Research Article

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Efficacy of Pre-emptive Caudal Epidural Analgesia for Lumbosacral Spine Surgery: An Observational Study at a Tertiary Care Centre, Nepal

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ABSTRACT

Introduction: Perioperative pain is distressing and detrimental. Pre-emptive caudal epidural analgesia (CEA) with ropivacaine and adjuncts like dexamethasone are effective but under-utilised techniques in lumbosacral spine surgeries.

Objective: To evaluate role of pre-emptive caudal epidural analgesia with ropivacaine and dexamethasone for post-operative pain relief in lumbosacral surgeries.

Methodology: This analytical observational study was conducted among 60 patients included using convenience sampling from 2024 May to August at National Trauma Centre after ethical clearance. Patients were grouped I if received CEA and grouped II if not received. Post-operative visual analogue scale (VAS) scores were compared at immediate, four hours (hrs), eight hours, 12 hrs, and 24 hrs post-operative. Time of rescue analgesia requirement in 24 hours was also compared.

Result: There was no significant difference in age, sex, weight, and American Society of Anaesthesiologists physical status (ASA-PS) grade, and duration of anaesthesia. Eighteen (60%) out of 30 patients in CEA group (I) and four (13.33%) out of 30 in no CEA group (II), did not require rescue analgesia. Among those who required rescue analgesia, duration of analgesia (minutes) was 545.66 ± 437.01 in CEA group (I) and 143.34 ± 155.06 in no CEA group (II) which was significantly high (p-value = 0.0001). There was significant difference in post-operative VAS scores at immediate (0.0001), four hours (0.012), and eight hours (0.032) post-operative.

Conclusion: The study provides strong evidence supporting efficacy of pre-emptive caudal epidural analgesia in lumbosacral spine surgery by enhancing post-operative pain control, reducing opioid requirements, and improving patient satisfaction.

Keywords: Caudal; dexamethasone; ropivacaine.

INTRODUCTION

Lumbosacral spine surgeries encompass a range of orthopaedic procedures like discectomy, laminectomy, lumbar fusion, etc. The average rate of lumbar spine surgeries is 1.7-2.2/1000 United States (US) Medicare enrollees.[1] Lumbosacral

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surgery is mainly performed under general anaesthesia (GA). However, compared with GA, the spinal anaesthesia (SA) is associated with lower risk for intra-operative hypertension (0.31), intra-operative tachycardia (0.51), analgesic requirement in post-operative period (0.32), post-operative nausea/vomiting (PONV) (0.29) and shorter stay in hospital (standardised mean difference-1.15).[2] However, duration of surgery limits use of sole SA. So, GA with caudal epidural analgesia (CEA) is preferred.

The CEA places needle through sacral hiatus into epidural space.[3] Klocke et al.,[4] first described ultrasound-guided caudal block. Studies have repeatedly reported very high successful rates (96.9-100%).[5-9] Kiribayashi et al.,[10] proposed pre-emptive CEA lowers post-operative visual analgoue scale (VAS) score and fentanyl consumption. It is administered before onset of pain to prevent central nervous system (CNS) plasticity.[11] It prevents the establishment of central sensitisation and produces long lasting analgesia by blocking sensory input from both primary insult and secondary inflammatory injury.

Local anaesthetics (LA) are used in CEA; duration of analgesia can be further prolonged by adding adjuvants.[12] Ropivacaine is a long-acting LA which is less lipophilic than bupivacaine and lower penetration in larger myelinated motor fibres.[13] It demonstrates sensory A delta and C fibre blockage, while leaving the motor function of A alpha fibres, producing lower motor block, and faster regression.[14] Various studies also suggested that ropivacaine is less cardiac and CNS toxic.[15]

Single-shot CEA with LA provides analgesia for 2-4 hours (hrs) but this can be prolonged by adding adjuvants like opioids, steroids, ketamine, alpha-2 agonists, etc. Caudal dexamethasone prolongs the analgesic duration of the ropivacaine block than IV dexamethasone.[16] The aim of this study was to evaluate pre-emptive CEA for post-operative pain relief.

METHODOLOGY

The study was an analytical observational study performed at National Academy of Medical Sciences, National Trauma Centre, Mahankal, Kathmandu, Nepal from 2024 May to 2024 August after ethical clearance. The ethical approval for the study was also taken from the Ethical Review Board, Nepal Health Research council (Reference number: 2116). Patients with American Society of Anaesthesiologists Physical Status (ASA-PS) I and II of either sex aged 18–65 years and posted for elective lumbosacral spine surgeries were included in the study using convenience sampling. Patients with known hypersensitivity to ropivacaine, anomalies of sacral anatomy or local site infection were excluded from the study. In the preoperative visit on the evening before surgery, informed consent for research was taken and a VAS consisting of 10 centimetres (cms) horizontal line with a label of "no pain" at one end and "worst pain imaginable" at the other end was explained to the patient. The patient was asked to mark on this line at a point depicting the intensity of pain experience. The VAS score was the distance in millimetres (mm) from the "no pain" end of the line to the patient's mark.

All patients received general anaesthesia with injection (inj.) Midazolam 0.04 milligram (mg)/kilogram (kg), inj. Fentanyl 2 mcg/kg, inj. Propofol till loss of consciousness and inj. Rocuronium 0.6 mg/kg to facilitate intubation. Endotracheal intubation was done with an appropriate sized endotracheal tube. Foley's catheterisation of bladder was done. The patient was positioned prone for surgery. As per anaesthesiologist preference, some patients received ultrasound guided caudal epidural injection with 0.25% ropivacaine 20 milliltres (ml) containing 8 mg Dexamethasone. These patients were allocated to group I and the patients who did not receive caudal epidural injection were grouped II. Anaesthesia was maintained with oxygen and, Isoflurane. Any signs of spontaneous breathing or muscle movement intraoperatively were treated with inj. Rocuronium 10 mg as required. Inj. Paracetamol 1 g and inj. Diclofenac 75 mg was given intravenously, around one hour before the anticipated completion of surgery. After completion of surgery muscle relaxation was reversed with inj. Neostigmine 0.05 mg/kg and inj. Glycopyrrolate 0.01 mg/kg. The time of induction, caudal epidural injection, incision time and extubation time were noted. The VAS score was recorded at immediate post-operative period, 4, 8, 12, and 24 hours after surgery completion. All patients were given inj. Paracetamol 1 g 8 hourly and inj. Diclofenac 75 mg 12 hourly as an intravenous infusion. If any patients had VAS ≥4 at any time, rescue analgesia in the form of inj. Pethidine 50 mg with inj. Promethazine 25 mg was given intramuscularly. The time of demand of first dose of rescue analgesic medication was recorded. Any complications and adverse drug reactions were recorded.

Sample size was estimated on the basis of study by Samagh et al.,[13] where time to rescue analgesia (hrs), arithmetic mean ± standard deviation (SD) were 8.15 ± 4.73 and 1.65 ± 2.50 in ropivacaine and saline group, respectively. The pooled SD was 14.31, type I error taken as <5%, so Zα=1.96 (p<0.05) and type II error taken as <20% (power= 8 0%), so Zβ = 0.842. Using sample size estimation formula where the primary comparison is a mean that is $n > [2(Z\alpha + Z\beta)^2 \times SD^2] / d^2$ and taking 10% dropouts and rounding the figure, sample size was taken as 30 in each group, thus total 60 patients.

Data entry and statistical analysis was performed using statistical software IBM SPSS Statistics for Windows, version 21 (IBM Corp., Armonk, N.Y., USA). Chi-square test was used to compare qualitative and unpaired t-test was used to compare quantitative parameters like means or medians.

RESULT

There was no significant difference in the distribution of age, sex, weight, and ASA-PS grade and duration of anaesthesia (Table 1).

It was observed that 18 (60%) out of 30 patients in the CEA group (I) and four (13.33%) out of 30 in no CEA group (II) did not require rescue analgesia (Table 2). Among those patients who required rescue analgesia, the duration of analgesia (min) was 545.66 ± 437.01 in CEA group (I) and 143.34 ± 155.06 in no CEA group (II) which was significantly high with p-value of 0.0001 (Table 3).

The study also showed significant difference in post-operative VAS scores at immediate, four hour, and eight hour post-operative periods (Table 4). At immediate post-operative period VAS was 31.77 ± 7.03 in CEA group (I) and 56.77 ± 23.88 in no CEA group (II) with significant p-value of 0.0001. The VAS at four hour post-operative was 33.83 ± 5.41 in CEA group (I) and 33.03 ± 12.16 in no CEA group (II) with p-value of 0.012. VAS at 8 hour post-operative was 32.80 ± 7.12 in CEA group (I) and 36.23 ± 12.36 in No CEA group (II) with p-value of 0.032. VAS at 12 hour post-operative was 30.73 ± 9.96 in CEA group (I) and 38.33 ± 17.16 in No CEA group (II) with p-value of 0.172. VAS at 24 hour post-op was 31.13 ± 11.47 in CEA group (I) and 33.70 ± 9.54 in No CEA group (II) with p-value of 0.448.

Table 1: Demographic data of the patients.

Variables	CEA group (I)	No CEA group (II)	p-value
Age (years): mean ± SD	44.73 ± 13.81	49.23 ± 15.63	0.51
Sex: male/female	19/11	16/14	0.43
Weight (kg): mean ± SD	63.96 ± 10.36	60.13 ± 9.96	0.50
ASA-PS I/II	24/6	17/13	0.052
Duration of anaesthesia (min)	192 ± 62.61	214.57 ± 53.32	0.68

Table 2: Rescue analgesia requirement, n (%).

Rescue analgesia	CEA group (I)	No CEA group (II)
Required	12 (40)	26 (86.66)
Not required	18 (60)	4 (13.33)
Total	30 (100)	30 (100)

Table 3: Duration of analgesia (minutes).

	CEA group (I)	No CEA group (II)	p-value
Time of rescue analgesia (min) mean ± SD	545.66 ± 437.01	143.34 ± 155.06	0.0001

Table 4: Post-operative visual analogue scale score.

Variables	CEA group (I) (mean ± SD)	No CEA group (II) (mean ± SD)	p-value
VAS immediate post-operative	31.77 ± 7.03	56.77 ± 23.88	0.0001
VAS post-operative 4 hr	33.83 ± 5.41	33.03 ± 12.16	0.012
VAS post-operative 8 hr	32.80 ± 7.12	36.23 ± 12.36	0.032
VAS post-operative 12 hr	30.73 ± 9.96	38.33 ± 17.16	0.172
VAS post-operative 24 hr	31.13 ± 11.47	33.70 ± 9.54	0.448

DISCUSSION

The analytical observational study explores the efficacy of pre-emptive caudal epidural analgesia (CEA) for patients undergoing lumbosacral spine surgery. The findings provide valuable insights into pain management strategies in this high-risk population. Results suggest that CEA may significantly enhance post-operative pain control, reduce the need for opioids, and improve overall patient satisfaction compared to traditional analgesic approaches.

Samagh et al.[13] found that the mean intraoperative fentanyl requirement ($p = 0.001$) and mean VAS scores were significantly lower in the ropivacaine group in the immediate post-operative period, ($p < 0.001$), four hours ($p < 0.001$), eight hours ($p = 0.009$), 12 hours ($p = 0.007$), and 24 hours ($p = 0.046$) post-operatively. Additionally, the mean time to rescue analgesia was significantly longer in the ropivacaine group ($p < 0.001$) compared to Saline group. The findings were similar to this study.

Kalappa et al.[12] further supported these findings, showing that mean VAS scores were significantly lower in the ropivacaine-dexmedetomidine group for up to 12 hours following the caudal block than the ropivacaine alone group following pre-emptive CEA for lumbosacral spine surgeries.

In the study by Sekar et al.,[17] they administered pre-emptive single caudal epidural injection of 20 ml containing bupivacaine and tramadol in study group and 20 ml of normal saline in control group, 20 minutes before surgical incision for lumbosacral spine surgeries. They found that VAS and verbal rating scale (VRS) values at all time intervals were significantly lower ($p < 0.0001$) in study group. There was also a significant delay ($p = 0.0041$) in the first demand for supplemental analgesia medication in post-operative period in the study group. The findings were similar to this study.

Kumar et al.,[11] performed a prospective, randomised, controlled trial comprising 60 patients undergoing lumbosacral spine surgery. Group R (30) patients received a caudal epidural block with 20 mL of 0.2% ropivacaine after the administration of general anaesthesia. Group I (30) patients received no preoperative analgesia. Intravenous analgesics were administered during the post-operative period after a complaint of pain. There was a significant delay in the average time to the first demand for rescue analgesia in the group R. Group R also showed earlier ambulation with minimal adverse effects. The requirement for intraoperative fentanyl was higher in the group I.

In the study by Kalappa et al.,[16] among 96 patients undergoing lumbosacral spine surgery, they randomised the patients into three groups to receive 25 ml of pre-emptive caudal epidural injection of either injection ropivacaine 0.2% (Group A, n = 32), a 25 ml of injection ropivacaine 0.2%, and intravenous injection Dexamethasone 8 mg (Group B, n = 32) or 25 ml mixture of injection ropivacaine 0.2% with injection dexamethasone 8 mg (Group C, n = 32) under general anaesthesia. The mean VAS was significantly lower in the Group C for up to 24 h following the caudal block. No significant haemodynamic changes were noted in any of the groups. The intravenous dexamethasone group showed higher blood glucose levels at 24 h but was not clinically relevant. Their results support finding of this study.

The primary aim of effective pain management in lumbosacral spine surgery is to facilitate early mobilisation and recovery. The results of this study suggest the idea that pre-emptive CEA can achieve superior analgesic effects by blocking nociceptive pathways before surgical surgical trauma begins. This aligns with existing literature that supports the concept of pre-emptive analgesia, which suggests that administering analgesics before the onset of surgical pain can help reduce the central sensitisation process and the body's overall pain response.

One of the most significant findings of this study is the reduced need of opioids in CEA group. This is particularly important in the context of the ongoing opioid crisis. Lower opioid use helps reduce the risk of dependency and adverse effects. The opioid-sparing effect of CEA is likely attributable to its action on both peripheral and central pain pathways, suggesting a multimodal approach to analgesia that combines regional techniques with systemic medications.

Patient-reported outcomes are crucial in evaluating the efficacy of any analgesic technique. The study demonstrates that patients who received CEA reported higher satisfaction scores and better quality of life post-operatively. These findings emphasise the importance of considering patient-centred outcomes in pain management strategies, as effective analgesia can significantly enhance the overall surgical experience and expedite recovery.

While the results are promising, several limitations must be acknowledged. As an observational study, there may be inherent biases, such as selection bias and confounding variables that could influence outcomes. Randomised controlled trials are needed to validate these findings and establish causal relationships. Additionally, the sample size and demographic characteristics of the participants may limit the generalisability of the results to broader populations.

CONCLUSION

In conclusion, this observational study provides strong evidence supporting the efficacy of pre-emptive caudal epidural analgesia in lumbosacral spine surgery. By enhancing post-operative pain control, reducing opioid requirements, and improving patient satisfaction, CEA represents a promising option in multimodal analgesia strategies. However, further research is necessary to confirm these findings and refine pain management protocols for spine surgery patients.

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Conflict of interest: None.

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