e-ISSN: 0976-822X, p-ISSN:2961-6042

Available online on http://www.ijcpr.com/

International Journal of Current Pharmaceutical Review and Research 2024; 16(11); 436-442

Original Research Article

Efficacy of Peripheral Nerve Stimulator-Guided Sacral Plexus Block for Postoperative Pain Relief in Below-Knee Orthopaedic Surgery: A Prospective Observational Study

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Received: 27-09-2024 / Revised: 16-10-2024 / Accepted: 03-11-2024

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Conflict of interest: Nil

Abstract

Background: Postoperative pain after below-knee orthopaedic surgery may delay mobilisation and recovery. Sacral plexus block can provide analgesia to the posterior thigh, lower leg and foot, and may be useful as part of multimodal postoperative analgesia.

Aim: To evaluate the efficacy of peripheral nerve stimulator-guided sacral plexus block for postoperative pain relief in below-knee orthopaedic surgery.

Methods: This prospective observational study included 60 ASA grade I and II patients undergoing below-knee orthopaedic surgery. All patients received peripheral nerve stimulator-guided sacral plexus block with 20 ml of 0.5% bupivacaine by posterior approach, followed by spinal anaesthesia. Postoperative pain was assessed using visual analogue scale at 2-hour intervals for 24 hours. Intravenous diclofenac sodium 75 mg was given as rescue analgesia when VAS score exceeded 4. Haemodynamic parameters, time to first rescue analgesia and adverse reactions were recorded.

Results: The mean age was 36.8 ± 6.9 years. Mean VAS score was 0 up to 4 hours and increased gradually, reaching a maximum of 3.28 ± 1.01 at 16 hours. The mean time to rescue analgesia was 17.0 ± 2.2 hours. Rescue analgesia was required between 12–18 hours in 88.3% patients and between 18–24 hours in 11.7%. Pulse rate and mean arterial pressure remained clinically stable. No adverse reaction was observed.

Conclusion: Single-shot peripheral nerve stimulator-guided sacral plexus block provided effective postoperative analgesia with prolonged time to rescue analgesia and stable haemodynamics in below-knee orthopaedic surgery.

Keywords: Sacral plexus block, postoperative analgesia, below-knee surgery, bupivacaine, VAS.

Introduction

Anaesthesia for lower limb surgeries is challenging as many patients undergoing lower limb surgeries may have associated comorbid conditions such as cardiac, renal, cerebral, respiratory and endocrine diseases. These conditions may adversely affect surgical outcome and increase perioperative and postoperative morbidity [1-3]. Effective perioperative management of anaesthesia and postoperative analgesia is therefore important for patient comfort and satisfaction, early mobilisation, reduction of postoperative morbidity and prevention of muscle spasms that may interfere with rehabilitation [4].

Fractures of the lower limb are associated with considerable pain. Undertreated pain has been demonstrated to be an independent risk factor for delirium in older adults undergoing surgery [5]. The prevalence of delirium following lower limb fractures has been reported to range from 13% to 61% [6,7]. Delirium has been associated with delayed recovery, increased mortality, prolonged hospital stay and poorer physical, cognitive and affective function after fracture [6,8].

Pain has been defined by the International Association for the Study of Pain as an unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage. Postoperative pain after lower limb orthopaedic surgery is a distressing symptom and an important component of postoperative morbidity. It may prevent early ambulation, which is essential for rehabilitation and prevention of complications such as deep vein thrombosis [9].

Lower extremity blocks are safe and have advantages such as postoperative pain relief and avoidance of complete sympathectomy. Recent applications have focused more on postoperative

analgesia rather than intraoperative anaesthesia, with the objective of improving patient comfort and assisting rehabilitation. The nerve supply to the lower extremity is derived from the lumbar and sacral plexuses. The sacral plexus provides motor and sensory innervation to the posterior thigh, most of the lower leg and foot, and part of the pelvis. It is part of the lumbosacral plexus and emerges from L4 to S4 [10].

The use of peripheral nerve blocks has become increasingly popular in the last two decades. With anatomical landmark-based techniques, peripheral nerve stimulators and ultrasound-guided approaches, newer types of nerve blocks have become possible with wider indications and lower risk of complications [6,7,11]. Regional anaesthesia provides several advantages, including ability to keep the patient conscious during surgery, maintenance of spontaneous respiration, preservation of protective reflexes, early postoperative mobilisation, shortening of hospital stay and prolonged postoperative pain relief. It also avoids several complications of general anaesthesia in this patient group [2,8,11].

Various techniques are used for postoperative pain relief after lower limb surgeries, including patient-controlled analgesia pumps with opioids, subarachnoid analgesia, epidural catheters, anterior and posterior lumbar plexus blocks and non-steroidal anti-inflammatory drugs [4]. While several studies suggest the use of sacral plexus or sciatic nerve block, others have included anterior and posterior nerve blocks in combination. The doses and concentrations of local anaesthetic drugs also vary, and fixed doses have often been used irrespective of body weight [12,13]. Findings in the literature are not uniform, although most studies report beneficial effects. Most available studies focus on sciatic nerve block, with fewer studies specifically evaluating sacral plexus block [13,14]. Therefore, there is a need for further work to define the role of sacral plexus block in postoperative pain management after below-knee orthopaedic surgery. The present study was undertaken to evaluate the efficacy of peripheral nerve stimulator-guided sacral plexus block as part of a multimodal analgesic regimen after below-knee orthopaedic surgery.

Aim and Objectives

Aim: To evaluate the efficacy of sacral plexus block for postoperative pain management in below-knee orthopaedic surgery in terms of improved degree and duration of pain relief.

Objectives

1. To study the duration of sacral plexus block and requirement of rescue analgesia after sacral plexus block.
2. To study the adverse effects of sacral plexus block.

Materials and Methods

The study was undertaken after approval from the Institutional Ethics Committee of Poona Hospital and Research Centre, Pune.

Study Area: The study was conducted in the major operation theatre of Poona Hospital and Research Centre, Pune. It is a 350-bedded tertiary care centre with all major specialties and intensive care facilities.

Study Population: The study was conducted among 60 indoor patients admitted for below-knee orthopaedic surgery. Patients were observed in the postoperative recovery room and ward.

Study Design: This was a prospective observational study. Sixty patients of American Society of Anaesthesiologists physical status I and II, aged 18–60 years, scheduled for below-knee orthopaedic surgeries, were included. Sacral plexus block was given with 20 ml of 0.5% bupivacaine using peripheral nerve stimulator guidance, followed by subarachnoid block. Pain was assessed for 24 hours using visual analogue scale postoperatively at intervals of 2 hours. Diclofenac sodium was given as rescue analgesia when VAS score was more than 4. Time of supplemental analgesia was noted.

Sample Size: Based on previously published studies and using the formula $N = Z\alpha^2 P(1-P) / \delta^2$, the calculated sample size was 55 patients. It was decided to recruit 60 patients.

Study Duration: The study was conducted over a duration of 6 months, from the date of approval by the Institutional Ethics Committee to 30 September 2017.

Inclusion Criteria: Patients scheduled for below-knee open reduction and internal fixation surgery for fractures, patients belonging to ASA grade I and II, and patients aged 18–60 years were included.

Exclusion Criteria: Patients without written informed consent or those withdrawing consent, patients belonging to ASA grade III and IV, patients using regular analgesic medication for chronic pain, patients with history of allergy to the study drug or drug components, and patients with bleeding diathesis or infection at the site of block were excluded.

Anaesthesia Management: Pre-anaesthesia check-up was done one day prior to surgery. Patients were evaluated for systemic diseases and relevant laboratory investigations were recorded. The procedure was explained to the patients and written informed consent was obtained. Patients were

educated about the visual analogue scale. Patients were kept fasting for 6 hours. After shifting to the operation theatre, intravenous access was secured. Standard monitors were attached and baseline pulse rate, blood pressure, oxygen saturation and ECG were recorded. All patients were preloaded with Ringer lactate 10 ml/kg, 15 minutes before surgery.

Peripheral nerve stimulator-guided sacral plexus block was given by posterior approach before spinal anaesthesia. The patient was positioned laterally, with the leg to be blocked rolled forward onto the flexed knee as the heel rested on the knee of the dependent non-operative leg, in modified Sims position. A line was drawn connecting the posterior superior iliac spine to the ischial tuberosity. The line was divided into three parts and the needle entry point was identified at the junction of the middle two-thirds and lateral one-third.

After skin disinfection, local anaesthetic was infiltrated subcutaneously at the needle insertion site. The nerve stimulator was set to deliver a current intensity of 1.5 mA. A 22-gauge, 10–12 cm atraumatic insulated needle was advanced until motor response was elicited in the form of twitches of the foot and toes. After initial stimulation of the sacral plexus was obtained, the stimulating current was gradually decreased until twitches were still seen or felt at 0.2–0.5 mA. After proper needle placement and negative aspiration of blood, 20 ml of 0.5% bupivacaine was injected.Spinal anaesthesia was then administered under strict aseptic precautions using a 25-gauge Quincke spinal needle at L3–L4 space. Three ml of 0.5% hyperbaric bupivacaine was given intrathecally.

Monitoring

1. Haemodynamic parameters: pulse rate and mean arterial pressure.
2. Respiratory parameters: oxygen saturation and respiratory rate.
3. Characteristics of sensory block: time to reach peak sensory block using pin-prick method.
4. Characteristics of motor block using modified Bromage scale.
5. Adverse effects including nausea, vomiting, pruritus, hypotension, bradycardia, respiratory depression, sedation and prolonged sensory or motor blockade.
6. Postoperative analgesia using visual analogue scale.

Pain was assessed using VAS score from 0 to 10, where 0 indicated no pain and 10 indicated worst possible pain. Assessment was done at 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22 and 24 hours postoperatively. Intravenous diclofenac sodium 75 mg was administered slowly as rescue analgesia when VAS score exceeded 4. Time of supplemental analgesia was noted.

Statistical Analysis: Data on categorical variables were expressed as number and percentage. Data on continuous variables were expressed as mean ± standard deviation. Pair-wise comparisons were done using repeated-measures analysis of variance. The normality assumption was tested before applying repeated-measures ANOVA. Data were entered and cleaned in Microsoft Excel before analysis. Statistical analysis was performed using SPSS version 21.0. A p-value less than 0.05 was considered statistically significant.

Observations and Results

A total of 60 patients were recruited as per the calculated sample size. There were no dropouts and no failed block cases.

Table 1: Age distribution of cases studied

Age group	Number of cases	Percentage
20–29 years	11	18.3
30–39 years	28	46.7
40–49 years	19	31.7
50–60 years	2	3.3
Total	60	100.0

Of 60 cases studied, 11 cases (18.3%) were aged 20–29 years, 28 cases (46.7%) were aged 30–39 years, 19 cases (31.7%) were aged 40–49 years and 2 cases (3.3%) were aged 50–60 years. The mean age was 36.8 ± 6.9 years, with a range of 23–52 years.

Table 2: Sex distribution of cases studied

Sex	Number of cases	Percentage
Male	31	51.7
Female	29	48.3
Total	60	100.0

Of 60 cases studied, 31 cases (51.7%) were males and 29 cases (48.3%) were females. The male-to-female ratio was 1.07:1.

Table 3. Distribution according to ASA grade

ASA grade	Number of cases	Percentage
Grade I	41	68.3
Grade II	19	31.7
Total	60	100.0

Of 60 cases studied, 41 cases (68.3%) belonged to ASA grade I and 19 cases (31.7%) belonged to ASA grade II.

Table 4: Distribution of mean preoperative and Post operative pulse rate

Time interval	Mean pulse rate/min	SD	Pair-wise p-value compared with preoperative value
Preoperative	88.7	6.2	Reference
0 hour	75.9	4.2	0.001
2 hours	76.6	3.9	0.001
4 hours	76.6	3.7	0.001
6 hours	75.5	3.2	0.001
8 hours	75.3	3.0	0.001
10 hours	75.9	3.3	0.001
12 hours	76.4	3.3	0.001
14 hours	76.0	3.7	0.001
16 hours	82.6	5.8	0.001
18 hours	81.7	3.4	0.001
20 hours	80.7	3.3	0.001
22 hours	81.3	3.6	0.001
24 hours	81.2	3.5	0.001

Test applied: Repeated-measures ANOVA. Mean preoperative pulse rate was significantly higher compared with mean pulse rate at all postoperative time intervals studied. All pair-wise comparisons were highly significant, with p=0.001.

Table 5: Distribution of mean preoperative and postoperative mean arterial pressure

Time interval	Mean arterial pressure, mmHg	SD	Pair-wise p-value compared with preoperative value
Preoperative	87.0	4.0	Reference
0 hour	84.3	2.2	0.001
2 hours	84.3	2.2	0.001
4 hours	84.9	2.4	0.001
6 hours	84.4	2.2	0.001
8 hours	84.4	2.5	0.001
10 hours	84.5	1.9	0.001
12 hours	84.9	2.1	0.002
14 hours	85.3	1.9	0.002
16 hours	86.9	2.8	0.843
18 hours	85.4	2.0	0.006
20 hours	84.8	1.2	0.001
22 hours	84.9	1.4	0.001
24 hours	84.8	1.3	0.001

Test applied: Repeated-measures ANOVA. Mean preoperative mean arterial pressure was significantly higher compared with most postoperative time intervals. The difference between preoperative MAP and MAP at 16 hours was not statistically significant (p=0.843). Overall, mean arterial pressure remained clinically stable throughout the postoperative period.

Table 6: Distribution of postoperative pain score by VAS

Time interval	Mean VAS score	SD	Pair-wise p-value compared with 0-hour VAS
0 hour	0.00	0.00	Reference
2 hours	0.00	0.00	0.001
4 hours	0.00	0.00	0.001
6 hours	0.52	0.83	0.001
8 hours	0.52	0.83	0.001
10 hours	1.13	0.93	0.001
12 hours	1.52	1.03	0.001
14 hours	2.30	0.98	0.001
16 hours	3.28	1.01	0.001
18 hours	2.42	0.96	0.001
20 hours	2.12	0.55	0.001
22 hours	2.67	0.60	0.001
24 hours	2.87	0.43	0.001

Test applied: Repeated-measures ANOVA. Mean VAS score was 0.00 at 0, 2 and 4 hours. It increased gradually from 6 hours onward and reached the maximum value at 16 hours, with mean VAS score of 3.28 ± 1.01. The mean 0-hour pain score was significantly lower compared with pain scores at later postoperative intervals, with p=0.001 for all pair-wise comparisons as reported in the dissertation analysis.

Table 7: Distribution according to time to rescue analgesia

Time to rescue analgesia	Number of cases	Percentage
12–18 hours	53	88.3
18–24 hours	7	11.7
Total	60	100.0

Of 60 cases studied, 53 cases (88.3%) required rescue analgesia between 12 and 18 hours, while 7 cases (11.7%) required rescue analgesia between 18 and 24 hours. The mean time to rescue analgesia was 17.0 ± 2.2 hours, with a range of 12–24 hours.

Table 8: Distribution according to adverse reaction

Adverse reaction	Number of cases	Percentage
No	60	100.0
Yes	0	0.0
Total	60	100.0

No adverse reaction was observed in any patient. No adverse systemic toxicity of bupivacaine such as seizure, arrhythmia or cardiovascular collapse was noted. Neither vascular puncture nor paraesthesia occurred. No complications such as haematoma, infection or persistent paraesthesia were observed within 24 hours after surgery.

Discussion

Relieving pain is one of the fundamental responsibilities of medical practitioners and is usually a primary goal of patients seeking medical care. Published reviews have shown that a large proportion of patients may receive ineffective, inadequate, unsatisfactory or delayed pain relief [15]. Postoperative pain is an important cause of unplanned hospital admission after ambulatory surgery and is a major source of dissatisfaction with perioperative outcome. Foot and ankle surgeries are often associated with severe postoperative pain, which may require high doses of systemic analgesics and interfere with early mobilisation [16].

Recent applications of regional anaesthesia have focused more on postoperative analgesia than intraoperative anaesthesia, with the aim of improving patient comfort and assisting rehabilitation. Regional anaesthesia may reduce the stress response, systemic analgesic requirements and opioid-related side effects. In the present study, an attempt was made to evaluate the efficacy of single-shot sacral plexus block for postoperative pain relief in below-knee orthopaedic surgery.

In this prospective observational study of 60 patients, the mean age was 36.8 ± 6.9 years and the age range was 23–52 years. Most patients were in the 30–39 years age group. Males constituted 51.7% and females 48.3%, with a male-to-female ratio of 1.07:1. ASA grade I patients constituted 68.3% and ASA grade II patients constituted 31.7%.

The postoperative haemodynamic parameters remained clinically stable. The mean preoperative pulse rate was 88.7 ± 6.2/min, which decreased after surgery and remained stable during most postoperative time intervals. Pair-wise comparison showed that the difference between preoperative pulse rate and postoperative pulse rate at all observed time intervals was statistically significant (p=0.001). A mild increase in pulse rate was observed from 16 hours onward, which may be related to increasing VAS score and the need for rescue analgesia. Mean arterial pressure also remained stable throughout the postoperative period. Compared with preoperative MAP, the difference was statistically significant at most postoperative time intervals, while the difference at 16 hours was not statistically significant (p=0.843).

Parker et al. reported that nerve blocks reduce pain score and analgesic requirements [17]. In the present study, VAS score remained 0 up to 4 hours and remained low in the early postoperative period. The mean VAS score gradually increased after 6 hours and reached maximum at 16 hours. Pair-wise comparison of VAS score with 0-hour value showed statistically significant difference at all postoperative time intervals as reported in the dissertation analysis (p=0.001). The mean time to rescue analgesia was 17.0 ± 2.2 hours, suggesting that sacral plexus block provided prolonged postoperative analgesia in below-knee orthopaedic surgery.

The findings of the present study are comparable with the study by Monsó et al., who evaluated sciatic nerve blockade in the popliteal fossa for surgery of the dorsal foot. They reported high efficacy and good postoperative analgesia, with no major complications [13]. Similarly, Adalı et al. studied spinal anaesthesia and combined sciatic nerve/lumbar plexus block techniques in lower extremity orthopaedic surgery and reported that both techniques were effective, with prolonged duration of regional anaesthesia in the combined block group [2].

Sinha et al. studied the efficacy of single-shot sciatic nerve block for postoperative pain management in below-knee orthopaedic surgery. They found that single-shot sciatic nerve block provided effective pain relief to the majority of patients up to 18 hours and reduced postoperative analgesic requirement, with no adverse systemic toxicity of bupivacaine [18]. These findings are similar to the present study, in which mean time to rescue analgesia was 17 hours and no adverse reaction was observed.

Hegde and Manjunath evaluated the clinical efficacy of sciatic nerve block for below-knee orthopaedic surgeries and reported effective postoperative analgesia, good patient and surgeon satisfaction, and absence of haemodynamic instability or adverse events [19]. The present study also found stable haemodynamic parameters and no adverse reaction after sacral plexus block.

Vinod et al. evaluated combined psoas compartment block and sacral plexus block for lower limb surgeries and concluded that the technique was a safe alternative to neuraxial block, with good patient and surgeon satisfaction, less urinary retention and prolonged postoperative pain relief [20]. Although the present study used sacral plexus block followed by spinal anaesthesia, it similarly supports the role of sacral plexus block in providing postoperative analgesia for lower limb surgery.

No adverse systemic toxicity of bupivacaine such as seizure, arrhythmia or cardiovascular collapse was noted in the present study. Neither vascular puncture nor paraesthesia occurred. No complications such as haematoma, infection or persistent neurological deficit were observed within 24 hours after surgery. Thus, the study demonstrated useful postoperative pain relief with

single-shot sacral plexus block, along with haemodynamic stability and absence of observed complications.

However, the present study did not include a control group. Therefore, although the findings indicate effective postoperative analgesia after sacral plexus block, direct comparison with spinal anaesthesia alone or other analgesic techniques cannot be made. Further controlled studies are needed to establish comparative efficacy.

Limitations

The onset and quality of sacral plexus block could not be assessed independently because subarachnoid block was given immediately after sacral plexus block. The total duration of analgesia in patients who did not require rescue analgesia beyond 24 hours could not be assessed because observation was limited to 24 hours. Local infiltration was required in patients where the incision site involved the medial side of the leg. All blocks were performed by the same investigator, which reduced technical variability but may limit generalisation. The sample size was small and not sufficient to assess rare safety events. The VAS requires patient concentration and coordination and may be prone to some error in the immediate postoperative period.

Conclusion

Single-shot peripheral nerve stimulator-guided sacral plexus block using 20 ml of 0.5% bupivacaine provided effective postoperative pain relief in patients undergoing below-knee orthopaedic surgery. It was associated with prolonged time to rescue analgesia, low postoperative VAS scores in the early postoperative period, stable haemodynamic parameters and no observed adverse reaction during the 24-hour postoperative observation period. Sacral plexus block appears to be a promising component of multimodal analgesia for below-knee orthopaedic surgeries.

Recommendations

Sacral plexus block may be used as an effective method for providing postoperative analgesia in below-knee orthopaedic surgeries. A volume of 20 ml of 0.5% bupivacaine appears effective for postoperative pain relief in this setting. Further studies with larger sample size, control groups, different local anaesthetic agents, varying concentrations, adjuvants and ultrasound-guided techniques are recommended.

Ethical Approval: The study was conducted after approval from the Institutional Ethics Committee of Poona Hospital and Research Centre, Pune.

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