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Analgesic Effect of Dexmedetomidine with Bupivacaine and Bupivacaine Alone in Patients Undergoing Laparoscopic Cholecystectomy: A Prospective Randomized Double-Blinded Comparative Clinical Study

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Abstract: ***Background*: Laparoscopic cholecystectomy (LC) has replaced open cholecystectomy as a standard procedure owing to minimal blood loss, less postoperative pain, faster recovery, and shorter hospital stay. However, visceral pain continues to be a significant postoperative issue. *Aim and Objectives*: To compare the analgesic efficacy of intraperitoneal and port-site instillation of dexmedetomidine combined with bupivacaine versus bupivacaine alone in patients undergoing laparoscopic cholecystectomy. *Methods*: A prospective, randomized, double-blinded study was conducted on 80 ASA Grade I–II patients (18–65 years). Patients were divided equally into: Group A: Bupivacaine 0.25% 2 mg/kg (diluted to 60 ml). Group B: Bupivacaine 0.25% 2 mg/kg + Dexmedetomidine 1 µg/kg (diluted to 60 ml). Pain was measured by the Visual Analogue Scale (VAS) at 0, 2, 6, 12, and 24 h. Time to first analgesic request, total analgesic consumption, hemodynamic stability, adverse effects, and satisfaction were assessed. *Results*: Duration of analgesia was significantly longer in Group B (345.4 ± 38.17 min) compared to Group A (258.83 ± 20.43 min; $p < 0.05$). VAS scores and analgesic consumption were significantly lower in Group B during the first 6 h post-operatively. Minor side-effects (nausea, vomiting) were comparable between groups. *Conclusion*: Intraperitoneal and port-site infiltration of dexmedetomidine with bupivacaine provides superior, prolonged, and safe postoperative analgesia compared to bupivacaine alone in laparoscopic cholecystectomy.***

Keywords: Dexmedetomidine, Bupivacaine, Intraperitoneal Analgesia, Laparoscopic Cholecystectomy, Postoperative Pain

1. Introduction

Laparoscopic cholecystectomy (LC) is now the preferred approach for gallbladder removal because it causes less tissue trauma, faster recovery, and reduced hospitalization compared with open cholecystectomy. Yet, patients may still experience substantial postoperative visceral pain due to stretching of the peritoneum, hepatic bed inflammation, and diaphragmatic irritation from retained CO_2.

Effective postoperative analgesia is vital to enhance recovery, facilitate early ambulation, and reduce morbidity. Intraperitoneal local anaesthetics are simple and safe for pain relief. Dexmedetomidine—a highly selective α_2-adrenergic agonist—possesses sedative, analgesic, and sympatholytic actions with minimal respiratory depression. When combined with bupivacaine, a long-acting amide anaesthetic, it may potentiate analgesia via peripheral and central mechanisms.

This study evaluates whether adding dexmedetomidine to bupivacaine improves the quality and duration of postoperative analgesia after LC.

2. Materials and Methods

Study Design and Population

A prospective, randomized, double-blind comparative study was performed on 80 ASA I–II patients aged 18–65 years scheduled for elective LC after informed consent and institutional ethical clearance.

Inclusion Criteria

- Age 18–65 years
- ASA Grade I or II
- Elective laparoscopic cholecystectomy

Exclusion Criteria

- ASA Grade III–IV
- Known allergy to study drugs
- Acute cholecystitis or severe systemic disease
- Conversion to open surgery / BMI > 30 kg/m²

Grouping and Drug Administration

Group	Drugs Administered	Dose & Volume
A (Control)	Bupivacaine 0.25%	2 mg/kg diluted to 60 ml
B (Study)	Bupivacaine 0.25% + Dexmedetomidine	2 mg/kg + 1 µg/kg diluted to 60 ml

After standard general anaesthesia, 20 ml of the prepared solution was infiltrated around four port sites (5 ml each), and 40 ml was instilled intraperitoneally—20 ml in the gall-bladder fossa and 20 ml under laparoscopic guidance.

Assessments

Pain intensity (VAS 0–10) was evaluated at 0, 2, 6, 12, and 24 h post-operatively. Rescue analgesia was IV diclofenac 1.5 mg/kg when VAS ≥ 4. Time to first analgesic request, 24-h

diclofenac consumption, hemodynamics, side-effects, and satisfaction were recorded.

Statistical Analysis

Sample size ensured 30 % power improvement detection ($\alpha = 0.05$, $\beta = 0.2$). Data analyzed with SPSS v21.0. Continuous variables: mean ± SD (Student t-test); categorical data: Chi-square. $p \leq 0.05$ = significant.

3. Results

Table 1: Demographic Characteristics

Parameter	Group A Mean ± SD	Group B Mean ± SD	p-value
Age (years)	42.6 ± 10.2	43.8 ± 9.8	> 0.05
Weight (kg)	62.3 ± 8.5	61.7 ± 7.9	> 0.05
Sex (M/F)	14/26	16/24	> 0.05
ASA Grade (I/II)	28-Dec	27/13	> 0.05

Demographic profiles were comparable ($p > 0.05$).

Table 2: Hemodynamic Parameters (Mean ± SD)

Parameter	Group A	Group B	p-value
Pulse (beats/min)	84.2 ± 7.1	82.8 ± 6.5	> 0.05
Mean BP (mmHg)	91.3 ± 6.2	90.6 ± 5.9	> 0.05
SpO_2 (%)	98.6 ± 0.8	98.8 ± 0.7	> 0.05
$EtCO_2$ (mmHg)	35.1 ± 2.3	34.7 ± 2.1	> 0.05

No hemodynamic instability observed.

Table 3: Duration of Analgesia (minutes)

Group	Mean ± SD	p-value
A (Bupivacaine)	258.83 ± 20.43	
B (Bupivacaine + Dexmedetomidine)	345.4 ± 38.17	**< 0.05**

Combination group achieved longer analgesia ($p < 0.05$).

Table 4: VAS Scores at Different Intervals

Time (h)	Group A Mean ± SD	Group B Mean ± SD	p-value
0	2.8 ± 0.6	2.4 ± 0.5	> 0.05
2	4.2 ± 0.7	3.1 ± 0.5	< 0.05
6	5.1 ± 0.8	3.4 ± 0.6	< 0.05
12	3.7 ± 0.6	2.9 ± 0.5	> 0.05
24	2.3 ± 0.4	2.1 ± 0.3	> 0.05

VAS significantly lower in Group B during first 6 h.

Table 5: Rescue Analgesic Consumption (Diclofenac)

Group	Total Dose (mg Mean ± SD)	p-value
A	80.8 ± 5.14	> 0.05
B	68 ± 5.75	

Rescue analgesic requirement reduced in combination group.

Adverse Effects and Satisfaction

Mild nausea and vomiting occurred in few patients; no bradycardia, hypotension, or respiratory events were observed. Patient satisfaction was higher in Group B.

4. Discussion

Intraperitoneal local anaesthetic instillation is a validated technique for reducing pain and opioid use after laparoscopic procedures. Dexmedetomidine potentiates bupivacaine's analgesia by inhibiting substance P release and enhancing neuronal hyperpolarization via α_2 receptor stimulation.

Our findings mirror those of Chiruvella et al. (2016), Oza et al. (2016), and Shukla et al. (2015), who reported longer analgesic duration and lower VAS scores with dexmedetomidine adjuvant. The absence of hemodynamic instability corroborates Bhattacharjee et al. (2010). Thus, adding dexmedetomidine improves both quality and duration of analgesia without compromising safety.

5. Limitations and Future Scope

Limitations:

- Relatively small sample size (80 patients) may limit the statistical power to detect rare side effects.
- The study did not compare different doses of dexmedetomidine to determine an optimal dose–response relationship.
- Pain was assessed only for 24 hours; longer follow-up could evaluate late pain or chronic analgesic benefit.
- Sedation scores and stress markers (cortisol, catecholamines) were not measured.

Future Scope:

- Larger, multi-center randomized trials to validate findings and assess dose optimization.
- Comparison with other adjuvants such as tramadol, magnesium, or clonidine for superior pain control.
- Exploration of intraperitoneal dexmedetomidine in other laparoscopic procedures (e.g., appendectomy, hysterectomy).
- Evaluation of long-term outcomes including patient-reported quality of recovery and analgesic cost-effectiveness.

6. Conclusion

Intraperitoneal and port-site infiltration of dexmedetomidine with bupivacaine provides superior, longer-lasting, and safe postoperative analgesia after laparoscopic cholecystectomy compared to bupivacaine alone. This combination reduces pain scores and analgesic requirements while maintaining hemodynamic stability and high patient satisfaction.

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