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A Review of Local Anesthetic Techniques for Analgesia After Laparoscopic Surgery

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Context: Laparoscopic surgery is considered to be a minimally invasive procedure with fewer complications and faster recovery. However, pain following such surgery is still a major problem.

Evidence acquisition: A multimodal approach to pain management has been suggested for optimal treatment of pain after laparoscopic surgery. Other than the parenteral and oral pain medications used, various local anesthetic techniques can provide analgesia following laparoscopic surgical procedures.

Results: Local anesthetic can be instilled locally at the wound site in the form of incisional or intraperitoneal approach, or around the nerves as a spinal, epidural, paravertebral or transversus abdominis plane block. Lidocaine has also been studied as an intravenous infusion to provide postoperative analgesia following laparoscopic surgery.

Conclusions: There is still not a definitive consensus as to which technique is superior, but including one of the methods in addition to providing the patient with parenteral and enteral drugs could provide better postsurgical analgesia. The aim of this review article is to look at the effectiveness of various local anesthetic techniques available to provide analgesia following laparoscopic surgery.

Keywords: Laparoscopic Surgery; Local Anesthetics; Postoperative Pain; Regional Anesthesia

1. Context

Laparoscopic approaches to surgery have increased dramatically over the past several years. Reasons for their popularity are improved postoperative pain and improved healing time as compared to open techniques, which can result in earlier recovery and discharge from the hospital (1). Controlling pain, nausea and vomiting in the postoperative period can help decrease the recovery period and avoid a prolonged hospital stay.

2. Evidence Acquisition

A multimodal approach to pain management involving the use of non-steroidal anti-inflammatory drugs, opioids, and local anesthetic infiltration has been suggested as the optimal combination for laparoscopic surgery (2). There are a variety of local anesthetic techniques available which have been investigated in order to find out their potential analgesic benefits in laparoscopic surgery. This review details those techniques as well as the clinical data available.

2.1. Local Anesthetic Techniques

2.1.1. Incisional Local Anesthetic

Local anesthetics (LA) have been injected subcutaneously into the incisional site, into the periportal fascia, and into the muscle and parietal peritoneum to provide pain relief in laparoscopic surgery. The injection of LA at the incision site blocks Aδ and C fibers and prevents the transmission of pain impulses from the surgical incision site to the brain.

Most of the studies have used longer acting LA like bupivacaine (3), ropivacaine (4) or levobupivacaine (5, 6) to provide pain relief. The doses and the concentrations used were also variable. In a review article by Bisgaard et al. on laparoscopic cholecystectomy (2), seven of the eight studies showed that incisional local anesthetics provided superior analgesia and significantly decreased the amount of opioid used in the post-operative period. Seven of the studies included used bupivacaine with doses ranging from 70 to 140 mg and only one study used ropivacaine 200 mg (2).

Implication for health policy/practice/research/medical education:
Local anesthetic techniques are an important part of multimodal pain management after a variety of laparoscopic surgeries. This review describes the techniques available and their effectiveness in managing pain.

Pre-incisional LA has also been used to relieve postoperative pain. The reason behind using preemptive analgesia is that the treatment is initiated before the surgical procedure which prevents sensitization of nociceptors and can reduce pain postoperatively (7). In a randomized trial, preemptive administration of bupivacaine before laparoscopic surgery decreased the postoperative pain and allowed rapid return of normal activities. The study also showed that infiltrating bupivacaine at the time of incisional closure did not offer any analgesic benefit (8).

In a meta-analysis by Coughlin et al. there was a significant improvement in postoperative pain at 4 hours and 24 hours when local anesthetic was injected preemptively compared with the placebo (9). However, when compared with incisional anesthetic infiltration after the surgery, there was no difference in the pain scores.

2.1.2. Intraperitoneal Local Anesthetic

Local anesthetic can be injected into the peritoneum through the ports created either before the start of surgery or prior to closure. It may be injected over the visceral peritoneum through the trocar site or into the surgical bed after the excision of the organ or under the diaphragm. The reason for the injection of sub-diaphragmatic LA is to decrease the incidence of shoulder pain.

The early use of intraperitoneal LA was to decrease shoulder pain after laparoscopic day surgery (10). Several studies have utilized this method of analgesia. Bupivacaine (11), levobupivacaine (12), lidocaine (13) and ropivacaine (14) have been used intraperitoneally in varying doses to achieve analgesia.

A systematic review in 2005 showed that 14 of the 23 studies showed a reduction in pain scores in the intraperitoneal LA group after laparoscopic cholecystectomy (15). A meta-analysis by Bisgaard et al. on intraperitoneal LA versus placebo in laparoscopic cholecystectomy patients showed that 15 out of 24 randomized trials showed significant analgesic benefits while the remaining 9 trials had no effect (2). In addition, a review by Mitra et al. pointed out that larger volumes of local anesthetic solution lead to better pain control than smaller volumes (1). Also, higher concentrations of local anesthetic such as 0.25% or 0.5% of ropivacaine or bupivacaine may have better analgesic effect (1).

In a systematic review involving 5 randomized trials of laparoscopic gastric procedures, intraperitoneal LA was shown to decrease both abdominal and shoulder pain (16). A meta-analysis of 7 randomized controlled trials comparing pain scores after intraperitoneal analgesic with placebo during gynecological laparoscopic surgery indicated that the pain was significantly reduced in the first 6 hours after surgery (17). In a study by Johnson et al. on laparoscopic cholecystectomy patients, a comparison between incisional versus intraperitoneal LA showed no significant analgesic differences between the two groups (18).

Some authors have shown that preemptive use of intraperitoneal LA was more successful in preventing postoperative pain. Barczynski et al. showed that preemptive instillation of bupivacaine was superior to pre-closure instillation (19). A meta-analysis of six studies that compared preemptive intraperitoneal LA with postoperative LA showed that there was a reduction in the postoperative pain scores when LA is used prior to surgical stimulus (9). Although there are not many studies where an infusion of LA was used, Gupta et al. used intraperitoneal infusion of levobupivacaine after elective abdominal hysterectomy and showed that it significantly decreased opioid consumption (20).

2.1.3. Incisional and Intraperitoneal Combination Local Anesthetic

A combined technique using local anesthetic both intraperitoneally and in the incisional area to provide analgesia has been studied. A literature search identified 6 studies that used incisional and intraperitoneal LA. Bisgaard et al. infiltrated ropivacaine or saline into the port incisions and intraperitoneally at several sites (21). They found that this regimen significantly reduced incisional pain during the first 3 hours but did not have any benefit on visceral or shoulder pain. Nausea was significantly less in the ropivacaine group when compared to the placebo group (21). The similar findings were also confirmed later in patients undergoing laparoscopic cholecystectomy (22).

In a study conducted with levobupivacaine, a combination of incisional LA and intraperitoneal LA had better postoperative analgesia over only intraperitoneal or only incisional groups (23). The result that incisional and intraperitoneal LA had an additive effect was also shown in a study using ropivacaine (24). A study by Pappas-gogos et al. used ropivacaine both at the trocar site and intraperitoneally under the right hemi diaphragm (25). It showed that LA could be safely used to provide adequate pain relief. However, in a retrospective analysis on laparoscopic colorectal surgical patients, the use of LA did not provide effective analgesia or influence the postoperative opioid requirement (26).

2.2. Spinal Anesthesia

Spinal anesthesia has been looked at for its potential benefits in laparoscopic surgery. It involves injection of local anesthetic in the subarachnoid space, providing anesthesia of the abdomen and lower extremities depending on the volume and spread of the local anesthetic. Spinal anesthesia is a less invasive anesthetic technique that has been shown to have less morbidity and mortality when compared to general anesthesia (27). It has other advantages such as patients can be more awake immediately after surgery, they tend to have less nausea and vomiting, and ambulate faster than those receiving general anesthesia (27).

A study comparing spinal to general anesthesia in day surgery patients undergoing laparoscopic cholecystectomy showed many benefits (28). The study randomized 180 patients to receive either spinal or general anesthesia and found less pain and lower incidence of postoperative nausea and vomiting, which lead to lower incidence of overnight stay in the spinal anesthesia group.

Spinal anesthesia has been studied in laparoscopic colon resection (29). The study involved 50 patients receiving a general anesthetic and randomized them to receive either a spinal anesthetic with bupivacaine and morphine, or patient-controlled analgesia (PCA) with systemic morphine. The study found improved quality of analgesia in the first 24 hours in the spinal analgesia group, but no differences in return of bowel function or length of hospital stay (29).

2.3. Epidural Analgesia

Epidural anesthesia is a technique whereby a catheter is inserted into the epidural space, outside of the subarachnoid space. An epidural catheter can provide a prolonged infusion of a combination of local anesthetic and opioid to provide analgesia after a variety of surgical procedures.

A meta-analysis showed that epidural analgesia is superior to both systemic and IV PCA opioids in a variety of procedures during the first three days after surgery (30). The potential benefits of epidural analgesia in laparoscopic surgery have been less studied. A meta-analysis on the effects of epidural analgesia on bowel function after laparoscopic colorectal surgery found improved pain scores and faster return of bowel function on patients who received epidural (31).

Two studies have looked at epidural analgesia for laparoscopic cholecystectomy patients (32, 33). The first compared the effectiveness of intravenous versus epidural fentanyl in patients receiving a general anesthetic (32). Patients receiving the epidural analgesia had significantly improved pain scores in the first 24 hours. The second studied patients older than 65 years undergoing laparoscopic cholecystectomy (33). One group received IV anesthesia with droperidol, pentazocine and 60% nitrous oxide followed by IV PCA with a combination of buprenorphine and droperidol, while the second group received a combined general/epidural technique. The epidural infusion had a combination of bupivacaine, buprenorphine and droperidol. The study found similar quality of postoperative analgesia in the IV PCA and epidural groups (33).

Yet another study looked at epidural analgesia after laparoscopic sigmoidectomy (34). The study compared 60 patients who received either epidural or no epidural. The results found a significant reduction in pain and need for opioids in the epidural group, but no improvement in mobilization, return to oral intake, or length of hospital stay (34).

A couple of studies have compared spinal and epidural analgesia for laparoscopic surgery. A study by Calvo-Soto et al. compared the techniques in patients undergoing laparoscopic cholecystectomy under general anesthesia (35). They found a measured decrease in the neuroendocrine stress response in the spinal group compared to epidural. Another study compared epidural, spinal and IV PCA in patients undergoing laparoscopic colorectal surgery (36). Primary outcomes were length of hospital stay and return to bowel function. Interestingly, the study found that both spinal and IV PCA patients achieved those outcomes similarly and better than those receiving epidural analgesia.

2.4. Paravertebral Block

Thoracic paravertebral block is a nerve block technique which involves injection of local anesthetic near the thoracic spinal nerves emerging from the intervertebral foramen. Neural blockade here results in ipsilateral somatic and sympathetic nerve blockade. The resultant anesthesia or analgesia is similar to a one-sided epidural. Injection at different locations in the thoracic and lumbar spine can give a segmental anesthesia or analgesia with minimal hemodynamic changes.

There are two trials (37, 38) and a case series (39) describing its use to help with analgesia after laparoscopic procedures. Naja et al. in 2004 studied 60 total patients receiving a general anesthetic for laparoscopic cholecystectomy with and without bilateral paravertebral blocks at the T5-T6 level (37). The local anesthetic injected was a combination of lidocaine, bupivacaine, fentanyl and clonidine. The group that received paravertebral blocks had significantly decreased pain for 72 hours after surgery, in addition to decreased need for rescue analgesic and decreased nausea during the first 12 hours after surgery. Another study by Naja et al. in 2011 also looked at the difference in preoperative versus postoperative paravertebral blocks for laparoscopic cholecystectomy (38). The results found improved pain scores, consumption of analgesics and reduced hospital stay in patient receiving preoperative blocks.

A series of 30 patients receiving paravertebral blocks for analgesia after hand-assisted laparoscopic nephrectomy was published (39). The dermatomes T10-T12 and L1 were blocked with 3-5 ml of ropivacaine 0.1% at each level. The researchers showed improved pain scores and decreased cumulative morphine in this case series when compared to other studies in a similar population.

2.5. Transversus Abdominis Plane Block

The transversus abdominis plane block (TAP) is a technique where local anesthetic is injected into the transversus abdominis fascia plane, where the nerves from T6-L1 are located, providing analgesia of the anterolateral abdominal wall (40). The technique has recently become more popular due to the use of ultrasound guidance.

Four studies have looked at the potential benefits of

TAP blocks in laparoscopic cholecystectomy patients (40-43). The study by Petersen et al. showed improvement in pain scores during coughing and decreased opioid requirements (40). The study by El-Dawlaty et al. showed that bilateral ultrasound-guided TAP block reduced opioid requirements (41). Ra et al. showed a reduction in pain scores during the first 24 hours after surgery (43). However, the study by Ortiz et al. which compared TAP blocks to local anesthetic infiltration of port sites, found no difference between the techniques (42). Another study by Sandeman et al. compared TAP blocks to no block for laparoscopic appendectomy (44). In addition, all patients also received port site local anesthetic infiltration. They also found no difference in pain scores or analgesic requirements.

One study looked at the use of TAP blocks to treat pain after laparoscopic colorectal surgery (45). Bilateral blocks were performed in the treatment group and researchers found reduced morphine requirements in the TAP block group. However, both groups had similar pain scores. Another study looked at the benefit of TAP blocks in laparoscopic bariatric surgery (46). They found lower pain scores in the TAP block group and decreased analgesic requirements.

2.6. Intravenous Lidocaine

Intravenous lidocaine infusion (IVLI) is known to have analgesic (47), anti-hyperalgesic (48), and anti-inflammatory actions (49). Lidocaine has also been used intravenously to provide analgesia for various laparoscopic surgical procedures.

Intraoperative infusion of lidocaine has been shown to decrease opioid consumption, improve pain scores and bowel function in patients undergoing laparoscopic abdominal surgeries (50-52). Its use has been shown to also decrease hospital stay (50). In a study comparing IVLI with thoracic epidural analgesia, pain was better controlled in the epidural group but the return of bowel function was similar in both groups who underwent laparoscopic colorectal procedures (53). However, in a study by Wuethrich et al. there was no difference in opioid consumption, hospital stay or in the return of bowel function after laparoscopic renal surgery (54). The benefits of intravenous infusion of lidocaine were also noted in ambulatory laparoscopic surgical patients. It decreased the opioid consumption and also improved the quality of life postoperatively without affecting the time to discharge from the post anesthesia care unit (55).

3. Results

3.1. Local Anesthetic Techniques

Although a number of studies have reported a favorable benefit from the use of incisional local anesthetics, the effect is seen only in the early postoperative period for the first 3-4 hours. They can be used only as adjuncts to pain medications but not as a sole agent for pain relief.

Intraperitoneal instillation of local anesthetic for postoperative pain relief is controversial as there are many studies that show no beneficial effect. However, preemptive use of intraperitoneal local anesthetic has been shown to decrease postoperative pain when compared to placebo.

The prospective studies done on the combined incisional-intraperitoneal local anesthetic technique did show some benefit but the evidence is inconclusive. It is also important not to exceed the toxic dose of the local anesthetic while using the combined technique.

3.2. Spinal Anesthesia

The routine use of spinal anesthesia for laparoscopic surgery is not recommended at this time. Its use for these types of procedures should be based on the risks and benefits specific to each patient. Future studies may help us decide if the analgesia provided by spinal anesthesia is better than the other more common analgesic techniques.

3.3. Epidural Analgesia

Epidural analgesia may have its benefits in some patients undergoing laparoscopic procedures, but selection is very important. The goal is to improve analgesia but also not slow down the recovery process in these patients. In patients with a history of difficult to treat pain, perhaps this technique should be considered as part of multimodal pain management.

3.4. Paravertebral Block

The data is currently limited on the potential benefits of paravertebral blocks in laparoscopic surgery patients. As these blocks become more popular with the use of ultrasound for guidance, more studies are expected to be published. The limited results show potential for benefit in some patients.

3.5. Transversus Abdominis Plane block

The data so far shows mixed reviews on the analgesic benefits of transversus abdominis plane block in laparoscopic surgery, especially when compared to local anesthetic infiltration of port sites. Hopefully more studies will be done that will help us decide which procedures this block can provide the most benefit for.

3.6. Intravenous Lidocaine

Although lidocaine infusion appears to have some analgesic benefits, the data available in management of pain after laparoscopic surgery is still limited. More studies are needed to confirm the beneficial effects of intravenous lidocaine.

4. Conclusions

There are a variety of local anesthetic techniques available to decrease pain after laparoscopic surgery. Although the use of incisional and intraperitoneal local anesthetics is a common practice, there are other techniques available that may also help decrease pain as part of a multimodal approach to pain management. Optimizing the risk to benefit ratio for a given patient is important when deciding to use one of these techniques. As the newer techniques such as paravertebral and transversus abdominis plane blocks gain more popularity, they will influence more research to be done in this field. In the near future, we should be able to come up with better and more definitive answers as to which techniques benefit patients compared to current standard of care.

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Authors' Contribution

Drs. Jaime Ortiz and Suman Rajagopalan contributed at all phases of this review article.

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