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Original Research Article

Effect of Dexmedetomidine on Sevoflurane Requirement during General Anaesthesia for Laparoscopic Cholecystectomy: A Prospective Comparative Study

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Conflict of interest: Nil

Abstract

Introduction: Dexmedetomidine is a selective α2-adrenergic agonist with sedative, analgesic and sympatholytic properties that may reduce anaesthetic requirements. This study evaluated its effect on sevoflurane requirement during general anaesthesia for laparoscopic cholecystectomy.

Materials and Methods: This prospective comparative study was conducted at a tertiary care centre in Western Gujarat among 200 ASA physical status I–II patients aged 18–50 years undergoing elective laparoscopic cholecystectomy. Patients were divided into two groups of 100 each. The dexmedetomidine group received intravenous dexmedetomidine 1 µg/kg over 10 minutes followed by 0.5 µg/kg/hour, while the control group received normal saline. Sevoflurane consumption, BIS and MAC values, propofol requirement, haemodynamic parameters, SpO_2 and time to first rescue analgesia were compared between the groups.

Results: Baseline characteristics and duration of surgery were comparable between the groups. Total sevoflurane consumption was significantly lower with dexmedetomidine (19.62±1.90 vs. 26.20±1.44 mL; P<0.001), as was the induction dose of propofol (98.00±8.23 vs. 130.80±13.96 mg; P<0.001). Time to first rescue analgesia was significantly prolonged (32.55±12.48 vs. 16.43±8.68 min; P<0.001). BIS scores remained comparable, whereas significant differences were observed in MAC and sevoflurane dial concentration. Heart rate and blood pressure were generally lower in the dexmedetomidine group, while SpO_2 remained comparable throughout the perioperative period.

Conclusion: Dexmedetomidine reduced sevoflurane and propofol requirements and prolonged the time to rescue analgesia while maintaining a comparable BIS-monitored depth of anaesthesia.

Keywords: Dexmedetomidine; Sevoflurane; Laparoscopic Cholecystectomy; General Anaesthesia.

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Introduction

Laparoscopic cholecystectomy is a commonly performed minimally invasive procedure associated with reduced postoperative pain, shorter hospital stay and faster recovery. [1] However, pneumoperitoneum produces cardiovascular and respiratory changes, making adequate control of anaesthetic depth and haemodynamic parameters important during general anaesthesia. [2]

Sevoflurane is commonly used for maintenance of general anaesthesia, while bispectral index (BIS) monitoring allows objective assessment and appropriate titration of anaesthetic depth. [3]

Dexmedetomidine is a selective α2-adrenergic receptor agonist with sedative, analgesic, anxiolytic and sympatholytic properties. [4] Its administration as an adjunct to general anaesthesia may attenuate haemodynamic responses and reduce the requirement for inhalational anaesthetic agents. [5] Therefore, the present study was conducted at a tertiary care centre in Western Gujarat to evaluate the effect of intravenous dexmedetomidine on sevoflurane requirement during general anaesthesia for laparoscopic cholecystectomy.

Materials and Methods

This hospital-based prospective comparative study was conducted in the Department of Anaesthesiology at a tertiary care centre in Western Gujarat, India, after approval from the Institutional

Ethics Committee. Patients aged 18–50 years, of either sex, belonging to ASA physical status I or II and undergoing elective laparoscopic cholecystectomy under general anaesthesia were included after obtaining written informed consent. Patients with significant cardiovascular, respiratory, hepatic or renal disease, resting bradycardia, contraindications to dexmedetomidine, pregnancy or lactation, and those unwilling to participate were excluded. The original protocol planned enrolment of 200 patients.

Patients were divided into two groups. Group D received intravenous dexmedetomidine 1 µg/kg over 10 minutes, followed by an infusion of 0.5 µg/kg/hour, while Group C received an equivalent volume of normal saline. Standard monitoring including ECG, heart rate, non-invasive blood pressure, SpO_2 and BIS was applied. General anaesthesia was induced with intravenous fentanyl 1 µg/kg and propofol 1–2.5 mg/kg, titrated to achieve a BIS value of approximately 50 ± 5. Cisatracurium 0.15 mg/kg was administered to facilitate airway management. Anaesthesia was maintained with sevoflurane in oxygen and air using volume-controlled ventilation. Sevoflurane concentration was adjusted according to anaesthetic depth and BIS values. Intraoperative heart rate, blood pressure, SpO_2, BIS, MAC, fresh gas flow and sevoflurane vaporizer setting were recorded at predefined intervals. Total sevoflurane consumption was calculated from the vaporizer setting, fresh gas flow and duration of administration. The induction dose of propofol and duration of anaesthesia were also recorded.

The primary outcome was the difference in sevoflurane requirement between the two groups. Other parameters included BIS and MAC values, propofol requirement, intraoperative haemodynamic parameters, postoperative vital parameters at 6 and 12 hours, and time to first rescue analgesia. Data were analysed using SPSS version 26. Continuous variables were expressed as mean ± standard deviation and categorical variables as frequencies and percentages. Appropriate parametric or non-parametric tests and Chi-square/Fisher's exact test were applied, with $p < 0.05$ considered statistically significant.

Results

A total of 200 patients were included, with 100 patients each in the dexmedetomidine and control groups. Baseline demographic and clinical characteristics were broadly comparable with respect to age distribution, sex, ASA physical status, and duration of surgery.

Table 1: Baseline demographic and clinical characteristics of the study groups

Parameter	Dexmedetomidine Group (n=100)	Control Group (n=100)	P value
Age (years), n			**0.734**
≤30	21	18	
31–40	34	39	
41–50	45	43	
Gender, n			**0.454**
Female	64	69	
Male	36	31	
ASA grade, n			**0.157**
ASA I	45	55	
ASA II	55	45	
Duration of surgery (min), mean ± SD	48.72 ± 1.83	48.60 ± 2.12	0.669

There were no statistically significant differences between the groups regarding age (P=0.734), gender (P=0.454), ASA grade (P=0.157), or duration of surgery (P=0.669), indicating comparable baseline characteristics.

Table 2: Comparison of anaesthetic requirements and analgesic outcomes

Parameter	Dexmedetomidine Group (n=100)	Control Group (n=100)	P value
First rescue analgesia (min)	32.55 ± 12.48	16.43 ± 8.68	**<0.001**
Induction dose of propofol (mg)	98.00 ± 8.23	130.80 ± 13.96	**<0.001**
Total sevoflurane consumption (mL)	19.62 ± 1.90	26.20 ± 1.44	**<0.001**

Dexmedetomidine was associated with significantly lower anaesthetic requirements. Mean propofol requirement was 98.00 mg compared with 130.80 mg in controls, while total sevoflurane consumption was 19.62 mL versus 26.20 mL, respectively (both P<0.001). The time to first rescue analgesia was also significantly prolonged in the dexmedetomidine group (32.55 vs. 16.43 minutes; P<0.001).

Table 3: Comparison of BIS score, sevoflurane dial concentration and MAC values

Time	BIS Dex	BIS Control	Dial Conc. Dex	Dial Conc. Control	MAC Dex	MAC Control
Baseline	100.00 ± 0.00	100.00 ± 0.00	0.34 ± 0.75	0.44 ± 0.83	0.00 ± 0.00	0.00 ± 0.00
5 min	48.96 ± 8.11	49.34 ± 6.07	1.64 ± 0.48	1.82 ± 0.43	0.683*	0.813 ± 0.11
10 min	47.07 ± 5.33	48.44 ± 7.40	1.190 ± 0.39	1.580 ± 0.67	1.187*	0.844 ± 0.14
15 min	46.71 ± 8.63	47.58 ± 3.51	1.085 ± 0.27	2.125 ± 0.51	0.542*	0.907 ± 0.11
20 min	48.56 ± 4.20	49.09 ± 6.75	1.025 ± 0.37	1.700 ± 0.80	0.580*	0.892 ± 0.12
25 min	50.63 ± 4.16	52.01 ± 2.93	1.038 ± 0.46	2.486 ± 0.53	0.473*	0.896 ± 0.09
30 min	49.44 ± 3.32	50.50 ± 3.15	0.954 ± 0.43	2.90 ± 0.90	0.436*	0.925 ± 0.10
35 min	48.66 ± 5.10	49.34 ± 2.03	0.956 ± 0.48	2.005 ± 0.62	0.442*	0.885 ± 0.08
40 min	48.37 ± 2.14	49.98 ± 2.51	0.882 ± 0.47	1.998 ± 0.63	0.409*	0.907 ± 0.06
45 min	49.08 ± 1.60	50.70 ± 2.89	0.826 ± 0.24	2.390 ± 0.76	0.408*	0.882 ± 0.07
50 min	48.79 ± 3.35	49.87 ± 3.15	1.052 ± 0.44	2.513 ± 0.53	0.467*	0.866 ± 0.07

Statistical comparison: BIS scores did not differ significantly between groups at any measured time point (all P>0.05). For dial concentration, the difference was nonsignificant at baseline (P=0.375), significant at 5 minutes (P=0.006), and highly significant from 10–50 minutes (all P<0.001). MAC differed significantly at 5 minutes (P=0.023) and at all subsequent measurements (P<0.001).

Table 4. Comparison of perioperative haemodynamic and oxygen saturation parameters

Time	HR Dex	HR Control	SBP Dex	SBP Control	DBP Dex	DBP Control	SpO_2 Dex	SpO_2 Control
Baseline	88.67±5.5	92.63±5.3	131.37±8.3	133.65±6.6	85.58±5.9	87.60±4.6	99.80±0.55	99.92±0.27
5 min	78.12±9.2	84.40±4.2	119.32±12.09	124.08±11.8	73.88±7.9	80.26±6.9	99.56±0.79	99.63±0.77
10 min	71.98±7.2	84.34±5.1	113.16±12.88	120.86±10.3	72.96±7.6	83.03±9.8	99.76±0.75	99.69±0.79
15 min	70.76±6.9	85.56±4.8	109.40±12.31	126.73±8.3	69.18±7.6	86.51±9.8	99.88±0.47	99.88±0.47
20 min	70.06±10.16	88.76±5.4	110.67±10.71	133.80±7.7	71.53±8.5	93.70±8.8	99.81±0.52	99.84±0.43
25 min	71.54±11.07	88.32±4.9	108.41±11.23	135.00±9.6	71.29±9.9	89.34±12.15	99.74±0.56	99.63±0.70
30 min	67.30±11.80	87.58±4.3	107.85±10.53	138.36±11.3	67.32±10.46	90.10±7.8	99.63±0.69	99.72±0.63
35 min	67.56±11.73	86.64±3.6	104.60±9.4	134.00±9.6	66.60±8.7	91.56±6.6	99.76±0.65	99.57±0.78
40 min	67.48±10.09	85.58±3.4	108.28±6.4	135.78±12.14	68.65±8.0	92.70±7.9	99.78±0.77	99.70±0.67
45 min	69.10±10.42	86.64±4.9	107.14±7.3	135.64±10.6	68.34±8.3	92.47±6.1	99.76±0.65	99.81±0.52
50 min	67.82±12.37	87.39±4.1	109.80±10.73	134.60±7.6	71.81±10.50	88.03±8.8	99.83±0.69	99.84±0.64
Post-extubation	70.80±9.4	78.36±7.1	114.60±8.6	120.53±11.0	71.58±6.3	78.80±12.14	99.78±0.54	99.65±0.70
6 h	77.28±7.7	81.14±8.6	117.98±9.2	123.15±16.0	76.17±7.1	81.11±13.81	99.82±0.59	99.77±0.58
12 h	79.58±8.0	81.90±5.08	119.66±8.2	123.73±14.4	78.12±7.5	80.01±10.96	99.87±0.63	99.83±0.69

Values are mean ± SD. HR: heart rate; SBP: systolic blood pressure; DBP: diastolic blood pressure; SpO_2: peripheral oxygen saturation.

Heart rate was significantly lower in the dexmedetomidine group at baseline and throughout the intraoperative period (P<0.001), as well as post-extubation and at 6 hours (P<0.001) and 12 hours (P=0.001). SBP was also significantly lower in the dexmedetomidine group at all evaluated time points, including baseline (P=0.034), 5 minutes (P=0.006), the subsequent intraoperative measurements (P<0.001), post-extubation

(P<0.001), 6 hours (P=0.006), and 12 hours (P=0.016).

DBP followed a similar pattern, with significantly lower values in the dexmedetomidine group from baseline through the intraoperative period and post-extubation. The difference remained significant at 6 hours (P=0.002), whereas by 12 hours the groups were comparable (78.12±7.5 vs. 80.01±10.96 mmHg; P=0.157).

In contrast, oxygen saturation remained consistently high and comparable between the two groups throughout the perioperative period. Mean SpO_2 remained approximately 99–100% from baseline through 12 hours postoperatively, and none of the between-group differences reached statistical significance.

Discussion

The present study evaluated the effect of dexmedetomidine as an adjunct to general anaesthesia in patients undergoing laparoscopic cholecystectomy. The two groups were comparable with respect to age, gender, ASA grade and duration of surgery, providing a similar baseline for assessment of anaesthetic outcomes. The principal finding was a significant anaesthetic-sparing effect with dexmedetomidine. Total sevoflurane consumption was significantly lower in the dexmedetomidine group than in the control group (19.62±1.90 vs. 26.20±1.44 mL; P<0.001). Similar findings were reported by Patel et al. [6], who demonstrated a significant reduction in sevoflurane requirement with continuous dexmedetomidine infusion, and by Harsoor et al.7, who reported reduced hourly sevoflurane requirements during dexmedetomidine-assisted general anaesthesia. Tang et al. [8] also reported reduced sevoflurane requirements with dexmedetomidine in their meta-analysis. These findings support the role of dexmedetomidine as an effective anaesthetic-sparing adjunct.

The induction dose of propofol was also significantly lower with dexmedetomidine (98.00±8.23 mg) compared with the control group (130.80±13.96 mg; P<0.001). This finding indicates that the anaesthetic-sparing action of dexmedetomidine was not limited to the inhalational agent.

Zhao et al. [9] similarly demonstrated that dexmedetomidine significantly reduced the median effective concentration of propofol required for induction. Studies by Anjum et al. [10] and Ghodki et al. [11] also demonstrated reduced anaesthetic requirements when dexmedetomidine was incorporated into the anaesthetic regimen. In our study, BIS values remained comparable between the two groups throughout the procedure despite the lower anaesthetic requirement. This is clinically relevant because it suggests that the reduction in anaesthetic consumption was achieved while maintaining a comparable BIS-monitored depth of anaesthesia.

A significant reduction in sevoflurane dial concentration and MAC requirement was observed with dexmedetomidine during the intraoperative period. The difference in dial concentration became significant from 5 minutes onward and remained highly significant during subsequent measurements, while MAC values were also significantly different between the groups. These findings are supported by Magalhães et al. [12], who demonstrated reduced end-tidal sevoflurane concentration during continuous dexmedetomidine infusion. Similarly, Fragen et al. [13] demonstrated a reduction in the MAC of sevoflurane, while Aantaa et al. [14] reported a reduction in isoflurane MAC following dexmedetomidine administration. Thus, the lower total sevoflurane consumption observed in our study is also supported by the serial changes in dial concentration and MAC requirement.

Dexmedetomidine also demonstrated a beneficial effect on postoperative analgesic requirement. The mean time to first rescue analgesia was significantly longer in the dexmedetomidine group (32.55±12.48 minutes) than in the control group (16.43±8.68 minutes; P<0.001). Garg et al. [15] reported reduced rescue analgesic requirements following dexmedetomidine administration, while Keniya et al. [16] demonstrated approximately 40% reduction in fentanyl requirement.

The systematic review and meta-analysis by Wang et al. [17] similarly showed decreased postoperative pain and opioid consumption with intravenous dexmedetomidine. Panchgar et al. [18] also reported substantially prolonged time to rescue analgesia and reduced postoperative analgesic requirement. These observations support the analgesic-sparing properties of dexmedetomidine in addition to its anaesthetic-sparing effect.

Regarding haemodynamic parameters, heart rate, systolic blood pressure and diastolic blood pressure were generally lower in the dexmedetomidine group during the intraoperative and early postoperative periods. Patel et al [6] similarly reported significant reductions in heart rate and blood pressure following dexmedetomidine administration, while Kaur et al. [19] demonstrated attenuation of the haemodynamic response to laryngoscopy and intubation. These effects are consistent with the sympatholytic properties of dexmedetomidine. Importantly, SpO_2 remained consistently high and did not differ significantly between the groups at any evaluated time point, indicating preservation of oxygenation. Overall, the findings demonstrate that dexmedetomidine reduced sevoflurane and propofol requirements, prolonged postoperative analgesia and modified perioperative haemodynamic responses while maintaining comparable BIS values and oxygen saturation.

Conclusion

Dexmedetomidine used as an adjunct to general anaesthesia during laparoscopic cholecystectomy was associated with significantly reduced sevoflurane consumption and propofol requirement and a longer time to first rescue analgesia. Comparable BIS values despite lower anaesthetic requirements support its sevoflurane-sparing effect, while perioperative oxygen saturation remained comparable between groups. These findings suggest that dexmedetomidine can be a useful anaesthetic adjunct for reducing overall anaesthetic requirements during laparoscopic cholecystectomy.

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