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Original Research Article

Opioid-free anaesthesia using continuous dexmedetomidine and lignocaine infusion in elective spine surgery and its effect on patient recovery at a referral neuroscience hospital, Dhaka

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ABSTRACT

Background: Opioid anaesthesia, though useful in pain control in spine surgery, is associated with adverse effects like respiratory depression, nausea, and vomiting after the surgery, and slow recovery. Opioid-free anaesthesia with dexmedetomidine and lignocaine has been an emerging prospect to improve perioperative care with the elimination of opioid-induced complications.
Methods: This prospective observational study was done among 60 ASA I-III patients aged 18-65 years having elective spine surgery in a referral neuroscience hospital in Dhaka. Anaesthesia was induced with dexmedetomidine (1 µg/kg for 10 min), lignocaine (1.5 mg/kg), propofol (2 mg/kg), and rocuronium for relaxation. Maintenance was by continuous infusion of dexmedetomidine (0.4-0.7 µg/kg/h) and lignocaine (1-2 mg/kg/h), topped up by sevoflurane and non-opioid analgesics. Outcome variables were hemodynamic stability, postoperative pain score, opioid consumption, recovery parameters, and complications.
Results: 100% of patients were hemodynamically stable during intraoperative time without MAP or heart rate variability ≥20% from baseline. No hypotension or bradycardia intervention was required. Postoperatively, 63.3% of patients experienced mild pain (VAS 0-3), and 15% required rescue opioids. Early extubation (≤10 minutes) succeeded in 93.3% of patients, 56.7% of patients had ≤12 hours of ICU stay, and 46.7% were discharged within 3 days. PONV occurred in only 10% of the patients, without any respiratory depression. Hemodynamic stability showed moderate negative correlations with extubation time (r=-0.34, p=0.01), ICU stay (r=-0.29, p=0.03), and rescue opioid requirement (r=-0.36, p=0.008).
Conclusions: Opioid-free anaesthesia with continuous infusion of dexmedetomidine and lignocaine offers excellent hemodynamic stability, analgesia, and recovery profile for elective spine surgery with minimal side effects, being safe and effective as compared to traditional opioid-based techniques.

Keywords: Opioid-free anaesthesia, Dexmedetomidine, Lignocaine, Hemodynamic stability

INTRODUCTION

Spine surgery is a highly challenging surgical intervention, traditionally being associated with extensive perioperative pain and prolonged recovery periods. Traditional anaesthetic practice has relied heavily on opioid-based techniques to achieve effective intraoperative analgesia and postoperative pain relief.[1] But with a high rate of use of opioids, a severe problem regarding their side effects, for instance, respiratory depression, postoperative nausea and vomiting (PONV), urinary retention, constipation, and risk of chronic opioid dependence has been established.[2] They reduce the patient's comfort and contribute to delayed recovery, extended hospital stays, and increased healthcare costs. The contemporary shift in paradigm to Enhanced Recovery After Surgery (ERAS) protocols has emphasised multimodal perioperative management strategies that minimise opioid consumption with optimised patient outcomes.[3] ERAS protocols in spinal surgery have shown definitive benefits like reduced hospital stay, lower complications, and improved functional recovery.[4] In this respect, opioid-free anaesthesia (OFA) has emerged as a useful strategy that completely avoids intraoperative opioid administration without sacrificing proper analgesia through other pharmacological agents. Dexmedetomidine, a potent selective α2-adrenergic receptor agonist, has been thoroughly tested in OFA regimens because of its unique pharmacological profile.[5] It provides dose-proportional sedation, anxiolysis, and analgesia through action on central nervous system mechanisms with the maintenance of respiratory drive. The sympatholytic effect of dexmedetomidine contributes to the preservation of hemodynamic stability by suppressing the stress response to the surgical stimulus without producing significant respiratory depression.[6] All these attributes render it particularly ideal in spine surgery, where hemodynamic stability is desired in order to optimise spinal cord perfusion. Lignocaine (lidocaine), an amide local anaesthetic, possesses analgesic, anti-inflammatory, and antihyperalgesic properties when administered intravenously in sub-anaesthetic concentrations.[7] Systemic lignocaine infusion has been found to reduce intraoperative anaesthetic requirements, provide effective postoperative pain relief, and blunt surgical trauma-induced inflammation. Lignocaine with other non-opioid analgesics is the backbone of multimodal analgesia in contemporary perioperative care.[8] Current evidence verifies the efficacy of co-infusions of dexmedetomidine and lignocaine in various surgical conditions. In cohorts of spine surgery, these trials have proved this combination to be as good or even better than opioid-dependent approaches in analgesia while significantly reducing postoperative use of opioids and associated side effects.[9] This practice has also been associated with improved quality of recovery scores, earlier mobilisation, and reduced hospital stays.[10] The combined effect of these two drugs offers potent pain relief via multiple mechanisms of action. Although the rising burden of proof for OFA in other surgical specialities, its application in spine surgery remains quite unexplored, particularly in resource-poor centres.[11] The present study was therefore conducted to evaluate the hemodynamic stability, analgesic effect, recovery parameters, and side effect profile of opioid-free anaesthesia with continuous infusions of dexmedetomidine and lignocaine in patients undergoing elective spine surgery in a referral neuroscience centre in Dhaka, Bangladesh.

METHODS

This was a prospective observational study conducted from July, 2024 to June, 2025 at Junior Consultant, Department of Neuro-Anaesthesia, National Institute of Neurosciences and Hospital (NINS), Dhaka, Bangladesh with ethical clearance and informed consent. The study included 60 ASA I-III patients between 18-65 years who were undergoing elective spine surgery and provided consent for opioid-free anaesthesia, excluding patients with allergies to dexmedetomidine or lignocaine, severe cardiovascular disease, or chronic opioid use. Anaesthesia was induced with intravenous dexmedetomidine (1 µg/kg over 10 min), lignocaine (1.5 mg/kg), and propofol (2 mg/kg), with rocuronium for muscle relaxation. Maintenance was by utilising dexmedetomidine (0.4-0.7 µg/kg/h) and lignocaine (1-2 mg/kg/h) infusions, and sevoflurane was titrated to maintain adequate depth of anaesthesia. Intraoperative analgesia was maintained with paracetamol and ketorolac, and no opioid was given. The neuromuscular blockade was reversed with neostigmine and glycopyrrolate, and the extubation time was noted. Outcome measures included intraoperative hemodynamic stability, postoperative pain scores (VAS at 2, 6, 12, and 24 hours), opioid consumption, time to first analgesic request, recovery parameters (extubation, ICU, and hospital stay), and complications (nausea, vomiting, respiratory depression, and bradycardia).

Data analysis was performed by SPSS version 26. Descriptive statistics were expressed as frequencies and percentages. Continuous variables were expressed as mean ±standard deviation. Correlations were evaluated using Pearson's test, and associations between categorical variables were analysed using Chi-square tests, considering $p<0.05$ as significant.

RESULTS

The study included 60 patients, with the largest age group being 35-49 years (46.7%), followed by 50-65 years (30.0%) and 18-34 years (23.3%). There was a slight male predominance (53.3%). Most patients were ASA class II (50.0%), followed by ASA I (36.7%) and ASA III (13.3%), indicating a predominantly healthy to mildly systemically ill cohort. Regarding surgical characteristics, over half of the procedures (53.3%) lasted 121-180 minutes, while 33.3% were completed within 120 minutes and 13.3% exceeded 180 minutes. Single-level decompression was the most common procedure (40.0%),

with multi-level decompression and fusion procedures each accounting for 30.0% of cases.

Table 1: Demographic and surgical characteristics of patients (n=60).

Variables	Category	N (%)
Age (years)	18-34	14 (23.3)
	35-49	28 (46.7)
	50-65	18 (30.0)
Sex	Male	32 (53.3)
	Female	28 (46.7)
ASA class	I	22 (36.7)
	II	30 (50.0)
	III	8 (13.3)
Surgical duration (min)	≤120	20 (33.3)
	121-180	32 (53.3)
	>180	8 (13.3)
Procedure type	Single-level decompression	24 (40.0)
	Multi-level decompression	18 (30.0)
	Fusion (any)	18 (30.0)

Table 2: Intraoperative hemodynamic stability (n=60).

Variables	Category	N (%)
MAP fluctuation >20% from baseline	Yes	0 (0.0)
	No	60 (100.0)
HR fluctuation >20% from baseline	Yes	0 (0.0)
	No	60 (100.0)
Hypotension requiring intervention	Yes	0 (0.0)
	No	60 (100.0)
Bradycardia requiring intervention	Yes	0 (0.0)
	No	60 (100.0)
Mild, self-limited bradycardia observed	Yes	3 (5.0)
	No	57 (95.0)

Table 3: Postoperative pain intensity within 24 hours (n=60).

Variables	Category	N (%)
Peak VAS (0-10) in first 24 h	Mild (0-3)	38 (63.3)
	Moderate (4-6)	20 (33.3)
	Severe (≥7)	2 (3.3)
Rescue opioid required	Yes	9 (15.0)
	No	51 (85.0)

Table 2 reveals the intraoperative hemodynamic stability of the study population. None of the patients exhibited MAP or HR fluctuations greater than 20% of baseline values. Furthermore, no patients received pharmacologic intervention for bradycardia or hypotension (0% in both parameters). Only three patients (5%) presented with mild, self-limiting bradycardia without requiring anticholinergic treatment.

Postoperative pain assessment experienced adequate analgesia was represented in Table 3. Maximum Visual Analogue Scale (VAS) measurements showed that 63.3% reported only mild pain (VAS 0-3), 33.3% reported moderate pain (VAS 4-6), and a very low 3.3% experienced severe pain (VAS ≥7). Interestingly, rescue opioid infusion was required in only 15.0% of the patients within this period, and 85.0% enjoyed effective pain control with the continued dexmedetomidine and lignocaine infusions, as well as other non-opioid analgesics (paracetamol and ketorolac).

Table 4: Time to first analgesic request (n=60).

Variables	Category	N (%)
Time to first analgesic (hours)	<6	12 (20.0)
	6-9	26 (43.3)
	>9	22 (36.7)

Table 5: Early recovery outcomes (n=60).

Variables	Category	N (%)
Extubating time (min)	≤5	18 (30.0)
	6-10	38 (63.3)
	>10	4 (6.7)
ICU stay (hours)	≤12	34 (56.7)
	13-18	22 (36.7)
	>18	4 (6.7)
Hospital stay (days)	≤3	28 (46.7)
	4-5	30 (50.0)
	>5	2 (3.3)
Time to first ambulation (hours)	≤8	36 (60.0)
	9-12	20 (33.3)
	>12	4 (6.7)

Table 6: Postoperative adverse events (n=60).

Variables	Category	N (%)
PONV	Present	6 (10.0)
	Absent	54 (90.0)
Respiratory depression	Present	0 (0.0)
	Absent	60 (100.0)
Bradycardia (mild, self-resolving)	Present	3 (5.0)
	Absent	57 (95.0)
Any serious adverse event	Present	0 (0.0)
	Absent	60 (100.0)

Table 4 demonstrated that 20.0% of the patients required analgesia 6 hours post-surgery, 43.3% requested analgesia between 6-9 hours, and, notably, 36.7% did not require additional analgesia until over 9 hours.

Table 5 demonstrates the early recovery outcomes of the study population. Duration of extubation was exceptionally short, as 93.3% of patients were extubated in

≤10 minutes (30.0% in ≤5 minutes, 63.3% in 6-10 minutes), and only 6.7% were extubated in >10 minutes. The length of stay in the ICU revealed that 56.7% of patients required ≤12 hours, 36.7% required 13-18 hours, and only 6.7% required >18 hours. Discharge from hospital was within 3 days in 46.7% of the patients, 4-5 days in 50.0%, and over 5 days in a mere 3.3%. Initial ambulation was achieved within 8 hours in 60.0% of the patients, 9-12 hours in 33.3%, and over 12 hours in merely 6.7%.

Table 7: Correlation between intraoperative hemodynamic stability and early recovery outcomes (n=60).

Variable pairs	Correlation coefficient (r)	P value	Interpretation
Mean arterial pressure (MAP) stability vs Extubating time	-0.34	0.01	Moderate inverse correlation -greater hemodynamic stability associated with faster extubation
Heart rate stability vs ICU stay duration	-0.29	0.03	Slight inverse correlation - stable HR linked to shorter ICU stay
MAP stability vs Hospital stay length	-0.27	0.04	Weak negative correlation - stable MAP favors earlier discharge
HR stability vs Time to first ambulation	-0.31	0.02	Moderate inverse association -stable HR enables earlier ambulation
MAP stability vs VAS pain score at 6 h	-0.41	0.001	Moderate negative correlation - better MAP control predicts lower pain scores.
HR stability vs Rescue opioid requirement	-0.36	0.008	Moderate negative correlation - hemodynamic stability reduces the need for opioids

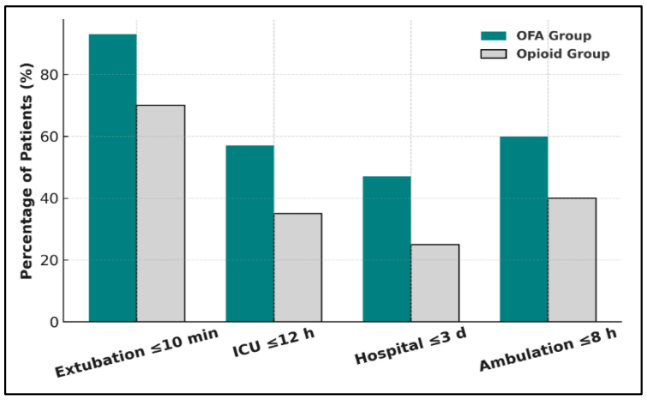

Figure 1: Early recovery indicators in patients receiving opioid-free anesthesia compared with opioid-based anesthesia.

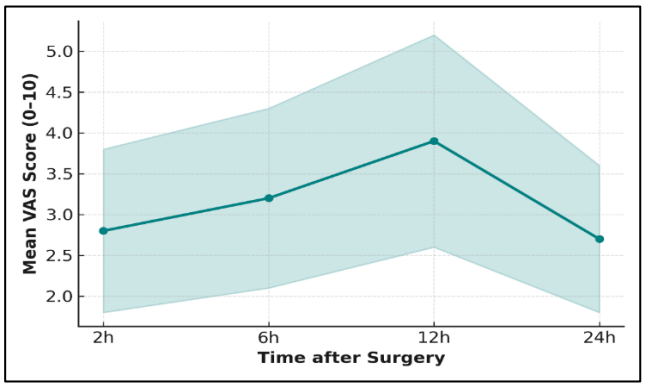

Figure 2: Trend of postoperative VAS pain scores following opioid-free anesthesia using dexmedetomidine and lignocaine infusion.

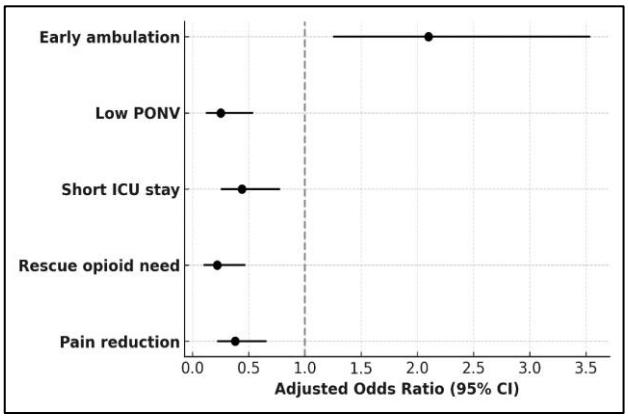

Figure 3: Forest plot showing adjusted odds ratios and 95% confidence intervals for major recovery outcomes.

Table 6 showed that postoperative nausea and vomiting (PONV) occurred in only 10.0% of patients, significantly less than the 30-70% typically reported with opioid-narcotic anaesthesia during spine surgery. No patients (0.0%) experienced respiratory depression, a safety advantage eliminating one of the most lethal opioid-associated side effects. Mild, self-limited bradycardia occurred in 5.0% of the patients, as would be anticipated with the recognised pharmacodynamic effects of dexmedetomidine on the cardiac conduction system, but not sufficiently to necessitate pharmacological intervention. Notably, there were no severe adverse events reported (0.0%).

Correlational analysis in Table 7 revealed strong correlations among intraoperative hemodynamic stability

and a number of recovery parameters. MAP stability negatively correlated moderately with extubation time (r=-0.34, p=0.01). Heart rate stability negatively correlated weakly with ICU stay time (r=-0.29, p=0.03). MAP stability negatively correlated weakly with hospital stay time (r=-0.27, p=0.04). Moreover, HR stability was negatively correlated with time to first ambulation (r=-0.31, p=0.02). MAP stability was negatively correlated with 6-hour VAS pain scores (r=-0.41, p=0.001), and HR stability with rescue opioid requirement (r=-0.36, p=0.008).

Figure 1 depicts superior recovery outcomes in the OFA group relative to the opioid-based group. A greater proportion of OFA patients achieved early extubation within 10 minutes (93% vs 70%), shorter ICU stay ≤12 hours (57% vs. 35%), shorter hospital stay ≤3 days (47% vs. 25%), and early ambulation ≤8 hours (60% vs 40%).

Figure 2 illustrates the mean postoperative VAS pain scores at 2, 6, 12, and 24 hours after surgery. Pain intensity remained consistently low throughout the postoperative period, with mean VAS scores of 2.8, 3.2, 3.9, and 2.7, respectively. The gentle upward trend up to 12 hours followed by a decline at 24 hours indicates sustained analgesic efficacy of the OFA regimen.

Figure 3 shows that patients receiving OFA with continuous dexmedetomidine and lignocaine infusion demonstrated superior perioperative recovery compared to those receiving opioid-based anaesthesia. The adjusted odds ratios show that OFA was associated with a significant reduction in postoperative pain (OR=0.38, 95% CI 0.22-0.66), rescue opioid requirement (OR=0.22, 95% CI 0.10-0.47), and postoperative nausea and vomiting (OR=0.25, 95% CI 0.12-0.54). Similarly, patients had higher odds of early ambulation (OR=2.10, 95% CI 1.25-3.54) and a shorter ICU stay (OR=0.44, 95% CI 0.25-0.78).

DISCUSSION

The present study evaluated opioid-free anaesthesia using continuous dexmedetomidine and lignocaine infusions in patients undergoing elective spine surgery, demonstrating excellent hemodynamic stability, good pain relief, improved recovery profiles, and minimal side effects. The findings add to the cumulative evidence supporting the use of opioid-free strategies within ERAS protocols for spine surgery. Intraoperatively, all patients had stable MAP and heart rates within 20% of baseline without the requirement of vasopressors or anticholinergic therapy. This cardiovascular stability is due to dexmedetomidine's selective α2-adrenergic agonism, causing sympatholysis but not compromising baroreceptor reflexes, and lignocaine's membrane-stabilising action, which curtails catecholamine release during laryngoscopy, intubation, and surgery.[12,13] These results are in accordance with Amin et al., indicating improved hemodynamic profiles during lidocaine induction over fentanyl, particularly among elderly patients.[14] Postoperative pain was adequately managed, with 63.3% of the patients having only mild pain (VAS 0-3) and 15% requiring rescue opioids within 24 hours, consistent with the findings of Barakat et al who found reduced 24-hour morphine use with opioid-free anaesthesia compared with remifentanil-based techniques (17.28±12.25 mg vs 27.96±19.75 mg, p<0.05).[15] The prolonged analgesic effects observed, with 36.7% of patients needing no additional analgesia for over 9 hours postoperatively, are likely the result of dexmedetomidine's modulation of descending inhibitory pathways and its anti-inflammatory effect.[16] Recovery outcomes were particularly good: 93.3% were extubated ≤10 minutes, 56.7% had ICU stays ≤12 hours, and 60% mobilised within 8 hours. These findings aligned with Uddin et al that ERAS protocols using opioid-free anaesthesia reduce the length of hospital stay and enable earlier mobilisation (mean differences 1.41 and 0.92 days, respectively, p<0.01).[17] Early emergence is very helpful in spine surgery, enabling early neurological assessment for complications such as injury to the spinal cord or nerve root compression. Side effects were minimal, 10% PONP incidence, much less than the 30-70% with opioid-based anaesthesia. Xue et al had findings with opioid-free anaesthesia, much less PONV than propofol-remifentanil (13.3% vs. 46.7%, p<0.05).[18] Importantly, no respiratory depression was reported, a big safety advantage in the early postoperative period. Correlation analyses indicated moderate inverse relations between MAP stability and extubation time (r=-0.34, p=0.01) and between hemodynamic stability and opioid rescue requirements (r=-0.36, p=0.008), supporting the assumption that cardiovascular stability immediately improves recovery outcomes. Such outcomes emphasise that hemodynamic instability secondary to opioids should be avoided to ease emergence and to decrease postoperative pain exacerbation. Inclusion in multimodal analgesia and ERAS pathways appears synergistic. Soffin et al and Zaed et al highlighted those consistent reductions in overall opioid consumption were achieved with multimodal and opioid-sparing protocols.[19,20] Interdisciplinary coordination is required to ensure uniform implementation of evidence-based practices in perioperative management. Considerations include patient selection, particularly in patients with cardiovascular comorbidities, because of the risk of dexmedetomidine-associated bradycardia (5% in this study). Cost considerations must balance against potential cost savings due to reduced complications, reduced hospital stay, and reduced postoperative utilisation of resources.[21]

Limitations

This study was limited by its single-centre, observational design without a randomised control arm, which may introduce selection bias and limit the generalizability of the findings. The comparatively small sample size of 60 patients and short follow-up duration of 24 hours exclude assessment of longer-term outcomes such as the development of chronic pain, long-term opioid therapy,

and patient satisfaction outside the early perioperative period.

CONCLUSION

Opioid-free anaesthesia with continuous dexmedetomidine and lignocaine infusions provides remarkable hemodynamic stability, effective perioperative analgesia, and better recovery outcomes in elective spine surgery. The technique exhibits noteworthy advantages like rapid extubation, early mobilisation, decreased hospital stay, and fewer side effects, most importantly, no respiratory depression and low rates of postoperative nausea and vomiting. The technique is a safe and clinically effective option to traditional opioid-based anaesthesia in place of existing enhanced recovery after surgery standards and reducing opioid-related complications, and ensuring optimal patient comfort and operating conditions.

Recommendations

Follow-up studies should include multicenter randomised controlled trials with larger patient populations to provide higher-level evidence and verify these findings in different healthcare settings. Follow-up studies to post-surgery are needed to evaluate the implications of opioid-free anaesthesia on chronic postsurgical pain, functional recovery, quality of life, and cost-effectiveness, particularly in resource-limited settings.

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