Regional analgesia for patients with traumatic rib fractures: A narrative review

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Approximately 35% of all blunt trauma patients and two thirds of thoracic trauma patients sustain one or more rib fractures.[1,2] Common causes are motor vehicle accidents, physical violence, sports injuries, and falls in the elderly. Less common but important causes are child abuse and repetitive strain injuries such as in athletes. Ribs affected by osteopenia, cancer, and pathological weakness (e.g., osteogenesis imperfecta) are particularly susceptible to fracture.

The recovery of a patient with rib fractures depends also on the severity of internal and/or other injuries and how well pain is managed. Inadequate analgesia and/or over reliance on opioids lead to splinting, immobility, shallow breathing, and poor pulmonary toilet. The incidence of pneumonia in the elderly population with three to four and more than six rib fractures is 31% and 51%, respectively.[3–5] A review of 64,750 traumatic rib fracture patients in the National Trauma Data Bank revealed an all-cause mortality rate of 5.8% among those who sustained a single traumatic rib fracture.[4] For each additional rib fractured in the elderly, the risk of pneumonia and mortality increases by 27% and 19%, respectively.[3–5] The all-cause mortality of patients under and older than 65 years with three or more fractured ribs is 10% and 20%, respectively.[3–5] Mortality in elderly patients with more than six rib fractures is 33%.[4] These statistics yield an empiric rule-of-thumb that, for those older than 65 years, every fractured rib is associated with an incremental 5% risk of mortality.

In flail chest (i.e., when contiguous ribs are displaced at ≥2 places), the floating segment moves paradoxically with respiration. Impairment in respiration is severe if three or more ribs are involved. Flail chest is associated with mortality of 16% to 17%, increasing to 42% when pulmonary contusion is also present.[5,6] Many affected patients will require mechanical ventilation. There is increasing evidence that surgical fixation of flail rib fractures within 24 to 72 hours after injury in combination with optimal analgesia shortens the duration of mechanical ventilation, intensive care, and hospital lengths of stay and reduces the incidence of pneumonia and the need for tracheostomy.[6]

Many trauma patients with multiple rib fractures need to be mechanically ventilated because of concomitant injuries and respiratory compromise from lung contusions, pneumothorax, poor pulmonary toilet, flail segment, and/or inadequate pain control. In addition, such patients often require high-dose opioids potentially exacerbating the respiratory compromise caused by a dose-dependent central nervous depressive effect. Hence, in a consensus statement by 14 surgeons from the United States, United Kingdom, and Australia, there was unanimous agreement that regional analgesia should be considered in all patients with multiple rib fractures and in those requiring surgical rib fixation.[7]

The purpose of this narrative review is to summarize commonly used strategies for pain control in patients with rib fractures, with an emphasis on regional blocks and their effectiveness and considerations.

PAIN MANAGEMENT STRATEGIES

Younger patients and those with three or less rib fractures and nonsevere internal injuries should receive multimodal analgesia according to the World Health Organization pain ladder, which includes nonsteroidal anti-inflammatory drugs, acetaminophen, and gabapentinoids followed by oral or parenteral opioids.[8] Admission to the hospital with the hope for relatively early discharge could be considered in patients with forced vital capacity (FVC) of 15 mL/kg or greater[9] in the absence of hemothorax, pneumothorax, or bilateral fractures with debilitating pain. Intensive care unit (ICU) or step-down unit admission is advisable for adults with FVC of 15 mL/kg or less.[9–13] Epidural (or equivalent) regional analgesia should also be considered for all patients 65 years or older and/or in the presence of rest pain (≥6/10), four or more rib fractures, weak cough, and/or FVC of 15 mL/kg or less.[10–13] Finally, close monitoring and strong consideration for a regional block are recommended for patients with a deteriorating clinical picture and failed conservative pain treatment in the first 48–72 hours.[14]

Further adjuncts may be considered for patients who fail initial multimodal analgesic regimens and/or those who have a contraindication to regional analgesia. These include ketamine,[15] magnesium,[16] and tramadol. Furthermore, lidocaine infusion is gaining popularity outside its initial recommendation for perioperative analgesia in abdominal surgery. Notably, such adjunct agents are generally inadequate in controlling breakthrough pain and may be associated with significant adverse effects (e.g., respiratory depression, airway obstruction in patients with obstructive

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sleep apnea, somnolence, delirium, cognitive dissociation, etc.), particularly when combined with opioids.

Regional analgesia is the most effective way of controlling rib fracture pain and should be considered as part of the multimodal regime.[11,17] It is safe, effective, and void of significant central nervous depressive effects, thereby facilitating chest physiotherapy, ambulation, and possibly weaning from mechanical ventilation.[18] Furthermore, its opioid-sparing effect helps prevent opioid-related adverse effects such as nausea, vomiting, pruritus, somnolence, ventilatory depression, and constipation. For those reasons, we are of the opinion that catheter-based analgesia should be considered early in high-risk patients who do not initially require intubation but may deteriorate later. In intubated patients, however, we do not recommend regional blocks until weaning from mechanical ventilation begins because these patients are often already sedated (which generally includes an analgesic component such as an opioid infusion) to tolerate mechanical ventilation. After a successful block, an almost 50% improvement in FVC and other respiratory parameters, as well as a dramatic drop in pain scores, may be expected.[19,20] However, complete abolition of pain from regional blocks is infrequently achieved because of the use of low concentrations of local anesthetic (LA) to achieve high-volume injections with less risk of LA toxicity and, in the case of epidural analgesia, motor blockade of the legs. Furthermore, trauma patients commonly have multiple pain generators, which are not always covered by a single block. Therefore, continuous reevaluation and analgesic supplementation (using a stepwise multimodal approach for breakthrough pain) are essential. A word of caution is that pain relief from a regional modality can be quick, thereby exposing the risk of over sedation from previously administered systemic opioids.

Most regional blocks for rib fractures are performed by anesthesiologists. With the advent of ultrasound (US) guidance, emergency physicians are increasingly incorporating regional blocks into their clinical practice.[21,22] Importantly, certain regional analgesia principals must be adhered too. Practitioners need to balance the familiarity with the technique and its associated risks with the clinical picture and potential benefits. Considerations for LA toxicity are particularly relevant in small and elderly patients and those with poor liver and/or renal function, serious trauma, and trauma with multiple pain generators requiring more than one block. Trauma patients are often cognitively compromised, and therefore, consenting may be an issue and pose an ethical consideration. Most blocks require immobility and patient cooperation, which need to be coordinated with the patient and other members of the team. Hemostatic deficiencies will dictate the contraindications to blocks especially those surrounding the spinal cord (i.e., neuraxial or paravertebral techniques). Guidelines as per the American Society of Regional Anesthesia are helpful in these situations.[23] Once a catheter is sited, thromboprophylaxis is not contraindicated and dalteparin should be used in accordance to the latest 2018 American Society of Regional Anesthesia guidelines.[23] Systemic and local infections, as well as direct trauma (resulting in altered anatomy) to the block/puncture site, are relative contraindications to all blocks.

REGIONAL ANALGESIA

Regional analgesia for multiple fractured ribs involves the use of a single (bolus dose) injection typically followed by continuous infusion of LA to provide analgesia to multiple contiguous ribs.[17,22,24] In the techniques reviewed herein, LA is deposited near or just above (because of slight preferential caudal spread of the LA in part due to gravity) the midpoint of the range of rib fractures to achieve a total cephalad-caudal spread of six to eight dermatomes.[17] From clinical experience, a 10 to 30 mL bolus of LA provides analgesia for 2 to 12 hours, depending on technique and the concentration of LA used. A catheter is left in place for continuous infusion of LA for days. Patients with rib fractures returning to work with a catheter in situ for up to 18 days have been described.[25,26] Dual catheters (with attending increased risk of LA toxicity) can be considered for more extensive fractures.[17]

Epidural, paravertebral, and the thoracic interfascial plane blocks/paravertebral variants (i.e., erector spinae intercostal/paraspinal, midpoint transverse, rhomboid/intercostal, and retrolaminar blocks) target the ventral and dorsal rami of the spinal nerves whereas the midintercostal regional and serratus anterior plane blocks target the ventral rami of the nerves. A summary of these blocks is presented in Table 1.

Thoracic Epidural Block

This time-tested technique is favored by many anesthesiologists and is typically performed without US guidance. It

TABLE 1. Comparison of the Various Regional Analgesia Options for Rib Fractures

Technique	Ultrasound Guidance	Sidedness	Failure Rate	Drop in BP	LA Toxicity Risk	Risk to Spinal Cord	Pneumothorax Risk	Urinary Retention	Pruritis
Epidural	Rarely	Bilateral	13%[27]	Always	Lowest	Rare	Zero	Common	Common
Paravertebral	Optional	Unilateral	10%[28]	2%[29]	Low	Extremely rare	0.5%[28]	No	No
ESP	Recommended	Unilateral	?	Rare	Low	Extremely rare	Rare	No	No
Retrolaminar	Recommended	Unilateral	?	Rare	Low	Extremely rare	Rare	No	No
Midpoint transverse process to pleura	Recommended	Unilateral	?	Rare	Low	Extremely rare	Rare	No	No
Subrhomboid	Always	Unilateral	?	Rare	Low	Extremely rare	Rare	No	No
Intercostal	Optional	Unilateral	Low	Rare	Highest	Zero	Highest	No	No
Serratus anterior plane	Always	Unilateral	?	Rare	Low	Zero	Low	No	No

BP, blood pressure.

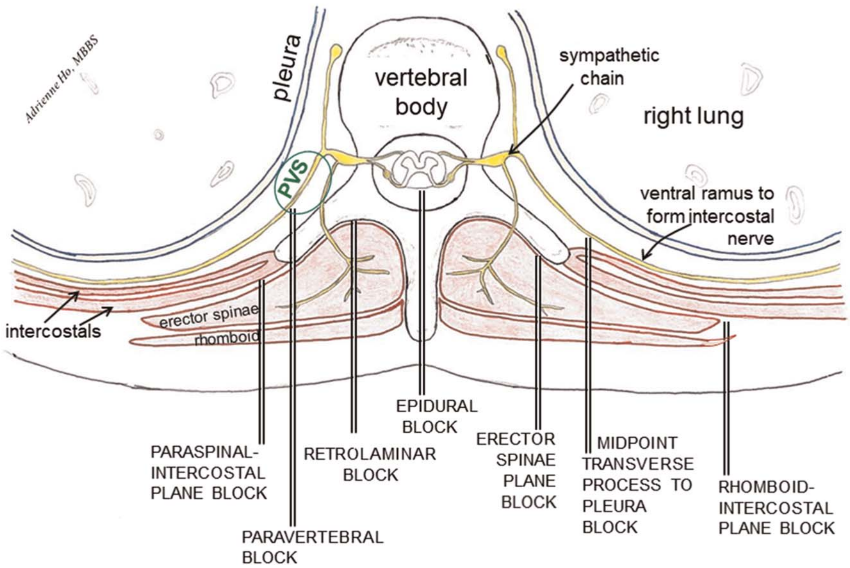

Figure 1. Epidural block, paravertebral block, and the various thoracic interfascial plane blocks/paravertebral variants that can be used to provide analgesia for patients with rib fractures. PVS, paravertebral space.

generally involves insertion of an epidural catheter for continuous infusion of LA resulting in prolonged analgesia. Bilateral spinal nerves are blocked as they emerge from the vertebral column (Fig. 1). Sympathetic blockade causing a drop in blood pressure always occurs and has implications in the hypovolemic patient. Catheters should not be sited or withdrawn when there is significant bleeding diathesis for fear of a neuraxial hematoma (incidence, 0.01%[30]) causing cord compression that may be masked by the sensory blockade. Because there is a very small risk of the needle puncturing the dura, raised intracranial pressure is a contraindication. Likewise, epidural pain management catheters are relatively contraindicated in patients who cannot report severe pain/paresthesia during placement in the highly unlikely event that the needle hits the spinal cord.[31] Because of the presence of opioid receptors on the spinal cord, addition of a small amount of opioid to the LA not only enhances analgesia but also allows lower concentrations of LA with less chance of LA toxicity and motor blockade.[32] However, the opioid frequently causes pruritis and nausea.[32] Excluding inability to insert catheter, failure rate is approximately 13% but is variable depending on setting and definition of failure.[27] Uncommonly, the catheter may veer to one side causing unilateral block[33] that happens to be on the wrong side of unilateral rib fractures.

Thoracic Paravertebral Block

The paravertebral space is bounded medially by the vertebral column, anteriorly by the pleura, and loosely posteriorly by the superior costotransverse ligament. Thoracic paravertebral block is performed with or without US guidance. Needle entry point is 2 to 3 cm (in adults) lateral to midline (Figs. 1 & 2). In the landmark technique, once the needle tip contacts the transverse process, the needle is slightly withdrawn and redirected either in a cephalad or caudad direction (i.e., above or below the transverse process) before further advancing (approximately 1 cm) through the superior costotransverse ligament into the paravertebral space. Alternatively, the block needle is guided by US to pierce the same ligament, stopping short of the pleura. Local anesthetic in the paravertebral space blocks the spinal nerves that emerge from the neuroaxis, spreading also to the prevertebral, epidural, and intercostal spaces.[34] It is a highly effective mainly unilateral block that has a much less chance of spinal cord injury than epidural.[17,19,35] Even so, most authorities recommend precautions in patients with bleeding diathesis, similar to that of an epidural.[23] There is a chance of ipsilateral pneumothorax (0.5%[28]), a consideration especially when there is no chest drain. Like all other alternatives to epidural, the incidence for hypotension (2%),[29] nausea, or pruritis is much reduced.[34,36] Paravertebral block generally requires higher LA volumes and/or concentrations (≥0.25%).[17] Fortunately, unless repeated boluses are given, LA toxicity from a continuous infusion is uncommon and typically manifest insidiously as perioral numbness/tingling, sedation, or delirium, not convulsions or arrhythmias.[36] The failure rate of approximately 10% is also dependent on setting and definition.[28] Unlike epidural block, a paravertebral block (and other unilateral blocks to be discussed below) guarantees that the correct side is blocked. In bilateral fractures, bilateral paravertebral blocks are sometimes used[17] although for simplicity and safety, epidural is often preferred.

Thoracic Interfascial Plane Blocks/Paravertebral Variants

Simpler, more superficial, and thus theoretically safer techniques have emerged in recent years. The aggregate of these novel blocks uses the principle of LA spread between a tissue plane that anesthetizes the ventral ramus or branches thereof.[37] Although research is emerging, the choice of block is primarily based on the location of the rib fractures; hence, more posterior fractures require a more posterior block. The commonly described

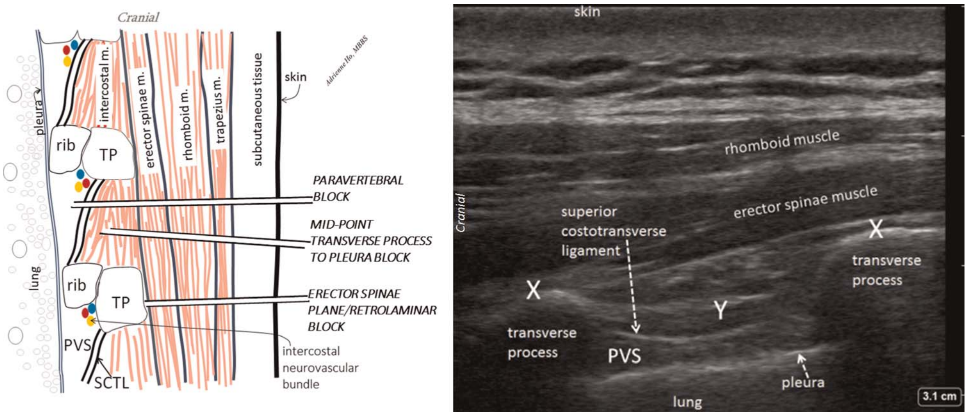

Figure 2. Left panel, a sagittal view at and near midline illustrating the thoracic paravertebral block and interfascial plane blocks/ paravertebral variants. Right panel, ultrasound anatomy. X is the points for ESP block. Y is the point for middle transverse process to pleura block. The orientations of the two panels are different. The schematic represents the typical situation in which the blocks are performed with the patient sitting, preferred by most patients and practitioners. The right panel represents how the image is shown on an ultrasound machine. PVS, paravertebral space. SCTL, superior costotransverse ligament; TP, transverse process; m., muscle.

blocks for chest trauma include erector spinae plane (ESP) block, retrolaminar block, midpoint transverse process to pleura block, paraspinal/intercostal, and subrhomboid/intercostal blocks, which will be described in this article. Some of these newer blocks can be easily mastered by trauma and emergency physicians, respirologists, and intensivists using US guidance.[21,22,38] To date, there has been mainly anecdotal evidence that they are effective or noninferior to paravertebral and epidural blocks in rib fractures and chest and upper abdominal surgeries. Their failure rates and comparative performance are unknown. The risks of pneumothorax, spinal hematoma, and inadvertent subarachnoid injection of LA are theoretically less but not totally eliminated.[39,40]

The effectiveness of these thoracic interfascial plane blocks/paravertebral variants is based on the fact that the approximately 1-mm-thick superior costotransverse ligament, which forms the posterior boundary of the paravertebral space, is fenestrated, as are the intertransverse muscles.[41] As such, LA injected before the block needle passes this ligament (i.e., posterior to the ligament as opposed to anterior to the ligament in a classic paravertebral block) and within the intercostal muscles may reach the epidural, paravertebral, and intercostal spaces, as well as the intervertebral foramina.[21,24,41–55] Furthermore, there are gaps between the ligament and the vertebral bodies to allow LA to reach the spinal nerves.[52] Because of the indirect pathways to the target nerves, larger volumes of LA may be required; there is also some, albeit inconclusive, evidence that intermittent bolus injections under higher pressures may achieve better LA spread than slow continuous infusion of equivalent LA volumes.[56]

ESP Block

This is a simple and increasingly popular new block. Local anesthetic is deposited between the erector spinae muscle and the adjacent transverse process (Fig. 2).[21,24,46,47] Similar to the paravertebral block, the clinician simply advances the block needle, with or without US guidance, until its tip hits the transverse process, whereupon LA is deposited followed by catheterization. There is no need to advance the needle past the transverse process, thus making this block much simpler and less risky than the paravertebral block. In case series[20,21,24,44–47] and in our experience, this block is effective in rib fractures. In cadavers, dye could be seen to spread to the paravertebral and epidural spaces, and the lateral cutaneous branches of the intercostal nerves.[45,46] Conversely, a recent study demonstrated a wide (10 dermatomes) craniocaudal spread of the dye solution with lateral extension toward the costotransverse region, but no diffusion to the paravertebral space.[57]

Retrolaminar Block

This novel block is virtually identical to the erector spinae plane (ESP) block except needle entry through the skin is slightly more medial to target the lamina instead of the transverse process.[45,49–52] In magnetic resonance imaging and cadaveric studies, both ESP and retrolaminar blocks exhibited spread to the epidural and neural foraminal spaces over two to five levels, although the former produced additional spread to intercostal spaces over five to nine levels and was associated with a greater extent of craniocaudal spread along the paraspinal muscles.[45,46] Anecdotally, this block is effective in multiple rib fractures.[51]

Midpoint Transverse Process to Pleura Block

Once the needle comes into contact with the transverse process, the block needle is slightly withdrawn and redirected before further advancement so that its tip is positioned midway between the posterior border of the transverse process and the pleura (thus, not penetrating the superior costotransverse ligament). Local anesthetic is injected into the intercostal muscles.[54] The application of this block in rib fractures has not been reported. Cadaveric studies show dye spread to the paravertebral space.[54]

Paraspinal/Intercostal Block

Similar to the other thoracic interfascial plane blocks/ paravertebral variants, needle entry point is slightly lateral to that of paravertebral block, and LA is deposited in the plane between the ESP and the external oblique muscles.[55] Its application in rib fractures has not been reported.

Subrhomboid/Intercostal Plane Block

A skin incision is made, if performed by surgeon, or a block needle under US guidance is inserted, if performed by anesthesiologist, medial to the border (T3–6) of the scapula.[58] A catheter is placed or tunnelled into the tissue plane between the rhomboid major and intercostal muscles.[58] A cadaveric study showed that injected ink spread to the lateral branches of the intercostal nerves from T3 to T9 reaching the posterior primary rami.[44] A small case series suggests that this block reduces pain associated with rib fractures.[58]

For the midpoint transverse process to pleura, intercostal/paraspinal, and subrhomboidal/intercostal blocks, the need to advance the needle beyond the transverse process theoretically increases the risk of pneumothorax as compared with the ESP and retrolaminar blocks.

Intercostal Block

This block is easy to execute and is performed by respiratory, trauma and emergency physicians, thoracic surgeons, and anesthesiologists. This regional technique, however, has been largely supplanted by other blocks because of short duration of blockade requiring repeated injections, thus resulting in significant discomfort and heightened risk of pneumothorax and LA toxicity.[35] Lastly, since each fractured rib is blocked, as well as one level above and one below, this can significantly contribute to patient discomfort.[35] Injections are anywhere between the midaxillary line and the paraspinal muscles. After positioning the patient, the operator first palpates or visualizes with US the affected ribs, maneuvers that are associated with considerable patient discomfort.[17] The risk of pneumothorax is relatively high because of the multiplicity and repetitiveness of the injections.[59] Systemic absorption of LA deposited into the vascularized intercostal groves is rapid, thus increasing the risk of LA toxicity.[17] As such, it is generally considered when there are only one to two rib fractures, and systemic analgesics are inadequate. For comfort, repeat injections may be required[35] and should be performed before the previous blocks completely wear off (usually <8–12 hours depending on the concentration and volume of the LA used). For patients requiring surgical treatment of trauma-related injuries who present concomitant rib fractures, a catheter can be inserted by a surgeon lateral to the paraspinous muscles and tunneled perpendicular and superficial to the affected ribs in an extrathoracic location before emergence from general anesthesia.[60,61] With this technique, the problems associated with repeated multiple injections are avoided. There is no risk to the spinal cord although inadvertent total spinal anesthesia via an intercostal catheter placed intraoperatively by a surgeon has been reported.[39] Trauma patients are often coagulopathic or are on thromboprophylaxis, which contraindicate central blocks but not to the same extent with intercostal blocks.

Serratus Anterior Plane Blocks

The serratus anterior muscle is attached to the medial border of the scapula and the anterior surface of the first to the eighth or ninth rib (Fig. 3). The ribs and the thoracic intercostal nerves lie deep to and pierce the serratus anterior muscle. The lateral cutaneous branches of the intercostal nerves are blocked by depositing LA into the plane below (serratus-intercostal myofascial plane) or above (serratus-latissimus dorsi myofascial

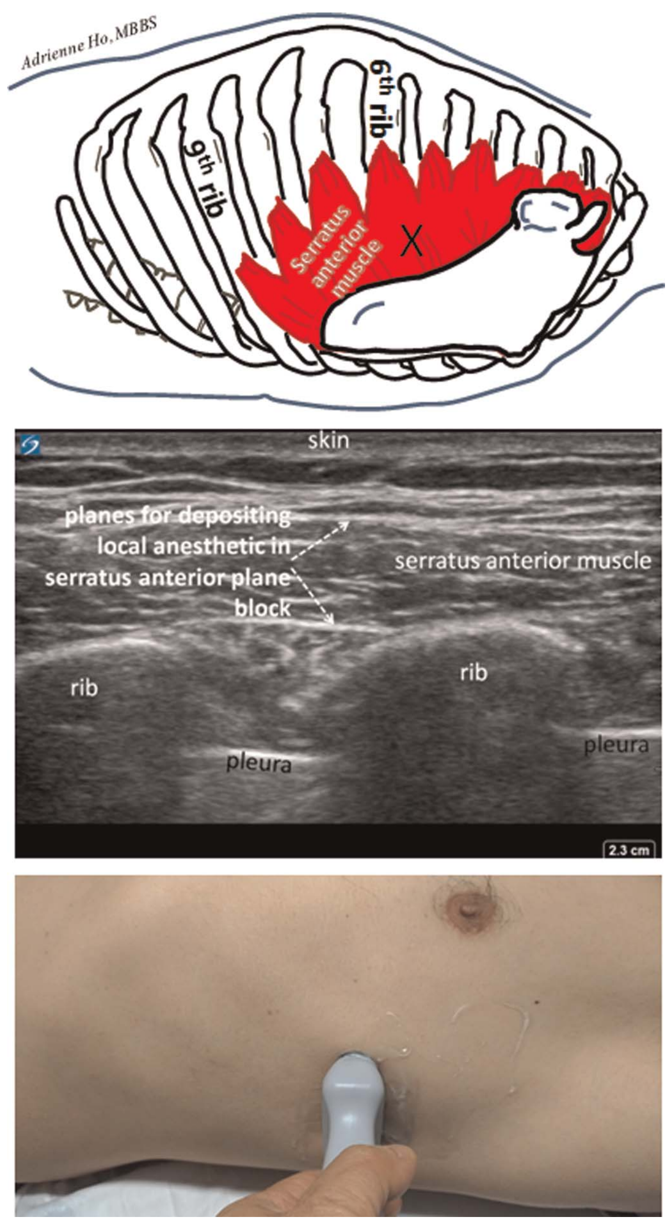

Figure 3. Serratus anterior plane block. Top panel, Location of rib fractures in our index patient. X marks the spot of the block needle tip. Middle panel, ultrasound anatomy. Bottom panel, placement of ultrasound probe.

plane) the serratus anterior muscle at the midaxillary line.[22,62–68] Injectate at high volume spread extensively in the anterior chest wall and no spread posteriorly in a cadaveric study.[68–70] In volunteers, injection of 0.4 mL/kg of levobupivacaine 0.125% and 0.1 mmol/kg of gadolinium into the superficial plane blocked T2 to T9, lasting a mean of 12.5 hours. This block is suited only for anterolateral rib fractures[22,62–67] but not for posterior rib fractures.[71] Pain from deeper structures (e.g., chest drain) may not be covered.[22] Structures innervated by the anterior cutaneous branch of the intercostal nerve are also not blocked. A distinct advantage of this block is that it can be performed on a supine patient between the anterior and posterior axillary lines and between the second and seventh ribs (Fig. 3), thus sparing the distressed patient from significant discomfort associated with lateral or upright positioning. This block has also been shown to be equivalent to thoracic epidural block in thoracotomy but with, as expected, less hypotension.[66–68]

Interpleural Block

Local anesthetic is injected between the visceral and parietal pleura. The negative interpleural pressure during inspiration signals entry of the needle tip into the interpleural space, whereupon LA is injected followed by catheterization. The problems with this block are many: dilution of the LA if effusion/hemothorax is present; high risk of pneumothorax; risk of LA toxicity; loss of LA from a chest drain, if present; and the need to position the patient laterally with the fractured side up to allow the LA to gravitate toward the nerve roots.[72] This block has largely been supplanted by other/newer techniques.[35,73,74]

COMPARATIVE STUDIES

Epidural Block Versus Intravenous Opioids in Patients With Multiple Rib Fractures

A meta-analysis of four randomized controlled trials (RCTs) comparing epidural analgesia versus intravenous (i.v.) opioids showed only trends favoring epidural in shorter length of hospital stay (−6.69 [−19.81 to 6.42] days), shorter ICU stay (−4.85 [−11.18 to 1.47] days), fewer mechanical ventilation days (−6.99 [−16.66 to 2.67] days), and fewer pulmonary complications (odds ratio, 0.58 [0.21 to 1.61] days).[75] In all RCTs and observational studies, pain scores at rest and with coughing were significantly lower in the epidural groups versus i.v. groups.[75] Two similar meta-analyses have shown no significant difference in mortality between epidural and i.v. analgesia.[76,77] These results, however, must be interpreted with caution, as major trauma involves multisystem derangements, and thus, adequate analgesia is one of many variables that can influence major outcomes. Contradicting these results, for instance, was a before-after study showing that implementation of a rib fracture multidisciplinary clinical pathway that led to increased use of epidural analgesia in patients with weak cough, resting pain score of greater than 6/10, and maximum inspiratory volume on incentive spirometry of less than 15 mL/kg decreased mechanical ventilator-dependent days, lengths of stay, infectious morbidity, and mortality.[12] In one study published in 2018, geriatric patients with rib fractures randomized to regional analgesia had less delirium and opioid requirement than those receiving systemic analgesia.[78]

Paravertebral Block Versus Intravenous Opioids in Patients With Multiple Rib Fractures

One RCT in patients with unilateral rib fractures showed that thoracic paravertebral block resulted in significantly better oxygenation and respiratory mechanics, lowered pain scores associated with rest and coughing, and reduced nausea and vomiting, somnolence, and pulmonary complications.[79]

Intercostal and Thoracic Interfascial Plane Blocks/Paravertebral Variants Versus Epidural Block in Patients With Multiple Rib Fractures

One RCT by Hashemzadeh et al.[80] showed in patients with multiple rib fractures that epidural resulted in a trend toward shorter ICU stay and a significantly shorter hospital length of stay and better pain scores (resting and coughing) when compared with intercostal block. Conversely, retrospective studies suggest that continuous intercostal nerve block is associated with equivalent pain scores,[81] but less ICU admission,[81] shorter ICU[81] and hospital[61,81] stay, and better improvement in incentive spirometry volumes[81] when compared with epidural analgesia. It is noteworthy that the epidural cohort had significantly poorer preblock spirometry than the intercostal group in one study[81] and higher number of bilateral rib fractures in the other.[61] In Mohta et al.'s[82] RCT, there was no significant difference in ICU and hospital lengths of stay between thoracic epidural and paravertebral analgesia in patients with unilateral multiple fractured ribs. In an RCT, Shelley et al.[58] found that subrhomboid-intercostal plane block (placed by surgeon or anesthesiologist) provides better pain relief after initial placement and less hypotension, when compared with thoracic epidural block (placed by anesthesiologist). The two techniques were associated with similar hospital length of stay, spirometry, and discharge disposition.[58] An RCT comparing ESP and thoracic paravertebral blocks for unilateral rib fractures is ongoing.[83]

Regional Blocks in Patients Undergoing Thoracotomy or Chest Wall Surgery

One can also draw inferences from studies comparing analgesic techniques in chest surgeries. One RCT compared retrolaminar block versus paravertebral block, both sited before modified radical mastectomy; the retrolaminar cohort required more opioid supplementation intraoperatively, larger volumes of LA during the first 24 hours postoperatively for equivalent analgesia, and equivalent efficacy at 24 to 72 hours postoperative.[64] In case reports, the midpoint transverse process to pleura block provided good analgesia after breast surgery.[54] The paraspinal/intercostal block has been used successfully in thoracic surgery.[55] There have been numerous reports attesting to the equivalent efficacies between thoracic epidural and paravertebral blocks in chest surgeries. The latest comparison between epidural and paravertebral blocks in pancreatic surgery again showed equivalent analgesia but more adverse effects with epidural.[84] Khalil et al.[66] compared the postoperative analgesic effect of serratus anterior plane block versus thoracic epidural block for open thoracotomy and found the pain relief comparable during the first 24 hours postoperatively. Hetta and Rezk[84] found in an RCT that, for radical mastectomy with axillary evacuation, pain and opioid consumption within the first 24 hours of surgery was less with paravertebral block than with serratus plane block.

SUMMARY

Regional analgesia should be considered early in all high-risk (multiple fractures, flail chest, advanced age, other injuries) rib fracture situations. In-hospital patients need to be reevaluated frequently to ensure adequate analgesia. If the clinical picture deteriorates (e.g., progressive respiratory failure), the need for regional blocks and/or rib platting should be considered. Although there are insufficient data to date to show reductions in mortality with regional blocks, the improved analgesia and reduction of opioid requirements provided by regional blocks are a worthy endpoint in itself. Furthermore, inadequate analgesia and over reliance on opioids for acute pain increase the risk of chronic opioid dependency.[85] The emergence of various thoracic interfascial plane blocks/paravertebral variants, which are simpler and carry less serious complications, infers that epidural and paravertebral blocks are no longer the only choices for regional techniques and that anesthesiologists are no longer the only specialists who are able to provide them.[21,22] Preliminary evidence suggests that all these interfascial plane blocks/paravertebral variants provide good analgesia in rib fractures. Erector spinae plane block appears to be one that has garnered the most interest for now, and the serratus anterior plane block, which can be performed with the patient in the supine position, is also promising for nonposterior rib fractures. Until more evidence becomes available, choosing which block for analgesia in multiple rib fractures would depend mainly on the available expertise and anatomical location of fractures.

AUTHORSHIP

A.M.-H.H. helped by designing the study and participating in drafting and revising the article, as well as approving the final version for publication. A. K.H. helped by participating in drafting and revising the article, creating the figures, and approving the final version for publication. G.B.M. helped by participating in analyzing the data, critically revising the article, formatting it according to journal's requirements, drafting the abstract, and approving the final version for publication. G.K. helped by participating in analyzing the data, critically revising the article, and approving the final version for publication. M.K.K. helped by participating in drafting and revising the article and approving the final version for publication.

DISCLOSURE

The authors declare no conflicts of interest.

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