in a sitting or lateral position. Intravenous line secured under aseptic technique. Midline was found between L2 and L3 spinous process. Then, 3 mL of 1% lidocaine superficially and deeply injected. After that, a 19-gauge Tuohy needle (curved blunt tip) inserted to identify the epidural space in which loss of resistance was the sign. Finally, an epidural catheter of 16–18 g introduced through the needle hole within the epidural space, the needle removed, and the catheter held by adhesion plaster. The process started immediately before the start of general anesthesia and held in position for 48 h post-surgery.

Drugs and doses

As a prophylactic antibiotic, 2 g of ceftriaxone were given intravenously 2 h before surgery and intravenous amikacin 500 mg every 12 h postoperatively.

A bolus dose of 4 ml of 5% bupivacaine plus 8 ml of 2% lidocaine diluted with distilled water to 20 ml, started during surgery and later on every 8–10 h in which the catheter removed at the end of the last bolus. The number of the bolus doses was approximately 5–6 doses within 48 h.

Intravenous injection of paracetamol 1000 mg started after surgery and repeated every 12 h for 3 days or as needed by the patient. Morphine was injected as a rescue analgesic.

Outcomes

- Pain assessed by numeric pain score (NPS) [12] every 6 h to the end of 48 h, where:

Zero = no pain and 10 is worst pain at rest and movement. Observers took the scores every 6 h.

- Additional analgesia required and their types.
- Adverse drug reaction including hypotension, nausea and vomiting, and drop on movement records.
- Hospital discharge day.
- Mobilization of patients.

During the first 24 h, movement of limbs in bed was observed. After 24h,partial weight-bearing with the aid of walker was allowed for 1-2 times until the end of 48h. Finally, weight-bearing and walking were observed after 2 post-operative days at the end of the last bolus infusion dose.

Statistical analysis

From the records of 70 patients searched, only 65 records were analyzed. Five records excluded due to incomplete observations (2) and slippage of the catheter (3). Data were analyzed with the SPSS (version 22) statistical software package, with the categorical data analyzed by Friedman's two-way analysis of variance test and Wilcoxon signed-rank test as required. Numerical parametric variables expressed by mean ± standard deviation, or percentages and compared by one-way ANOVA. Level of significance tested at $p < 0.05$.

Results

Analysis of 65 patients' recorded numeric pain scores revealed mild pain perception through the first 48 h postoperatively. Yet, a significant rise in pain score noted during the 42 h $p \leq 0.05$ when compared with the initial pain score observation. The 48 h records, on the other hand, revealed a non-significant difference (Figure 1).

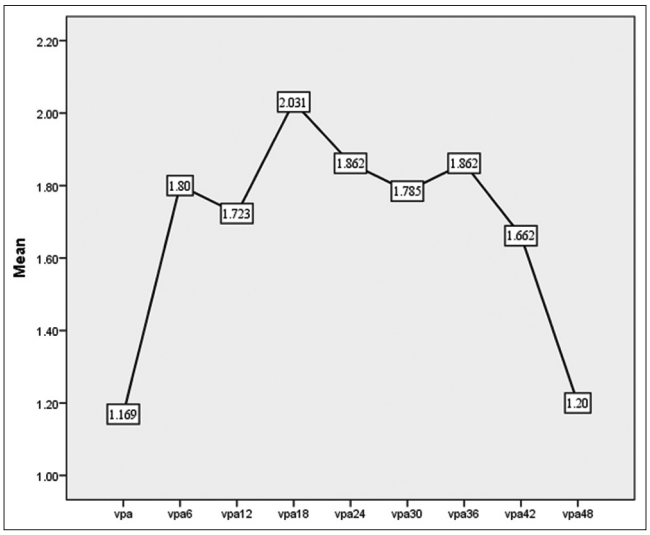

Figure 1: Numeric pain score (NPS) mean variations every 6 h after surgery

Surgeons' records showed no impairment in patients' movement or muscle tone during hospital residency. In addition to that, expected hypotension observed in 4 (6.15%) patients while no records of nausea or vomiting detected (Table 2).

Table 2: Post-operative outcomes of 65 patients underwent hip arthroplasty with epidural analgesia

Variable	Patients (n = 65)	p value
Pain scale (numeric pain scale)	1.688 ± 0.9666	0.001*
Operation period	90.41 ± 2.17	0.878
Hospital stay	3–4 days	0.432
Additional analgesia	Morphine 11 (16.9%) Paracetamol 1 (1.6%)	0.00*
Adverse reactions		
Hypotension	4 (6.15%)	0.00*
Nausea and vomiting	0	
Headache	5 (7.69%)	0.00*

*$p \leq 0.05$. Values expressed by mean ± standard deviation, the numbers in parenthesis represent percentages.

Rescue analgesia administered to patients who had moderate-to-severe pain perception during their hospital residency, in which morphine was the choice for those who had not responded to paracetamol extra dose.

No significant difference detected regarding age and gender, $p \geq 0.05$ (Table 1). Conversely, operation cause showed a significant difference in type. According to surgeons' notes, mobility of limbs was within the accepted range without impedance. All patients included in study had urinary catheters removed after 48 h. At the end of 48 hr. and after catheter removal, patients prescribed with oral analgesics including paracetamol and/or naproxen until hospital discharge.

Discussion

Our study's main finding is that epidural analgesia with bolus infusions of bupivacaine and lidocaine provides adequate pain control after total hip arthroplasty. This finding proved through pain scores (NPS) that during the first 48 hrs after surgery, mild pain perception was shown. This result shows the effectiveness of epidural analgesia technique over opioid systemic administration [13], [14]. Whereas, this finding disagrees with Choi *et al*. [14] review conclusions that found epidural analgesia for post-arthroplasty surgeries effective for the first 6 h only. Nevertheless, the same review mentioned that evidences from total hip replacement surgeries were inconclusive. In this study, epidural analgesia supplemented with paracetamol, which could explain why adequate analgesia accomplished for 48 h post-surgery.

Multimodal analgesia plays a pivotal role in ensuring patients satisfaction and opioid sparing. Accordingly, paracetamol administered as part of hospital protocol for such surgeries. The effectiveness of paracetamol addition goes with Singla *et al*. [15]

study who analyzed the results of two previous studies that used intravenous 1 g paracetamol multiple dosing during the first 24 h after post-orthopedic arthroplasty surgeries and found it to improve post-surgical pain control and reduce opioid consumption. Yet, in our study, paracetamol was administered intravenously for 48 h at 12 h interval.

Numerical pain scores show variation in significance when compared with the first record, except for the last record, which accomplished at 48 h. The effect of analgesics delivered during anesthesia on the first recorded score, could explain that variation. On the contrary, there was no significant difference between the first and last scores, which provides another clue about the effectiveness of epidural analgesia in the present study.

Until recently, no single ideal local anesthetic drug could provide side effect – free epidural analgesia. Therefore, lidocaine selected as an adjuvant to bupivacaine for reducing its possible adverse effects and providing rapid onset of action [11]. Bupivacaine and lidocaine are among the most common local anesthetics used in epidural analgesia. According to Atasever *et al*. cohort study [16], combination of these two local anesthetics found to be safe and effective for caudal block in circumcision surgery. Moreover, their combination is widely used for labor analgesia [17]. To the best of our knowledge, the effectiveness of epidural bupivacaine and lidocaine combination for post-total hip arthroplasty is not well established yet.

The main adverse effects were low incidence of mild headache and hypotension, which disappeared after paracetamol injection, as the patients' records declared. However, these adverse effects documented as acceptable. Mild adverse effects could be explained by the competence behavior between lidocaine and bupivacaine on binding to sodium channel receptor sites, in which lidocaine has higher affinity and ability to associate and dissociate than bupivacaine. Thus, lower incidence of sympathetic block expected indeed [18].

According to the surgeons' post-operative examination records, patients were able to move their limbs in bed during the first 24 h and their mobility was within the accepted range during their hospital stay. Although this result not based on well-recorded scores and statistical evaluation, it could reveal that the combination of these two local anesthetics decreases the known motor blockade affinity of bupivacaine if used alone and prolongs their analgesic efficiency by approximately 8 h to the next bolus dose. Ahmed and Baig [19] study found that continuous lumbar epidural infusion of bupivacaine and fentanyl is associated with limbs motor weakness in 36.5% of patients undergoing abdominal surgery. However, in this study, epidural analgesia maintained by bolus infusion rather than continuous infusion and without fentanyl addition, and this could explain the reduction of motor blocking affinity of bupivacaine.

Rescue analgesia with morphine was given to 11 (16.9%) of the patients in this study, which represent opioid sparing result. This outcome concurs with Soffin *et al*. [20] who proved that multimodal analgesia with regional analgesia lowers overall perioperative opioid consumption for patients undergoing total hip or knee replacement. Opioid sparing seems fundamental for surgeries accompanied by acute severe post-operative pain like total hip replacement.

The main limitations of the present study were incomplete patients' records, except for the records included, which affected sample size and conclusion power, and the inability to verify mobility tests used for patients. Besides, the data belong to a single orthopedic surgical center. The present study was a retrospective study that attempted to evaluate and improve hospital epidural analgesia for orthopedic surgeries. Accordingly, we recommend well-organized clinical trials to verify the effectiveness and safety of epidural analgesia by comparing local anesthetics alone and in combination, as well as improving documentation of patients' records for better evaluation.

Conclusions

In addition to paracetamol intravenous injection, epidural analgesia with bolus infusion of lidocaine and bupivacaine provides an effective and safe pain control approach for 48 h for patients who have undergone total hip replacement surgery. This approach was effective in opioid sparing during hospital stay without intervention with patients' mobility.

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Authors' contributions

AAM., HM., MTJ, and AHA conceived and designed the study, conducted research, provided research materials, collected, and organized data. AAM analyzed and interpreted data. AAM wrote initial and final draft of article and provided logistic support. All authors have critically reviewed and approved the final

draft and are responsible for the content and similarity index of the manuscript.

Data Availability Statement

Research data are not shared. The data are not publicly available due to privacy or ethical restrictions.

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