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Role of Regional Anesthesia in Intensive Care: An Updated Narrative Review

Yoğun Bakımda Bölgesel Anestezinin Rolü: Güncellenmiş Bir Derleme

Received/Geliş Tarihi : 31.10.2024
Accepted/Kabul Tarihi : 18.11.2024

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ABSTRACT Objective: This review aims to provide a synopsis of regional analgesic modalities in the intensive care unit (ICU) context and to evaluate existing literature regarding the benefits and limitations of performing these procedures in critically ill patients. Specifically, we review regional techniques in the setting of traumatic rib fractures and extremity fractures, thoracic surgery, major abdominal surgery, and cardiac surgery. We additionally discuss the limitations of clinical practice in performing regional anesthesia in the ICU setting. Overall, the current literature demonstrates promising benefits of regional analgesia in critically ill patients. However, more extensive high-powered studies are needed to determine optimal analgesic strategies in this tenuous population. **Keywords:** Regional anesthesia, intensive care unit, acute pain, pain management, post-traumatic pain

ÖZ Amaç: Bu incelemenin amacı, yoğun bakım ünitesi (YBÜ) bağlamında bölgesel analjezik modalitelerinin bir özetini sunmak ve bu prosedürlerin kritik hastalarda gerçekleştirilmesinin faydaları ve sınırlamaları ile ilgili mevcut literatürü değerlendirmektir. Çalışmamızda özellikle travmatik kaburga ve ekstremité kırıkları, torasik cerrahi, majör abdominal cerrahi ve kalp cerrahisi için bölgesel teknikleri gözden geçirildi. Ayrıca, YBÜ ortamında bölgesel anestezi gerçekleştirirken klinik uygulamanın sınırlamaları da tartışıldı. Genel olarak, mevcut literatür, kritik hastalarda bölgesel analjezinin ümit verici faydalarını göstermektedir. Ancak, bu hassas popülasyon için optimum analjezik stratejileri belirlemek için daha kapsamlı, yüksek güçlü çalışmalara ihtiyaç vardır.

Anahtar Kelimeler: Bölgesel anestezi, yoğun bakım ünitesi, akut ağrı, ağrı yönetimi, travma sonrası ağrı

Introduction

Pain is pervasive and burdensome for critically ill patients. Approximately 50-70% of patients in intensive care units (ICUs) suffer from pain (1-3) -a figure likely underestimated considering the prevalence of mechanical ventilation, sedation, and delirium in these populations (2,4,5). If untreated, pain related to critical illness can evolve into chronic pathologic pain observed in 14-77% of ICU survivors (6,7). Patients remember pain long after they leave the ICU (8), with many experiencing post-traumatic stress disorder (9) and ICU-acquired opioid dependence (10). Undertreated pain is also linked to higher mortality rates (11), increased sympathetic stress (12), and decreased tissue oxygen tension, which may lead to poor surgical wound healing and

infection (13,14). Consequently, adequate pain control is paramount in the ICU.

Regional techniques are essential to multimodal analgesia in perioperative populations (15). Such techniques offer significant advantages over multimodal pain medications alone, including reduced risk of persistent postoperative pain (16), superior analgesia with lower opioid requirements (17), and fewer side effects with higher patient satisfaction (18). Furthermore, a recent meta-analysis found that regional techniques reduce postoperative neurocognitive dysfunction in major noncardiac surgery (19). Considering the value of regional techniques in perioperative patients, these modalities may represent a promising direction to optimize pain management in critically ill patients, particularly those with post-traumatic or post-surgical presentations.



In this narrative review, we discuss the utility of regional anesthesia for various patient populations in the critical care unit and the challenges faced when performing regional techniques in this high-acuity setting.

Regional Anesthesia for Post-Trauma Patients in the ICU

Trauma represents a significant source of critical illness, making up 46.9% of patients in the ICU, according to a multicenter prevalence study (20). Of these, the most common traumatic injuries were rib fractures at 41.6%, brain injuries at 38.8%, and hemothorax/pneumothorax at 30.8% (20). Most trauma patients report severe pain (21,22). However, pain management in the setting of acute trauma can be complicated by hemodynamic instability, airway compromise, and neurologic injury. Furthermore, systemic opioids can cause sedation and depression of cardiovascular and respiratory functions (23,24), which can worsen a patient's clinical picture and interfere with neurologic exams. As such, regional techniques are especially advantageous in critically ill trauma patients, providing site-specific analgesia with minimal side effects.

Blunt Thoracic Trauma and Rib Fractures

Blunt chest trauma involves injuries ranging from rib fractures, soft tissue contusions, and pneumothoraces (25). Notably, splinting caused by chest wall pain reduces ventilatory effort, which can lead to atelectasis and pneumonia (26). For chest trauma, numerous regional anesthesia techniques can be employed, including thoracic epidural analgesia (TEA), thoracic paravertebral blocks (TPVB), erector spinae plane blocks (ESP), serratus anterior plane blocks (SAP), and intercostal nerve blocks.

In 2016, the Eastern Association for the Surgery of Trauma (EAST) and the Trauma Anesthesiology Society jointly recommended epidurals over non-regional modalities of pain control in blunt thoracic trauma (27). Additionally, two systematic reviews concluded that epidurals provided superior pain relief compared to other modalities in rib fractures (28,29). However, the idea that epidural analgesia is superior to other regional techniques has been challenged by recent meta-analyses, with both Peek et al. (28) and Duch et al. (30) finding no advantages to epidurals over peripheral blocks in terms of mortality, duration of mechanical ventilation, and pulmonary complications. A meta-analysis of 12 studies found peripheral nerve blocks (TPVBs, intercostal, ESP, and SAP) to have better immediate pain control than conventional analgesics, including epidurals (31). A notable

randomized controlled trial (RCT) by McKendy et al. (32) reported increased respiratory complications in patients with multiple rib fractures who received epidurals. However, this observational study has a high potential for selection bias due to the cohort-matched group design determined by the clinician's decision to place an epidural or not. Particularly in patients with hemodynamic instability or coagulopathy, other regional modalities may be more appropriate and should be considered. An overview of the indications, benefits, and risks of thoracic regional techniques can be found in Figure 1.

Two recent RCTs support the efficacy of paravertebral blocks for improving pulmonary function parameters in rib fractures (33,34). A scoping review of 37 studies found almost universal improvements in pain and respiratory parameters after ESP blocks in rib fracture patients without complications, even in the setting of anticoagulation and coagulopathy (35). Indeed, RCTs suggest ESP blocks may be as effective as TPVB (36) with lower pain scores compared to intercostal (37) and SAP blocks (38). Independently, the SABRE RCT found clinically meaningful reduction in pain and opioid use with SAP versus standard of care (39). Intercostal blocks with liposomal bupivacaine, while safe, did not improve clinical outcomes (40).

Notably, in geriatric patients, a cohort particularly vulnerable to rib fractures and resultant complications, extensive retrospective studies noted the benefit of early regional intervention to prevent intubation (41) with similar outcomes between TEA and TPVB (42), suggesting further subgroup RCT assessments are needed.

Overall, recent literature on regional techniques in blunt chest trauma remains low quality and heterogeneous, making definitive conclusions regarding the optimal analgesic technique impossible. In fact, by 2023, EAST had changed its previous recommendation for epidurals over systemic modalities due to insufficient evidence of the superiority of epidural or locoregional techniques over other multimodal analgesia. Instead, they suggested providers use their judgment and available resources to provide a multifaceted pain management strategy (43) -a sentiment echoed by Hammal et al. (29) in their updated 2024 systematic review.

Regional Anesthesia for Post-Surgical Patients in the ICU

Around one-third of all critically ill patients worldwide are admitted to surgical ICUs following major elective or emergency surgeries (44,45). Over half of post-surgical ICU patients report pain at maximal intensity with suboptimal pain

control (46). The following section will focus on evidence for the use of regional analgesia for specific subpopulations of post-surgical patients in the ICU.

Extremity Injuries, Surgeries, and Considerations

While traumatic extremity injuries are common, the majority are treated with surgery and will, therefore, be discussed in this section.

Hip fractures tend to occur in patients who are older, more frail, and have more comorbidities than other trauma patients (47). Lumbar epidural analgesia reduces major adverse cardiac events after hip fracture. The American College of Cardiology/American Heart Association (ACC/AHA) recommended epidural consideration for hip fractures in their 2024 guidelines for perioperative cardiovascular

management (48). Peripheral blocks are another alternative, and a Cochrane review of peripheral nerve blocks in hip fractures showed reduced pain scores and confusion in patients receiving regional analgesia (49). The innervation to the hip is complex and involves numerous nerves and their articular branches, including the femoral, obturator, and accessory obturator nerves for the anterior capsule. The posterior joint capsule innervation involves the nerve to the quadratus femoris, sciatic, and superior and inferior gluteal nerves (50). These nerves, in addition to the lateral femoral cutaneous (LFCN), ilioinguinal, iliohypogastric, and posterior femoral cutaneous nerves, contribute to skin innervation over standard surgical incisions for hip fractures. Each nerve can be targeted individually or in combination proximally, like femoral and obturator nerve coverage with a lumbar plexus

Thoracic Regional Techniques

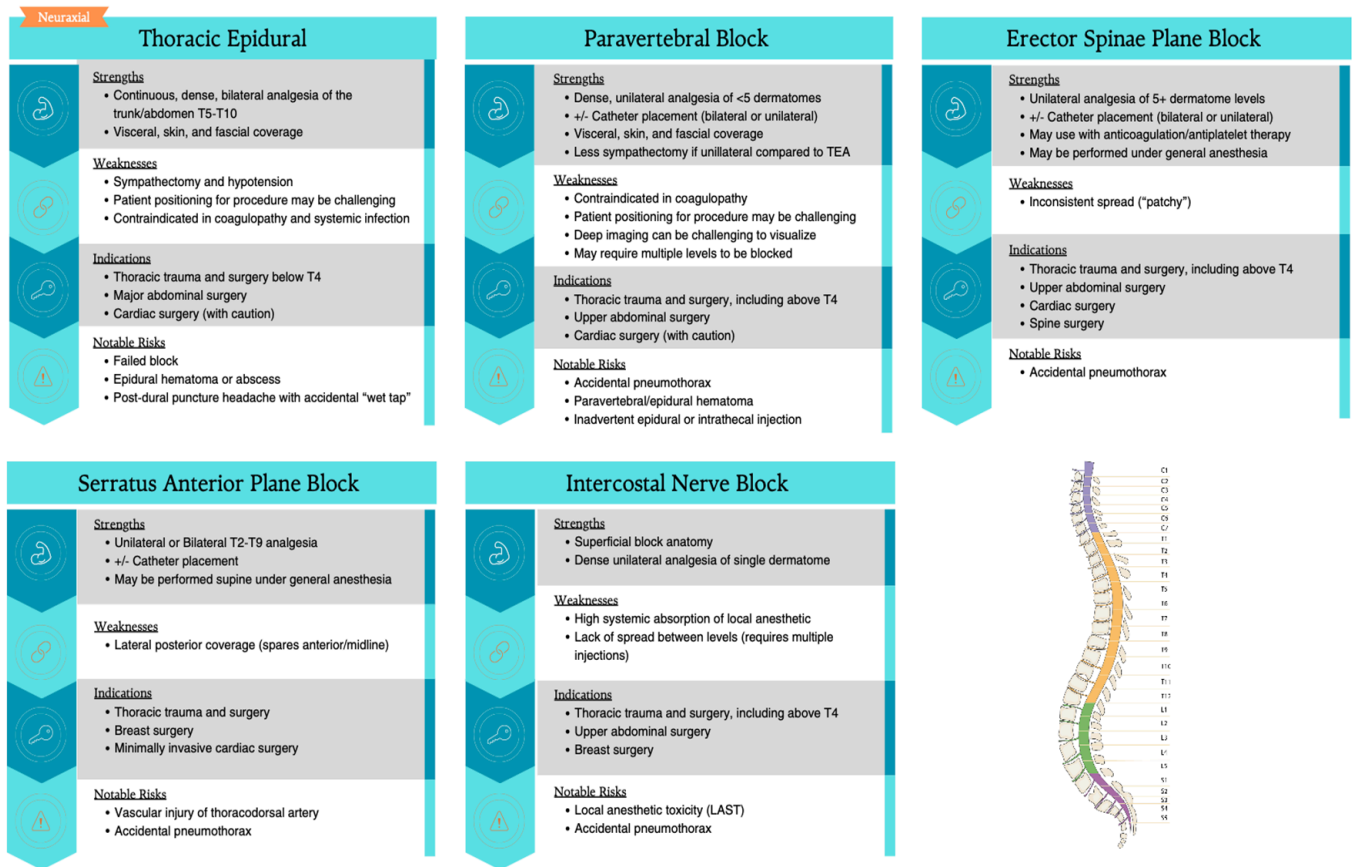


Figure 1. Thoracic regional techniques

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block. However, newer fascial plane blocks, such as the suprainguinal fascia iliaca and the pericapsular nerve group (PENG), allow multiple nerves to be targeted in a single injection. A multisite RCT found femoral nerve blockade followed by continuous fascia iliaca blocks to provide superior pain scores and walking distances compared to standard systemic therapy in hip fractures (51). Fascia iliaca blockade has been observed to be safe and reliable by a systematic review of 27 RCTs (52). Studies ranging from case series to RCTs support the role of PENG blocks in this fragile patient population (53,54) which may be superior to femoral and fascia iliaca blocks (55,56). There is also evidence of benefit when PENG and fascia iliaca blocks are combined (57). Additional blocks with potential efficacy in this patient population include lumbar quadratus lumborum (QL) and ESP blocks (58).

Other types of extremity fractures warrant different regional techniques. Numerous studies demonstrate a reduction in opioid consumption and improved pain scores when regional anesthesia is utilized for extremity fractures (59-61). For clavicle fractures, superficial or intermediate

cervical plexus blocks combined with interscalene blockade is a classic combination for both medial and lateral coverage (62). For upper extremity fractures, brachial plexus blocks may be considered, including interscalene, supraclavicular, infraclavicular, costoclavicular, and axillary approaches, as well as individual axillary or suprascapular nerve blocks (63-65). For lower extremity fractures, clinicians can consider femoral, LFCN, adductor canal saphenous, and nerve to the vastus medialis blockade, obturator, genicular, iPACK, parasacral, subgluteal, or popliteal sciatic nerve, and ankle blocks (66-68). The choice of nerve block technique depends largely on the location of trauma, the need for analgesia alone, or the need for surgical-level anesthesia. A summary of regional techniques for upper and lower extremities may be found in Figure 2 and Figure 3, respectively.

When caring for patients with traumatic extremity injuries, the potential for compartment syndrome must be considered. The most common injuries associated with compartment syndrome in descending order are tibial shaft fractures, soft tissue injuries, and distal radius fractures (69). Controversy exists between anesthesiologists and

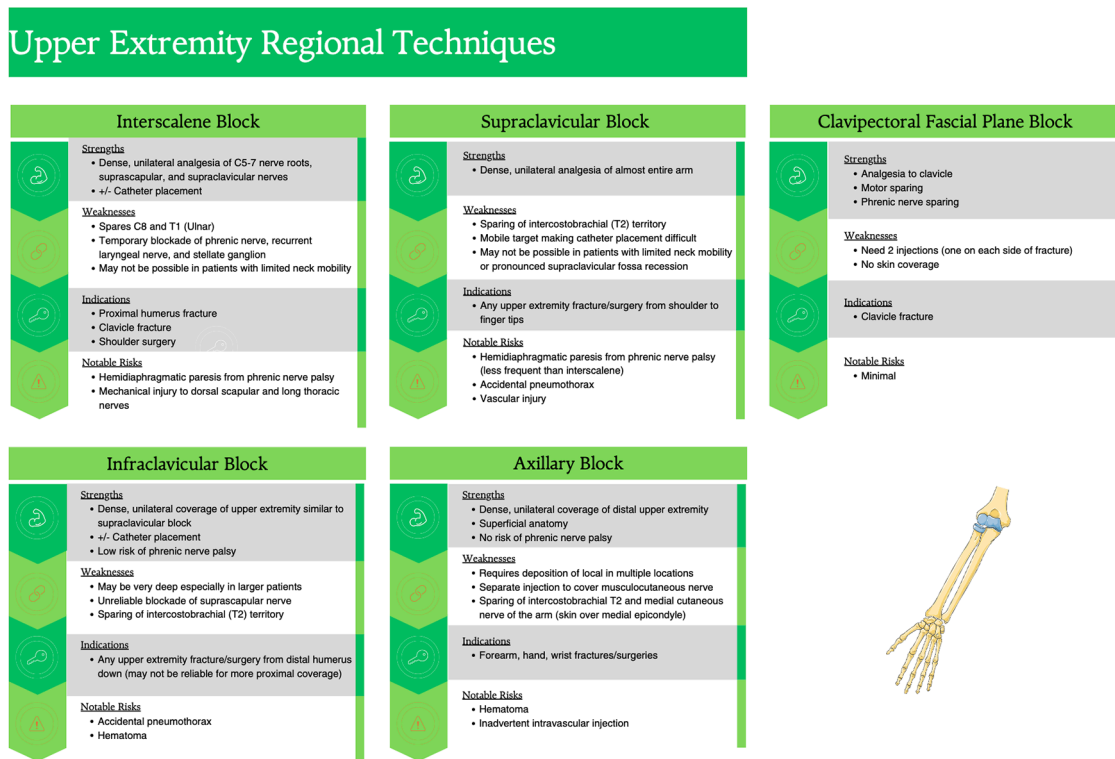


Figure 2. Upper extremity regional techniques
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surgeons regarding the potential for regional techniques to delay the diagnosis of this rare but devastating complication by masking one of the earliest clinical signs of compartment syndrome: pain. Unfortunately, the current literature on this subject is not robust and primarily comprises case reports and series. In the last 10 years, there have been two systematic reviews on the subject. Driscoll et al. (70) found that 75% of 34 case reports published since 2009 did not show an increased risk for delayed diagnosis of compartment syndrome following regional anesthesia in orthopedic procedures. Tran et al. (71) found only 6 case reports, 2 of which demonstrated delayed diagnosis of compartment syndrome in the setting of peripheral nerve blockade for long bone fractures. A retrospective study by Cunningham et al. (60) found regional techniques reduced opioid use without incidence of compartment syndrome in tibial plateau fracture. Also notable is a study by Chen et al. (72) in healthy volunteers, which showed regional blocks did decrease ischemic pain but to variable extents, suggesting that regional techniques can be titrated to balance analgesic benefits with the risk of delaying diagnosis. Given the paucity of literature, it is challenging to determine the best analgesic path for patients at risk for compartment syndrome. The European Society of Regional Anaesthesia and Pain Therapy (ESRA) and the American Society of Regional Anesthesia

and Pain Medicine (ASRA) 2015 joint committee provided evidence-based advice for pediatric patients focusing on low-dose local anesthetics and infusion rates as well as close monitoring when regional anesthesia is used in high-risk patients (73). Unfortunately, no such recommendations exist in adult populations.

Not all traumatic limb injuries result in fractures. Traumatic amputations have increased globally in recent years (74). Adequate pain control in the setting of amputation is critical due to the risk of phantom limb pain, which is estimated to affect 64% of patients (75) and is thought to be caused by cortical reorganization (76). Regional analgesia may play a fundamental role in mitigating the risk of this debilitating chronic condition (77). A multicentered RCT found that continuous nerve catheters doubled the chance of clinically significant improvement of phantom limb pain (78). However, more studies are needed to elucidate the role of regional anesthesia in this population fully.

Thoracic Surgery

There are many studies on regional anesthesia in thoracic surgery. This review will focus on thoracotomies and esophagectomies to reflect the patient population of the ICU. Thoracic surgery is unique in that pulmonary rather than cardiovascular complications account for most morbidity and

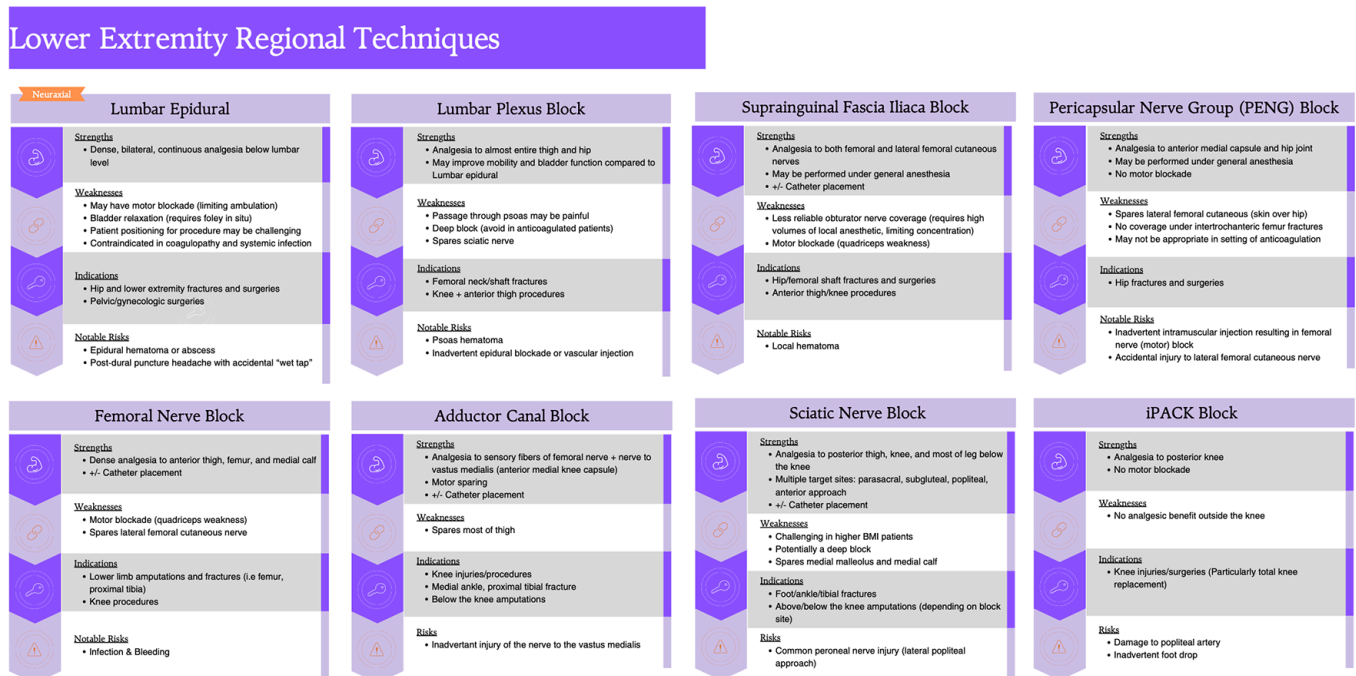


Figure 3. Lower extremity regional techniques

mortality (79). A 2017 meta-analysis showed no differences in postoperative pulmonary complications (PPCs) or pain scores between systemic and epidural analgesia or systemic and paravertebral analgesia after esophagectomy. Still, the interpretation is limited by their inclusion of studies that were not high-level RCTs (80). A more stringent 2020 meta-analysis of 2494 patients found low-quality evidence that epidurals reduce the risk of PPCs in patients undergoing major abdominal and thoracic surgery (81). Most recently, a 2024 meta-analysis found a similar reduction of PPCs and better pain reduction associated with epidurals after esophagectomy (82). Other systematic reviews have shown regional techniques can reduce persistent postoperative pain (83) and reduce opioid consumption (84) after thoracic surgeries.

Numerous systematic reviews demonstrate equal analgesic efficacy of paravertebral blocks to epidurals with a lower risk of complications (85-87). Another meta-analysis found TPVBs were superior to ESP for postoperative analgesia after thoracic surgery (88). Even so, two meta-analyses found postoperative pain control benefits from ESP blocks (89,90). Recent systematic reviews have also shown intercostal blocks to be non-inferior to TPVBs and TEAs (91) and found SAPs to provide effective analgesia in the thoracic surgical population (92-94). Generally, the same variety of regional techniques may be employed for thoracic surgery as for thoracic trauma (as listed in Figure 1), and it is up to the clinician to determine which technique is best on a case-by-case basis.

Patients receiving lung transplants make up a notable population of thoracic surgical patients. TEA is the touchstone for analgesia after lung transplant surgery, though few studies are available in this population. Preoperative TEA is associated with better pain control, lower opioid use, and shorter duration of mechanical ventilation and ICU stay (95). However, TEA must be used cautiously in this population, which may require anticoagulation for extracorporeal membrane oxygenation in the perioperative period (96). Two small studies have also found paravertebral catheters effective (97,98).

Major Abdominal and Vascular Surgery

TEA is the gold standard for postoperative pain relief after major abdominal surgery (99-101). The 2024 ACC/AHA guidelines recommend thoracic epidurals for major abdominal surgery based on moderate evidence supporting a decreased risk of major adverse cardiovascular events (48).

In open abdominal aortic aneurysm repairs, combined TEA and general anesthesia are associated with reduced mortality, myocardial ischemia, postoperative bowel ischemia, and pulmonary complications (102). The use of TEA in thoraco-abdominal aortic aneurysm repair is associated with better postoperative pain control and lower in-hospital length of stay (103). A Cochrane review of 15 RCTs showed that postoperative epidural analgesia led to better pain management in the first 3 days by Visual Analog Scale scores, earlier tracheal extubation, and lower incidence of myocardial ischemia in this same population (104). However, it is prudent to consider that these studies included primarily trials conducted before 2000, before the availability of endovascular techniques. The impact of TEA on mortality and pulmonary and cardiac complications was not supported by a recent retrospective review of 2,145 patients who underwent aortic aneurysm repair between 2014 and 2016 and found that epidurals were correlated with higher transfusion requirements (105).

TEA is associated with failure rates as high as 32% (106) and hypotension (107). Additionally, an indwelling catheter is undesirable in a coagulopathic or septic patient, both of which are occasional complications after extensive abdominal surgery. Thus, other effective regional techniques may be considered for major abdominal and vascular surgeries, including paravertebral (108,109) and erector spinae catheters (110). Paravertebral catheters are likely to be most effective in the case of abdominal aortic aneurysm repair via retroperitoneal approach and have reduced risk of hypotension (108). Fascial plane blocks offer alternatives to TEA. While evidence for fascial plane blocks in the ICU population specifically is lacking, these blocks have been studied extensively in major abdominal surgery, specifically-transversus abdominis plane (TAP), erector spinae plane (ESP), QL, and rectus sheath blocks. Of these, ESP and QL blocks can provide some visceral analgesia due to the spread of local anesthetic to the paravertebral space, but this effect is inconsistent (111). Compared to TEA, studies on fascial plane blocks have demonstrated mixed results. While some studies found TAP blocks to be non-inferior to TEA, others show TEA patients to have lower opioid requirements and pain scores postoperatively (101,112). Nevertheless, there is consistent evidence that fascial plane blocks effectively decrease the need for postoperative opioids and lower pain scores in comparison to placebo (101,111,112). The choice between blocks depends on the surgery and placement of

incisions and drains. For example, while rectus sheath blocks are effective for midline incisions, TAP and QL blocks work well for lateral and transverse incisions. A description of abdominal wall regional techniques may be found in Figure 4.

Liver transplant surgery should be considered separately regarding candidacy for regional techniques. Liver transplant recipients have less postoperative pain compared to other major abdominal surgeries, potentially due to denervation of the donor liver, reduced abdominal distention after

drainage of ascites, and increased plasma levels of endogenous neuropeptides (113). Even so, liver transplant patients do experience significant postoperative pain and should be provided adequate analgesia. Coagulopathy and thrombocytopenia, often present in these patients, are a contraindication to epidural placement. Additionally, a recent retrospective study of 685 liver transplant patients found preoperative TEA to provide minimal differences in pain scores (Numerical Rating score of 1.4 vs 1.8) compared to

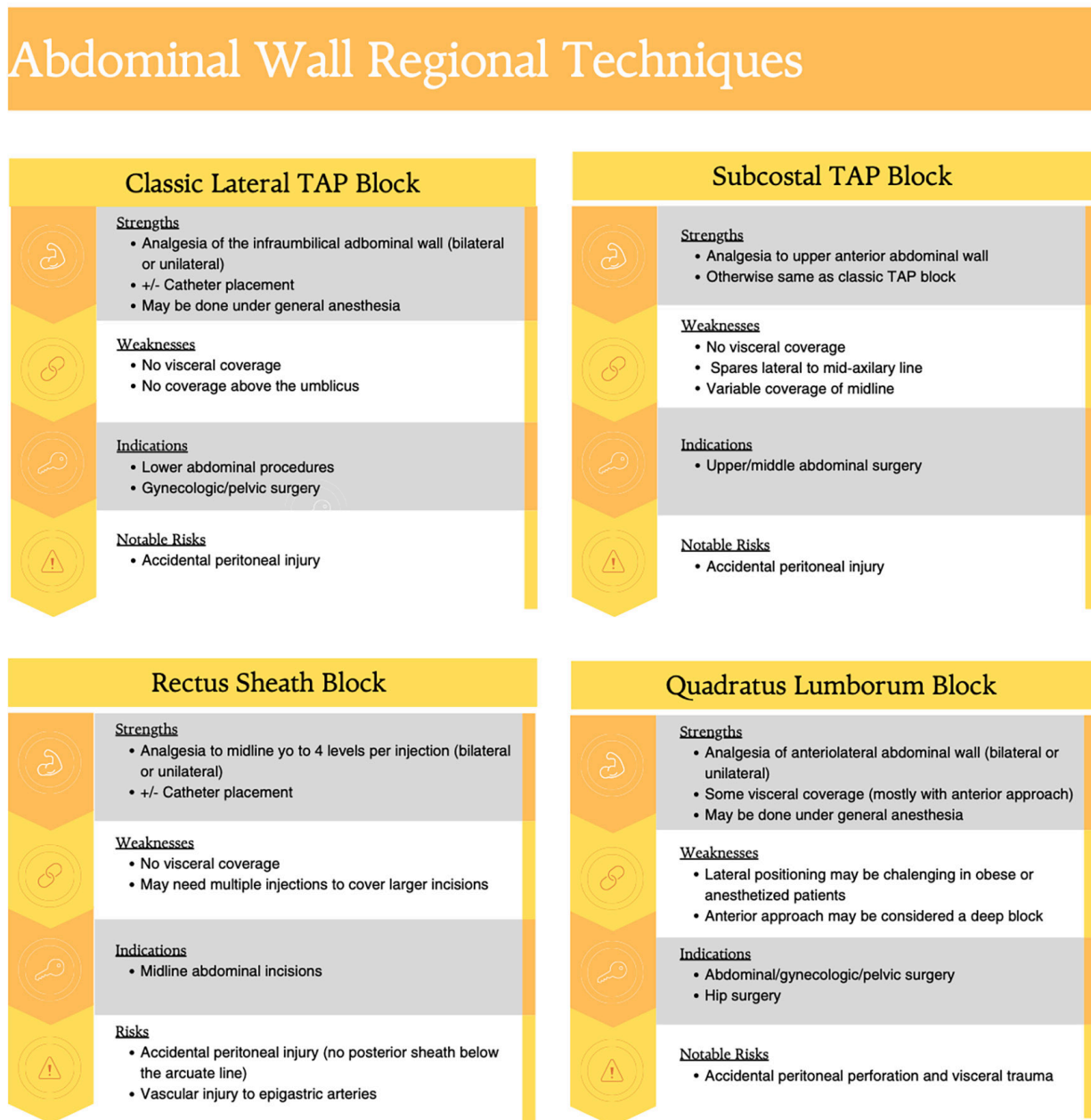


Figure 4. Abdominal wall regional techniques

patients without TEA (114). However, TEA is an effective mode of pain relief after open liver resection, including for donor liver resection, and has been shown to decrease opioid consumption in the postoperative period (115). Paravertebral catheters and single-shot blocks have also been effective, though pain control is inferior to TEA (115,116). TAP catheters and blocks are also an effective modality but have not been compared head to head with TEAs or PVBs (115,116).

Cardiac Surgery

We will briefly mention the utility of regional analgesia in cardiovascular surgical patients as they tend to present to subspecialty ICUs. Patients undergoing open heart surgery frequently require anticoagulation for cardiopulmonary bypass, which makes the use of TEA controversial. A Cochrane review concluded that TEA reduced pain scores by 1 point on a scale of 0 to 10, decreased the length of mechanical ventilation by 2.4 hours, and decreased the rate of myocardial infarction, atrial fibrillation, and respiratory depression at 30 days post-cardiac surgery (117). However, the evidence in this study was of low quality overall, and there was insufficient data to comment on the incidence of epidural hematoma. Based on mathematical modeling, the incidence of spinal injury from epidural hematoma is estimated between 1:150,000 and 1:1,500 for epidurals in conventional cardiac surgery (118). Of note, the 2018 ASRA guidelines state that there is insufficient evidence for an increased risk of epidural hematoma in the setting of cardiopulmonary bypass (119). Meanwhile, paravertebral blocks have been used increasingly for cardiac surgery, particularly in minimally invasive procedures performed via lateral thoracotomy (120). Paravertebral catheters placed perioperatively decrease intraoperative opioid use, reduce nausea and vomiting, and shorten the length of mechanical ventilation with minimal hypotension (121,122). In this patient population, it is essential to remember that paravertebral blocks are still considered a deep block, which puts them at higher risk in the setting of anticoagulation.

Limitations in Clinical Practice

Sedation

The prevalence of sedation among ICU patients presents a challenge to the performance of regional techniques. Light to moderate sedation, which maintains meaningful contact with the patient, is generally beneficial by providing anxiolysis and increasing patient tolerance of regional nerve blockade (123). However, controversy exists regarding the

safety of performing regional blocks on patients under deep sedation or general anesthesia, which obliterates feedback from the patient regarding periprocedural paresthesias and signs or symptoms of local anesthetic toxicity. Many assert that it is necessary for patients to be awake and cooperative enough to communicate when there is pain or paresthesia during a nerve block to protect against neural injury. This concern mainly applies to blocks targeted directly at a nerve versus fascial plane techniques, which are considered safe even under general anesthesia due to the lower risk of nerve damage (124). Indeed, ASRA recommends against regional techniques in heavily sedated or anesthetized patients unless the benefit clearly outweighs the risk (125). Even so, there is little evidence that pain or paresthesia predicts neural injury (126). In fact, regional techniques are routinely used safely in anesthetized pediatric patients. A study by the Pediatric Regional Anesthesia Network of over 100,000 blocks found no incidence of permanent neurologic deficits (127). A prospective study in sedated and mechanically ventilated trauma patients concluded that continuous regional anesthesia seems safe in the setting of heavy sedation—although with 76 patients analyzed, it was underpowered to see significant differences in outcomes (128). As such, the decision to perform regional techniques in heavily sedated patients in the ICU should be considered on a case-by-case basis with careful assessment of the risk-to-benefit ratio. Of note, the 2018 Pain, Agitation/Sedation, Delirium, Immobility, and Sleep Panel within the Society of Critical Care Medicine Congress strengthened their recommendation of light versus deep sedation in the management of critically ill patients, therefore in many cases this obstacle to providing regional anesthesia may lessen (129).

Sepsis and Infection

ICU patients frequently have pre-existing or nosocomial infections (130). Puncture site infection is an absolute contraindication to any regional technique. Systemic infection is often considered a relative contraindication to regional anesthesia due to concerns about seeding infection into fascial planes, nerves, or the neuraxial space, especially in the setting of indwelling catheters. A recent systematic review across various patient populations found that the incidence of infectious complications for central neuraxial blockade was 9/100,000 and 1.8% in peripheral nerve catheters (131). Recent studies show a low incidence of central nervous system infection after neuraxial techniques in patients at risk for or with active bacteremia in the acute

perioperative period (132). However, ICU admission is a risk factor for infection of peripheral nerve catheters (133), especially if they are in situ for over 48 hours (134). Factors that may reduce the risk of infection include prophylactic antibiotics (135) and tunneling of catheters (136). The risk of infection must be weighed against the benefits of regional techniques. Any indwelling catheters should be removed as early as is reasonable to minimize colonization while preserving maximal analgesic benefit.

Coagulopathies

Many patients in the ICU experience coagulopathies of various etiologies due to sepsis or trauma (137,138). Additionally, the use of anticoagulants and antiplatelet medication is expanding. Thus, clinicians must weigh the risks of regional anesthesia in patients susceptible to bleeding. ESRA and ASRA have guidelines for time intervals after cessation of antiplatelet and anticoagulant therapies before performing regional and neuraxial techniques (119,139). Bleeding complications following peripheral nerve blocks in patients on antiplatelet and anticoagulant medications are rare, estimated to be less than 1% (140). When weighing the risks for hematoma in coagulopathic patients, it is crucial to consider the depth and compressibility of the site for each regional technique. Neuraxial techniques have the highest relative risk followed in descending order of risk by deep blocks such as deep lumbar plexus, proximal sciatic, and infraclavicular blocks, in addition to perivascular blocks such as femoral or axillary blocks, then fascial plane blocks (141). Although controversial, many practitioners feel perineural catheters have a higher risk for bleeding, given they require a larger, blunt tip needle for placement, and there is an additional risk with catheter removal or dislodgement (142).

Hemodynamic Instability

Hemodynamic instability is a common concern in the critically ill, estimated to affect 19% of patients in the ICU (143). The cardiovascular stability of a patient must be considered in the context of regional analgesic techniques. Specifically, neuraxial techniques, such as epidurals and spinals, are associated with hypotension and bradycardia in the setting of sympathetic blockade (144,145). As such, neuraxial analgesia may be best avoided in patients already

at significant risk for hemodynamic compromise or already on vasopressor support. Consideration of shifting from a local anesthetic epidural infusion to solely an opioid infusion, such as fentanyl, may decrease hypotension (146,147). Even single-sided TVPB may decrease the total local anesthetic spread to the spinal sympathetic chain, lessening the risk of hypotension (85,87,108,148). On the other hand, peripheral nerve blockade may be beneficial in tenuous patients by avoiding the use of sedation medications, which can also compromise cardiovascular stability (149). For example, superficial cervical plexus blockade can facilitate awake central line cannulation (150) and intercostal block may be used for chest tube placement (151).

Conclusion

For patients in the ICU, pain is a prominent concern often associated with long-term consequences. Regional techniques offer targeted analgesia, generally without systemic side effects. From rib fractures and limb fractures to major surgeries, there is a clear benefit to regional analgesia among critically ill patients. However, current literature is insufficient to determine the best technique for optimal pain control in every case. As such, each patient should be evaluated carefully to determine their candidacy for regional analgesia versus systemic pain management alone. Hemodynamic status, infection, level of sedation, and site of surgery or injury are all factors to consider when choosing the best regional modality for each patient.

Ethics

Footnotes

Authorship Contributions

Concept: M.A.B., K.M.J., Design: M.A.B., K.M.J., Analysis or Interpretation: L.H., M.A.B., K.M.J., Literature Search: L.H., M.A.B., K.M.J., Writing: L.H., M.A.B., K.M.J.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

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