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Comparison of dexmedetomidine and dexamethasone for prevention of postoperative nausea and vomiting after laparoscopic cholecystectomy

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Abstract

Background: Postoperative nausea and vomiting (PONV) are usually defined as any nausea, retching, or vomiting that occurs during the first 24 postoperative hours.

Aim: To compare the efficacy of dexmedetomidine and dexamethasone in preventing postoperative nausea and vomiting (PONV) in patients undergoing laparoscopic cholecystectomy.

Patients and methods: This meta-analysis compared the efficacy of dexmedetomidine and dexamethasone in preventing postoperative nausea and vomiting (PONV) in patients undergoing laparoscopic cholecystectomy. Five studies were included, selected based on predefined inclusion and exclusion criteria to ensure consistency and reliability.

Results: Two studies reported (Intra-operative fentanyl) and all can be used. A significant heterogeneity was detected. Therefore, a random-effect model was used for analysis (I^2 = 93%, P=0.0003). The combined mean difference and 95% CIs was -12.36 (-17.15 to -7.56). The combined result demonstrates statistically significant difference between groups regarding (Intra-operative fentanyl) (Z= 5.05, P<0.00001). Three studies reported (Overall Post operative vomiting and nausea) and all can be used. A no significant heterogeneity was detected. Therefore, a random-effect model was used for analysis (I^2 = 0%, P=0.52). The combined mean difference and 95% CIs was 0.94 (0.55 to 1.61). The combined result demonstrates statistically no significant difference between groups regarding (Overall Post operative vomiting and nausea) (Z= 0.23, P=0.82).

Conclusion: Dexmedetomidine and dexamethasone effectively prevent PONV after laparoscopic cholecystectomy, with dexmedetomidine reducing opioid use, offering valuable insights for optimizing perioperative management in this patient population.

Key words: PONV; Dexmedetomidine; Dexamethasone.

Introduction

Postoperative nausea and vomiting (PONV) are usually defined as any nausea, retching, or vomiting that occurs during the first 24 postoperative hours. PONV is one of the most common causes of patient dissatisfaction after anesthesia, with a reported incidence as high as 63% after laparoscopic cholecystectomy **(1, 2).**

PONV may delay patient discharge from the post-anesthesia care unit (PACU) and increase unanticipated hospital admissions in outpatients. Therefore, prevention of PONV will improve patient satisfaction and decrease overall health care costs **(3).**

Dexmedetomidine is a potent α_2-adrenergic agonist with potential applications in clinical anesthesia because of its broad-spectrum effects, which include anxiolytic, sedative, analgesic, anesthetic-sparing, sympatholytic, and hemodynamic-stabilizing properties **(4).**

The intra-operative use of dexmedetomidine as an anesthetic adjuvant has led to significant reductions in the use of opioids and inhalation anesthetics, reduction in the incidence of emergence agitation, a favorable recovery profile, and reduction of postoperative pain without adverse hemodynamic effects, and hence it may decrease PONV **(4, 5).**

A pre-induction single dose of dexmedetomidine of 0.6-2 μg/kg resulted in the reduction of both inhalational anesthetic and opioid analgesic requirements during the intra-operative period. It was chosen the 1 μg/kg dose to avoid the hypotension and bradycardia that occurred with 2 μg/kg **(6, 7).**

Since 1981, dexamethasone has been reported to be effective in reducing the incidence of emesis in patients undergoing chemotherapy. The antiemetic effect of dexamethasone was reported to be equal to or better than the 5-HT_3 receptor antagonists, such as ondansetron and granisetron. Recently, dexamethasone has also been reported to be effective in reducing the incidence of postoperative nausea and vomiting (PONV) in paediatric patients undergoing strabismus repair, tonsillectomy and adenoidectomy, and in women undergoing major gynaecological surgery. In patients undergoing laparoscopic cholecystectomy for cholelithiasis, high incidences of PONV have been reported (53–72%) **(8 - 10).**

This meta-analysis study aimed to compare the efficacy of dexmedetomidine and dexamethasone in preventing postoperative nausea and vomiting (PONV) in patients undergoing laparoscopic cholecystectomy.

Patients and methods

This meta-analysis compared the efficacy of dexmedetomidine and dexamethasone in preventing postoperative nausea and vomiting (PONV) in patients undergoing laparoscopic cholecystectomy. Five studies were included, selected based on predefined inclusion and exclusion criteria to ensure consistency and reliability.

Population and Selection Criteria: Adult patients with ASA physical status I–II undergoing elective laparoscopic cholecystectomy for chronic calculous cholecystitis were included.

Inclusion Criteria: Age between 18 and 75 years, body mass index (BMI) ≤ 35 kg/m² and no known allergy to the studied medications.

Exclusion Criteria: Use of antiemetic drugs within 48 hours before surgery.

Methods

Patients were randomly assigned using computer-generated codes, sealed in sequentially numbered opaque envelopes. Two intervention groups were established: Dexmedetomidine group:

Received a single intravenous (IV) dose of 1 μg/kg after anesthesia induction and prior to skin incision. Dexamethasone group: Received a single IV dose of 8 mg under the same conditions.
A placebo control group was excluded for ethical considerations due to the high risk of PONV according to Apfel's risk score.
Anesthesia Protocol: A standardized anesthesia protocol was used: Pre-medication: IV midazolam (1–3 mg). Induction: IV fentanyl (1 μg/kg), propofol (2–2.5 mg/kg), and rocuronium bromide (0.6 mg/kg). Maintenance: Sevoflurane (1–2.5%) with depth of anesthesia monitored using BIS (target range: 40–60). The study medications were prepared by non-study personnel, diluted in 100 mL of 0.9% saline, and infused over 15 minutes**.**
Outcome: The following outcomes were evaluated: Postoperative nausea and vomiting (PONV): Measured using a 4-point subjective grading scale. Intraoperative fentanyl use: Total supplemental doses required. Duration of surgery: Recorded in minutes. Postoperative pain: Assessed using a Numeric Analogue Scale (0 = no pain, 10 = worst pain). All patients were monitored for 24 hours postoperatively for adverse events, including nausea, vomiting, and need for rescue antiemetics.
Statistical Analysis
Statistical analyses were conducted using Review Manager version 5.4.1. Binary outcomes were analyzed using the odds ratio (OR) with 95% confidence intervals (CIs), while continuous outcomes were analyzed using the mean difference (MD) with 95% CIs. Fixed-effect or random-effects models were applied depending on heterogeneity, assessed using the Q-statistic and I^2 test. A p-value < 0.05 was considered statistically significant.

Results

A total of 5 studies were selected for the current analysis, including a total of 457 patient. The publication year ranged from 2015 to 2022. 2 studies were carried out in India and 1 study was conducted in each of the following: Egypt, Nepal and Iran. Baseline characteristics of included studies are demonstrated in **Table 1**.

Author, year	year	country	Study period		Study design	Sample Size		
			from	to		Dexmedetomidine	Dexamethasone	Total
Mohamed H Bakri, 2015	2015	Egypt			randomized, controlled, double-blind study	43	43	86
Bikash Khadka, 2021	2021	Nepal	2019	2021	prospective randomized comparative	43	43	86
Siamak Rekei, 2021	2021	Iran			double-blind clinical trial	54	54	108
Singh, Manpreet, 2022	2022	India	2018	2019	prospective study	43	43	86
Srivastava, Vinit, 2022	2022	India	2019	2022	prospective, randomized, double-blind trial	45	46	91

Table 2. Patient's characteristics

The mean participants' age in studied groups was 41 ranging from 25 to 75 years, mean participants' weight in studied groups was 61.88 ranging from 47 to 78 and gender was reported in 3 studies with 52 male and 228 female as shown in **Table 2.**

Author, year	Age (year)						sex						Weight (kg)					
	Dexmedetomidine			Dexamethasone			Dexmedetomidine			Dexamethasone			Dexmedetomidine			Dexamethasone		
	mean	SD	total	mean	SD	total	male	female	total	male	female	total	mean	SD	total	mean	SD	total
Mohamed H Bakri, 2015	31.1	2.4	43	32.3	2.1	43	9	34	43	6	37	43	69.4	2.2	43	71.5	3.1	43
Bikash Khadka, 2021	40.72	2.8	43	41.65	2.07	43	17	26	43	7	36	43	51.63	1.6	43	63.14	0.91	43
Siamak Rekei, 2021	49	7.8	54	49.92	8.65	54	6	48	54	7	47	54						
Singh, Manpreet, 2022	41.2	11.4	43	40.8	10.9	43												
Srivastava, Vinit, 2022	47.9	6.67	45	48.17	5.28	46							64.08	8.39	45	64.29	9.58	46

Duration of surgery (min)

Four studies reported (Duration of surgery) and all can be used. A significant heterogeneity was detected. Therefore, a random-effect model was used for analysis (I^2 = 95%, P<0.00001). The combined mean difference and 95% CIs was 8.06 (6.83 to 9.30). The combined result demonstrates statistically significant difference between groups regarding (Duration of surgery) (Z = 12.79, P <0.00001).

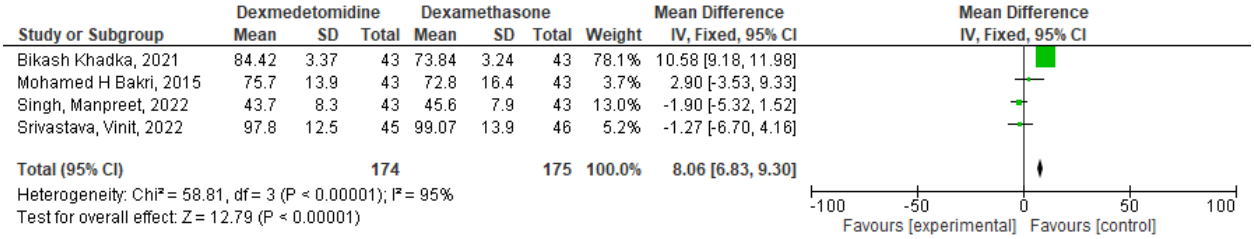

Figure 1. Forest plot of Duration of surgery demonstrates statistically significant difference between dexmedetomidine and dexamethasone groups.

History of previous PONV

Two studies reported (History of previous PONV) and all can be used. A no significant heterogeneity was detected. Therefore, a random-effect model was used for analysis (I^2 = 14%, P=0.28). The combined mean difference and 95% CIs was 1.43 (0.55 to 3.75). The combined result demonstrates no statistically significant difference between groups regarding (History of previous PONV) (Z= 0.73, P=0.47).

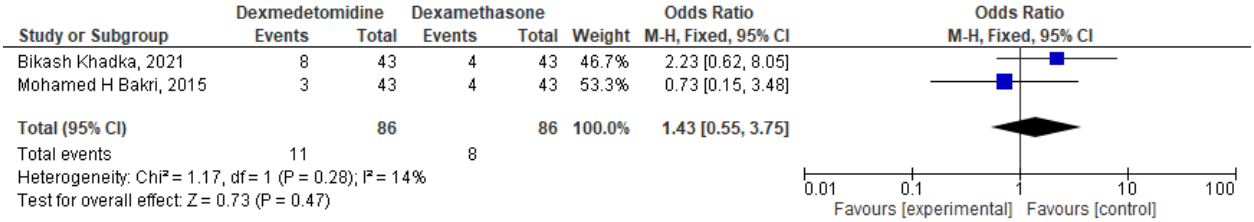

Figure 2. Forest plot of History of previous PONV demonstrates no statistically significant difference between dexmedetomidine and dexamethasone groups.

Intra-operative fentanyl (µg)

Two studies reported (Intra-operative fentanyl) and all can be used. A significant heterogeneity was detected. Therefore, a random-effect model was used for analysis (I^2 = 93%, P=0.0003). The combined mean difference and 95% CIs was -12.36 (-17.15 to -7.56). The combined result

demonstrates statistically significant difference between groups regarding (Intra-operative fentanyl) (Z= 5.05, P<0.00001).

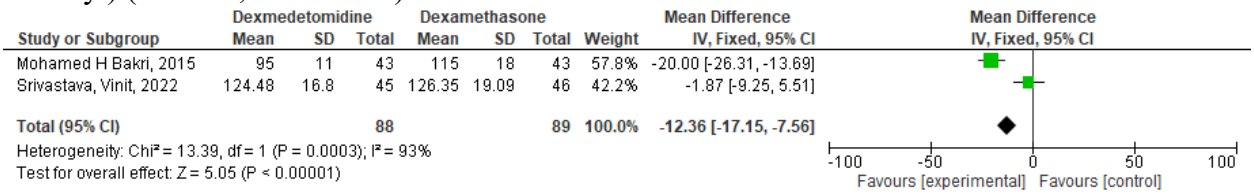

Figure 3. Forest plot of Intra-operative fentanyl demonstrates statistically significant difference between dexmedetomidine and dexamethasone groups.

Nausea

Four studies reported (Nausea) and all can be used. A no significant heterogeneity was detected. Therefore, a random-effect model was used for analysis (I^2 = 0%, P=0.44). The combined mean difference and 95% CIs was 1.41 (0.82 to 2.42). The combined result demonstrates statistically no significant difference between groups regarding (Nausea) (Z= 1.25, P=0.21).

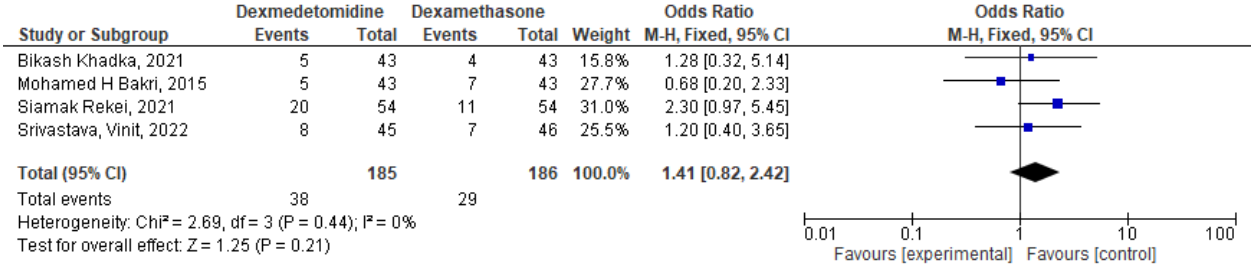

Figure 4. Forest plot of Nausea demonstrates no statistically significant difference between dexmedetomidine and dexamethasone groups.

Retching

Two studies reported (Retching) and all can be used. A no significant heterogeneity was detected. Therefore, a random-effect model was used for analysis (I^2 = 0%, P=0.66). The combined mean difference and 95% CIs was 0.70 (0.21 to 2.29). The combined result demonstrates statistically no significant difference between groups regarding (Retching) (Z= 0.60, P=0.55).

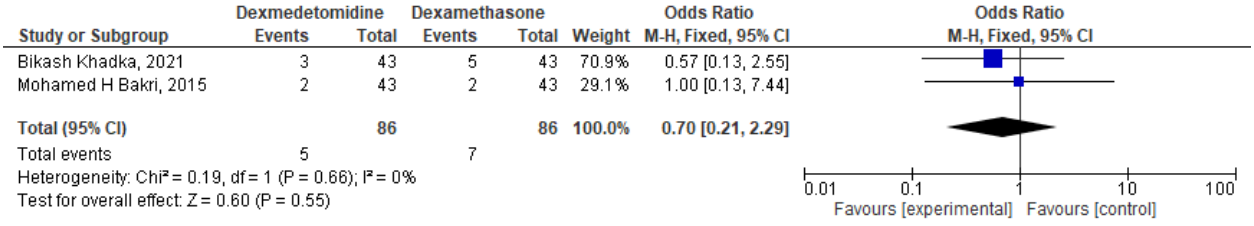

Figure 5. Forest plot of Retching demonstrates no statistically significant difference between dexmedetomidine and dexamethasone groups.

Vomiting

Three studies reported (Vomiting) and all can be used. A no significant heterogeneity was detected. Therefore, a random-effect model was used for analysis (I^2 = 0%, P=0.68). The combined mean difference and 95% CIs was 1.02 (0.45 to 2.31). The combined result demonstrates statistically no significant difference between groups regarding (Vomiting) (Z= 0.04, P=0.97).

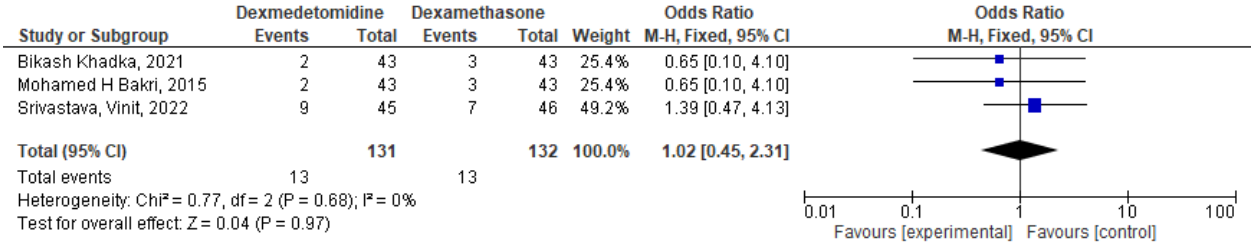

Figure 6. Forest plot of Vomiting demonstrates no statistically significant difference between dexmedetomidine and dexamethasone groups.

Overall Post operative vomiting and nausea

Three studies reported (Overall Post operative vomiting and nausea) and all can be used. A no significant heterogeneity was detected. Therefore, a random-effect model was used for analysis (I^2 = 0%, P=0.52). The combined mean difference and 95% CIs was 0.94 (0.55 to 1.61). The combined result demonstrates statistically no significant difference between groups regarding (Overall Post operative vomiting and nausea) (Z= 0.23, P=0.82).

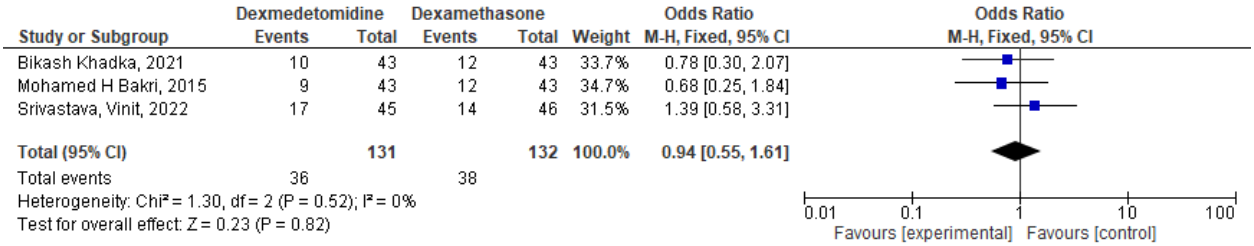

Figure 7. Forest plot of Overall Post operative vomiting and nausea demonstrates no statistically significant difference between dexmedetomidine and dexamethasone groups.

Discussion

The intraoperative use of dexmedetomidine as an anesthetic adjuvant has led to significant reductions in the use of opioids and inhalation anesthetics, reduction of postoperative pain without adverse hemodynamic effects, and hence it may decrease PONV **(4).**

Additionally, Dexamethasone is a medication used to prevent nausea and vomiting, with an unknown mechanism, but it is likely to inhibit the prostaglandins that reduce PONV. It is much cheaper than ondansetron that can be used with equal efficacy **(11, 12).**

These meta-analysis findings demonstrated a statistically significant reduction in intraoperative fentanyl use with dexmedetomidine but no significant differences between the groups in rates of

nausea, retching, vomiting, or overall PONV. The significant reduction in intraoperative fentanyl use with dexmedetomidine may be attributed to its opioid-sparing effects, mediated through alpha-2 adrenergic receptor agonism. However, the comparable PONV outcomes across both groups could indicate that both agents are equally effective in mitigating nausea and vomiting pathways, albeit through different mechanisms.

These results were consistent with those of **Bakri MH et al., (13)** who compared the effects of a single dose of 1 μg/kg dexmedetomidine and 8 mg dexamethasone administered after induction of anesthesia on PONV in laparoscopic cholecystectomy patients. In their study, the incidence of PONV was 21% in the dexmedetomidine group compared to 28% in the dexamethasone group (P = 0.6), and PONV severity was similar between groups (P = 0.07). Furthermore, they reported significantly lower intraoperative fentanyl use in the dexmedetomidine group.

The reduction of postoperative pain by dexmedetomidine could be explained by the activation of the α2-adrenoreceptor in the dorsal horn of the spinal cord, which inhibits the release of substance P, which modulates the transmission of nociceptive signals in the central nervous system, leading to a reduction of nociceptive inputs during the acute postoperative period **(14).**

Moreover, in a previous meta-analysis was conducted on the evaluation of the effect of dexmedetomidine on the prevention of nausea and vomiting Choubsaz **M et al., (15)** had findings including; Dexmed is superior to placebo in preventing nausea and vomiting in patients with or without high-risk factors and Dexmed during an operation reduces the use of analgesic drugs. The beneficial effect of Dexmedetomidine may be due to the direct antiemetic effect of α2 agonists.

Furthermore, our study was supported by those of, **Khadka B et al., (16)** who compared the efficacy of a single dose of 1 μg/kg of dexmedetomidine to a single dose of 8 mg dexamethasone to prevent nausea and vomiting. They revealed that the incidence of overall post-operative nausea and vomiting was 23.25% in the dexmedetomidine group in comparison to 27.9% of the dexamethasone group (p= 0.624). They concluded that the effects of dexmedetomidine are similar to that of dexamethasone in reducing the incidence and severity of postoperative nausea and vomiting following laparoscopic cholecystectomy.

Similarly, in a study of Srivastava **VK et al., (17)** who evaluated the intraperitoneal administration of dexamethasone, dexmedetomidine, and their combination for reducing PONV and postoperative analgesic requirements in laparoscopic hysterectomy patients. Their study demonstrated a significant reduction in the incidence of PONV within the first 24 hours postoperatively in the dexamethasone (D1), dexmedetomidine (D2), and combination (D3) groups compared to the control group (D4) (P = 0.001), with no significant differences among the intervention groups. Rescue antiemetic and analgesic use was significantly lower in the intervention groups compared to the control group (P = 0.002 and P = 0.0003, respectively). They concluded that intraperitoneal administration of dexamethasone, dexmedetomidine, or their combination effectively reduces PONV and postoperative analgesic requirements. However, the Srivastava **VK et al., (17)** study's focus on intraperitoneal administration and combination therapies introduces variables not addressed in our meta-analysis. These methodological differences limit direct comparison but reinforce the efficacy of dexmedetomidine in reducing postoperative analgesic requirements, consistent with our findings.

Conclusion

In conclusion, both dexmedetomidine and dexamethasone are effective for PONV prevention after laparoscopic cholecystectomy, with dexmedetomidine offering the additional benefit of reduced

intraoperative opioid use. These findings provide valuable insights for optimizing perioperative management in this patient population.

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