Current Pain and Headache Reports (2025) 29:18
https://doi.org/10.1007/s11916-024-01355-y

ACUTE PAIN MEDICINE (R URMAN, SECTION EDITOR)

Post-laparoscopic Shoulder Pain Management: A Narrative Review

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Accepted: 30 December 2024

Abstract

Purpose of Review Post-laparoscopic shoulder pain (PLSP) can slow patient recovery and extend hospital stays, making its management crucial for patients undergoing laparoscopic surgery. Current consensus guidelines say little about how to prevent or manage PLSP. In this context, a multimodal approach to PLSP management that maybe extend beyond the pharmaceutical interventions currently employed. A variety of devices comprising both invasive and noninvasive approaches are available to patients, serving as adjuvants to analgesics. In this review, we explore the potential causes of PLSP. Additionally, by searching relevant databases and reviewing existing literature, we provide a comprehensive summary of current PLSP management strategies excluding analgesics.

Recent Findings A total of 30 articles were reviewed. The review identified a number of different treatments for PLSP, including trendelenburg position, discharge of residual gas, pulmonary recruitment manoeuvre, low-pressure pneumoperitoneum and phrenic nerve block, among others. However, the inconsistencies in the study designs resulted in disparate conclusions.

Summary While the current studies provide valuable insights, there is a clear need for further research in this area.

Keywords Laparoscopic surgery · Shoulder pain · Multimodal analgesia · Phrenic nerve

Introduction

Post-laparoscopic shoulder pain (PLSP) is defined as shoulder pain that occurs within a few hours after laparoscopic surgery. It is typically mild to moderate in intensity, presenting as a dull pain lasting 2–3 days but can persist for up to 5 weeks postoperatively [1–2]. The literature indicates that the incidence of PLSP following various procedures is significant: 66% after laparoscopic gastrectomy [1], 57.1−65.5% after laparoscopic appendectomy [3], and up to 80% following gynecological laparoscopy [4]. Despite its prevalence, PLSP often does not receive adequate attention. A thorough understanding of PLSP management is crucial for improving patient outcomes. This paper aims to provide a reliable basis for the clinical treatment of PLSP by summarizing current management strategies, and proposes multimodal analgesia as the way forward to attain an effective pain relief and functional recovery in patients with PLSP.

Methods

The available literature was reviewed by searching PubMed, Cochrane Library and Web of Science databases. The search utilized MeSH terms and keywords such as “Laparoscopic Surgery”, “Shoulder Pain”, and “Controlled Clinical Trials”, without limitations in terms of publication date. Only English-language papers were considered. The screening process included reviewing the titles, abstracts, and full texts of the published studies. Additionally, the reference lists of the included randomized controlled trials (RCTs) were examined to identify any relevant trials that may have been overlooked but met the established criteria. The search was last updated in May 2024.

Of the 71 articles that were screened, 16 were excluded after duplicates removal, 25 were excluded after titles screening, abstracts screening and full text assessment. The remaining 30 eligible articles include 4 meta analysis and systematic reviews and 26 RCTs.

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Published online: 08 January 2025

This article is based on previously conducted studies and does not contain any new studies with human participants or animals performed by any of the authors.

Etiology of PLSP

The exact etiology of PLSP remains unknown, but most theories suggest it involves irritation of the phrenic nerve.

Referred pain occurs when pain from deep tissue or internal organs spreads to the skin area innervated by the same or adjacent spinal cord segments, causing discomfort in that skin area. The phrenic nerve originates from the anterior branches of C3 - C5 (primarily C4) and innervates the diaphragm. The supraclavicular nerve, a cutaneous branch of the cervical plexus, also arises from C3 - C4 and innervates the skin over the neck, upper chest, and shoulder. Since both the phrenic and supraclavicular nerves include C3 - C4 nerve roots, phrenic nerve stimulation can cause referred pain in the shoulder, forming the basis of PLSP.

During laparoscopic surgery, creating a CO_2 pneumoperitoneum can lead to an acidic environment and passive diaphragmatic distension, which may irritate and damage the phrenic nerve, contributing to PLSP [5–7]. Additionally, the artificial pneumoperitoneum can cause peritoneal microvascular rupture and bleeding, releasing inflammatory mediators that induce pain sensitization, thereby exacerbating shoulder pain. Other factors, such as improper positioning during surgery, excessive shoulder abduction, and early postoperative activity, can also worsen PLSP [8].

Treatment of PLSP

Trendelenburg Position

The trendelenburg position facilitates the movement of residual CO_2 in the abdominal cavity away from the diaphragm and towards the pelvis, where the rich vascularity of the pelvic region accelerates the absorption of CO_2. This position also reduces the stretching of visceral ligaments.

In a study involving 101 patients, the effect of the postoperative trendelenburg position on shoulder pain was evaluated. Pain scores were significantly lower in the intervention group (52 patients) at 12 h postoperatively compared to the control group (49 patients). The severity of pain decreased by 76% in the intervention group, compared to 6.9% in the control group [9].

Discharge of Residual Gas

Residual gas volume is significantly associated with higher pain intensity [10]. Various methods for discharging residual gas have been reviewed, including active gas aspiration, placing a drain, and intraperitoneal saline instillation at the end of surgery.

A systematic review of active gas aspiration showed that patients who underwent this procedure had significantly lower shoulder pain scores after laparoscopic cholecystectomy (LC) than those who did not [11]. However, another study with 60 randomized patients found that active suctioning had only a minor preventive effect on post-laparoscopic pain [10].

Several studies have indicated that gas drainage can be beneficial in managing PLSP, as it reduces the intensity of shoulder pain and the need for analgesics [12–14].

One study suggested that instilling 25–30 ml/kg of saline into the abdominal cavity and leaving it there can decrease the frequency of shoulder pain [15]. Although no patients in this study experienced postoperative ileus, evaluating the feasibility of this maneuver and the kinetics of intraperitoneal fluid absorption is recommended to prevent postoperative adhesions.

Pulmonary Recruitment Maneuver

Pulmonary Recruitment Maneuver (PRM) involves briefly applying significantly higher than usual positive pressure to the airways and alveoli during positive pressure ventilation. This method increases transpulmonary pressure, and re-expands collapsed alveoli.

Several studies have confirmed that applying a certain pressure with PRM, either alone or in combination with intraperitoneal saline infusion and the Trendelenburg position, can reduce the incidence of PLSP, alleviate shoulder pain, and decrease the need for analgesics [16–18]. The mechanism behind this effect is related to PRM's ability to promote the expulsion of CO_2 from the abdominal cavity.

Most researchers in RCTs used a pressure of 60 cmH_2O for PRM [17–18], while a few opted for 40 cmH_2O [19–20]. Although no adverse reactions related to higher airway pressures were reported in these studies, excessive airway pressure can lead to pneumothorax or other pulmonary and cardiovascular complications. Furthermore, most studies focused on gynecological laparoscopic surgeries. Therefore, further research is needed to validate the use of PRM in other types of laparoscopic surgeries and to determine the optimal pressure for PRM and the appropriate measures to combine with it.

It is also worth noting that respiratory physiotherapy with a similar mechanism has been shown to decrease the

severity of shoulder tip pain after LC without complications [13, 21].

Low-Pressure Pneumoperitoneum

Since excessive diaphragm stretching during laparoscopic surgery contributes to shoulder pain, low-pressure pneumoperitoneum might alleviate PLSP.

Typically, pneumoperitoneum pressure is set at 12–16 mmHg during laparoscopic procedures. However, several studies comparing low-pressure pneumoperitoneum (7–10 mmHg) with standard pressure pneumoperitoneum (12–16 mmHg) have found that the lower pressure not only reduces the frequency and severity of PLSP but also decreases the need for postoperative analgesic medication [22–26]. Additionally, Radosa et al. reported that low-pressure laparoscopic hysterectomy for benign uterine pathologies can reduce intraoperative and postoperative arterial pCO2 values [26].

A systematic review of 44 RCTs, including 12 focused on shoulder pain, supported these findings. It showed that 92 out of 515 patients (17.9%) in the low-pressure group experienced shoulder pain, compared to 193 out of 517 patients (37.3%) in the standard pressure group. The quality of evidence supporting the conclusion that low-pressure pneumoperitoneum reduces the incidence of shoulder pain is generally high [27].

However, one study noted that low-pressure pneumoperitoneum increased the operative time of LC by 2 min [28]. Therefore, further research is needed to determine whether the routine use of low-pressure pneumoperitoneum is advisable in laparoscopic surgery.

Phrenic Nerve Block

Shoulder pain can result from irritation or injury to the phrenic nerve. A phrenic nerve block (PNB), which prevents phrenic neural impulses from reaching the central nervous system, has been explored as a treatment option for this pain.

In a randomized controlled trial, researchers used 4 ml of 0.75% ropivacaine to block the phrenic nerve in patients undergoing laparoscopic gallbladder surgery [2]. The results showed a significant decrease in the overall incidence and severity of PLSP in the PNB group compared to the control group.

Although no respiratory complications were observed in this study, further research is needed to fully understand the effects of PNB on respiratory function.

Intraperitoneal Instillation Local Anesthetics

Many studies have confirmed that instilling local anesthetics into the abdominal cavity, either before creating a pneumoperitoneum or after surgery, can reduce the incidence of shoulder pain following laparoscopic procedures [29–32]. The analgesic effect is attributed to the ability of local anesthetics to block signal transmission from damaged intra-abdominal tissues.

Bupivacaine is the most commonly used local anesthetic for intraperitoneal instillation, followed by lidocaine and ropivacaine. In the studies we reviewed, there were no direct reports of adverse events associated with the use of these local anesthetics.

However, a systematic review reported conflicting results. This study included 24 RCTs and concluded that there was insufficient evidence to determine whether intraperitoneal instillation of local anesthetics effectively reduces the incidence of shoulder pain after LC. Based on current evidence, the authors stated that routine intraperitoneal instillation of local anesthetics is not recommended following LC [33].

Transcutaneous Electrical Nerve Stimulation

According to the gate control theory, thick sensory fibers (A-β) transmit signals faster than thin fibers (A-δ and C) that convey pain. Transcutaneous Electrical Nerve Stimulation (TENS) stimulates mechanoreceptors and thick sensory fibers, slowing down the transmission of pain signals to the brain. Additionally, TENS activates pain-inhibiting neurons at the dorsal horn level, which helps minimize pain by reducing the activity of projection neurons [34]. Moreover, TENS can relieve pain by stimulating endogenous opioid secretion [35].

Mottahedi et al. found that TENS combined with medication significantly reduced the intensity of PLSP compared to medication alone at all three measured times [36]. Nevertheless, Asgari et al. indicated that TENS was not superior to fentanyl for pain relief in laparoscopic surgery [37]. Future evaluations should focus on the specific parameters of TENS used and the dosage of analgesics.

Lidocaine Patch

A study by Kim et al. showed that a 5% lidocaine patch can reduce the overall incidence of shoulder pain after LC in female patients. At 24 and 48 h postoperatively, the shoulder pain scores were significantly lower in the patch group compared to the control group [38]. The analgesic effect can be attributed to the reduction in epidermal nerve fibre density following the application of a 5% lidocaine patch [39].

Intraperitoneal Dexamethasone

The study by Asgari et al. found that administering 16 mg of dexamethasone intraperitoneally significantly reduced the severity of PLSP compared with a placebo. It also decreased the need for narcotic analgesia [40]. The effectiveness of dexamethasone in reducing shoulder pain may be attributed to its anti-inflammatory properties, which help alleviate inflammation following laparoscopy.

Discussion

The objective of multimodal therapy is to reduce pain intensity and drug-related adverse events, accelerate recovery, and facilitate rehabilitation. The ideal outcome of multimodal therapy is the restoration of patients' functionality, the amelioration of quality of life, and the prevention of the progression of acute to chronic pain [41]. Multimodal analgesia has been included in the current international guideline recommendations for postoperative pain. However, there is a limited amount of high-quality research available on multimodal analgesia in PLSP management. Overall, there is a clear requirement for further high-quality clinical evidence, potentially based on a robust clinical trial design, to validate the efficacy of multimodal analgesia in the management of PLSP.

This review has some limitations. First, it may not have captured all relevant articles, as the literature review was limited to PubMed, Cochrane Library and Web of Science databases. Second, there may be bias in the review and assessment of articles due to the researchers' individual capacity and experience limitations. Third, as most of the relevant articles included in this review were clinical trials, some high quality retrospective studies may have been excluded. Lastly, restricting the selection to English-language publications may have inadvertently excluded potentially influential articles published in other languages.

Conclusion

While the current evidence does not identify a single treatment as the most effective for PLSP, this article has outlined various treatment options. Further research is needed to identify effective treatments for PLSP, understand the incremental benefits of combining interventions, and determine the most effective combinations and sequences of treatments.

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Author Contributions Xiaohui Luo processed the main concept and design of article. Yan Zhao and Wen Xin carried out most of the selection of the articles. Yan Zhao drafted the initial manuscript. All the authors contributed to the review and provided critical revisions to enhance the quality of the paper. All of the authors reviewed and approved the final draft of the submitted manuscript.

Funding No funding or sponsorship was received for this review or publication of this article.

Data Availability No datasets were generated or analysed during the current study.

Declarations

Competing Interests The authors declare no competing interests.

Human and Animal Rights All reported studies/experiments with human or animal subjects performed by the authors have been previously published and complied with all applicable ethical standards (including the Helsinki declaration and its amendments, institutional/national research committee standards, and international/national/institutional guidelines).

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