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Chest Wall and Abdominal Blocks for Thoracic and Abdominal Surgeries: A Review

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Abstract

Purpose of Review The purpose of this review is to provide an up-to-date description and overview of the rapidly growing literature pertaining to techniques and clinical applications of chest wall and abdominal fascial plane blocks in managing perioperative pain.

Recent Findings Clinical evidence suggests that regional anesthesia blocks, including fascial plane blocks, such as pectoralis, serratus, erector spinae, transversus abdominis, and quadratus lumborum blocks, are effective in providing analgesia for various surgical procedures and have more desirable side effect profile when compared to traditional neuraxial techniques. They offer advantages such as reduced opioid consumption, improved pain control, and decreased opioid-related side effects.

Summary Further research is needed to establish optimal techniques and indications for these blocks. Presently, they are a vital instrument in a gamut of multimodal analgesia options, especially when there are contraindications to neuraxial or para-neuraxial procedures. Ultimately, clinical judgment and provider skill set determine which blocks—alone or in combination—should be offered to any patient.

Keywords Thoracic paravertebral block (TPVB) · Erector spinae plane block (ESPB) · Intercostal nerve block (ICNB) · Pectoralis block I and II (PECS) · Serratus anterior plane block (SAPB) · Transversus abdominis plane (TAP) · Block and rectus sheath blocks · Quadratus lumborum block

Introduction

Regional anesthesia has been increasingly studied and utilized as an integral part of multimodal analgesia for a variety of surgical procedures, especially those resulting in moderate to severe postoperative pain. Among the benefits of using regional blocks with local anesthetics, studies have shown reduction in postoperative pain, and opioid utilization, enhanced patient comfort and recovery, earlier rehabilitation, and reduced hospital length of stay as well and potential contribution to reduction of persistent pain after surgery [1, 2].

Thoracic and abdominal surgeries, in particular, mastectomy, thoracotomy, and open abdominal procedures, can result in severe postoperative pain, which, if inadequately treated, contributes to increased perioperative morbidity and mortality. Furthermore, severe acute postoperative pain can contribute to development of persistent postsurgical pain and chronic opioid use.

In this review, we describe and evaluate current regional anesthesia modalities utilized for managing pain in thoracic and abdominal surgeries and discuss up-to-date evidence and their clinical applicability.

Chest Wall Blocks

Thoracic Paravertebral Block

Thoracic paravertebral block (TPVB) is a compartment block that relies on the spread of injected local anesthetic (LA) within the paravertebral space. This block anesthetizes spinal nerves emerging from intervertebral foramina and produces unilateral, segmental, somatic, and sympathetic nerve block [3]. Anatomical dissection and imaging studies have recently redefined the thoracic paravertebral space

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(TPS) contents and boundaries [4]. The posterior wall of the TPS is formed mainly by the internal intercostal membrane (IICM) and superior costotransverse ligament (SCTL). The pleura forms the anterolateral wall. The vertebral body and accompanying intervertebral foramen form most of the medial border of the TPS [4]. Only the ventral rami of the spinal nerve and sympathetic trunk emerged at the TPS, and the posterior rami of the spinal nerve directly proceed into the space posterior to the SCTL [3]. Several slits in the SCTL create channels between the retro SCTL space and TPS [4, 5]. This fact is relevant clinically as it explains the mechanism of action in the other recently studied peri-spinal blocks, inter-transverse process block (ITPB), and erector spinae plane block (ESPB). The ITPB block is a modification of the TPVB in which the LA is deposited superficially to the SCTL [6]. In an ESPB, the LA is deposited between the erector spinae muscle and the transverse process (Fig. 1).

Paravertebral block has been used as the primary anesthetic in breast and thoracic surgery. It has also been widely utilized to provide analgesia following rib fractures, thoracotomy, nephrectomy, and cholecystectomy [3, 5]. In a systematic review and meta-analysis of randomized controlled trials (RCT), TPVB was found to be as effective as thoracic epidural analgesia for post-thoracotomy pain relief and is associated with fewer side effects and complications [7]. The researchers found that pain scores at rest and during activity/coughing at 4–8, 24, and 48 h postoperatively were similar in both the TPVB and thoracic epidural groups. Hypotension and urinary retention were more common in the epidural analgesia group [7]. A recent meta-analysis of 66 trials comparing local infiltration and regional anesthesia modalities in breast surgery found superior pain control for up to 12 h following TPVB and also ESPB [8]. Pain relief was evident at rest or on movement and was associated with reduced cumulative IV morphine equivalent consumption in the first postoperative 48 h [8]. In a recent randomized controlled trial, researchers compared TPVB and ESPB for postoperative analgesia after video-assisted thoracic surgery (VATS) [9]. Eighty patients were randomly assigned into two groups to undergo TPVB or ESPB and receive a catheter

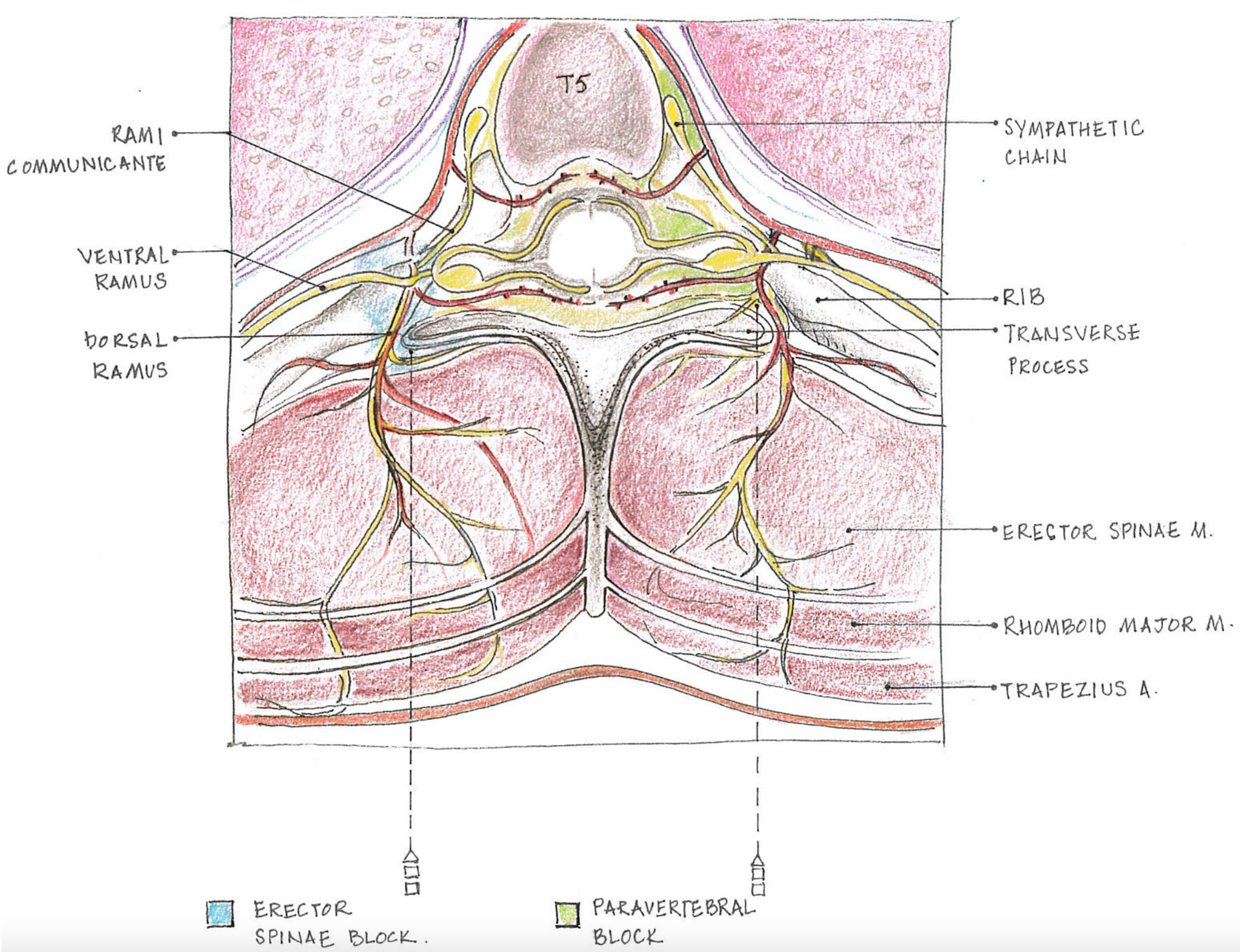

Fig. 1 ESPB PVTB anatomy

for continuous LA infusion postoperatively. The median pain scores at rest at 1, 2, and 24 h were 2 (1–3) versus 4 (1–6.5), 2 (1–3) vs 3 (2–5), and 1 (0–2) versus 1 (0–3), with p values = 0.02, 0.01, and 0.006, respectively. The median difference in pain scores at rest 24 h postoperatively was 1 (range 0–1), demonstrating the non-inferiority of ESPB. However, the number of anesthetized dermatomes at the parasternal region was significantly greater in the TPVB than in the ESPB group ($p < 0.0001$) indicating potential better coverage of PVTB in procedures with wider or multiple incisions [9].

Previous studies suggested that paravertebral blocks may prevent chronic pain after breast surgery. However, recent evidence challenged this hypothesis. In a prospective, multicenter, randomized, double-blind, placebo-controlled study, 380 women undergoing partial or complete mastectomy with or without lymph node dissection were randomized to receive preoperative paravertebral block with either 0.35 ml/kg 0.75% ropivacaine (paravertebral group) or saline (control group) [10]. The primary endpoint was the incidence of chronic pain with a visual analogue scale (VAS) score greater than or equal to 3 out of 10, 3 months after surgery. At 3 months, chronic pain was reported in 93 of 178 (52.2%) and 83 of 174 (47.7%) patients in the paravertebral and control groups, respectively. At 6 and 12 months, chronic pain occurred in 104 of 178 (58.4%) versus 79 of 174 (45.4%) and 105 of 178 (59.0%) versus 93 of 174 (53.4%) patients in the paravertebral and control groups, respectively. The study showed greater acute postoperative pain control in the paravertebral group. Postoperative morphine consumption was 73% less in the paravertebral group (odds ratio, 0.272 [95% CI, 0.171 to 0.429]; $P = 0.001$). The researcher concluded that paravertebral block did result in less immediate postoperative pain and opioid use but did not significantly reduce the incidence of chronic pain after breast surgery. A meta-analysis done in 2022 showed similar results. The study included a total of 1028 adult patients from 10 RCTs. The incidence of chronic postsurgical pain (CPSP) after thoracic surgery was not reduced in the TPVB group compared with no block [11].

A recent randomized trial comparing ultrasound-guided multi-injection ITPB and TPVB for mastectomy plus sentinel or axillary lymph node dissection showed non-inferiority of ITPB [12]. The researchers randomized eighty-eight females to receive either ITPB or TPVB, both performed at T2–6 with 5 mL of 0.5% ropivacaine per level. The worst resting pain scores within 30 min in the recovery room were 0 (0, 1) in the ITPB group and 0.5 (0, 2) in the TPVB group, with a median difference of 0 (95% CI 0 to 0). A possible explanation is that the retro SCTL space communicates with the TPS via several slits in the SCTL. This allows local anesthetics deposited superficially to the SCTL to diffuse into the paravertebral space and exert their effects on target nerves.

Erector Spinae Plane Block

The erector spinae plane block (ESPB) is a paraspinal fascial plane block that involves depositing LA in the plane between the transverse process of the thoracic or lumbar vertebra and the anterior fascia of the erector spinae muscles. This technique was initially described in 2016, and its use has expanded since [13]. A recent study evaluated the spread of local anesthetics after ESPB in ten healthy volunteers [14]. Subjects received a right-sided ESPB at the level of the seventh thoracic vertebra, consisting of 30 mL 0.25% ropivacaine with 0.3mL gadolinium. The primary outcome was the evaluation of the spread of local anesthetic on MRI (magnetic resonance imaging) 1-h post block. The researchers showed that 9/10 had spread to the paravertebral space, and 8/10 had spread to the neural foramina. Four of the ten volunteers had spread to the epidural space. Sensory testing showed highly variable results and was not consistent with the spread visualized on MRI. They concluded that sensory loss does not indicate the actual spread of local anesthetics and that clinical analgesic effects, not cutaneous testing, should be used when performing an ESPB [14]. Analgesic coverage of ESPB compared to PVTB and intercostal nerve block is shown in Fig. 2.

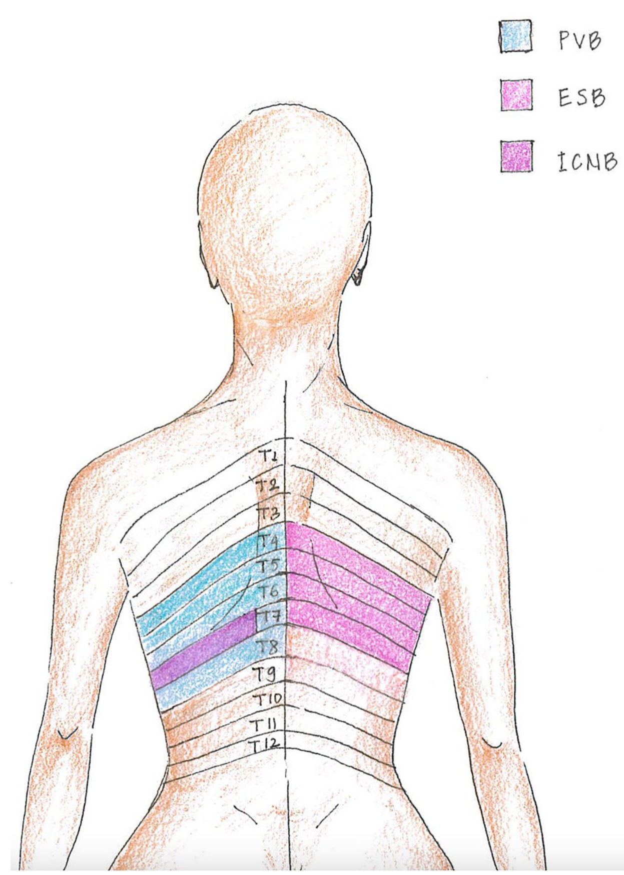

Fig. 2 Back chest wall block distribution

ESPB has been utilized to provide analgesia for thoracoabdominal procedures as a potentially safer substitution for epidural or paravertebral techniques. Huang et al. conducted a metanalysis of RCTs that compared an ESPB to non-block care or TPVB for postoperative analgesia in breast and thoracic surgery patients [15]. They included 14 RCTs comprised of 1018 patients. Seven studies included thoracic surgery, and seven studies included breast surgery patients. Meta-analysis revealed that ESPB significantly reduced 24-h opioid consumption compared with the non-block groups (− 10.5 mg; 95% CI: − 16.49 to − 3.81; $p = 0.002$; I2 = 99%). Patients who received ESPB had significantly reduced pain scores at rest or movement at various time points postoperatively compared with non-block group and had reduced rates of postoperative nausea and vomiting (OR 0.48; 95%CI 0.27 to 0.86; $p = 0.01$; I2 = 0%). Compared to TPVB, patients who received ESPB had no significant differences in the analgesic efficacy in pain scores, 24-h opioid consumption, or rates of postoperative nausea and vomiting (PONV) [15]. A meta-analysis done in 2021 included 1092 patients from seventeen studies involving thoracic surgery [16•]. ESPB reduced 24-h postoperative opioid consumption (mean difference [MD] − 17.49, 95% CI − 26.87 to − 8.12), pain score at rest (MD − 0.82, 95% CI − 1.31 to − 0.33), and pain score at movement (MD − 0.77, 95% CI − 1.20 to − 0.3) compared to no block.

As the injection site is distant from major vascular structures, the spinal cord, and the pleura, ESPB has been deemed a safer alternative to epidural and paravertebral blocks. This led to the utilization of ESPB in cardiac surgery and in patients receiving anticoagulants or antiplatelet therapy. A randomized controlled trial divided one hundred and six adult patients undergoing elective cardiac surgery with cardiopulmonary bypass into two groups [17]. One group received ultrasound-guided bilateral ESPBs with 3 mg/kg of 0.375% ropivacaine before anesthesia induction at the T6 transverse process level. The second group received paracetamol and tramadol intravenously in the postoperative period. The median pain score at rest after extubation in the ESPB group was 0 of 10 until hour 6, 3 of 10 at hour 8, and 4 of 10 at hours 10 and 12 post-extubation. These were significantly less than the paracetamol and tramadol group ($p = 0.0001$). The researchers concluded that ESPB provided safe and effective analgesia for a longer duration than medical management alone [17].

Pectoralis Nerve Block

The "PECS I" block was developed as a regional anesthesia technique for breast surgery to relieve pain in the anterior chest [18]. It involves injecting a local anesthetic between the pectoral muscles targeting the medial and lateral pectoral nerves. The block was subsequently modified to the "PECS II" technique, which involves additional administration of local anesthetic between the pectoralis minor, underlying rib, and serratus anterior muscles. The added block expands the analgesic coverage to include the intercostobrachial and intercostal nerve distribution, at T3–T6, and the long thoracic nerve, which together innervate the anterolateral chest and adjacent axilla [19, 20, 21•]. Recently, it has been proposed that the block nomenclature be updated to more anatomically accurate "interpectoral block" for PECS I block and "pecto-serratus + interpectoral block" for the PECS II block [22].

The PECS blocks have been commonly used in oncological breast surgery, such as modified radical mastectomy, in patients undergoing axillary lymph node dissections, lateral breast and chest wall surgery, or reconstructive breast procedures involving breast expanders or subpectoral prosthesis insertion [19, 20, 23••]. Meta-analysis by Meisner et al. evaluating PECs blocks in breast surgery found moderate quality evidence that PECS block, compared with no treatment, reduces postoperative pain intensity at rest [24]. Systematic review and meta-analysis including 14 randomized trials comparing pectoralis-II block with paravertebral blocks found no differences in pain scores or opioid consumption between the patients having surgery for breast cancer. Pectoralis-II reduced pain intensity and morphine consumption during the first 24 h postoperatively when compared with systemic analgesia alone; and it provided analgesic benefits noninferior to those of paravertebral block after breast cancer surgery [25]. The role of single shot PECS blocks in managing pain in cancer-related breast surgeries has been further studied and established as equivalent, if not better than the other chest wall blocks, serratus anterior plane block (SAPB), ESP, and PVTB [26•]. Going one step further in the evaluation of potential benefits of PECS II blocks in breast cancer surgery, a large RCT looked at markers of recurrence in these patients. Anesthesia techniques including volatile agents, propofol, and opioids have been studied in the past. Kaplan–Meier survival curves showed that the recurrence-free survival, distant recurrence-free survival, and overall survival did not differ with use of PECS II blocks [27]. In recent studies looking at the efficacy of PECS blocks in breast augmentation, substantial pain reduction effects were observed [28, 29]. Retrospective reviews, however, have not shown similar results for reduction mammoplasty, though, and tumescent anesthesia may remain superior to PECS blocks in these cases [30, 31].

Promising results have been showed in terms of opioid requirements and ICU lengths of stay in prospective and retrospective, observational studies in both open and robotic cardiac surgeries [32–34]. A randomized controlled trial conducted by Kumar et al. compared the effectiveness of bilateral PECS II block with systemic analgesia alone in 40 adult patients who underwent median sternotomy.

The study found that the group receiving PECS II block had lower opioid requirements and shorter extubation times [35]. In patients with median sternotomies, combination with pecto-intercostal fascial plane block (PIFB) block, serratus anterior plane block (SAPB) fared better in chest tube pain compared to PECS blocks alone [36].

PECS blocks have been utilized in cardiac device implantations with reduction in postoperative pain as evidenced in recent small, randomized control trials, and retrospective reviews [37–39].

Serratus Anterior Plane Block

Blanco et al. introduced the serratus anterior plane block (SAPB) as a method for pain relief in the lateral thoracic wall, providing analgesia across four to five dermatomal levels, ranging from T2 to T9 [40]. The correct plane is identified by visualizing the thoracodorsal artery between the serratus anterior (SAm) and latissimus dorsi muscles, local anesthetic is deposited either above (superficial) or below (deep) the SAm plane, or both (combination) [21•, 40]. This block effectively anesthetizes the lateral cutaneous branches of the intercostal nerves, which emerge between the layers of muscles, as well as the long thoracic, thoracodorsal, and intercostobrachial nerves. Furthermore, the deeper sub-serratus block can serve as a location for placing a catheter for continuous infusion of local anesthetic [20]. SAPB, in relation to the other anterior chest wall blocks, is presented in Fig. 3.

Results of a recent meta-analysis of 23 RCTs of SAPB against no block demonstrated that SAPB enhanced postoperative analgesia and reduced analgesic drug consumption and significantly lowered the incidence of PONV in thoracic surgery [41]. For thoracoscopic surgeries, however, in a Bayesian meta-analysis of 61 studies, authors found SAPB to be the least favorable of the non-TEA techniques in terms of opioid consumption, out of PVB, ESPB, and intercostal nerve block (ICNB). TPVB was found to be the best followed by ESPB [42]. These results were replicated by a frequentist meta-analysis, showing TPVB to provide the best analgesic efficacy following VATS, with ESPB being comparable [43]. Scorsese's meta-analysis of 42 RCTs found that in patients undergoing VATS, SAPB, TEA, ESPB, and

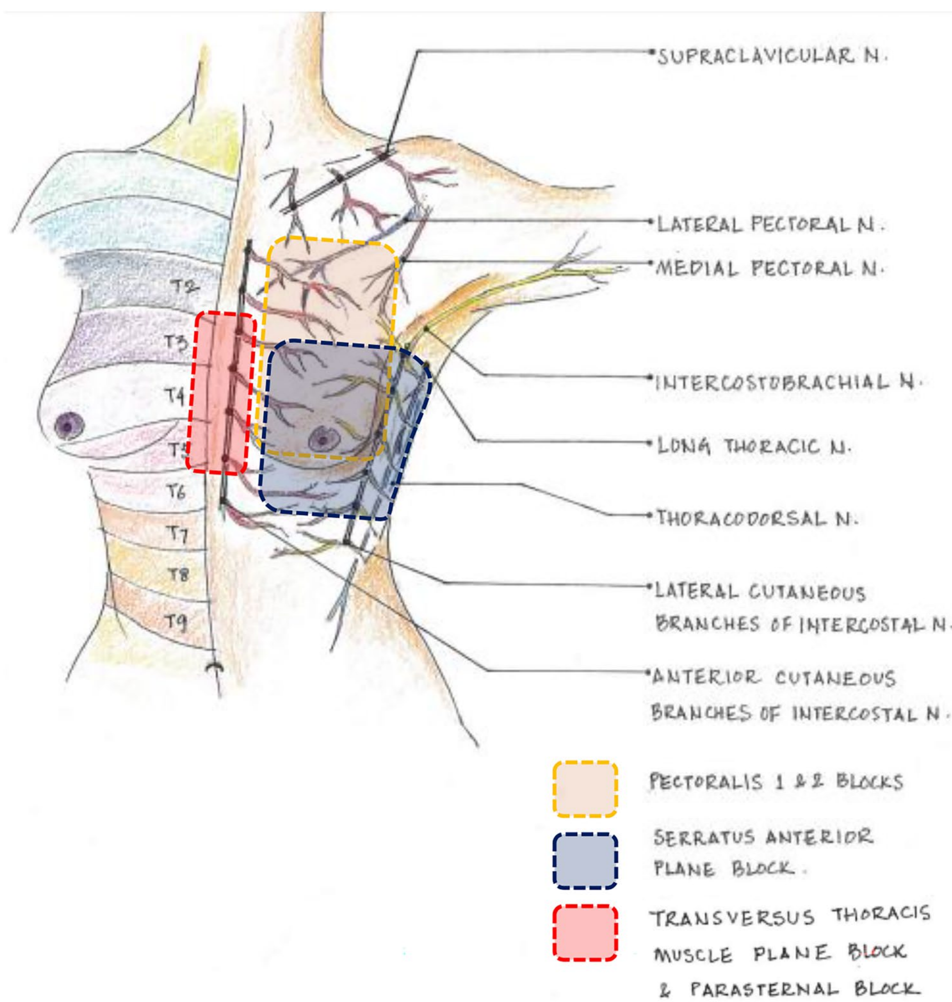

Fig. 3 Chest wall block anterior anatomy

PVB all had lower cumulative pain scores, but SAPB did not have lower 24-h opioid requirements like the others [44•]. Comparing the deep SAPB and a combination of deep and superficial SAPB in VATS, an RCT of 60 patients found that the combined approach provided more effective and longer analgesia [45]. A systematic review and meta-analysis by Singh et al. investigated 24 RCTs, comparing the analgesic efficacy of SAPB to no blocks or other blocks in breast surgery [46]. They found moderate evidence that SAPB significantly reduces 24 h OME, with greater reduction seen in superficial SAPB, also with significant decreases in PONV. They did not find statistically significant differences in these parameters when SAPB was compared to PVB, PECS, and ESP, and the choice may have been guided by risk/safety profile, what is convenient to the surgical field and the anesthesiologist's preferred skill set.

In terms of robotic cardiac surgery, a RCT of 194 patients showed that there was no benefit of a combination of SAPB and PECS II block on opioid consumption or respiratory parameters as compared to routine analgesia on the first 3days [47].

RCTs are lacking evaluating SAPBs in patients with rib fractures. However, SAPBs were deemed to be safe and effective in patients with multiple rib fractures in a systematic review of one RCT, multiple retrospective reviews and case series [48].

Intercostal Nerve Block

The twelve intercostal nerves travel in neurovascular bundles with an intercostal artery and vein superior to them, and they originate from the ventral branches of spinal nerves. They give off various branches and provide sensory innervation to much of the back, trunk, and upper abdomen, as well as motor innervation to accompanying muscles (Fig. 4). The intercostal nerve block (ICNB) has long been utilized as an important regional technique for thoracic and upper abdominal surgery. The ultrasound-guided technique, performed at various anatomical locations, may allow for better accuracy and visualization, as well as use of lesser volume of local anesthetic, compared to landmark technique [49]. A block needle is typically inserted in a plane aiming slightly cephalad and advanced until the needle tip is visualized just below the inferior border of the rib. Due to proximity of vascular structures, frequent negative aspiration with incremental injections is important.

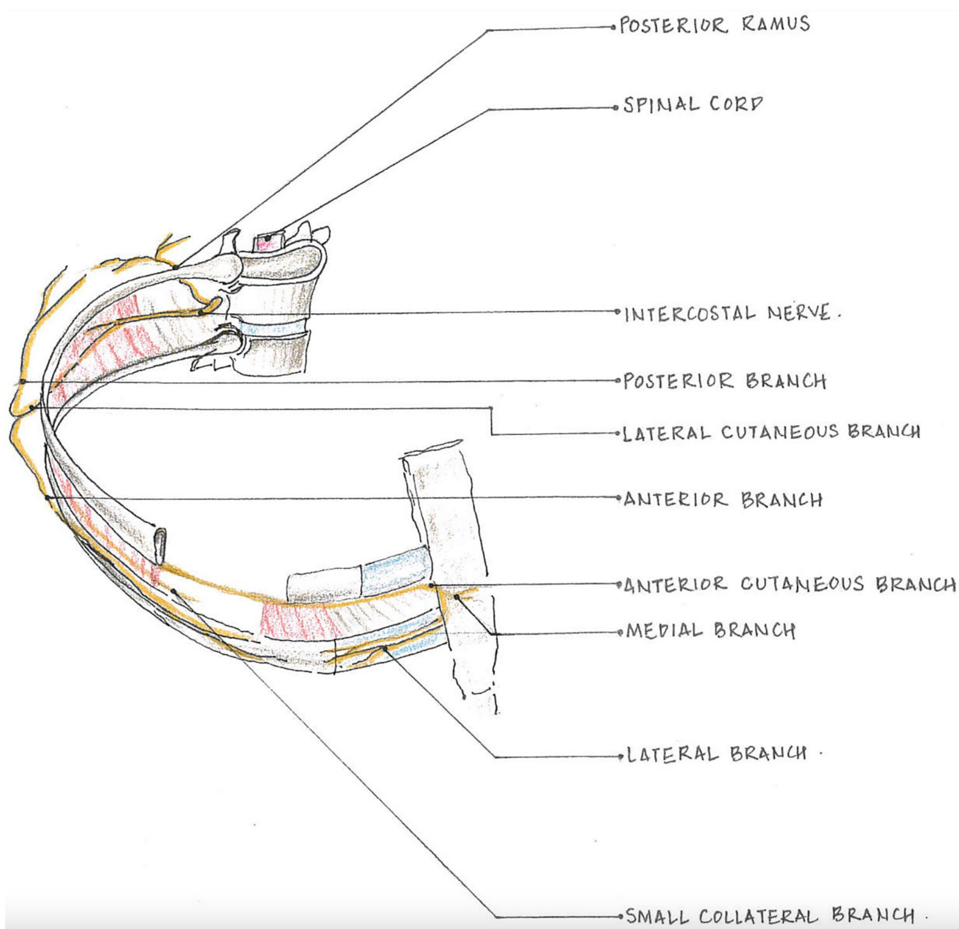

Fig. 4 Rib anatomy

There have been several recent meta-analyses on the utility of intercostal nerve blocks for thoracic surgery. Guerra-Londono et al. analyzed 59 studies and found that single-injection intercostal nerve block significantly reduced acute pain scores after thoracic surgery compared to systemic analgesia [50]. When compared to paravertebral blocks and thoracic epidural analgesia, intercostal nerve blocks were clinically noninferior, though the decrease in morphine milligram equivalents was not as pronounced with intercostal nerve blocks. Huan et al. similarly found that intercostal nerve blocks did not reduce postoperative morphine consumption as much as paravertebral blocks for thoracic and breast surgery [51]. For pediatric patients undergoing pectus excavatum repair, ICNB was found to reduce acute pain scores compared to opioid based PCA in the majority of studies analyzed [52]. Sandeep et al. analyzed 38 RCTs on regional techniques for video-assisted thoracoscopic surgery (VATS) [53]. They found that patients who underwent thoracic paravertebral block or serratus anterior plane block had lower pain scores at 48 h after surgery compared to patients who received intercostal nerve block. Likewise, Jo et al. found that pain scores were lower for patients who received intercostal nerve block compared to control (no block) for VATS, but again paravertebral blocks had the most pronounced effect on postoperative opioid consumption when compared to control [43]. Zeng et al. analyzed 35 trials and found that patients who received epidural analgesia reported lower pain scores at 24 h postoperatively when compared to patients who received intercostal nerve blocks [54].

The external oblique intercostal block is a modified newer technique, utilized for upper abdominal surgeries, but not yet extensively studied in randomized controlled trials. The ultrasound probe is placed in the anterior axillary line in a sagittal plane to image the space between the sixth and seventh ribs, typically. The block needle is then advanced from cephalad to caudad, and local anesthetic is injected beneath the external oblique muscle and superficial to the intercostal muscles, to anesthetize branches of intercostal nerves. This technique has been employed for various open abdominal procedures such as liver surgery, open cholecystectomy, and pancreatectomy [55–57]. Erskine and White recently published a review on the technique in which they discussed utilization of catheters reported in the literature and resultant dermatomal spread [58]. The vast majority (96%) of blocks covered T6–T10 levels, from midline to posterior axillary line. The review also mentioned a retrospective cohort study on 120 laparoscopic bariatric surgery patients, 74 of whom received regional anesthesia. Fifteen of these 74 patients received external oblique intercostal blocks, and postoperative opioid consumption for these 15 patients was similar to that of patients who received rectus sheath or TAP blocks [59].

Summary of the chest wall blocks in cross section are presented in Fig. 5.

Abdominal Wall Blocks

Transversus Abdominis Plane Block

The goal of the transversus abdominis plane (TAP) block is to anesthetize the anterior and lateral rami of thoracic spinal nerves that innervate the anterior abdominal wall. The midaxillary or lateral approach typically provides coverage for T10–T12 level and is performed just above the umbilicus The ultrasound probe is placed in transverse orientation to identify three muscle layers—the external oblique, internal oblique, and transversus abdominis. The block needle is inserted under US guidance with the tip visualized between the internal oblique and transversus abdominis. Subcostal approach aims to deposit local anesthetic in the plane between rectus and transversus abdominis muscles, providing analgesia for T7-T10 levels. TAP block, along with other abdominal wall blocks, is shown in Fig. 6.

A recent meta-analysis found that TAP blocks led to a significant reduction in opioid consumption on the first postoperative day without causing postoperative complications in colorectal surgery [60]. Two other meta-analyses had similar findings for laparoscopic colorectal surgery [61, 62]. For laparoscopic cholecystectomy, the evidence is somewhat mixed when comparing TAP blocks to wound infiltration—one meta-analysis reported there is moderate-to-high level evidence supporting TAP blocks over wound infiltration, while other found that TAP blocks were more effective than conventional pain control but not port site infiltration [63, 64]. De Cassai et al. found in their meta-analysis that wound infiltration was one of the least effective techniques for reducing opioid consumption after laparoscopic cholecystectomy, while TAP and erector spinae blocks were among the most effective [65]. For inguinal and infra-umbilical hernia repairs, recent meta-analysis reported moderate level evidence that TAP blocks were more effective than wound infiltration [66]. Cai et al. also found TAP blocks to be more effective than wound infiltration in controlling early postoperative pain in their meta-analysis on various types of abdominal surgery [67].

There have been numerous studies on the utility of TAP blocks for cesarean sections—a couple of meta-analyses have supported the efficacy of TAP blocks in the absence of long-acting neuraxial opioids [68, 69]. One meta-analysis analyzed both strategies for cesarean section acute pain control and found that intrathecal morphine was associated with superior analgesia compared to TAP blocks but higher postoperative nausea and vomiting [70]. For general abdominal surgery, many studies have compared TAP blocks to epidural analgesia. Qin et al. found that epidural analgesia, when compared to continuous TAP block combined with NSAIDs, was non-inferior in terms of postoperative pain control but associated with

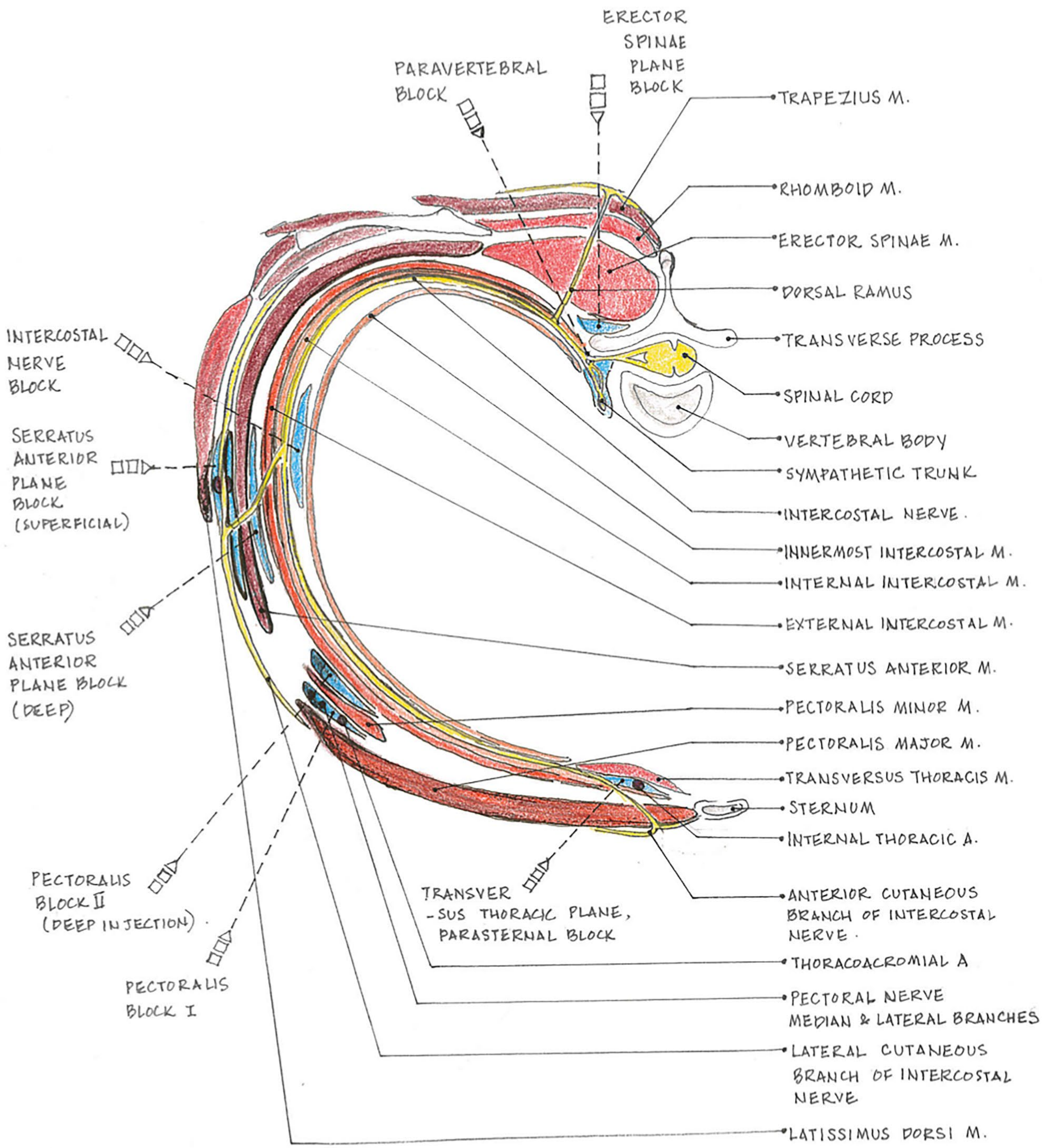

Fig. 5 Rib chest wall block cross-section

more side effects [71]. Similarly, another meta-analysis reported moderate evidence that TAP block and epidural analgesia were equally effective for abdominal surgeries in children and adults, and TAP blocks were associated with less hypotension [72]. A third meta-analysis likewise found no meaningful difference in pain scores between thoracic epidural and TAP groups for general abdominal surgery [73•]. Hamid et al. advocated for laparoscopic-guided TAP blocks in minimally invasive surgery as a safer alternative to epidural analgesia and found this approach was superior to local infiltration analgesia [74]. TAP blocks also have been studied in bariatric surgery—several meta-analyses support it as a safe and effective technique for this patient population [75–77].

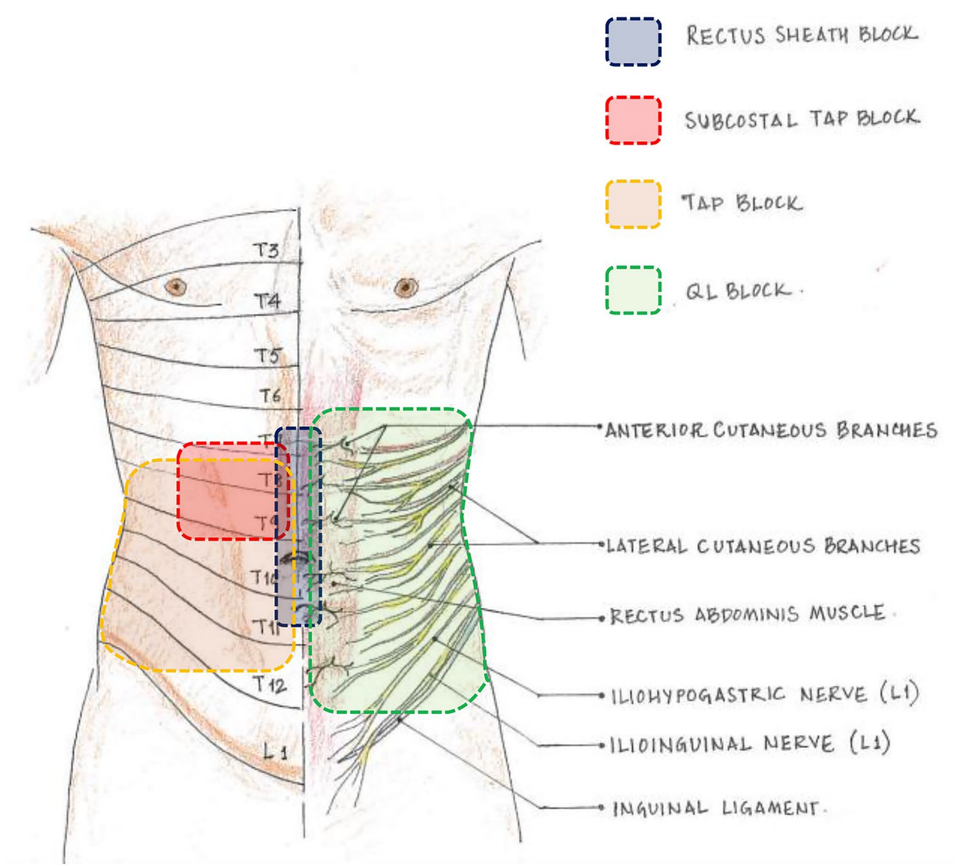

Fig. 6 Abdominal block anterior anatomy

Rectus Sheath Block

The rectus sheath block can provide analgesia for the periumbilical abdominal wall area by targeting the anterior cutaneous branches of intercostal nerves. The ultrasound probe is placed in a transverse orientation off the midline to image the lateral edge of the rectus muscle, the posterior rectus sheath, and the transversus abdominis muscle below. The block needle is then advanced in plane, typically from lateral to medial, through the rectus muscle until the tip of the needle reaches the space between rectus and posterior sheath.

There have been relatively few published studies on rectus sheath blocks, but there are some meta-analyses worth noting. A meta-analysis by Hamid et al. included 9 trials and looked at the efficacy of rectus sheath blocks for laparoscopic surgeries [78]. The authors found that rectus sheath blocks were associated with reduced pain scores immediately postoperatively (0–2 h) and at the 10–12-h mark compared to control. Twenty-four-hour opioid consumption was also significantly reduced for patients who received a block, and none of the included studies reported local or systemic complications. A smaller meta-analysis from 2022 including 4 studies (total of 143 patients) failed to find a significant difference in postoperative morphine use when comparing rectus sheath block with local anesthetic infiltration in children undergoing umbilical hernia repair [79]. For patients undergoing laparoscopic cholecystectomy, rectus sheath blocks were not as effective as other blocks—namely erector spinae, paravertebral, quadratus lumborum, and TAP—in reducing postoperative pain according to a meta-analysis that included 84 studies [65]. Similarly for abdominoplasty procedures, rectus sheath was shown to be less efficacious than TAP [80]. There are very few randomized controlled trials on rectus sheath blocks that included at least 100 patients, and two of them focused on gynecological surgery. The first of these trials compared continuous rectus sheath block to epidural analgesia and found that the former was non-inferior to epidural analgesia at rest, but not at movement for gynecological cancer patients [81]. The second trial demonstrated that laparoscopic-guided rectus sheath block did not reduce postoperative pain compared to control for laparoscopic gynecological surgery, though it was found to be a safe method with fewer reported complications [82].

Quadratus Lumborum Block

The quadratus lumborum block (QLB) is a regional anesthesia technique used to provide pain relief in the lower back, flank, and abdomen. The QL muscle originates from the posteromedial iliac crests and inserts on the twelfth rib and

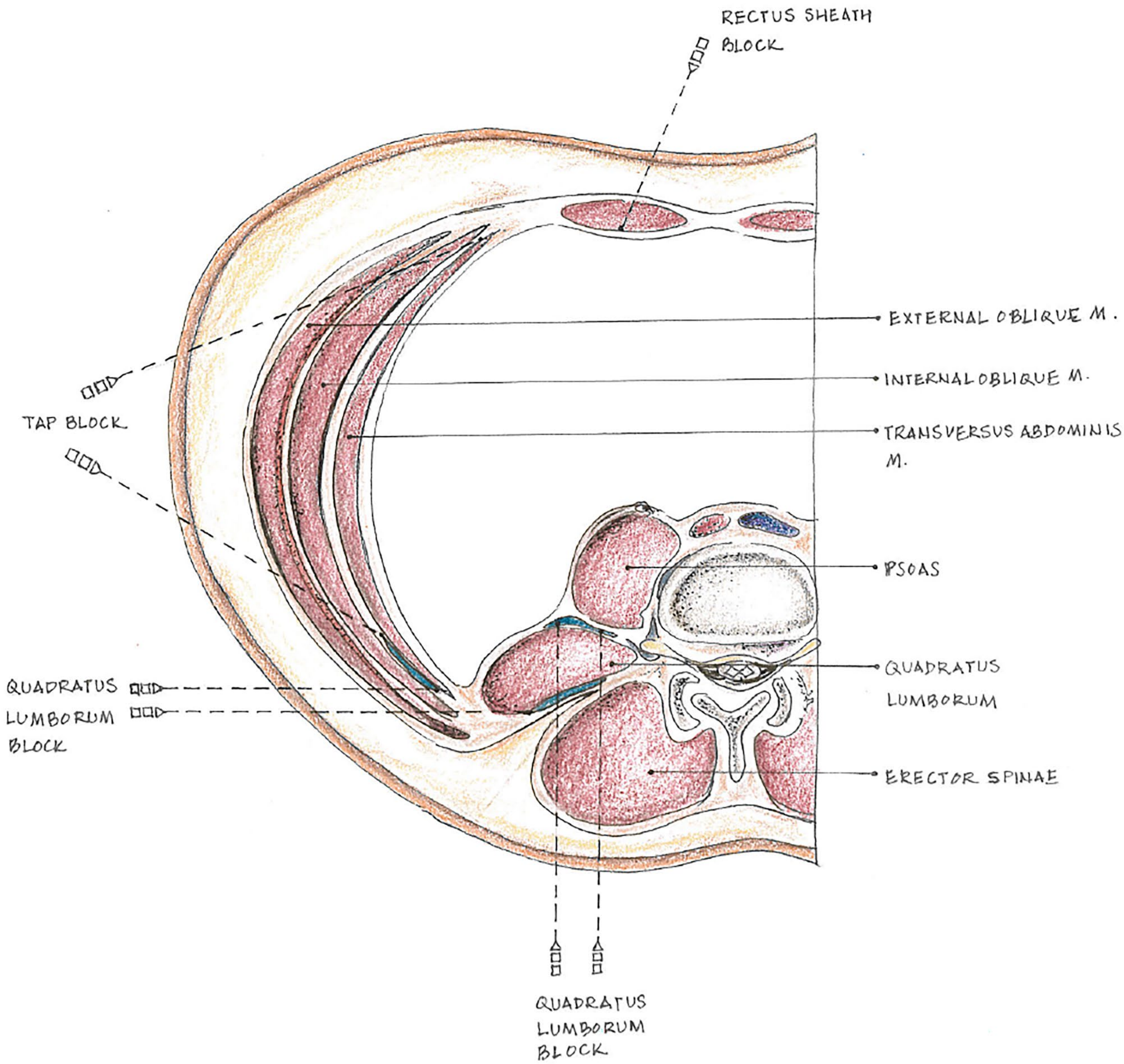

Fig. 7 Abdominal blocks

lumbar vertebrae. The block procedure involves injection of local anesthetic, either at the lateral border of the QL muscle beyond the transversus abdominis aponeurosis (lateral approach) (QLB1), posterior to the surface of QL muscle between the QL and ESP muscle (posterior approach) (QLB2), or between the QL and psoas muscles (anterior approach) (QLB 3) [83].

A meta-analysis and systematic review published in 2023 concluded that QL blocks effectively reduce the pain, PONV after urologic surgeries, and 24-h opioid consumption was reduced in non-laparotomy procedures. This study included 13 RCTs which were heterogenous in terms of different QLB approaches [84•]. Another systematic review and meta-analysis showed that single-shot QLB provided a statistically significant but clinically small improvement in postoperative analgesia and recovery for patients undergoing nephrectomy [85]. The efficacy of QLB in children undergoing laparoscopic lower abdominal surgery was also shown in a prospective randomized trial comparing QLB 2 block to caudal anesthesia and TAPB in 150 patients [86]. A recent meta-analysis showed that the USG guided QLB2 block significantly reduced acute postoperative pain for 24 h and more so in patients who undergo spinal instead of general anesthesia. Of the 14 RCTs included in this meta-analysis, six involved elective cesarean sections, six were laparoscopic (cholecystectomy, radical gastrectomy, colorectal resection renal surgery and gynecologic surgery), and the other two were abdominal wall surgeries [87]. Liu et al. studied QL block versus TAP block for postoperative analgesia in abdominal surgery and found the QL block to provide better pain management with less opioid consumption than the TAP block [88].

A large meta-analysis comparing TAP blocks with QLB for cesarian sections found that in the absence of neuraxial morphine, TAP and/or QLB reduced pain and opioid consumption [89]. QLB more effectively reduced pain at 36 h (very low-quality evidence). Notably most trials included evaluated lateral and posterior QLB which may theoretically have less paravertebral spread leading to comparable analgesia as TAP block, without visceral coverage. A systematic review and meta-analysis by Hussain et al. also suggested enhanced analgesia with QLB post-cesarian section in the absence of spinal morphine [90•]. Summary of abdominal wall blocks in cross section is shown in Fig. 7.

In conclusion, regional anesthesia blocks play an important role in perioperative pain management, and there has been an expansion of research into the anatomy, technique, and clinical applicability of various blocks. More high-quality RCTs are needed to further delineate the role of specific regional interventions in chest wall and abdominal surgeries, with particular emphasis on procedure resulting in moderate and severe pain.

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Compliance with Ethical Standards

Conflict of Interest None.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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Papers of particular interest, published recently, have been highlighted as:
- • Of importance
- •• Of major importance

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