

General Anesthesia versus Spinal Anesthesia for Laparoscopic Cholecystectomy: A Systematic Review and Meta-Analytic Synthesis of Clinical Outcomes, Safety, and Recovery Metrics

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Abstract

Background

Laparoscopic cholecystectomy (LC) is conventionally performed under general anesthesia (GA), which provides a secured airway, controlled ventilation and predictable operating conditions during carbon-dioxide pneumoperitoneum. Spinal anesthesia (SA) has been evaluated as an alternative technique that may avoid tracheal instrumentation and improve early postoperative analgesia.

Objective

To systematically review evidence published before 2021 comparing SA with GA for elective LC in adults, with emphasis on postoperative pain, postoperative nausea and vomiting (PONV), urinary retention, shoulder pain, conversion to GA, intraoperative events, operative time, recovery, hospital stay and patient satisfaction.

Methods

A structured literature review was performed using PubMed/MEDLINE-indexed literature and reference lists of relevant randomized controlled trials and systematic reviews. Eligible studies were adult elective LC studies published before 1 January 2021 that directly compared SA with GA and reported at least one relevant perioperative outcome. Randomized and prospective comparative evidence was synthesized narratively. Quantitative findings from established pre-2021 meta-analyses were incorporated; no new patient-level meta-analysis was performed.

Results

The evidence base included several randomized comparative studies. A published 2016 meta-analysis of eight randomized trials involving 723 participants reported lower postoperative pain with SA, significantly lower PONV (OR 0.38, 95% CI 0.19–0.76; $P=0.006$; $I^2=13\%$), and significantly greater urinary retention (OR 4.95, 95% CI 1.24–19.71; $P=0.02$). Individual trials generally reported comparable operative outcomes and hospital stay. Shoulder pain and occasional conversion to GA remained important limitations.

Conclusion

SA appears feasible for appropriately selected adults undergoing elective LC and may provide better early postoperative pain control and less PONV than GA. However, urinary retention, shoulder discomfort, hemodynamic effects and possible conversion to GA must be considered. The pre-2021 evidence supports individualized anesthetic selection rather than routine replacement of GA by SA.

Keywords: laparoscopic cholecystectomy; spinal anesthesia; general anesthesia; postoperative pain; postoperative nausea and vomiting; urinary retention; shoulder pain; systematic review; meta-analysis.

1. Introduction

Laparoscopic cholecystectomy has become the standard surgical approach for symptomatic gallstone disease because of its minimally invasive nature, reduced postoperative morbidity and relatively rapid recovery [1,2]. General anesthesia remains the conventional technique because it provides a secured airway, controlled ventilation, immobility and predictable operating conditions during pneumoperitoneum [3].

Despite these advantages, GA may be associated with airway instrumentation, postoperative nausea and vomiting, sore throat, residual anesthetic effects and opioid-related adverse effects [4]. These considerations have stimulated interest in regional anesthetic techniques, particularly SA.

SA for LC was initially considered challenging because carbon-dioxide pneumoperitoneum may cause diaphragmatic irritation, shoulder pain, respiratory discomfort and hemodynamic changes. Nevertheless, randomized studies have demonstrated that LC can be completed under SA in appropriately selected patients [5–8].

Imbelloni et al. demonstrated the feasibility of SA for LC with favorable postoperative pain outcomes [5]. Bessa et al. subsequently reported a prospective randomized comparison of 60 patients with comparable surgical outcomes [6]. Tiwari et al. evaluated anesthesia time, pneumoperitoneum time, surgical time, intraoperative events and postoperative pain and supported the feasibility of SA [7]. Sinha et al. reported significantly lower postoperative pain at 4, 8, 12 and 24 hours after SA, without significant differences in complications, hospital stay, recovery or satisfaction [8].

The evidence was subsequently synthesized by Yu et al. in a 2015 meta-analysis of randomized controlled trials [9]. Wang et al. published a further systematic review and meta-analysis in 2016 involving eight randomized trials and 723 patients; that analysis reported lower postoperative pain and PONV with SA but increased urinary retention [10]. Kalaivani et al. highlighted shoulder pain and conversion to GA as important limitations [11].

Accordingly, this systematic review was undertaken to synthesize the pre-2021 evidence regarding efficacy, safety and recovery outcomes of SA compared with GA for elective LC.

2. Research Question and PICO

Among adult patients undergoing elective laparoscopic cholecystectomy, does spinal anesthesia, compared with general anesthesia, provide improved postoperative analgesia and recovery while maintaining acceptable safety and surgical feasibility?

Table 1. PICO framework and eligibility criteria

Domain	Specification
Population	Adults undergoing elective laparoscopic cholecystectomy
Intervention	Spinal anesthesia
Comparator	General anesthesia
Primary outcomes	Postoperative pain and perioperative safety
Secondary outcomes	PONV; urinary retention; shoulder pain; conversion to GA; operative time; recovery; hospital stay; satisfaction; intraoperative hemodynamic events
Eligible designs	Randomized controlled and prospective comparative studies
Publication cutoff	Before 1 January 2021

3. Methods

3.1 Reporting framework

The review was structured according to PRISMA principles [12]. PRISMA 2020 recommends transparent reporting of the rationale, objectives, eligibility criteria, information sources, search and selection processes, risk-of-bias assessment, synthesis methods and limitations. The present manuscript follows these reporting principles as far as supported by the available source material.

3.2 Information sources and search strategy

The source review searched PubMed/MEDLINE-indexed literature and the reference lists of relevant randomized trials, systematic reviews and meta-analyses. Search concepts included “laparoscopic cholecystectomy,” “spinal anesthesia/anaesthesia,” “general anesthesia/anaesthesia,” “regional anesthesia,” “postoperative pain,” “postoperative nausea and vomiting,” “urinary retention,” and “randomized controlled trial.” The major pre-2021 meta-analyses identified were those by Yu et al. [9] and Wang et al. [10].

Because the source manuscript does not document the exact final search dates, complete database-specific search strings, or the number of records retrieved from each source, these items should be completed from the author's search log before journal submission rather than estimated.

3.3 Eligibility criteria

Inclusion criteria were: adult patients undergoing elective LC; direct comparison of SA and GA; randomized controlled or prospective comparative design; at least one relevant perioperative outcome; and publication before 1 January 2021.

Studies were excluded if they involved pediatric patients, evaluated open cholecystectomy without separable LC data, were case reports or noncomparative case series, did not clearly identify the anesthetic technique, or were published after the prespecified cutoff.

3.4 Outcomes

The principal outcomes were postoperative pain and perioperative safety. Secondary outcomes were PONV, urinary retention, shoulder pain, conversion to GA, operative time, recovery, hospital stay, patient satisfaction and intraoperative hemodynamic events.

3.5 Data synthesis and statistical approach

The present manuscript synthesizes published randomized evidence and effect estimates reported by established pre-2021 meta-analyses. The reported odds ratios and confidence intervals were not recalculated from individual patient data. Therefore, the term “meta-analytic synthesis” refers to incorporation and interpretation of published meta-analytic estimates rather than a de novo pooled analysis.

3.6 Risk of bias and certainty of evidence

The source manuscript identifies limitations including small samples, predominance of ASA I–II participants, inability to blind anesthesia providers and participants, heterogeneous spinal techniques, and non-standardized postoperative analgesic and antiemetic protocols. A formal study-level risk-of-bias table using a validated instrument was not provided in the source material; consequently, no unsupported risk-of-bias ratings are assigned here.

3.7 Registration and protocol

No prospective registration number or publicly accessible protocol is reported in the source manuscript. The review should therefore be described as not prospectively registered unless the author has a valid registration record to add.

3.8 Ethics

Ethics approval and patient consent were not applicable because this review synthesizes previously published literature and involves no new patient recruitment or identifiable patient data.

3.9 NMC and publication-ethics statement

The manuscript is prepared with attention to professional and research-ethics principles applicable to medical publication in India. NMC's professional-conduct framework emphasizes ethical research, protection of research participants, and unbiased scientific communication. Because this is a literature-based review with no human participant recruitment, institutional ethics approval is not ordinarily applicable; however, the target journal's requirements should be followed.

4. Results

4.1 Characteristics of included evidence

Several randomized controlled studies evaluated SA versus GA for LC [5–8,11]. Imbelloni et al. demonstrated feasibility [5]. Bessa et al. randomized 60 patients, with 30 receiving SA and 30 GA [6]. Tiwari et al. reported a prospective randomized study involving more than 200 analyzed patients [7]. Kalaivani et al. randomized 50 ASA I–II patients; six patients (24%) in the SA group developed shoulder pain and two (8%) required conversion to GA [11]. Sinha et al. reported a randomized study of 100 ASA I–II patients in which all procedures were completed under the allocated anesthetic and postoperative pain was lower at 4, 8, 12 and 24 hours after SA [8].

Table 2. Characteristics of principal randomized/comparative studies

Study	Design / sample	Outcomes	Principal finding
Imbelloni et al. [5]	Randomized comparison; sample not specified in source	Feasibility; postoperative pain	SA feasible for LC with favorable postoperative pain outcomes.
Bessa et al. [6]	Prospective randomized; n=60 (30 SA, 30 GA)	Intraoperative events; complications; pain	Comparable surgical outcomes reported.
Tiwari et al. [7]	Prospective randomized; >200 analyzed	Anesthesia, pneumoperitoneum and operative time; intraoperative events; pain	Supported feasibility of SA.
Sinha et al. [8]	Randomized; n=100 ASA I–II	Pain; complications; recovery; stay; satisfaction	Lower pain at 4, 8, 12 and 24 h; no conversion; no significant difference in stay, recovery or satisfaction.
Kalaivani et al. [11]	Prospective randomized; n=50 ASA I–II	Shoulder pain; conversion to GA	Shoulder pain 24% in SA group; conversion to GA 8% (2/25).

4.2 Postoperative pain

The 2015 meta-analysis by Yu et al. identified postoperative pain as a principal outcome [9]. Wang et al. subsequently included eight randomized trials involving 723 patients and reported significantly lower postoperative visual analogue pain scores at 24 hours with SA [10]. The consistency of this finding across the cited randomized studies and meta-analyses suggests that improved early postoperative analgesia is the most consistent clinical advantage of SA.

4.3 PONV

Wang et al. reported significantly less PONV with SA compared with GA (OR 0.38, 95% CI 0.19–0.76; $P=0.006$), with low statistical heterogeneity ($I^2=13\%$) [10].

4.4 Urinary retention

Urinary retention was significantly more frequent after SA (OR 4.95, 95% CI 1.24–19.71; $P=0.02$) [10]. This finding is clinically plausible because neuraxial blockade may temporarily interfere with bladder sensation and detrusor function.

4.5 Shoulder pain and conversion to GA

Shoulder pain remains an important limitation of SA during LC. Kalaivani et al. reported shoulder pain in 24% of SA patients and conversion to GA in 8% [11]. In contrast, Sinha et al. reported no conversions [8]. Variation may reflect differences in patient selection, spinal technique, intrathecal opioid use, pneumoperitoneum pressure, surgical experience and tolerance of visceral/diaphragmatic discomfort.

4.6 Operative time, recovery and hospital stay

Most randomized studies did not demonstrate a clinically important increase in operative time with SA [6,7]. Sinha et al. reported no significant difference in hospital stay, recovery or satisfaction [8]. Thus, the principal apparent advantage of SA is early symptom control rather than a consistently shorter hospital stay.

Table 3. Summary of major comparative outcomes

Outcome	Published finding	Clinical interpretation
Postoperative pain	Lower with SA in randomized studies and published meta-analyses [8–10]	Most consistent advantage of SA.
PONV	OR 0.38 (95% CI 0.19–0.76); $P=0.006$; $I^2=13\%$ [10]	Significantly lower odds with SA.
Urinary retention	OR 4.95 (95% CI 1.24–19.71); $P=0.02$ [10]	Significantly more frequent with SA.
Shoulder pain	24% in SA group in Kalaivani et al. [11]	Important limitation of pneumoperitoneum under SA.
Conversion to GA	8% (2/25) in Kalaivani et al.; none in Sinha et al. [8,11]	Generally uncommon but variable; immediate conversion capability is required.
Operative time / hospital stay	No clinically important difference reported in cited randomized studies [6–8]	No consistent advantage demonstrated.

Note: Effect estimates are reproduced from the cited published evidence; no new pooled estimate was calculated.

5. Discussion

The principal finding of this systematic review is that SA is a feasible alternative to GA for selected adults undergoing elective LC, with the strongest evidence supporting improved postoperative pain and reduced PONV [9,10].

The analgesic benefit is supported by individual randomized studies and meta-analyses. Sinha et al. demonstrated significantly lower pain scores at 4, 8, 12 and 24 hours after SA [8]. Imbelloni et al. also reported favorable postoperative pain outcomes [5]. The 2015 meta-analysis by Yu et al. and the 2016 meta-analysis by Wang et al. further supported lower postoperative pain with SA [9,10].

Reduced PONV is the second major potential advantage. Wang et al. reported an OR of 0.38 (95% CI 0.19–0.76) for PONV with SA, with low heterogeneity [10]. This may partly reflect avoidance of inhalational anesthetic exposure and reduced opioid requirements, although differences in antiemetic prophylaxis between trials should be considered.

The principal adverse outcome favoring GA was urinary retention. Wang et al. found a significantly higher risk with SA (OR 4.95, 95% CI 1.24–19.71) [10]. This should be incorporated into perioperative counseling and postoperative monitoring, particularly where early discharge is planned.

Shoulder pain remains a clinically relevant limitation. Kalaivani et al. observed shoulder pain in 24% of patients receiving SA and conversion to GA in 8% [11]. The finding illustrates that neuraxial somatic blockade does not necessarily eliminate visceral or diaphragmatic discomfort caused by pneumoperitoneum. Conversely, Sinha et al. reported no conversions [8]. These differences emphasize the importance of patient selection, low-pressure pneumoperitoneum when appropriate, adequate block, surgical expertise and readiness to convert to GA.

GA retains important advantages when airway control and controlled ventilation are priorities. Patients with substantial pulmonary disease, anticipated difficult or prolonged surgery, poor tolerance of pneumoperitoneum, or other clinical circumstances requiring secure airway management may be better suited to GA. SA should therefore be considered an alternative strategy rather than a universal replacement for GA.

The findings are consistent with the broader conclusion of the pre-2021 evidence: anesthetic choice should be individualized. The apparent benefits of SA are most relevant to early postoperative pain and PONV, whereas GA provides more predictable airway and ventilatory control. The balance should be determined by patient characteristics, surgical requirements, institutional expertise and availability of immediate conversion to GA [5–11].

5.1 Strengths

Strengths include a focused adult elective-LC question, emphasis on randomized and prospective comparative evidence, incorporation of established pre-2021 meta-analyses, evaluation of both benefits and adverse outcomes, and attention to patient-centered recovery measures.

5.2 Limitations

The evidence base is limited by small individual trials, predominant enrollment of healthy ASA I–II patients, heterogeneous anesthetic techniques, inability to blind anesthesia providers or patients, and non-standardized postoperative analgesic and antiemetic regimens [6,8,11]. The source manuscript also does not provide a complete database-by-database search record, PRISMA study-selection counts, or a formal validated risk-of-bias assessment. In addition, this manuscript does not perform a new patient-level or study-level pooled meta-analysis; it incorporates effect estimates from published meta-analyses.

5.3 Clinical implications

SA may be considered for appropriately selected elective LC patients when reduced postoperative pain or PONV is desirable, avoidance of tracheal instrumentation is advantageous, low-pressure pneumoperitoneum can be used, and an experienced anesthetic and surgical team is available. Facilities for prompt conversion to GA should be immediately available.

5.4 Future research

Future randomized trials should standardize spinal technique, local anesthetic and intrathecal opioid regimens, pneumoperitoneum pressure, postoperative analgesia and antiemetic protocols. Outcomes should include quality of recovery, opioid consumption, patient-reported outcomes, urinary function, shoulder pain, conversion to GA, cost-effectiveness and outcomes in patients with higher perioperative risk.

6. Conclusion

Pre-2021 evidence indicates that spinal anesthesia is a feasible alternative to general anesthesia for laparoscopic cholecystectomy in appropriately selected adult patients. Compared with GA, SA is associated with lower postoperative pain and reduced PONV, while urinary retention occurs more frequently. Shoulder pain and occasional conversion to GA remain relevant limitations. Accordingly, the evidence supports individualized anesthetic selection rather than routine replacement of GA by SA.

7. Declarations

7.1 Ethics approval

Not applicable. This systematic review synthesizes previously published literature and does not involve new patient recruitment or identifiable patient data.

7.2 Consent for publication

Not applicable.

7.3 Competing interests

The author declares no competing interests.

7.4 Funding

No external funding was received for preparation of this manuscript.

7.5 Author contribution

Dr Devendra Prasad Bairwa conceived the review, evaluated the literature, synthesized the evidence and prepared the manuscript.

7.6 Data availability

No new patient-level dataset was generated. Data summarized in this review are derived from the cited published literature.

7.7 Registration

No prospective review registration is reported in the source material. A registration number should be added if one exists.

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