DOI: https://doi.org/10.54393/pjhs.v5i12.1505

PAKISTAN JOURNAL OF HEALTH SCIENCES
(LAHORE)
https://thejas.com.pk/index.php/pjhs
ISSN (P): 2790-9352, (E): 2790-9344
Volume 5, Issue 12 (Deccember 2024)

Original Article

OPEN ACCESS

Effectiveness of Bupivacaine Infiltration in Reducing Postoperative Pain in Patients Undergoing Percutaneous Nephrolithotomy

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ARTICLE INFO

Keywords:

Percutaneous Nephrolithotomy, Bupivacaine Infiltration, Postoperative Pain, Gender

How to Cite:

Raza, A., Khursheed, S., Ahmed, W., Rajpar, Z. H., Soomro, N., Kumar, R., & Shah, S. Z. A. (2024). Effectiveness of Bupivacaine Infiltration in Reducing Postoperative Pain in Patients Undergoing Percutaneous Nephrolithotomy: Bupivacaine Infiltration in Reducing Postoperative Pain in Percutaneous Nephrolithotomy. Pakistan Journal of Health Sciences,5(12), 217-222. https://doi.org/10.54393/pjhsv5i12.1505

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Received date: 13th April, 2024
Accepted date: 4th December, 2024
Published date: 31st December, 2024

ABSTRACT

Percutaneous Nephrolithotomy is a standard way to treat large renal calculi because it is slightly invasive. One big problem with normal percutaneous nephrolithotomy, though, is that patients often have discomfort and pain at the nephrostomy place after the surgery. **Objective:** To evaluate the effectiveness of bupivacaine infiltration in reducing postoperative pain in patients undergoing percutaneous nephrolithotomy. **Methods:** The quasi-study lasted for six months at Liaquat National Hospital in Karachi. A total of 60 patients were recruited as Group A=30 patients(20ml/50mg of 0.25% bupivacaine)and Group B=30 patients(20ml of normal saline). All the patients had percutaneous nephrolithotomy and at the end of the operation; a 12 Fr nephrostomy tube was put in place. All patients were carefully watched, and their pain levels were measured using a visual analogue scale and computed as mean ± SD. **Results:** Group A had a mean age of 39.9 ± 12.9 years, and Group B had a mean age of 39.4 ± 11.2 years. There were 16 men (53.3%) and 14 women (46.7%) in Group A, and 20 men (66.7%) and 10 women (33.3%) in Group B. The average amount of pain after surgery was 2.07 ± 0.78 in Group A and 4.80 ± 0.92 in Group B. The p-value was found to be extremely significant, which means it was 0.0001. **Conclusion:** It was concluded that the postoperative pain score was significantly better in bupivacaine infiltration as compared to placebo in percutaneous nephrolithotomy.

INTRODUCTION

Nephrolithiasis, also known as renal stones, is a urological disorder characterized by the formation of stones within the kidneys due to the crystallization of substances from urine [1]. Crystallization can occur within the urinary system due to either an abundance of stone-forming materials or a lack of chemicals that inhibit stone formation [2]. Notably, bilateral renal stones are linked to life-threatening problems like obstructive uropathy and kidney failure, so it's important to think about any kind of immediate action [3]. Risk factors for these problems include urinary tract obstruction and metabolic disorders.

These past few years, the side with symptoms or more stones has usually had the treatment of choice, which is surgical removal or percutaneous nephrolithotomy (PCNL) [4]. Percutaneous nephrolithotomy (PCNL) is a well-known way to eliminate big, complicated kidney stones. The main goal of medical treatment is to get rid of as many stones as possible with as little harm to the patient as possible [5]. It is less painful for patients to have a smaller nephrostomy tube put in at the end of a percutaneous nephrolithotomy [6]. Applying local anesthetics directly to the surgical site has been shown to help reduce pain after several surgeries

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[7]. Putting bupivacaine along the nephrostomy tube after PCNL dramatically lowers the need for painkillers and peritubular infiltration [8]. A visual analogue scale was used to measure the amount of pain two hours after PCNL [9]. In real life, nerve function loss happens in this order: (1) pain, (2) temperature, (3) touch, (4) proprioception, and (5) leg muscle tone [10]. With bupivacaine, the anesthesia lasts a lot longer than with any other widely used local anesthetic. Some people have also noticed that there's a period of pain relief that lasts after the feeling is restored. During this time, strong painkillers are not needed as much [11]. A former study compared the average pain after surgery between people who had bupivacaine injected into their nephrostomy tube before surgery and people who had a placebo [12]. Analgesia given before the onset of pain, that is, pre-emptive analgesia, prevents the plasticity of the central nervous system and hence gives more effective pain relief. The local infiltration bupivacaine at the surgical site has become relatively common for several surgical procedures and can produce effective analgesia and has the advantage of relative simplicity compared with other regional anesthesia techniques.

This study aims to find out how much pain patients who had bupivacaine injected into their nephrostomy tube before surgery had compared to patients who had a placebo before percutaneous nephrolithotomy for symptomatic nephrolithiasis. This will help researchers understand the situation in the area better as in critical patient care, lowering pain after surgery is a primary goal. The study's results would also let current and local data know which strategy is better than another and suggest the first choice of treatment to lower pain, morbidities, and complications. Ultimately, this would ease the patients' clinical outcomes.

METHODS

The six-month comparative quasi-study was conducted in the Department of Urology at Liaquat National Hospital in Karachi, from January 27, 2021, to July 26, 2021. The study used a sample size of 60 people, with 30 in each group. WHO software was used to determine the sample size; non-probability, convenience sampling was used to pick the samples. The study included patients who had percutaneous nephrolithotomy for pain in the flanks radiating to the groin (Visual Analogue Scale (VAS)>4) for more than 24 hours, were of either gender, had an American Society of Anesthesiologists (ASA) level of less than 2, and were between the ages of 20 and 60. Patients who refused to participate had a nephrostomy tube size greater than 12 Fr, had a history of Hepatitis C, B, or human immunodeficiency virus (HIV) infection, had a history of cancer, had a history of hypo or hyperthyroidism, or were pregnant were excluded or the study. Before the study was carried out, the institutional ethics review committee asked for and granted permission (R.C-LNH-Urology-12/2021/151). A brief account of each patient's background was gathered. Patients were given group A (20ml/50mg of 0.25% bupivacaine) or B (20ml of normal water) in a sealed, opaque envelope. The percutaneous nephrolithotomy was done on all of the patients while they were under general anesthesia. At the end of the operation, a 12 Fr nephrostomy tube was put in place. All surgeries in both groups were carried out by a single urologist who was an expert and had more than ten years of expertise. After surgery, every patient was carefully watched for six hours, and the researcher checked their pain status by using a visual analogue scale [13]. The patient was told that the visual analogue scale measured different types of pain on a scale from zero to ten, where zero means no pain and ten means the worst pain possible. The patient was then asked to mark the number that best described their pain. A wall-mounted scale was used to measure each participant's height in meters, and a weighing machine was used to measure their weight to the nearest kilogram. Before the process, their Body Mass Index (BMI) was also calculated. The results of the quantitative variables (age, height, weight, size of stone, VAS pain score, and length of surgery) and qualitative variables (gender, diabetes mellitus type II, high blood pressure, BMI>30 kg/m2, side of stone, and smoking status) are presented as mean ± SD, frequencies and percentages while the diabetes mellitus, hypertension and smoking was explored by taking clinical history, the BMI was estimated by measuring height and weight whereas the site of the stone was identified by ultrasound findings. SPSS Version 20.0 was used to look at the data for quantitative factors like their ages, height, weight, stone size, VAS pain score, and surgery length; the mean and standard deviation were found. For qualitative factors like gender, type II diabetes, high blood pressure, BMI>30 kg/m2, side of stone and smoking status, rates and proportions were found. Various factors like age, gender, diabetes mellitus, hypertension, BMI greater than 30 kg/m2, smoking, side of the stone, and length of surgery were controlled to see how they affected the results. After sorting, an independent sample t-test was used for quantitative data while chi-square for qualitative data and a p-value of ≤0.05 was considered statistically significant.

RESULTS

60 patients with symptomatic nephrolithiasis were split into two equal groups: Group A (20ml/50mg of 0.25% bupivacaine) and Group B (20 of normal saline). Group A's mean age was 39.9 ± 12.9 years, and Group B's was 39.4 ± 11.2 years. Group A's mean height was 1.69 ± 0.08 meters, and Group B's was 1.68 ± 0.08 meters. The mean weight for group A was 75.4 ± 8.6 kg and for group B it was 76.7 ± 9.3 kg. The mean body mass index for Group A was 26.5 ± 3.3 kg/m2

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and for Group B it was 27.3 ± 3.5 kg/m2. Group A had 16 men (53.3%) and 14 women (46.7%), while Group B had 20 men (66.7%) and 10 women (33.3%). The average stone size in Group A was 2.7 mm, and the average stone size in Group B was 2.5 mm, with a standard deviation of 0.4 mm. Surgery took 1.74 ± 0.35 hours on average for Group A and 1.58 ± 0.42 hours on average for Group B (Table 1).

Table 1: Descriptive Statistics of Study Population

Groups [A=30] [B=30]	Mean ± SD
Age (Years)	
Group A	39.9 ± 12.9
Group B	39.4 ± 11.2
Height (m)	
Group A	1.69 ± 0.08
Group B	1.68 ± 1.55
Weight (Kg)	
Group A	75.4 ± 8.6
Group B	76.7 ± 57
BMI (kg/m^2)	
Group A	26.5 ± 3.3
Group B	27.3 ± 3.5
Stone Size (mm)	
Group A	2.7± 0.7
Group B	2.5± 0.4
Duration of Surgery (Hours)	
Group A	1.74 ± 0.35
Group B	1.58 ± 0.42

The body mass index showed that 25 (83.3%) patients were between 20 to 30 kg/m2 and 5 (16.7%) patients were >30 kg/m^2 were included in group A while 21 (70.0%) and 9 (30.0%) patients between 20 to 30 and >30 kg/m^2 were included in group B respectively. The frequency distribution of diabetes mellitus, hypertension, body mass index, side of stone and smoking is analyzed (Table 2).

Table 2: Frequency Distribution of Diabetes Mellitus, Hypertension, Body Mass Index, Side of Stone and Smoking (n=60)

Variables	Group A n=30	Group B n=30	p-value
Diabetes Mellitus			
Yes	13 (43.3%)	10 (33.3%)	0.03
No	17 (56.7%)	20 (66.7%)	
Hypertension			
Yes	15 (50.0%)	10 (33.3%)	0.12
No	15 (50.0%)	20 (66.7%)	
Body Mass Index (kg/m^2)			
20-30	25 (83.3%)	21 (70.0%)	0.05
>30	5 (16.7%)	9 (30.0%)	
Side of Stone			
Right Side	20 (66.7%)	16 (53.3%)	0.24
Left Side	10 (33.3%)	14 (46.7%)	
Smoking			
Yes	9 (30.0%)	10 (33.3%)	0.41
No	21 (70.0%)	20 (66.7%)	

In the group-wise distribution of the side of the stone, 20 (66.7%) patients had a stone on the right side and 10 (33.3%) had a stone detected on the left side in Group A while 16 (53.3%) and 14 (46.7%) had stone was detected in right and left side respectively in Group B. Out of 60 patients, 9 (30.0%) and 10 (33.3%) patients were smokers in Group A and B while 21 (70%) and 20 (66.7%) were non-smokers in Group A and B respectively. In a comparison of both groups, mean post-operative pain was noted as 2.07 ± 0.78 in Group A whereas 4.80 ± 0.92 in Group B and the p-value was found to be significant i.e. (p<0.01) whereas the statistics for postoperative pain (in terms of mean ± SD) with age group, gender, diabetes mellitus, hypertension, BMI, side of the stone, smoking status and duration of surgery were also seen to be significant (Table 3).

Table 3: Stratification of Study Variables with Post-Operative Pain Between Groups (A and B)

Variables	Group	Post-Operative Pain Mean ± SD	*p-value
Age Group (In Years)			
21-40 (n=31)	Group A	2.00 ± 0.73	<0.01
	Group B	5.02 ± 0.04	
>40 (n=29)	Group A	2.14 ± 0.86	<0.01
	Group B	5.01 ± 1.01	
Gender			
Male (n=36)	Group A	2.00 ± 0.73	<0.01
	Group B	4.31 ± 0.92	
Female (n=24)	Group A	2.14 ± 0.86	<0.01
	Group B	4.52 ± 0.62	
Diabetes Mellitus			
Yes (n=23)	Group A	2.15 ± 0.98	<0.01
	Group B	4.73 ± 0.82	
No (n=37)	Group A	2.00 ± 0.61	<0.01
	Group B	4.30 ± 0.91	
Hypertension			
Yes (n=25)	Group A	2.06 ± 0.70	<0.01
	Group B	5.21± 1.10	
No (n=35)	Group A	2.06 ± 0.88	<0.01
	Group B	5.42 ± 0.71	
Body Mass Index [Kg/M^2]			
20 - 30 (n=46)	Group A	2.12 ± 0.78	<0.01
	Group B	5.41 ± 1.04	
>30 (n=14)	Group A	1.80 ± 0.83	<0.01
	Group B	5.52 ± 0.86	
Side of Stone			
Right Side (n=36)	Group A	2.05 ± 0.82	<0.01
	Group B	4.94 ± 1.31	
Left Side (n=24)	Group A	2.10 ± 0.73	<0.01
	Group B	4.62 ± 1.22	
Smoking Status			
Smoker (n=19)	Group A	2.00 ± 0.86	<0.01
	Group B	4.52 ± 1.42	
Non-Smoker (n=41)	Group A	2.09 ± 0.76	<0.01
	Group B	4.86 ± 1.23	

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Duration (In Hours)			
1 – 1.5 (n=31)	Group A	2.38 ± 0.76	<0.01
	Group B	5.11 ± 1.05	
>1.5 (n=29)	Group A	1.82 ± 0.72	<0.01
	Group B	5.31 ± 1.31	

*Applied Independent T-Test

DISCUSSION

Percutaneous nephrolithotomy (PCNL) is the best way to treat large renal calculi because it is minimally invasive and has few side effects [14]. In normal PCNL, a nephrostomy tube is put in to help with drainage, tamponade, and second-look surgery [15]. However, one of the biggest problems with standard PCNL patients is pain and discomfort at the nephrostomy site after surgery. This makes them stay in the hospital longer and need more painkillers, which slows their total recovery. Each of the painkillers has its side effects and restrictions. [16]. Individuals who have had PCNL have said that there isn't a set way to handle pain after surgery [17]. However, different ways of treating it have been offered, such as painkillers (narcotic and non-narcotic), patient-controlled analgesia pumps, single-dose subarachnoid anesthesia, and local absorption of anesthetic substances [18]. Even though using a small nephrostomy tube has led to less painkiller use, it doesn't help the patient and makes it harder for them to heal smoothly after surgery. Some studies have shown that bupivacaine infiltrated at the nephrostomy site reduced the need for painkillers after surgery [19, 20]. Over the past 30 years, the way kidney stones are treated has changed from open surgeries to silent methods like extracorporeal shockwave lithotripsy, as well as less invasive methods like PCNL. The PCNL procedure is a safe and successful way to treat patients with renal calculi, and it is less invasive than open surgery. This PCNL method has been used for a long time because it has high rates of tone-free hearing and very few problems. It is expected to be put in a nephrostomy tube 48 hours after PCNL to stop bleeding, make sure there is enough drainage, and allow for more endoscopic treatments. In recent years, tubeless PCNL has become popular, and it has been shown to significantly reduce pain in some patients after surgery. But a nephrostomy tube can't be given out when there are complicated stones, perforations, or too much blood. Not giving enough painkillers after surgery can make it take longer to move around, make breathing harder, and keep a person in the hospital longer. Painkillers like opioids and non-steroidal anti-inflammatory drugs have side effects that make it hard for people who might have kidney problems to use them. Anesthesiologists know how important it is to control pain well, which is one of their main goals. Our study's findings agree with those of many other studies done worldwide by different researchers. We discuss some of them here, along with our results. The people in Group A were 39.9 ± 12.9 years, and the mean age in Group B was 39.4 ± 11.2 years. Khan et al., found that out of 94 cases, the average age was 37.23 ± 11.31 years [12]. When the mean ages of the cases were compared to those from other studies, there were no significant differences. In the present research, 53.3% of the people in group A were men and 46.7% were women. Most people in Group B were men (66.7%), while only 33% were women. Honey *et al.*, found that 60.6% of the control group patients were men and 39.4% were women [20]. The current study found that the mean BMI for Group A was 26.5 ± 3.3 kg/m2, and the mean BMI for Group B was 27.3 ± 3.5 kg/m^2. The mean body mass index (BMI) for the control group was 28.2 kg/m^2 (4.6 kg/m^2), and for the bupivacaine group it was 28.1 kg/m2 (5.4 kg/m^2) [20]. The BMI figure was the same as what had been found before. Researchers found that the average stone dimension in the Group A case was 2.7 mm, with an error of 0.7 mm. The control group had a mean thickness of 28.3 mm [21]. According to Khan *et al.*, the average VAS pain score for patients in group A was 5.22 ± 0.76, and for patients in group B, it was 7.85 ± 0.78 [12]. Andreoni and colleagues noted that a single preoperative dose of subarachnoid spinal analgesia with morphine along with infiltration of the nephrostomy tract with bupivacaine was a statistically significant decrease in the requirement of postoperative parenteral pain medication [22]. Jonnavithula *et al.*, conducted a study on subcutaneous infiltration of bupivacaine versus saline after PCNL and showed reduced rescue analgesic requirement in the bupivacaine group [23].

CONCLUSIONS

It was concluded that postoperative pain score was significantly better in bupivacaine infiltration (Group A) as compared to placebo (Group B) in patients undergoing percutaneous nephrolithotomy for symptomatic nephrolithiasis. To confirm the results of this study, further studies with a large sample size and more parameters in multidisciplinary settings are needed.

Authors Contribution

Conceptualization: AR, WA, RK
Methodology: AR, SK, WA, NS, RK
Formal analysis: AR, ZHR, NS, RK
Writing review and editing: SK, WA, SZAS

All authors have read and agreed to the published version of the manuscript

Conflicts of Interest

All the authors declare no conflict of interest.

DOI: https://doi.org/10.54393/pjhs.v5i12.1505

Source of Funding

The author received no financial support for the research, authorship and/or publication of this article.

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