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| RESEARCH ARTICLE

Efficacy of Crural Block in Improving Pain Following Laparoscopic Hiatus Hernia Repair: A Cohort Comparison Study

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| ABSTRACT
Hiatus hernia repair is a common gastrointestinal surgery performed worldwide for the treatment of gastro-oesophageal reflux. In the last two decades, there has been a widespread shift from open to laparoscopic repair and this has been proven to significantly reduce postoperative pain, an earlier discharge and a faster return to work. Importantly, there is an obvious gap in the literature regarding postoperative pain experiences and whether any analgesia adjuncts are utilised and to what effect they have on reducing pain and reducing the need for traditional analgesia such as opioids. One novel adjunct uncommonly utilised clinically but not thus far researched is diaphragmatic crural regional infiltration with long-acting local anaesthesia, aiming to dampen pain signals generated from the abdominal and thoracic dissection performed during hiatus hernia repair. This is a low risk, low effort technique performed intraoperatively by the surgeon under direct vision at the end of surgery targeting the vagal afferent nociceptive nerve fibres found in the crural fibres, a viable target for blockade by local anaesthesia. A cohort comparison study was performed at a single centre assessing the effects of crural infiltration with long-acting local anaesthesia performed routinely by one higher volume upper gastrointestinal surgeon, whose cohort is the intervention group. The primary end points assessed were postoperative pain outcomes and opioid requirements and the intervention cohort's results were compared against that of another high volume upper gastrointestinal surgeon at the same hospital who does not perform crural infiltration. Consecutive cases were analysed from 2019-2021, comparing the two cohort groups' primary endpoints. Crural infiltration was found to be opioid-sparing, with patients requiring 2mg less morphine each day compared to the non-interventional group. In addition, the interventional cohort experienced reduced peak pain scores compared to the non-interventional group. Increasing age was protective against postoperative pain whilst patients who had purely para-oesophageal hernias experienced more pain than other hernia types. There appear to be potential positive effects of crural anaesthesia infiltration following hiatus hernia repair, though not statistically significant in this study. As such more research into its effects as it can be an important adjunct in reducing postoperative pain.

| KEYWORDS

Laparoscopic hiatus hernia repair, postoperative pain, crura, local anaesthesia, opioids

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1. Introduction

Laparoscopic hiatus hernia repair is common and complex surgery performed worldwide for treatment of gastro-oesophageal reflux disease (Chang & Thackeray, 2016). Although patients having laparoscopic hiatus hernia repair experience less pain than open surgery, postoperative pain can still be significant and lead to associated postoperative issues. These issues can include respiratory and other complications, delay in discharge and adverse effects from increasing requirements of systemic analgesia such as opioid. An important consideration in the potential multitude of problems associated with increased opioid use is the propensity for vomiting. Postoperative vomiting can result in the repaired diaphragm enduring excessive pressure and subsequently early recurrence and failure of the procedure (Dale et al., 2016). Despite this, there is minimal literature assessing the

severity of postoperative pain patients experience and the modalities of analgesia utilised, with studies showing that acute postoperative pain was unsatisfactorily managed (Sommer et al., 2008). These factors contribute to a suboptimal patient journey. Following hiatus hernia repair, multimodal analgesia has been shown optimise postoperative pain (Kazakova et al., 2019). One analgesic modality that has been well studied in other surgeries including laparotomies and caesarean sections, with favourable pain outcomes is regional nerve block with local anaesthesia (Siddiqui et al., 2011). Although crural anaesthesia block has been described in the literature (Dale et al., 2016), no study has investigated whether this low risk, low effort intraoperative intervention may lead to reduced postoperative pain and a reduction in opioid requirement postoperatively. The aim of our cohort comparative study was to assess whether this intervention was effective in improving these postoperative pain outcomes.

2. Literature review

Postoperative pain consists of a combination of a complex interplay between multiple pain mechanisms. This includes somatic pain fibres, spinal and autonomic nervous system mechanisms that generate pain (Anwar, 2016). Following hiatus hernia repair, somatic pain generated from Aδ and C fibres is found in crural nerve fibres (vagal afferent nociceptive nerve fibres), which can be significantly stimulated from the hiatal dissection, suture cruroplasty, the peritoneum and the abdominal wall (Kollarik et al., 2010) . Visceral pain fibres, Aδ and C fibres via the autonomic nervous system are found in the lower oesophageal sphincter, the phreno-oesophageal ligament, associated viscera, peritoneum and the mediastinum (Lottrup et al., 2011) (Kollarik et al., 2010). As such there are multiple centres that can trigger pain and as such be targeted for multimodal analgesia. Although systemic analgesia, such as opioid use, is common place following surgery, they can cause significant adverse effects and even longer-term dependence issues. Importantly, opioids can induce nausea and vomiting which can be detrimental following hiatus hernia repair (in some institutes, this can be seen a relative contraindication following hiatus hernia surgery) and alternative analgesia or adjuncts that reduce opioid requirements would be welcomed (Dale et al., 2016). Unfortunately, clinically and in the literature, opioids continue to be central in managing postoperative pain in surgeries (Bisgaard et al., 2004). Given crural fibres are encountered during hiatus hernia repair, one rarely described practice is to perform a regional block using long-acting local anaesthesia injected directly into the crural fibres to alleviate the pain signals originating from diaphragmatic inflammation caused by surgery (Bell et al., 2012). Despite this described practice, there are no studies to date that assess the efficacy of this practice in terms of reducing postoperative pain and opioid use during admission. Other regional blocks, transversus abdominus plane regional anaesthetic blocks following laparotomy and quadratus lumborum anaesthetic blocks following caesarean section, have been found to have statistically significant effects in reducing pain severity and have opioid sparing effects (Siddiqui et al., 2011). Based on the successes of regional blocks in other regions, the benefits of optimising postoperative pain without the adverse effects of opioid overuse and lack of research into this field, we performed a cohort comparison study to identify whether such a practice had a beneficiary effect on postoperative patients.

3. **Methodology**

This was a retrospective study at a single centre, a teaching hospital in Western Australia, where laparoscopic hiatus hernia repair is commonly performed by upper gastrointestinal surgical specialists. An analysis of elective laparoscopic surgery pain outcomes was conducted on two cohort of patients of the two highest volume surgeons. One surgeon (Surgeon 1) would routinely perform crural long-acting local anaesthesia block intraoperative at the end of the case under direct vision using ropivacaine 0.75% 10ml and the other surgeon did not. The primary end points were the mean pain, peak pain score over admission and mean daily opioid requirement. Pain scores over admission for our cohort were captured, with peak and mean scores calculated using the standardized Australian Modified Early warning score chart. Pain scores are self-reported by the patient from 0-10 (10 being the most severe pain). All opioids and their routes were converted to a standardised to oral morphine equivalent in mg. Inclusion criteria were elective, primary laparoscopic hiatus hernia repair at a single centre in Western Australia from 2019-2021 by the two highest volume surgeons described above and cases were collected in consecutive order. Exclusion criteria included hiatus hernia re-operation, concurrent intra-abdominal surgery (i.e., Roux-en-Y gastric bypass surgery), allergy to local anaesthesia, emergency surgery and patients with documented chronic pain and high dose preoperative opioid use. Approval was gained to perform this study from the health service's quality improvement and research committee.

4. Results

53 elective hiatus hernia repairs were performed at this single centre from 2019-2021. 13 were excluded according to the exclusion criteria. 40 cases were performed between the 2 surgeons and allocated as Surgeon 1 cases (routine crural infiltration, interventional cohort) and Surgeon 2 (no crural infiltration, non-interventional cohort). Each cohort consisted of 20 patients.
Demographic and surgical data:

Mean age: 63 years old.

Gender: 70% female

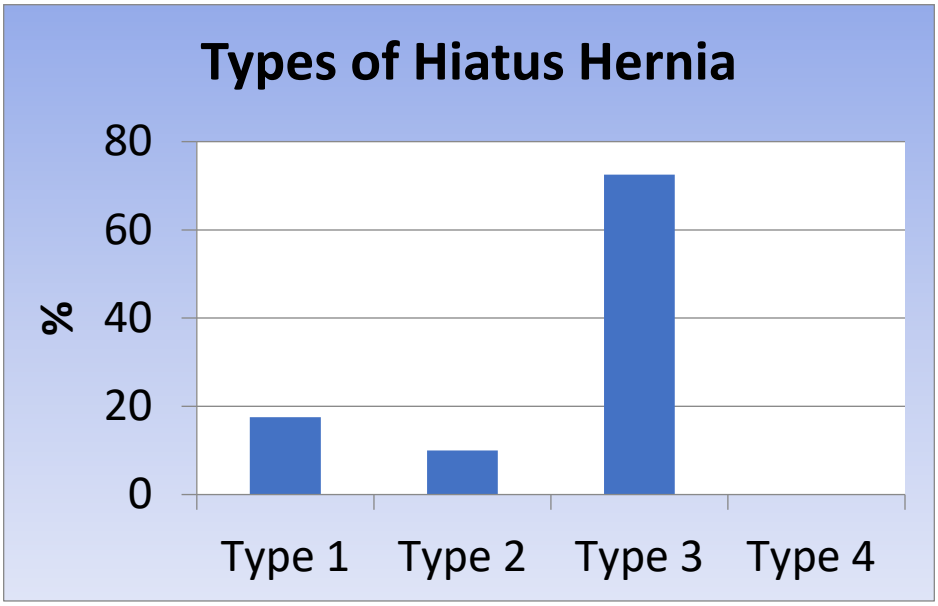

Figure 1: Distribution of hernia types. Type 1 = sliding hernia. Type 2 = para-oesophageal hernia. Type 3: Mixed hernia, combination of both Type 1 and 2. Type 4: Mixed hernia with additional herniation of viscera.

Peri-operative analgesia:

100% of patients received intraoperative intravenous opioids

100% of patients received intraoperative corticosteroids

100% of patients were charted for prn opioids, 2.5% had patient controlled IV opioid charted

4.1 Postoperative outcomes

Mean length of stay: 2.77 days

Complications: 5%. All complications were classified as low severity, Clavien-Dindo classification scores of 1-2 (atelectasis and pleural effusion). No patient reported postoperative dysphagia.

Mortality: 0% 30-day mortality.

4.2 Pain experience and implications

Mean pain score was 2.05/10. There was no direct comparison to this in the literature due to lack of research into this topic.

40% of prolonged length of stay (> 3 days) was directly attributed to pain related factors, similar to previous studies (Bisgaard et al., 2004).

4.3 Surgeon 1 and Surgeon 2 comparison

Direct comparison between Surgeon 1 (crural infiltration) and Surgeon 2 (no crural infiltration)

	Surgeon 1	Surgeon 2
Mean daily opioid use (oral morphine equivalent in mg)	27 mg	29 mg
Peak pain scores (score /10)	6.5/10	6.9/10
Mean pain scores (score /10)	2.4/10	1.7/10

Table 1. Comparing primary end points between interventional, Surgeon 1 cohort and non-interventional Surgeon 2 cohort.

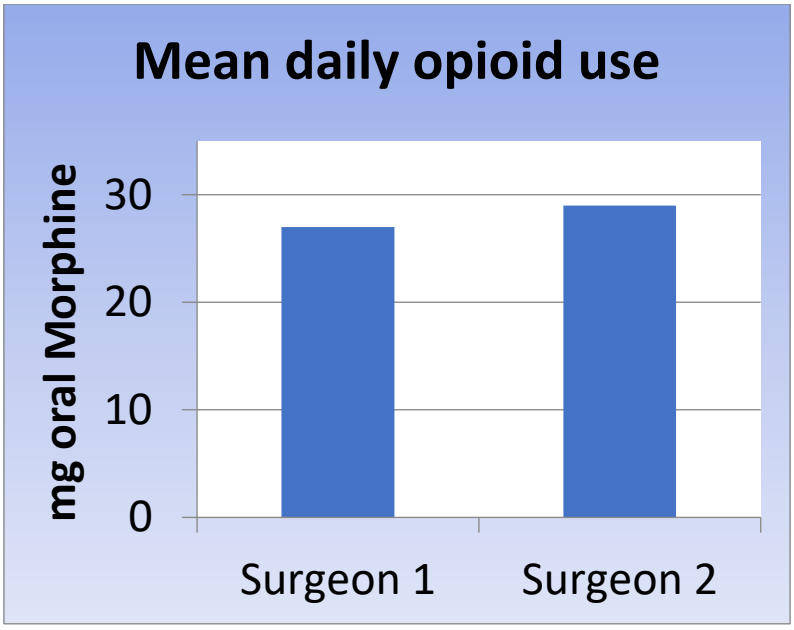

Figure 2: Mean daily opioid requirements following hiatus hernia repair performed by Surgeons 1 and 2, converted to oral morphine equivalent in mg.

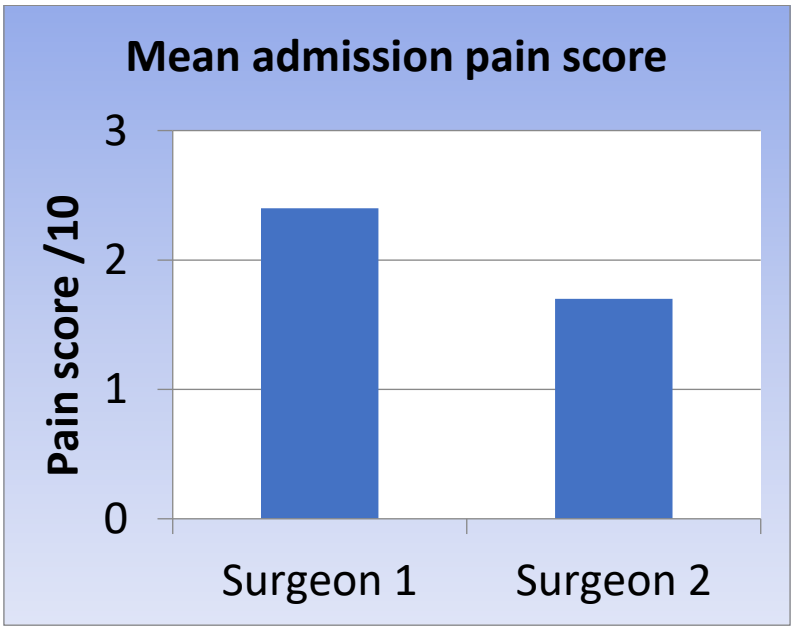

Figure 3: Mean admission pain scores (score /10) following hiatus hernia repair performed by Surgeons 1 and 2.

Surgeon 2's non-interventional cohort, in comparison to the interventional Surgeon 1 cohort, had:

- Additional 2mg of morphine (oral or equivalent) daily, p = 0.90
- Higher peak pain scores (on average + 0.4/10), p = 0.59
- Lower mean pain scores (-0.7/10), p = 0.06

Lasso regression was performed on dependent and independent variables that provide a reasonable prediction of primary end point outcomes:

Peak pain:

Variable	Coefficient Estimate
Intercept	4.033
Age	-0.039
Hernia Type – 2	0.111

Daily opioid use:

Variable	Coefficient Estimate
Intercept	44.40
Age	-0.26
Hernia Type – 2	1.97

Lasso regression analysis found that increasing age was significantly associated with reduced peak pain scores and reduced opioid requirement. Type 2 (purely para-oesophageal) hernia was significantly associated with the increasing requirement and peak pain scores.

5. Discussion

Postoperative pain following laparoscopic hiatus hernia repair, like other surgeries, is due to multiple factors including diaphragmatic and referred, incisional and visceral pain (Bell et al., 2012). The primary aim for managing these patients is to target these pain pathways and strike a fine balance between improving pain to allowing the patient to return to normal function in preparation for safe discharge. In additional, optimal pain control reduces complications from pain related physiological effects (immobility, deconditioning, atelectasis etc) and avoids the adverse effects of excessive analgesia dosing, namely opioids. This reiterates the importance of utilising other, lower risk pain relieving modalities which can work synergistically with traditional analgesia like opioids and have an opioid sparing effect (Kazakova et al., 2019). Given the pain mechanisms described above, local anaesthesia should provide some alleviation in postoperative pain as seen in transversus abdominus plane and quadratus lumborum regional blocks. Our study did demonstrate that crural infiltration with long-acting local anaesthesia had an opioid sparing effect and reduced the peak pain score compared to matched patients who did not have such infiltration. We found that 40% of delayed discharge was directly related to pain highlighting one of the many important consequences of postoperative pain. One cause of readmission in units advocating for early discharge following laparoscopic hiatus hernia repair is pain so the importance of optimising this prior to discharge is crucial (Molina et al., 2018). Interestingly, there was a reduced mean pain score for patients that did not have crural anaesthesia infiltration, although this was not statistically significant. This may be due to this group using more daily opioids.

Lasso regression analysis revealed two main variables that appear to have an effect on peak pain and daily opioid use, increasing age and para-oesophageal hernias. Increasing age seems to be protective against severe pain and daily opioid use. These findings are in line with previous larger studies (van Dijk et al., 2021). As our population ages, more elderly people are undergoing surgery. The elderly are more prone to adverse effects of medications including opioids and they have greater incidence of delirium, falls, acute renal and hepatic impairment and respiratory depression. Some of these adverse effects can also be caused by uncontrolled pain in the elderly (Aubrun & Marmion, 2007). Given the aging population and the fact that hiatus hernias become more prevalent and symptomatic with age, it is typically an older population that requires surgery (Khanna & Finch, 2011). This highlights the importance of utilising lower doses of systemic analgesia especially opioids as well as the importance of adjuncts, such as local anaesthesia blocks, in dose sparing such analgesics and alleviating pain in a different mechanism (Aubrun & Marmion, 2007).

It is clearly evident in the literature that minimally invasive hiatus hernia repair causes less postoperative pain compared to open. This is is why, for at least the last two decades, minimally invasive surgery has been the current standard of practice worldwide. However, there can be extensive and traumatic abdominal and thoracic dissection during hiatus hernia surgery, especially for large or complex hernias. As such research, albeit very limited, has tried to address postoperative pain following hiatus hernia repair. This has included a trial involving placing a local anaesthetic catheter adjacent to the repair site for a period of 7 days to assess patient convalesce and pain journey which did not show any statistical significance in pain outcomes between this and a control, non-interventional group (Bell et al., 2012). A limitation identified in that study was that catheter may not have been in the precise location to anaesthetise the afferent nerve fibres, a limitation overcome by our method of direct bolus injection into the crura where the afferent nerve fibres endings are located and initiate pain signals. Another trial assessing the efficacy of intravenous lidocaine in reducing postoperative pain found no significant results (Dale et al., 2016) and currently another clinical trial is underway assessing the efficacy of intravenous lidocaine in reducing post operative pain in laparoscopic hiatus hernia. This is the first study to assess and compare the efficacy of direct crural infiltration. There were positive findings associated with crural

infiltration in our study including the opioid sparing and peak pain effects, albeit not statistically significant, and no patient was identified as having any complication from the crural block itself.

More patients are needed to improve the quality of analysis. There were several limitations to this study including small sample size and retrospective data analysis. In terms of postoperative pain analysis, we analysed one simple, low risk and low effort intervention targeting one of the multiple complex pain pathways, so expectations regarding the magnitude of effect should be placed in perspective. As such surgeries are minimally invasive, clinicians may be falsely reassured that pain postoperatively will be minimal and not clinically significant. As described above, the pain experience appears to be underappreciated and, in this particular circumstance brings about two unique problems. The first is the risk of vomiting from over-reliance on opioids that can induce vomiting and cause acute disruption of the hiatal repair. The second is the elderly demographic that will likely undergo this surgery and their propensity to suffer more significantly from both uncontrolled pain and from overusing opioids. Thus, more attention is needed to highlight that hiatus hernia repair associated postoperative pain can be significant and needs addressing and one way to address this is by multimodal analgesia of which adjuncts such as local anaesthesia nerve blocks may have pain relieving and opioid sparing effects without much effort required to institute and without significant complications.

6. Conclusion

This is the first study assessing the efficacy of crural nerve blockade with local anaesthesia for postoperative pain management following laparoscopic hiatus hernia repair. It is clear there is an obvious gap in the literature regarding pain adjuncts utilised and, in general, acute postoperative pain experiences following hiatus hernia repair. Although laparoscopic surgery causes significantly less pain than open surgery, there is always more room to improve to ensure a safe and shorter admission not hindered by complications associated with pain and traditional analgesia currently utilised. The potential benefits as highlighted here include reducing peak pain levels, its opioid sparing effects and the associated positive sequelae. More research is required to more comprehensively assess the postoperative pain-relieving effects of crural anaesthesia. Given the low risk and minimal additional effort required to perform this technique intraoperatively, the potential positive effects of its widespread uptake make it an important step forward to further refine this surgical approach.

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Ethical approval: Approval was gained from the health service's quality improvement and research committee.
Informed consent: Verbal consent was obtained from all involved parties.

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