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Comparison of the Postoperative Analgesia Effects of Patient-Controlled Analgesia and Epidural Catheter After Posterior Instrumentation Surgery

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Abstract: To prospectively assess the effects of intravenous patient-controlled analgesia (IV PCA) and epidural patient-controlled analgesia (epidural PCA) on postoperative pain management following posterior instrumentation surgery. The study involved the ASA 1-2 group, 60 patients who underwent elective thoracic or lumbar posterior instrumentation surgery at our tertiary centre for spinal stenosis. Two groups of patients were created: Group 1 (n=30), IV PCA group, and Group 2 (n=30), epidural PCA group. IV PCA was applied by fentanyl. Epidural PCA was maintained by lading to epidural space by the neurosurgeon. Bupivacaine was administered to Group 2 patients in the recovery room. Following surgery, patients in both groups were assessed for pain using the visual analogue scale (VAS) and for motor block using the Bromage scale. Additionally, hemodynamic parameters, side effects, and patient satisfaction were noted. Following 48 hours, patients' overall rescue analgesia, opioid, and local anaesthetic requirements were recorded. Postoperative VAS scores of Group 2 at the 1st, 2nd, 4th, 8th, and 16th hours were lower than Group 1 and these differences was statistically significant. Postoperative patient satisfaction scores at 1st, 2nd, 4th, 8th, 12th, 16th, 20th, 24th, 30th, 36th, 42nd, and 48th hours were significantly different between the groups and the patient satisfaction scores of Group 2 were higher than the Group 1. Side effects were similar in both groups. Group 1 required statistically significantly higher number of rescue analgesia. This study shows that epidural PCA is more comfortable than IV PCA with low VAS and high patient satisfaction scores. As a conclusion, epidural PCA is a safe, highly efficient method for patients with posterior instrumentation surgery. ©2023 NTMS.

Keywords: Analgesia; Patient-Controlled; Pain; Postoperative.

1. Introduction

Posterior instrumentation surgery is a successful treatment for spinal stenosis [1]. Postoperative pain, however, is a usual and a serious incident after posterior instrumentation surgery. Poorly controlled postoperative pain not only reduces patients' quality of life and satisfaction, but also increases hospitalization, cardiopulmonary complications, pain-related morbidity, and hospital mortality [2-4]. However, there is no consensus on postoperative pain management after posterior instrumentation surgery [4, 6, 7].

Intravenously administered systemic opioids are often used for pain control, but several dose-related complications associated with opioid use have been reported. Anaesthesiologists should make all efforts to decrease the quantity of opioid supplied and discover alternative medications or ways for pain control

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because posterior instrumentation surgery is typically performed on elderly individuals [5].

Effective postoperative pain management techniques include the use of opioids or epidural analgesia along with local anaesthesia. Compared to intravenous PCA, these methods have certain advantages in that they offer more effective pain control and cause fewer complications during stomach, thoracic, and spine operations. The effectiveness and safety of continuous epidural analgesia with fentanyl, intravenous PCA, and bupivacaine for posterior instrumentation surgery, particularly postoperative complications, have not been demonstrated, however [6, 7]. In a prospective randomized controlled trial, we sought to compare the clinical outcomes of intravenous PCA with epidural analgesia.

2. Material and Methods

The study was approved by Atatürk University Faculty of Medicine Ethics Committee (06.06.2013(5)/4). Patients who willingly participated in the study and gave their informed consent. In this study CONSORT (Consolidated Standards of Reporting Trails) reporting guideline was used.

2.1. Patients

Sixty cases of ASA 1-2 group (18-65-year-old), who underwent elective thoracic or lumbar posterior instrumentation surgery for spinal stenosis at our tertiary centre were enrolled prospectively (Figure 1). According to the patients' preferences, they were split into two groups (Group 1; IV PCA group; Group 2; epidural PCA group).

Exclusion criteria included having a known allergy to study drugs, having undergone surgery at the fourth or higher level, refusing to participate in the study, using drugs previously, being pregnant, having a heart arrhythmia, or having a neurological deficiency.

2.2. Anaesthesia Method

For the induction of anaesthesia in two groups, IV 2 mg/kg propofol, 2 μg/kg fentanyl, 1 mg/kg lidocaine and 1 mg/kg rocuronium were administered. Anaesthesia was continued with 1-3% sevoflurane in 45% O_2+55% N_2O.

Group 1 (IV PCA Group): In Group 1 patients, PCA device in the recovery room was set as 75 μg loading, 20 μg/hour basal infusion, 20 μg bolus, 10 minutes locked time, fentanyl at a concentration of 10 μg/mL. If the VAS scores were above 3, 30 μg fentanyl bolus was performed for rescue analgesia and the subsequent bolus doses were increased to 30 μg. 75 mg of diclofenac sodium IM total amount of opioid was recorded after 48 hours of cases and rescue analgesic count.

Group 2 (Epidural PCA Group): For Group 2, still epidural space is open, the neurosurgeon placed the epidural catheter via the intact skin by the Tuohy needle at the end of the operation (Figure 2). In the recovery room, 0.1% bupivacaine+2 μg/mL fentanyl mixture was prepared and the PCA device was set as 10 mL loading dose, 10 mL/hour basal infusion, 10 mL bolus and 45 minutes locked time. If the VAS scores were above 3, 20 mL bolus dose was done for the rescue analgesia. In case of no analgesia within 20 minutes, the concentration of local anaesthetic was increased to 0.125% bupivacaine+2 μg/mL fentanyl and 20 mL bolus dose was performed.

2.3. Rescue Analgesia

If the pain still does not occur within 20 minutes, then 75 mg diclofenac sodium IM done. At the end of 48 hours, total opioid, local anaesthetic amount, and rescue analgesia count were recorded.

2.4. Measurements and Side Effects:

patients in both groups were assessed for pain using the visual analogue scale (VAS) and motor block using the Bromage scale at the 1^{th}, 2^{nd}, 4^{th}, 8^{th}, 12^{th}, 16^{th}, 20^{th}, 24^{th}, 30^{th}, 36^{th}, 42^{nd}, and 48^{th} hours following surgery, Simultaneously, hemodynamic parameters, and patient satisfaction (0=bad, 1=moderate, 2=good, 3=very good, 4=excellent) were recorded. The side effects such as nausea, vomiting, and itching were evaluated and recorded.

2.5. Statistical Analyses:

The statistical calculations were performed using IBM SPSS Statistics for Windows, Version 21.0 (IBM Corp., Armonk, NY). Continuous variables are expressed as Mean±Standard Deviation (SD), categorical data are expressed as n (%). According to the Power analysis, it has been calculated that a minimum of 21 patients should be evaluated for 0.05 error and 80% power *(http://clincalc.com/stats/samplesize.aspx)*. Histogram, Shapiro-Wilk and the one-sample Kolmogorov-Smirnov test were performed to determine the distribution of the data. Independent sample t-test was used to compare demographic characteristics, operation times, systolic, diastolic blood pressure values, pulse variables, VAS values and patient satisfaction scores in both groups. Linear regression analysis was performed to determine the effect of systolic, diastolic blood pressure values and pulse variables on VAS scores and patient satisfaction in each group. Chi-square test was used for side effect analysis. All tests were applied as two-sided whereby p-value <0.05 was considered as statistically significant.

3. Results

Demographic features of the groups are seen at Table 1. There was no statistically significant difference between the groups in terms of age, weight and gender. The operation time of the cases was similar in both groups.

VAS scores in Group 2 at postoperative 1^{st}, 2^{nd}, 4^{th}, 8^{th}, and 16^{th} hours were significantly lower than those in Group 1 (Table 2).

The patient satisfaction scores were higher in Group 2 than Group 1 for postoperative 1st, 2nd, 4th, 8th, 12th, 16th, 20th, 24th, 30th, 36th, 42nd, and 48th hours and the differences were statistically significant (Table 3).

In Group 1, 16 cases and in Group 2, 4 patients received rescue analgesia as 75 mg diclofenac sodium IM done. In Group 2, the need for rescue analgesia was found to be lower than group 1 and the differences was statistically significant (Table 4).

None of the 60 patients in Group 1 and Group 2 had urinary retention, urinary incontinence, or motor block during their hospitalization. All patients' Bromage scale was 0. Nausea and vomiting were seen in 4 cases in Group 1, 3 cases in Group 2, and metoclopramide intervention was performed.

Table 1: Demographic features of the groups.

	Group 1 (n=30)	**Group 2 (n=30)**	**P Values**
Age	51.5±11.2	53.3±8.7	0.483
Weight	75.6±13.1	79.7±12.3	0.226
Sex	16(53%)/14(47%)	15(50%)/15(50%)	0.800

All values are given as Mean±SD. Gender is given in %. P<0.05: statistically significant (independent samples t-test).

Table 2: Postoperative VAS Scores.

Time	**Group 1 (n=30)**	**Group 2 (n=30)**	**P Values**
1st hour	7.70±0.87	6.93±1.28	0.009
2nd hour	5.00±1.20	2.87±0.73	0.000
4th hour	3.03±0.85	2.00±0.37	0.000
8th hour	2.10±0.84	1.47±0.50	0.001
12th hour	1.50±0.77	1.20±0.61	0.102
16th hour	1.37±0.76	0.93±0.69	0.025
20th hour	1.03±0.76	0.80±0.61	0.197
24th hour	0.67±0.71	0.47±0.62	0.253
30th hour	0.57±0.62	0.33±0.66	0.166
36th hour	0.43±0.62	0.20±0.48	0.122
42nd hour	0.37±0.55	0.20±0.48	0.221
48th hour	0.37±0.55	0.20±0.48	0.221

All values are given as Mean±SD. P<0.05: statistically significant (independent samples t-test).

Table 3: Patient satisfaction scores.

Time	**Group 1 (n=30)**	**Group 2 (n=30)**	**P Values**
1st hour	0.97±0.76	1.50±0.63	0.005
2nd hour	1.40±0.89	2.67±0.71	0.000
4th hour	2.30±0.65	3.23±0.77	0.000
8th hour	2.63±0.85	3.60±0.56	0.000
12th hour	2.97±0.80	3.67±0.54	0.000
16th hour	3.17±0.69	3.80±0.40	0.000
20th hour	3.27±0.69	3.87±0.34	0.000
24th hour	3.47±0.57	3.87±0.34	0.002
30th hour	3.53±0.50	3.90±0.30	0.001
36th hour	3.53±0.50	3.87±0.43	0.008
42nd hour	3.60±0.49	3.90±0.30	0.007
48th hour	3.60±0.49	3.90±0.30	0.007

All values are given as Mean±SD. P<0.05: statistically significant (linear regression analysis).

Table 4: Rescue analgesia need.

	Group 1 (n=30)	Group 2 (n=30)	P Value
Cases	16	4	0.003

P<0.05: Statistically significant (Chi-square test).

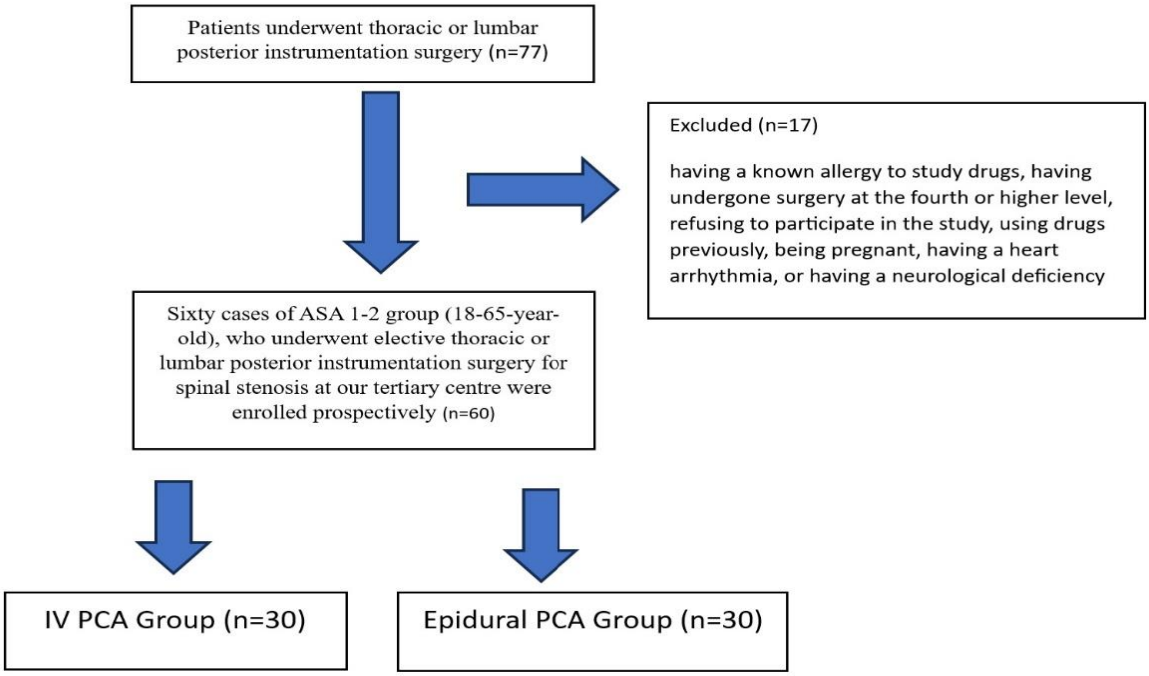

Figure 1: Flowchart of the study.

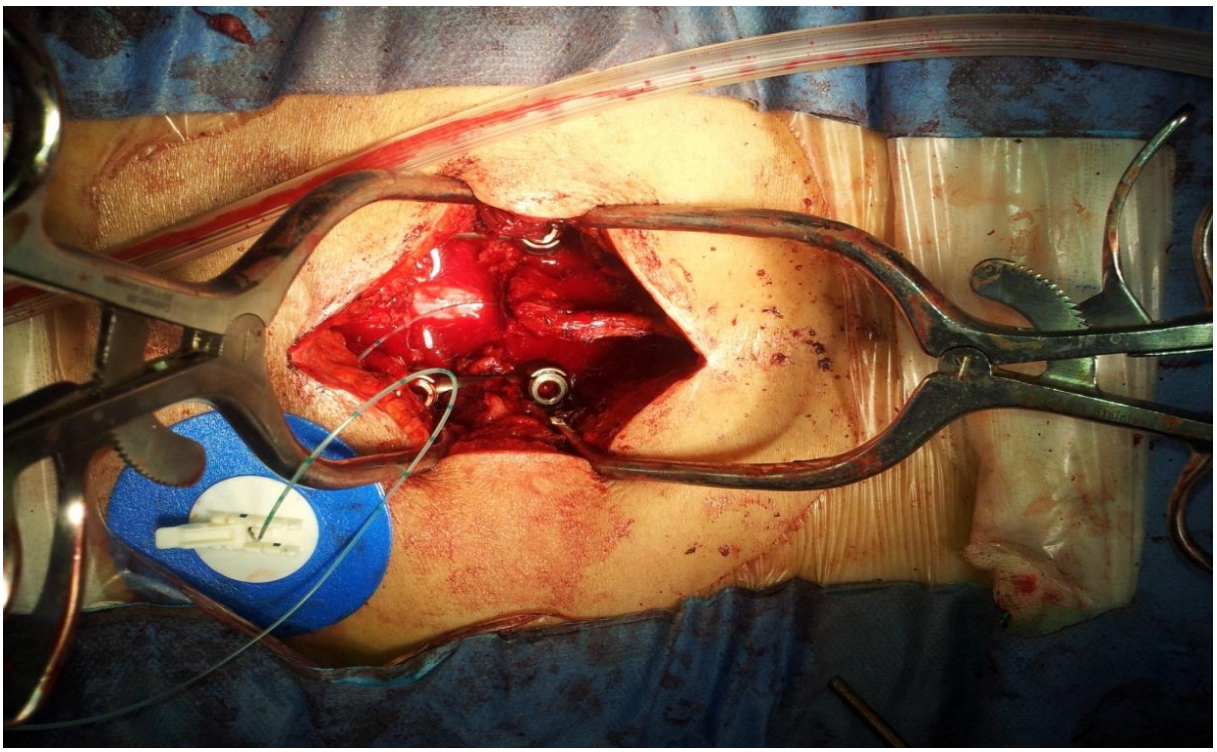

Figure 2: Epidural catheter on the epidural space.

4. Discussion

Our study found that, epidural PCA is linked with a lower pain score, more satisfied patients, and fewer complications in contrast to IV PCA in the postoperative period after thoracic and lumbar instrumentation surgery.

There are numerous views that use opioid analgesics with local anaesthesia to provide an effective analgesia method, reduce the dose of drugs to be administered, reduce the side effects of drugs, and prevent adverse physiological effects from endocrine stress response and painful stimulation [8,9]. Acute opioid-associated respiratory depression, heart toxicity, and central nervous system depression are more likely with epidural or intrathecal opioids. Since older people are typically candidates for posterior instrumentation surgery, adverse effects from epidural opioids may be more common and severe. Although continuous infusion of epidural opioids appears to be more prone to side effects, single-dose epidural opioids may be insufficient to control postoperative pain [8-10].

Most patients with posterior instrumentation surgery have severe pain. Epidural PCA and IV-PCA are two common options in the treatment of postoperative pain. In studies, different drug regimens have been compared at different doses but there is no universally accepted consensus about which analgesic approach performs better [7]. The literature has different opinions on the efficiency and safety of epidural pain control techniques. It was discovered that there is no discernible difference between those receiving epidural analgesia and those receiving a placebo. However, paraesthesia was more common in the epidural group [12]. Additionally, a different study discovered no discernible difference between IV PCA and epidural PCA. Only the intestinal sounds were reported earlier in the epidural group [13]. A study conducted on three groups of patients undergoing scoliosis surgery stated that the double catheter used for postoperative analgesia was superior to both a single catheter and iv PCA [14]. A case-control study consisting of 120 patients with lumbar degenerative disease has demonstrated, in the epidural PCA group, significantly lower VAS scores were detected in 3rd, 6th, 12th, 24th and 48th hours of surgery-related pain compared to the iv PCA group. In addition, the level of patient satisfaction was significantly higher than the PCA group and the side effects were lower [15].

Motor block after spinal cord surgery is an important issue that concerns all aspects of postoperative care. Close observation is necessary as higher concentration and infusion rate may cause temporary motor block. A study with 72 patients undergoing major spinal surgery, epidural PCA with ropivacaine and sufentanyl was compared to IV PCA with morphine. The excellent pain control in this study was probably due to a higher concentration of ropivacaine, a higher infusion rate, and the use of epidural opioids. In this study, ropivacaine was prepared at a concentration of 0.125% and this resulted in motor block in 5 of 28 patients [6]. In another study, the use of ropivacaine, which was %0.1, provided the desired pain control, but in nine of the 29 patients, unwanted transient loss of sensation and motor block were seen [16]. Since we utilized 0.125% bupivacaine in our trial, none of the patients experienced motor block. In addition, there are publications suggesting that the use of drugs at low concentration or low volume will result in failure [17, 18]. During an observational study of fourteen patients underwent posterior spinal fusion surgery, the epidural catheter was placed by the surgeon and checked by X-ray using radiopaque material. In 7 patients with high VAS scores, the epidural catheter was not in the proper position. It suggested that the correctly placed surgical epidural catheters could provide better postoperative analgesia and misplaced catheters were associated with inadequate analgesia [19]. In another study, 24 hours after spinal fusion surgery, in 33 (8%) of 413 patients, epidural infusion was stopped due to severe pain, this was stated to be brought on by the epidural catheter being positioned incorrectly. According to these results, insufficient analgesia after spinal surgery may be due to the epidural catheter's improper placement, which in turn leads to insufficient drug infusion into the epidural area [20]. In addition, bleeding in the surgical area or drainage catheters applied to this area may also be the cause of inadequate infusion.

The surgeons in our study placed the epidural catheter under direct visualization without radiographic validation. Patients were also classified according to their choices after the procedure was described. These may be the limitations of our study.

5. Conclusions

In conclusion, epidural PCA is a safe, highly efficient method for patients with posterior instrumentation surgery by providing effective postoperative analgesia, no serious side effects, high patient satisfaction.

Limitations of the Study

Additional to above mentioned limitations there were potential population bias, limited number of patients, single centre study.

Acknowledgement

None.

Conflict of Interests

The authors declare no conflict of interest.

Financial Support

No.

Author Contributions

MAK, HAA: Conceptualization, methodology, validation, formal analysis, investigation, data curation, writing-original draft preparation, writing-review and editing, visualization, and supervision. All authors have read and agreed to the published version of the manuscript.

Ethical Approval

It was approved by Atatürk University Faculty of Medicine Ethics Committee (06.06.2013(5)/4).

Data sharing statement

Available upon request from the corresponding authors. The data are not publicly available due to compliance with privacy laws.

Consent to participate and Informed Statement

Adults who willingly participated in the study and gave their informed consent to be study subjects provided all the data.

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