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REVIEW ARTICLE

Pain management after laminectomy: a systematic review and procedure-specific post-operative pain management (prospect) recommendations

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Abstract

Purpose With lumbar laminectomy increasingly being performed on an outpatient basis, optimal pain management is critical to avoid post-operative delay in discharge and readmission. The aim of this review was to evaluate the available literature and develop recommendations for optimal pain management after one- or two-level lumbar laminectomy.

Methods A systematic review utilizing the PROcedure-SPECific Post-operative Pain ManagemenT (PROSPECT) methodology was undertaken. Randomised controlled trials (RCTs) published in the English language from 1 January 2008 until 31 March 2020—assessing post-operative pain using analgesic, anaesthetic and surgical interventions—were identified from MEDLINE, EMBASE and Cochrane Databases.

Results Out of 65 eligible studies identified, 39 RCTs met the inclusion criteria. The analgesic regimen for lumbar laminectomy should include paracetamol and a non-steroidal anti-inflammatory drug (NSAID) or cyclooxygenase (COX)—2 selective inhibitor administered preoperatively or intraoperatively and continued post-operatively, with post-operative opioids for rescue analgesia. In addition, surgical wound instillation or infiltration with local anaesthetics prior to wound closure is recommended. Some interventions—gabapentinoids and intrathecal opioid administration—although effective, carry significant risks and consequently were omitted from the recommendations. Other interventions were also not recommended because there was insufficient, inconsistent or lack of evidence.

Conclusion Perioperative pain management for lumbar laminectomy should include paracetamol and NSAID- or COX-2-specific inhibitor, continued into the post-operative period, as well as intraoperative surgical wound instillation or infiltration. Opioids should be used as rescue medication post-operatively. Future studies are necessary to evaluate the efficacy of our recommendations.

Keywords Laminectomy · Analgesia · Systematic review · Evidence-based medicine

Introduction

Lumbar laminectomy is commonly performed in patients with lumbar spinal stenosis to relieve low back pain, reduce radiculopathy and improve overall function. These

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procedures are increasingly performed in an ambulatory or day-care setting. Inadequate pain management is one of the main reasons for delayed discharge or readmission after surgery [1, 4]. Effective pain control improves post-operative outcomes and patient satisfaction. Multimodal analgesia has frequently been recommended for enhanced recovery after surgery [5]. However, a lack of procedure-specific recommendations has resulted in heavy reliance on opioid medications [6]. Efforts to reduce opioid consumption and their associated adverse effects have been recently promoted [7].

The PROSPECT (PROcedure-SPECific Post-operative Pain ManagemenT) Working Group is a collaboration of surgeons and anaesthesiologists working to formulate procedure-specific recommendations for pain management after common but potentially painful operations. The recommendations are based on procedure-specific evidence as well as the balance between the efficacy and adverse effects of analgesic techniques and clinical relevance [8, 9].

The aim of this systematic review was to evaluate the available evidence on the management of pain after lumbar laminectomy. Post-operative pain outcomes (pain scores and analgesic requirements) were the primary focus, but other recovery outcomes—including adverse effects—were also assessed, when reported, and the limitations of the data were critically reviewed. The ultimate aim was to develop recommendations for pain management after laminectomy.

Methods

A systematic review of the literature associated with analgesia after lumbar laminectomy was conducted in accordance with the PROSPECT methodology [9]. The PROSPECT methodology requires that at least two RCTs are available to provide any guidance.

Research question

'How can we enhance perioperative pain management in patients undergoing lumbar laminectomy?'.

Eligibility criteria

Inclusion criteria were randomised control trials (RCTs) or systematic reviews of analgesic, anaesthetic and operative interventions, published in the English language assessing pain management for patients undergoing up to two-level lumbar laminectomy. The study was required to measure pain intensity using tools such as the numerical rating scale or visual analogue scale. Studies that reported data pooled from patients undergoing mixed surgical procedures were excluded if no response was received from the authors to provide data tables specifically related to laminectomy and the intended intervention. Only open procedures were deemed eligible, and minimal invasive procedures were therefore excluded.

Search strategy

EMBASE, MEDLINE, Pubmed and Cochrane Databases (Cochrane Central Register of Controlled Trials, Cochrane Database of Abstracts or Reviews of Effects, Cochrane Database of Systematic Reviews) were searched for studies published between 1 January 2008 and 31 March 2020.

Search terms related to pain and interventions for laminectomy AND pain OR pains OR pain management OR post-operative pain OR post-operative pain OR analgesia* OR anaesthesia* OR vas OR visual analogue* OR vrs OR verbal rating scale* OR nrs OR numerical rating scale* OR pain rating OR epidural OR neuraxial OR intrathecal OR paravertebral OR spinal OR infiltration OR nerve block* OR neural block* OR paravertebral block* OR field block* OR Ilioinguinal block* OR transversus abdominis plane block* OR tap block* OR NSAID* OR non-steroidal anti-inflammatory* OR non-steroidal anti-inflammatory* OR COX-2 OR Paracetamol OR acetaminophen OR clonidine OR opioid* OR ketamine OR corticosteroid* OR gabapentin OR pregabalin.

Study selection

A stepwise manner was used, which included screening of abstracts of potential articles. This process was undertaken by two reviewers, and the final results of each reviewer were compared. Any discrepancies between results were discussed within the working group, and a decision was made on inclusion or exclusion by consensus.

Assessment of the quality of evidence

The final articles were assessed by all authors, and again any discrepancies were resolved in the same fashion. Reasons for exclusion were provided for all articles that were excluded in this phase. Reference lists of the relevant articles were individually screened to assess for any additional articles that may have been missed in the initial literature search. Criteria employed in the assessment of the quality of eligible studies (Supplementary Table 1) included allocation concealment (A–adequate; B–Unclear; C–inadequate; D–not used); the numerical (1–5) quality scoring system employed by Jadad to assess randomisation, double blinding and flow of patients; a participant follow-up of greater or less than 80 percent; and

whether the study met the requirements of the Consolidated Standards of Reporting Trials (CONSORT) 2010 Statement.

Data extraction

Summary information for each included study was extracted and recorded in data tables. This information included timing of the intervention and mode of delivery, pain scores, whether pain was assessed at rest or during mobilisation, supplementary analgesic use, time to first analgesic administration, time intervals of pain measured. Unless specified otherwise, it was assumed that the pain scores were assessed at rest. The included studies were grouped together based upon the analgesic interventions (e.g. paracetamol, non-steroidal anti-inflammatory drugs [NSAIDs], gabapentinoids [pregabalin and gabapentin] and locoregional analgesia among others). The study assessing the effects of surgical techniques on analgesic outcomes was grouped separately.

Pain intensity scores were used as primary outcome measures. A difference in pain scores, between the intervention group and control group, of at least 1 cm/10 cm on VAS or 1/10 on NRS has been considered as clinically significant based on the publication by Myles et al. [10]. According to the PROSPECT methodology, clinically significant differences, rather than statistically significant differences, are used to determine recommendation. The effectiveness of each intervention for each outcome was evaluated qualitatively, by assessing the number of studies showing a significant difference between treatment arms ($P < 0.05$, as reported in the study publication). A meta-analysis was not performed due to the limited number of studies with homogenous design and differences in reporting of results, restricting pooled analysis.

Formulation of the recommendations

Recommendations are given when at least two congruent studies support an intervention. The proposed recommendations were sent to the PROSPECT Working Group for review and comments. A modified Delphi approach was utilised, which included several rounds of individual comments followed by round-table discussions. The modified Delphi method involved achieving consensus on recommendation for analgesic interventions that have at least two RCTs. Once consensus was achieved, the final manuscript was drafted by the lead authors, which was ultimately approved by the Working Group.

Results

The PRISMA flowchart establishing the search strategy and data is presented in Fig. 1. The methodological quality assessments of the 39 RCTs included for the final qualitative analysis are summarised in Supplementary Table 1. The characteristics of the included studies are shown in Supplementary Tables 2, 3.

Systemic Analgesic Interventions

Cakan et al. performed a placebo-controlled trial to evaluate the effect of intravenous (IV) paracetamol 1000 mg during the first 24 post-operative hours [11]. Rescue analgesia included IV patient-controlled analgesia (IV-PCA) morphine. Pain scores were significantly lower at 12 h, 18 h and 24 h post-surgery. However, morphine consumption was not statistically significant between the groups.

Kesimci et al. compared oral dexketoprofen 25 mg to oral paracetamol 500 mg to placebo, 30 min before induction of anaesthesia [12]. Rescue analgesia included IV-PCA morphine. There were no significant differences in pain scores between groups; however, opioid consumption was significantly lower in the dexketoprofen group.

Khajavikhan et al. compared celecoxib 400 mg administered 2 h before surgery and 200 mg administered 6 h after surgery with placebo [13]. Rescue analgesia included intermittent IV morphine. Significantly lower pain scores were noted in the celecoxib group, and total opioid consumption was also significantly lower in the celecoxib group.

Attia et al. compared oral etoricoxib 120 mg, oral duloxetine 60 mg, the combination of oral etoricoxib 120 mg and duloxetine 60 mg and placebo [14]. The drugs were administered 1 h before surgery as well as 24 h after surgery. Rescue analgesia included IV paracetamol and intermittent IV morphine. Pain scores were significantly lower at all times in patients receiving the combination of etoricoxib and duloxetine as well in patients receiving etoricoxib alone. Patients receiving the combination of etoricoxib and duloxetine also had significantly lower opioid consumption after surgery.

Duttchen et al. compared IV ketorolac 30 mg to IV ketorolac 15 mg [15]. Rescue analgesia included intermittent IV morphine. There was no significant difference between the two groups.

Nikooseresh et al. compared diclofenac 100 mg suppository to IV paracetamol 1000 mg [16]. Rescue analgesia included IV-PCA fentanyl. There was no significant difference in pain scores; however, opioid consumption was significantly lower with diclofenac.

Cassinelli et al. compared ketorolac 30 mg (15 mg if patient age > 65 years) to placebo [17]. Rescue analgesia included oral oxycodone and intermittent IV morphine. Pain

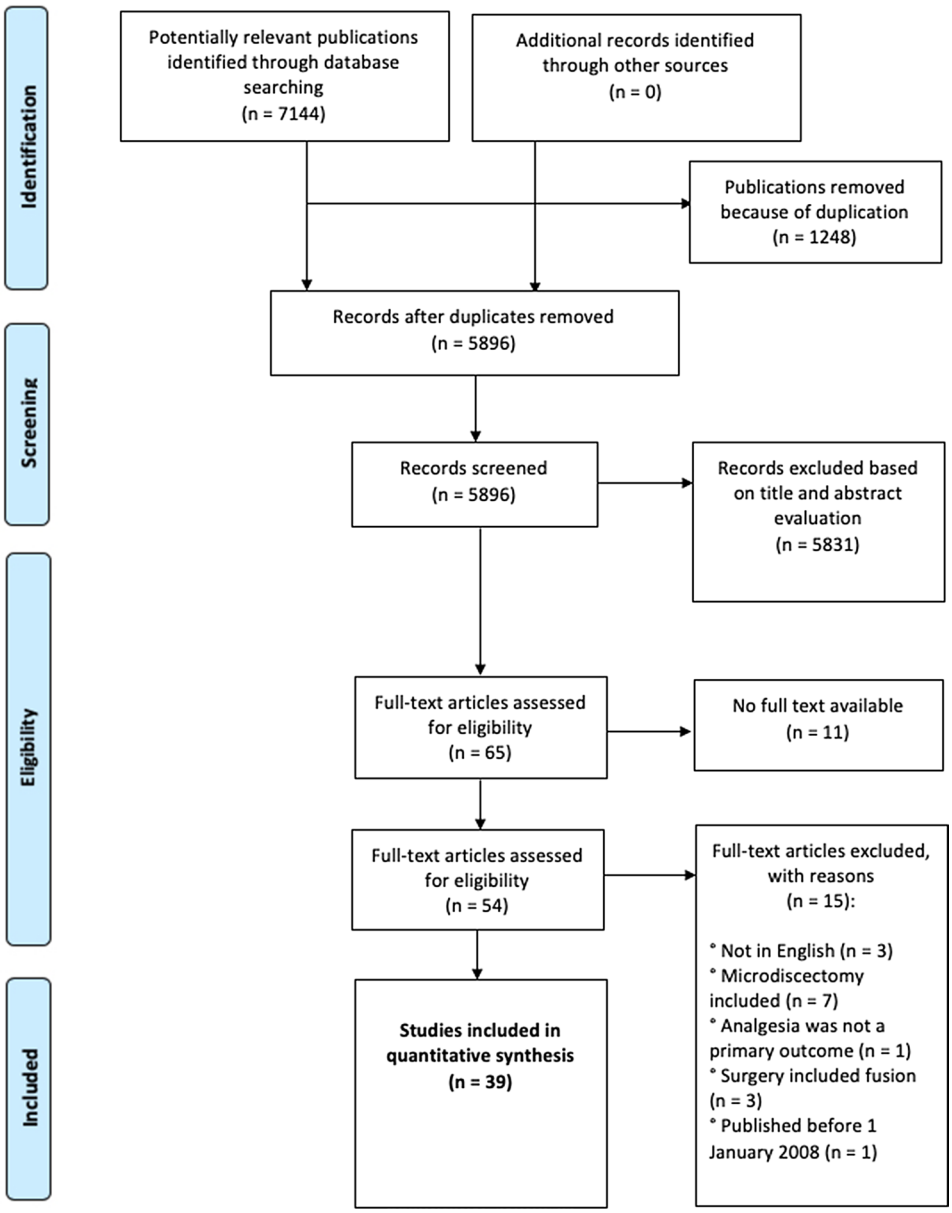

Fig. 1 PRISMA flowchart

scores and opioid consumption were significantly lower at 0 h and 4 h after surgery in patients receiving ketorolac.

Emamhadi et al. compared diclofenac 100 mg suppository to IM pethidine 0.5 mg/kg [18]. Rescue analgesia was not reported. Significantly lower pain scores were reported with pethidine at all time points after surgery.

Yadav et al. compared pregabalin 150 mg to pregabalin 300 mg and to placebo, administered 2 h before surgery [19]. Rescue analgesia included oral NSAIDs and IV-PCA fentanyl. Pain scores and opioid consumption after surgery were significantly lower in both groups of patients receiving pregabalin, without significant differences between the two different doses of pregabalin. There was a higher incidence of dizziness and blurred vision in patients receiving pregabalin 300 mg.

Kumar et al. compared oral pregabalin 150 mg, administered 1 h before induction, with oral tramadol 100 mg and with placebo [20]. Rescue analgesia included intermittent IV fentanyl and IV diclofenac. Significantly lower pain scores and opioid consumption were seen with both pregabalin and tramadol. Post hoc analysis significantly favoured the tramadol group. No significant difference in anxiety was reported. Adverse effects were not reported.

Choi et al. compared oral pregabalin 150 mg—administered twice a day with a total of 8 doses—to the combination of oral pregabalin 150 mg and IV dexamethasone 5 mg and to placebo [21]. Rescue analgesia included continuous IV fentanyl. Pain scores were significantly lower in both intervention groups. Opioid consumption was significantly lower with the combination of pregabalin

and dexamethasone. No significant differences in adverse effects were noted.

Javaherforooshzadeh et al. compared oral gabapentin 600 mg, administered 100 min before surgery, to oral melatonin 6 mg and to placebo [22]. Rescue analgesia included IV morphine and IV pethidine. Pain scores were significantly lower in patients that received gabapentin. Opioid consumption was significantly lower in both gabapentin and melatonin groups. No significant differences in adverse effects were noted.

Khan et al. compared oral gabapentin 600 mg, oral gabapentin 900 mg, oral gabapentin 1200 mg and placebo [23]. Rescue analgesia included IV-PCA morphine. Pain scores and opioid consumption were significantly lower in the gabapentin 900 mg and 1200 mg groups. The time of administration (2 h before surgery or at the end of surgery) did not impact the analgesic effect. Adverse effects were not reported.

Vasigh et al. compared oral gabapentin to oral celecoxib in two RCTs [24, 25]. Rescue analgesia included intermittent IV morphine. One RCT compared oral gabapentin 600 mg administered 2 h before surgery and 300 mg 6 h after surgery, the combination of oral gabapentin 300 mg and oral celecoxib 200 mg administered 2 h before surgery and 6 h after surgery and placebo [24]. Pain scores and opioid consumption were significantly lower in patients receiving the combination of gabapentin and celecoxib. The other RCT compared oral gabapentin 600 mg administered 2 h before surgery and 300 mg 6 h after surgery with oral celecoxib 400 mg administered 2 h before surgery and 200 mg 6 h after surgery and with placebo [25]. Pain scores were lower in patients receiving gabapentin, and opioid consumption was significantly lower in both intervention groups. Adverse effects were not reported.

Ozgencil et al. compared oral pregabalin 150 mg, oral gabapentin 1200 mg and placebo, administered twice before surgery and twice after surgery [26]. Rescue analgesia included IV-PCA morphine. Pain scores were significantly lower with pregabalin and gabapentin at 1 h, 2 h, 4 h and 6 h after surgery. Opioid consumption was significantly lower in both gabapentin and pregabalin groups at all time points, except at 6 h after surgery where opioid consumption was lower with pregabalin. Except for pruritus, the adverse effects observed were similar among groups. The incidence of pruritus was lower in both the gabapentin and pregabalin groups compared to the placebo group.

Wittayapairoj et al. compared IV dexamethasone 0.2 mg/kg administered before surgery to placebo [27]. Rescue analgesia included IV-PCA morphine. Pain scores were not significantly different between the two groups, but opioid consumption was significantly lower in patients receiving dexamethasone.

Ghaffaripour et al. compared IV magnesium, with a loading dose of 30 mg/kg at the start of surgery and a continuous infusion of 10 mg/kg/h during surgery, to placebo [28]. Rescue analgesia included IV-PCA morphine. There were no significant differences between the two groups.

Esmat et al. compared a transdermal fentanyl patch (50 µg/u), a transdermal melatonin delivery system (7 mg) and a transdermal placebo patch [29]. Rescue analgesia included IM pethidine. Pain scores did not differ significantly between groups, but opioid consumption was lower with transdermal fentanyl and melatonin.

Locoregional anaesthesia

Chan et al. evaluated the analgesic effects of intrathecal fentanyl 15 µg [30]. Patients in the control group did not receive an intervention. Rescue analgesia included IV-PCA morphine. Pain scores and opioid consumption were significantly lower in patients receiving intrathecal fentanyl. No significant differences in adverse effects were noted.

Yen et al. compared intrathecal morphine 3.5 µg/kg (with a maximum dose of 350 µg) to placebo [31]. Rescue analgesia included IV-PCA morphine. There was no significant difference in pain scores. Total opioid consumption, however, was significantly lower in patients receiving intrathecal morphine. No episodes of respiratory depression were observed in both groups.

Firouzian et al. compared the intrathecal morphine 200 µg to the combination of intrathecal morphine 200 µg and naloxone 20 µg [32]. Rescue analgesia included IV-PCA morphine. Pain scores and opioid consumption were significantly lower in patients receiving the combination of intrathecal morphine and naloxone. No significant differences in adverse effects were noted.

Kundra et al. compared epidural gelfoam soaked in morphine 5 mg to the combination of epidural gelfoam soaked in saline and epidural instillation with morphine 5 mg [33]. Rescue analgesia included IV diclofenac and intermittent IV morphine. Pain scores and opioid consumption were significantly lower in patients receiving epidural gelfoam soaked in morphine 5 mg. No significant differences in adverse effects were noted.

Guilfoyle et al. evaluated the analgesic effects of fentanyl 100 µg administered through an epidural catheter [34]. Patients in the control group received no intervention. Rescue analgesia was not reported. Pain scores were significantly lower in patients that received epidural fentanyl when admitted to the recovery, but not afterwards. No significant differences in adverse effects were noted.

Hassanein et al. compared epidural gelfoam soaked in morphine 5 mg (diluted in crystalloid), epidural gelfoam soaked in morphine 5 mg (diluted in colloid) and epidural instillation with morphine 5 mg [35]. Rescue analgesia

included IV diclofenac and intermittent IV morphine. Pain scores and opioid consumption were significantly lower in both epidural gelfoam groups. No significant differences in adverse effects were noted.

Kumari et al. compared epidural gelfoam soaked in 10 ml levobupivacaine 0.25% combined with dexamethasone 10 mg, epidural gelfoam soaked in 10 ml levobupivacaine 0.25% combined with saline and epidural gelfoam soaked in saline only [36]. Rescue analgesia included IV tramadol. Pain scores and opioid consumption were significantly lower in both groups that received epidural gelfoam soaked in levobupivacaine. The addition of dexamethasone did not result in significant differences. No significant differences in adverse effects were noted.

Giri et al. compared epidural gelfoam soaked in ketamine 50 mg diluted with 5 mL saline, epidural gelfoam soaked in nalbuphine 10 mg diluted with 5 mL saline and epidural gelfoam soaked in 5 mL saline [37]. Rescue analgesia included IV diclofenac. Pain scores were significantly lower in both intervention groups. Total diclofenac consumption was significantly lower in patients receiving epidural gelfoam soaked in ketamine 50 mg. No significant differences in adverse effects were noted.

Ozbek et al. evaluated the analgesic effects of a paravertebral block, performed with 5 mL levobupivacaine 0.5% for each nerve to upper dermatome of laminectomy level [38]. Patients in the control group did not receive any intervention. Rescue analgesia included IV-PCA morphine. Pain scores and opioid consumption were significantly lower in patients receiving a paravertebral block.

Mordeniz et al. evaluated the analgesic effects of a perineural infiltration with 2 ml of bupivacaine 0.5% [39]. Perineural infiltration was defined as the infiltration of local anaesthetics in the irritated neural root sheath, before root extraction. Patients in the control group did not receive any intervention. Rescue analgesia included IV tramadol Opioid consumption after surgery was significantly lower in patients that received a perineural infiltration.

Torun et al. evaluated the analgesic effects of a perineural infiltration with 0.5 ml of lidocaine 2% [40]. Patients in the control group did not receive any intervention. Rescue analgesia included IV tramadol. Opioid consumption after surgery was significantly lower in patients that received a perineural infiltration.

Saini et al. compared wound instillation with 20 ml of ropivacaine 0.25% to placebo [41]. Wound instillation was defined as the irrigation of the local analgesic into the surgical area for a dwell time of 60 s. Rescue analgesia included IV paracetamol and IV diclofenac. Pain scores and opioid consumption after surgery were significantly lower in the intervention group.

Jonnavithula et al. compared wound instillation with 20 ml of bupivacaine 0.25% to placebo [42]. Rescue analgesia included IM diclofenac. Pain scores and opioid consumption were significantly lower in patients that received wound instillation with bupivacaine.

Rahmanian et al. compared surgical wound instillation with 30 ml of bupivacaine 0.25% with placebo [43]. Rescue analgesia was not reported. Pain scores after surgery did not differ between the two groups.

Gurbet et al. compared wound infiltration with 20 ml of levobupivacaine 0.25% combined with methylprednisolone 40 mg, wound infiltration with 20 ml of bupivacaine 0.25% combined with methylprednisolone 40 mg and placebo [44]. Wound infiltration was defined as direct administration of the local analgesic along the line of the incision. Rescue analgesia included IV-PCA morphine. Pain scores and opioid consumption were significantly lower in both intervention groups.

Hazarika et al. compared local wound infiltration with 20 ml of bupivacaine 0.25% combined with magnesium sulphate 500 mg to 20 ml of ropivacaine 0.25% combined with magnesium sulphate 500 mg [45]. Rescue analgesia included IV nalbuphine. There was no significant difference in pain scores after surgery; however, opioid consumption was significantly lower in patients that received local wound infiltration with bupivacaine.

Multimodal analgesia

Garcia et al. evaluated the analgesic effects of a multimodal analgesic regimen (celecoxib 100 mg twice a day, pregabalin 75 mg twice a day and oxycodone 10 mg twice a day) [46]. Patients in the control group did not receive any intervention. Rescue analgesia included intermittent IV morphine. Pain scores and opioid consumption were significantly lower at all time points in patients receiving the multimodal regimen.

Anaesthetic technique

Vasigh et al. compared induction of anaesthesia with thiopentone and maintenance with sevoflurane, induction and maintenance with propofol, and induction with propofol and maintenance with sevoflurane [47]. Rescue analgesia included intermittent IV morphine. Pain scores and opioid consumption were significantly lower with an induction of anaesthesia with propofol and maintenance with sevoflurane.

Duger et al. compared spinal anaesthesia with 2 ml of bupivacaine 0.5% combined with morphine 0.1 mg, epidural anaesthesia with 10 ml of bupivacaine 0.5% combined with morphine 2 mg and combined spinal and epidural anaesthesia [CSE] with 1 ml of intrathecal bupivacaine 0.5% combined with morphine 0.05 mg and 6 ml of epidural bupivacaine 0.5% combined with morphine 2 mg [48]. Rescue

analgesia included IV-PCA morphine. Pain scores and opioid consumption were significantly lower with epidural anaesthesia and CSE.

Surgical technique

Watanabe et al. compared the technique of lumbar spinous process splitting laminectomy (LSPSL) to the conventional technique of laminectomy [49]. Rescue analgesia included oral NSAIDs. Pain scores were significantly lower with LSPSL. There was no significant difference between groups in opioid consumption.

Discussion

Interpretation

This systematic review included 39 RCTs with the majority of studies determined to be of high quality by the CONSORT statement. The strength of our systematic review stems from the PROSPECT methodology which goes beyond making recommendation based on the simple statistical analysis of the available evidence. The included studies are interpreted based on the use of a baseline analgesic technique (i.e. use of paracetamol and NSAID- or COX-2-specific inhibitor) and balancing the efficacy and adverse effects of the intervention as well as assimilating this information in the perioperative setting of lumbar laminectomy. Overall, the PROSPECT recommendations provide clinicians with supporting arguments for and against the use of analgesic interventions for laminectomy.

Based on the PROSPECT methodology, a combination of paracetamol and NSAID- or COX-2-specific inhibitor is recommended preoperatively or intraoperatively, which should be continued into the post-operative period, unless there are contraindications. Excellent evidence is available for the use of NSAIDs/COX-2-specific inhibitors, with five out of seven RCTs demonstrating improved outcomes. [12–14, 16, 17]. Duttchen et al. could not demonstrate a significant difference in outcomes between two different doses of ketorolac [15]. Emamhadi et al. compared the use of diclofenac to pethidine, showing less pain in patients treated with pethidine [18]. On the other hand, there is only one RCT available where the effect of paracetamol in patients undergoing lumbar laminectomy was evaluated [11]. However, the opioid-sparing effects of paracetamol are well described, and for this reason, paracetamol is also recommended for lumbar laminectomy. Furthermore, both Kesimci et al. and Nikosereth et al. reported no significant difference in post-operative pain scores between NSAIDs and paracetamol [12, 16].

Wound instillation or infiltration with local anaesthetics, performed by the surgeon just before wound closure, is recommended as the regional anaesthetic technique of choice. Wound instillation is defined as the irrigation of the local anaesthetics into the surgical area, while wound infiltration is defined as the direct injection of local anaesthetics into the tissue along the line of incision. For this recommendation, we decided not to distinguish between wound instillation and wound infiltration because these two techniques are closely related. Three RCTs of high quality showed significantly improved outcomes using wound instillation or infiltration [41, 42, 44]. One RCT did not show a significant analgesic benefit after wound instillation [43]. Another RCT compared the infiltration of two different local anaesthetics without a placebo group [45]. It is possible that some of the benefits from local anaesthetic wound instillation may be due to migration of local anaesthetic into the neuraxial planes. Surgical wound instillation or infiltration remains a simple technique that can be rapidly performed, with limited risk for side effects including anaesthetic systemic toxicity. Although the studies did not describe infiltration techniques, it is well accepted that any surgical site infiltration should involve local anaesthetic injection into multiple layers, similar to local infiltration techniques used for joint surgery. Intrathecal opioids have been demonstrated to provide excellent pain relief in patients undergoing lumbar laminectomy [30, 32]. However, the potential side effects are worrisome, particularly because this procedure is increasingly being performed as an outpatient procedure [2, 3]. These potential side effects include—but are not limited to—respiratory depression, cardiovascular stress, cognitive dysfunction, delayed wound healing, urinary and gastrointestinal dysfunction, as well as the risk of acquired tolerance and long-term opioid use. Therefore, it is prudent to avoid intrathecal opioids. In addition, it is unclear whether these neuraxial techniques provide any further enhanced clinically relevant pain relief over the use of basic analgesics combined with local anaesthetic instillation or infiltration. For the same reason, epidural analgesia is not recommended [33, 37]. Other regional anaesthetic techniques, such as paravertebral blocks and perineural infiltration, are not recommended due to limited procedure-specific evidence [38, 40].

Gabapentinoids are not recommended as the first line of treatment in spite of proven efficacy in this patient population [19, 26]. Similar to intrathecal and epidural analgesia, a significant risk of important side effects (including, but not limited to sedation, dizziness, visual blurring) is associated with the administration of these drugs. The FDA recently published an advisory emphasising the concerns of gabapentin and pregabalin [50].

Only limited procedure-specific evidence was available for dexamethasone, with one RCT showing reduced opioid consumption [27]. Therefore, dexamethasone cannot be recommended as part of the standard analgesic regimen in patients undergoing lumbar laminectomy. Nonetheless, it has an important role in the prevention of post-operative nausea and vomiting [51]. There were no published data assessing the analgesic effects of ketamine and alpha-2-agonists, such as dexmedetomidine or clonidine, which could be assessed in future studies.

We have found no evidence regarding analgesic regimens for challenging patient populations, such as chronic opioid consumers, which is a common phenomenon in this surgical population. Hence, there is a need for further research on this topic.

Opioids are recommended only as rescue medication for patients undergoing lumbar laminectomy [52]. We caution against the use of transdermal fentanyl patches in the perioperative period, because this treatment is not adapted for the treatment of acute post-operative pain [53].

Limitations

The limitations in this review are related to those of the included studies. There was considerable heterogeneity between studies such as variable dosing regimens, variable methods of administration and variable control groups as well as variable time points of pain assessments. The small size of most studies has the potential for estimation effect. In addition, the sample size of the studies was not adequate to draw valid conclusions concerning the safety profile of the analgesic interventions. Also, the analgesic interventions were not evaluated against a control group that included an optimised multimodal analgesic regimen.

Implications for future research

Future adequately powered studies should assess the effects of analgesic interventions not only on pain, opioid consumption, opioid-related adverse events and complications associated with the intervention, but also outcome measures such as time to ambulation, length of hospital stay and the occurrence of chronic pain or chronic opioid consumption. Furthermore, the influence of analgesic intervention on patient-specific factors such as chronic pain and chronic opioid therapy needs to be assessed.

Conclusion

In summary, this review has identified a perioperative analgesic regimen for optimal pain management after lumbar laminectomy (Table 1). This review also identified perioperative interventions that are not recommended for pain management in patients undergoing lumbar laminectomy (Table 2). Perioperative pain management for lumbar laminectomy should include paracetamol and NSAID- or COX-2-specific inhibitor, continued into the post-operative period, as well as intraoperative surgical wound instillation or infiltration. Opioids should be used as rescue medication post-operatively.

Table 1 Overall recommendations for perioperative pain management in patients undergoing lumbar laminectomy

Preoperative and intraoperative recommendations
Oral or IV paracetamol (Grade D)
Oral or IV NSAIDs/COX-2-specific inhibitors (Grade A)
Surgical wound instillation or infiltration with local anaesthetic (Grade A)
Post-operative recommendations
Oral or IV paracetamol (Grade D)
Oral or IV NSAIDs/COX-2-specific inhibitors (Grade A)
Opioids as rescue medication (Grade D)

COX-2, cyclooxygenase-2; IV, intravenous; NSAIDs, non-steroidal anti-inflammatory drugs

Table 2 Analgesic interventions that are not recommended for pain management in patients undergoing lumbar laminectomy

Intervention	Reason for not recommending
Dexamethasone	Limited procedure-specific evidence
Oral gabapentin/pregabalin	Significant risk for adverse effects
Intrathecal opioids	Significant risk for adverse effects
Epidural analgesia	Limited procedure-specific evidence and risk for adverse effects
Paravertebral block	Limited procedure-specific evidence
Surgical perineural infiltration	Limited procedure-specific evidence
Corticosteroids	Limited procedure-specific evidence
Intravenous magnesium	Lack of procedure-specific evidence
Transdermal fentanyl	Limited procedure-specific evidence and risk for adverse effects

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Author contributions LP and PLC conducted the literature search and analysed the retrieved articles with AS, JG and HB. LP and PLC wrote the manuscript, which was reviewed and edited by all the other authors who have also participated in the PROSPECT Working Group meetings using the Delphi method and in defining the methodology of the PROSPECT group.

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Compliance with ethical standards

Conflict of interest Philipp Lirk has no conflicts of interest to declare. Girish P. Joshi has received honoraria from Baxter and Pacira Pharmaceuticals. Francis Bonnet has received honoraria from Pfizer, The Medicine Company, Abbott France and Nordic Pharma France. Henrik Kehlet has received honoraria from Pfizer and Grunenthal. The Anesthesiology Unit of the University of Western Australia, but not Stephan Schug privately, has received research and travel funding and speaking and consulting honoraria from bioCSL, Eli Lilly, Indivior, iX Biopharma and Pfizer. Narinder Rawal has received honoraria from Baxter and Sintetica. Marc Van de Velde received honoraria from Sintetica, Grunenthal, Vifor Pharma, MSD, Nordic Pharma, Janssen Pharmaceuticals, Heron Therapeutics and Aquettant. Hélène Beloeil has received honoraria from Orion, Abbvie and Aspen.

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