



Role of regional analgesic techniques in ICU

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ABSTRACT

Pain is a major problem in patients admitted in the Intensive Care Units (ICU). Untreated pain has significant impact on the outcome of these patients, especially surgical patients. There is enough evidence in the literature which has demonstrated that inadequately treated pain in ICU leads to prolonged ventilation, longer ICU stay, morbidity and other issues like development of post-traumatic stress disorder (PTSD) and chronic post-surgical pain (CPSP). Regional anesthesia and analgesia (RA) techniques like epidural analgesia, paravertebral blocks, and other peripheral nerve blocks (PNB) play a great role in providing significant pain relief, thus, limiting the use of opioids. They facilitate in earlier weaning from ventilation, reducing respiratory morbidity, and faster rehabilitation. These RA techniques are most useful in polytrauma patients, major thoracoabdominal and orthopedic surgeries, as many of them require post-surgical ICU care. However, these RA techniques are underutilised in many ICUs. Many a times, ICU physicians are not well versed with these RA techniques, and sometimes have fixed misconceptions with regards to these blocks. In this review, we will discuss on the need of these RA techniques and make a quick presentation on the technical aspect of frequently used blocks. The review will only focus on Ultrasound-guided regional analgesia (USRA) techniques as USG is commonly available in ICUs.

Key words: Analgesia, Regional; Anesthetics, Local/therapeutic use; Critical Care; Intensive Care Units; Ketamine/therapeutic use; Lignocaine/therapeutic use; Pain Management; Pain, Postoperative/therapy; Anesthetics, Local; Dexmedetomidine

Abbreviations: PTSD (Post-traumatic stress disorder), CPSP (Chronic post-surgical pain), RA (Regional anesthesia and analgesia), USRA Ultrasound-guided regional analgesia), PNB (Peripheral nerve block), IFPB (Interfascial plane blocks), ASRA (American Society of Regional Anesthesia and Pain Medicine)

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INTRODUCTION

Pain is a very common problem in patients admitted to ICU. It has been found that as many as 50-70% patients admitted to the ICU suffer from moderate to severe intensity pain.¹⁻⁵ This is despite recent advances in technology like USG, newer drugs, varieties of opioids, and better understanding of pain pathophysiology. In a study of traumatic critically ill

patients admitted to ICU, 74% of patients reported their pain as moderate or severe. Interestingly, 95% physicians and 81% nurses felt that the patients' analgesic regimen has been adequate.⁶ This clearly demonstrates that pain is highly neglected in ICU patients.

In the ICU setting, the source of pain can be from multiple sources. In trauma patients, it can be from

rib fractures, to major axial skeleton or long bone fractures. Similarly, in post-surgical ICU patients (major orthopedic, thoracoabdominal, vascular or spine surgery), the pain from surgical site is moderate to severe in intensity. Apart from that, many patients have chest drains, multiple catheters, need frequent physiotherapy and position change adds up to the existing pain. It is imperative to provide effective pain relief which not only reduces pain intensity but also facilitates earlier recovery and rehabilitation. Adequate pain relief in trauma patients with multiple rib fractures helps in early weaning from ventilation, maintenance of effective oxygenation, rehabilitation and shorter ICU stay. There is accumulating evidence to suggest that development of chronic pain can be prevented if acute pain is managed effectively.⁵⁻⁷

Pain management in postoperative patient as well as ICU setting should always be multimodal as it helps in reduction of opioid use, lesser opioid related side effects, and better analgesia. High dose and long-term opioid use can lead to nausea, vomiting, respiratory depression, urinary retention, tolerance, dependence, ileus, delirium and difficulty in assessing neurological function because of sedation. Hence, an appropriately used regional anesthesia and analgesia (RA) technique reduces most of the opioid related side effects to a great extent. RA techniques range from commonly used epidural analgesia (for thoraco-abdominal surgery or trauma, pelvic or major limb reconstructive surgery), paravertebral blocks, intercostal blocks, to recent interfascial plane blocks (IFPB) for chest or abdomen, and extremity nerve or plexus blocks. With growing popularity and wide availability of USG in ICU, many of these peripheral nerve blocks (PNB) can be performed safely and accurately for many patients. In this review, we'll discuss on these PNBs, and briefly describe USG guided technique to help clinicians utilize RA technique for the larger benefit of patients.

UNIQUE PROBLEMS IN ICU AND IMPLICATIONS FOR RA

1. The Problem of Chronic Post-ICU Pain:

Majority of ICU patients experience pain during their hospital stay. Some of them unfortunately end up with persistent post-ICU pain. A recent trial found that the 6 months post-ICU chronic pain prevalence rate was 33% out of 202 surgical and medical ICU patients.⁸ Studies have found that a great majority of post-surgical patients (10-50%) develop CPSP.⁹ There are patient and procedure-specific risk factors for development of CPSP. All cardiac, aortic, major orthopedic, thoracotomy, and major abdominal

surgeries require post-operative ICU stay and are individualized risk factors for development of CPSP.⁹⁻¹¹ Younger age, female sex, patient's genetic endogenous analgesic system, preoperative and postoperative pain intensity, level of opioid exposure in pre-surgery period and untreated severe pain in post-operative period are all recognized as risk factors.¹⁰⁻¹² Out of all the modifiable risk factors, perioperative RA improve patient's status and outcomes.^{5,13,14} The mechanism for development of CPSP in ICU is because of peripheral and central sensitization that can occur after persistent acute pain or input of triggering factors.

2. Coagulopathy and Anticoagulation:

Coagulopathy is a big hurdle for performing RA procedures in ICU patients, especially epidural analgesia or deep peripheral nerve blocks or catheters. Many patients in ICU receive anticoagulation to reduce the possibility of deep vein thrombosis. Moreover, some patients develop bleeding diathesis during the course of their treatment in ICU. Thrombocytopenia or other clotting disorders are not uncommon in ICU patients. However, same principle applies for epidurals or PNBs as that of a surgical patient on anticoagulant. Recently, American Society of Regional Anesthesia and Pain Medicine (ASRA) published its 4th guidelines on anticoagulant and regional anesthesia management, and readers are requested to read and adhere to the guidelines for patient safety.¹⁵ At the end, benefit-risk-ratio should be taken into consideration and an individualized approach should be followed.

3. Infection:

Presence of serious infection also poses a problem for safe performance of RA technique. However, this holds true if there is significant systemic infection or infection at the site of injection. Neuraxial blocks are relatively contraindicated in patients with systemic infection. However, single shot PNB is not an issue if there is no infection at the injection site. But, sterile precautions should be followed while performing single shot or continuous PNBs.

4. Hemodynamic Instability:

In hemodynamically unstable patients, neuraxial blocks are contraindicated as it causes further sympatholysis and can increase the dose of vasopressors and inotropes. However, a PNB can be offered to such patients because once analgesia is provided, patient will not need other drugs like narcotics which can further cause hemodynamic compromise.

5. Heavy Sedation or use of Neuro-muscular Blocking Agents (NMBA)

Often patients in ICU are on sedatives or may be paralysed with NMBA when getting ventilated. Performing RA techniques in them is a very controversial topic itself. Neuraxial techniques like epidurals, especially thoracic epidurals should be done by experts as patient will not provide any feedback in case of trauma of spinal cord with inadvertent puncture. However, PNBs using ultrasound can be performed safely in trained hands. Needle tip should always be visualized, and appropriate volume and concentration of LA should be used. A heavily sedated patient cannot give consent for a regional anesthesia procedure. In such situations, family members should be explained the pros and cons and the procedure could still be performed once consent is available.

6. Multiorgan dysfunction

Multiorgan dysfunction leads to coagulopathy, renal insufficiency/ failure, hepatic dysfunction, altered mentation, thus limiting use of many systemic analgesics. This can make decision making complicated. Therefore, the decision has to be taken based on the severity of each organ and plan has to be made to make the patient pain free. In fact, RA techniques can be a boon in these patients. However, the dose, concentration, and volume of the LA should be taken into consideration as they get metabolized or excreted through liver or kidney.

COMMON RELEVANT RA TECHNIQUE UNDER USG IN ICU

1. Thoracic Paravertebral Block (TPVB):

Indications: Rib fractures, Thoracotomy, major thoracic and cardiac surgical patients

Thoracic epidural analgesia (TEA) is considered gold-standard to provide analgesia following multiple rib fracture, chest wall trauma, and major thoracic surgery. However, hypotension, leading to hemodynamic instability, urinary retention, and technical challenge to perform at mid-thoracic level are the limitations. But, they have been found to prevent and reduce the incidence of CPSP following major open lung surgery.¹⁴ Hence, TPVB is an alternative to TEA, and has been found to provide similar analgesia.

Technique: A linear array high frequency US probe is used for the TPVB. In ICU patients, this could be performed in lateral decubitus position. The desired spinous process should be identified counting down

from C7. A point can be marked with a marker pen at 2.5-3 cm from the spinous process. Perform a scout scan with the probe in sagittal (craniocaudal) orientation 2-3 cm from midline and identify TP, pleura and superior costotransverse ligament (SCTL) just above the pleura. TP and ribs are visualized as hyperechoic structures with acoustic shadowing below them (Figure 1). A Tuohy's needle or a block needle is inserted in-plane from cranial to caudal direction or vice versa. The needle can be inserted in out-of-plane as well. The needle should be seen throughout the procedure as pleural puncture and pneumothorax is a known complication of this procedure. In cases where the structures are not identifiable easily, it is suggested not to perform this block. Once SCTL is entered, LA (usually 20 ml for a single level injection) can be injected.

Another approach, is transverse scan to identify the apex of thoracic paravertebral space (TPVS). With this approach, spinous process is identified in the midline, and as the probe is moved laterally, lamina with erector spinae muscle on the top and then transverse process is identified. Further moving the probe in cephalo-caudad direction, the space below the rib and internal intercostal membrane (IIM) along with moving pleura is identified (Figure 2). The block needle is inserted in-plane from lateral to medial and IIM is punctured to deliver LA in the apex of TPVS. In both the approaches, deepening of pleura is observed and that is considered as the tell-tale sign of successful blockade.

2. Erector Spinae Plane (ESP) block:

Indications: Rib fractures, chest wall trauma, and post-thoracotomy pain.

ESP block is a recently described IFPB technique and the first literature was for thoracic neuropathic pain.¹⁶ In recent times, this simple block has become very popular and has been used for many conditions, including thoracic pain, thoracic trauma, rib fracture, thoracic or abdominal surgical patients either by single shot block or continuous technique.¹⁷⁻¹⁹ However, majority are case reports/ series. We have to wait for formal randomized trials to find out the benefits when compared with standard techniques like TEA or TPVB. But, it is quite promising from the initial cadaveric studies showing dye spread up to somatic nerves or even sympathetic chain and intercostal space.²⁰

Technique: Appropriate thoracic spinous process is identified by counting from C7 spinous process which is easily palpable. Injection is usually performed at T3-T5 level, but, it can be done even



Figure 1: TPVB Sagittal

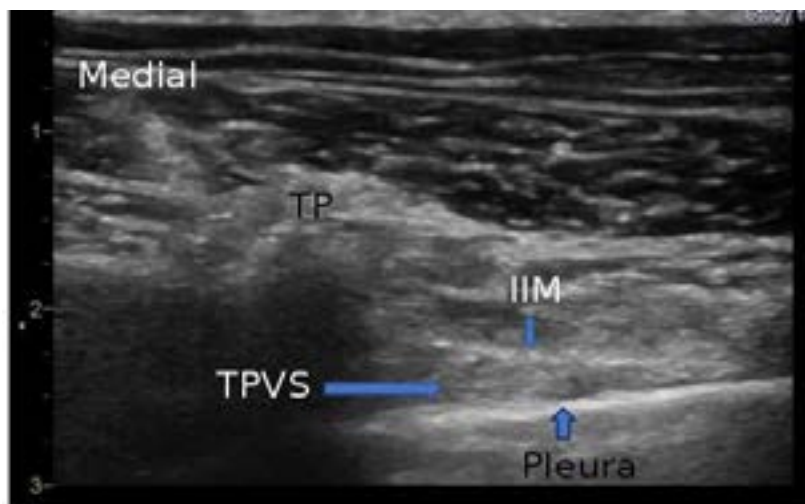


Figure 2: TPVB Transverse



Figure 3: ESP

at mid-to-lower thoracic levels. Spinous process can be identified and marked as well. A linear high frequency probe is usually used for an ESP block which should be placed in cranio-caudal orientation in midline at the spinous process level and then moved laterally to identify transverse process (TP). TP is approximately at 2.5-3 cm distance from spinous process. Erector spinae muscle (ESM), rhomboidus major and trapezius muscle should be identified from deep to superficial when the block is done at T3-5 level (Figure 3). Under aseptic technique and after skin infiltration with 2% lidocaine, a 18G Tuohy needle or block needle is introduced in-plane craniocaudally to contact with TP. Hydrodissection with NS should be done to confirm separation of ESM from TP. Once confirmed, 20 ml LA can be injected in aliquots of 5 ml. Once the drug is injected, an epidural catheter can be threaded and secured in ESP plane for continuous block.

3. Intercostal Block (ICB):

Indications: Rib fractures, post-thoracotomy pain.

Technique: USG guidance helps in accurate deposition of LA in the right place and decreases the chance of intravascular injection, and pneumothorax. With USG, the block can be performed before the division of the lateral branch which is essential for blocking an entire intercostal dermatome. To begin with, the individual ribs needs to be identified and marked as done with the landmark technique. In a sagittal plane, the USG probe is placed about 6-7 cm lateral to the spinous process at the level of angle of rib before branching of thoracoabdominal nerve. The ribs are identified as a round shaped superficial hyperechoic structure with acoustic shadow and shimmering pleura further

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down. In between two ribs, the layers of intercostal muscles (from superficial to deep: external intercostal, internal intercostal and innermost intercostal when scanned at the angle of the rib) are identified (Figure 4). The needle can then be inserted in or out of a plane until the tip is just below the inferior border of the rib between internal and innermost intercostal muscle. In-plane approach is preferred, and the needle tip should always be under vision to avoid inadvertent vascular or pleural puncture. Though, the intercostal vessels and nerves are classically described to have a subcostal location, there is anatomical variation, and the nerve can be well below the subcostal groove.²¹ Colour doppler should be employed to identify these vessels and needle insertion should be done accordingly. After negative aspiration, 2-4 mL of LA is injected which will push the pleura away. Unlike TPVB, or ESP block, ICB has to be done at multiple levels depending on the dermatome, myotome that needs to be covered.

4. Serratus Anterior Plane (SAP) block:

Indications: Fracture ribs, ICD pain.

Technique: SAP block is performed by abducting the patients arm and the USG probe is placed at around 5th rib in coronal plane.²²⁻²⁴ The belly of latissimus dorsi (LD) is visualised followed by a muscle over the ribs which is serratus anterior muscle(SAM). Thoracodorsal artery can sometimes be identified in the fascial plane between LD and SAM. There are two approaches for the SAP- superficial and deep SAP block. In the superficial SAP, the LA is injected in this fascial plane between LD and SAM, whereas, in deep SAP, the LA is deposited



Figure 4: Intercostal Block

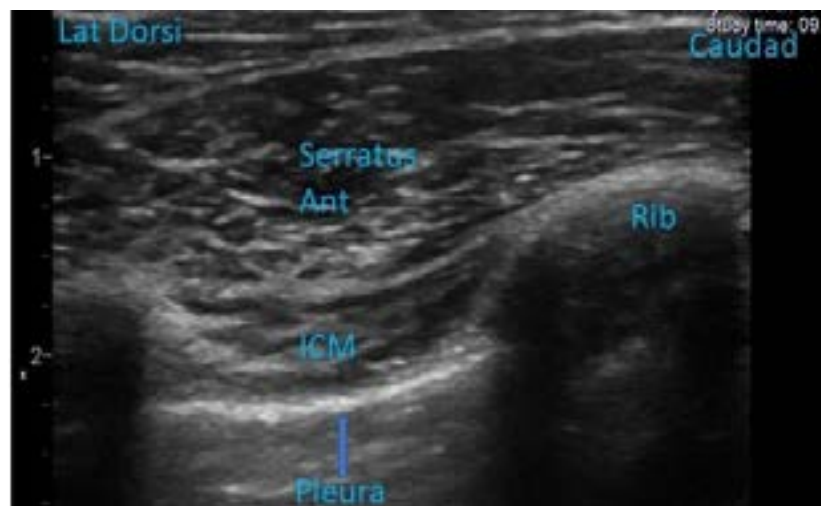


Figure 5: SAP Block

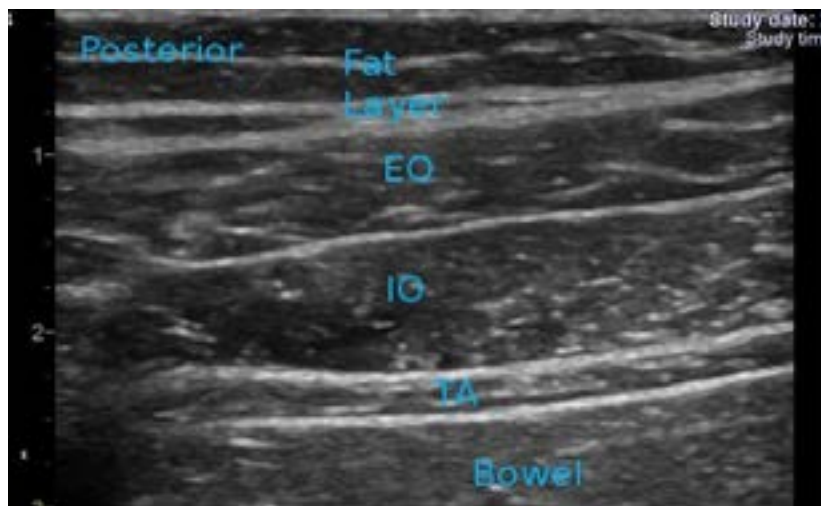


Figure 6: TAP Block



Figure 7: Femoral Nerve Block



Figure 8: suprainguinal long FICB

under the SAM. The sonoanatomy shows hyperechoic ribs, SAM on the top and pleura further down (Figure 5).

5. TAP block:

Indications: Fracture ribs, Laparotomies, Hernia repairs, Laparoscopic abdominal procedures, Obstetric surgery

Technique: For posterior TAP block, a high frequency linear probe or curvilinear probe in obese patients is placed at the midpoint of subcostal margin and iliac crest in mid-axillary line. The probe is moved to visualise 3 abdominal muscles: external oblique (EOM), internal oblique (IOM) and transversus abdominis (TAM) from superficial to deep (Figure 6). With an in-plane approach, a block needle is inserted from antero-medial to posterolateral side till it reaches the fascial plane between IOM and TAM.²⁵⁻²⁷ After hydrodissection with saline to confirm the correct needle tip position, local anesthetic is injected after negative aspiration of blood. For a subcostal TAP block, the US probe is placed along the subcostal margin to identify rectus abdominis muscle (RAM).²⁶ The probe is then moved laterally to identify TAM below RAM. The LA is injected in the fascial plane between these 2 muscles with the needle entering in-plane from medial to lateral side. Usually 15-20 ml of long acting LA is injected for analgesia. In recent times, many systematic reviews and meta-analysis on TAP block has been published and interested readers can be requested to read those papers.²⁷⁻²⁹

6. Femoral Nerve Block:

Indications: fracture shaft femur, injuries at anterior aspect of thigh and knee

Technique: A linear array high frequency probe is placed transversely in groin just below the inguinal ligament and femoral vessels are identified. Femoral nerve is lateral to the vessels and deep to fascia iliaca (FI). It appears as a hyperechoic, oval or triangular structure (Figure 7). Usually 15-20 ml LA can be deposited around the nerve after negative aspiration. This is a simple and basic level block.³⁰ The needle is usually inserted in-plane from lateral to medial. This block provides analgesia to anterior and medial aspect of thigh up to knee including hip fractures.

7, Fascia Iliaca Compartment Block (FICB):

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Indications: Injuries to anterior thigh/ knee/ hip, and simple and complex hip fracture

Technique: This is a compartment block targeting all 3 nerves of the lumbar plexus, namely femoral (FN), obturator (ON) and lateral femoral cutaneous nerve (LFCN) of thigh just below the FI. Earlier description was the standard technique of doing it below the inguinal ligament in a transverse axis scanning approach. However, in recent times, the longitudinal supra-inguinal approach has been described in the literature which provides better analgesia for hip fracture or even hip arthroplasty patients.³¹ Below, we have described both the approaches.

Classic approach: A linear array high frequency probe is placed transversely close to the femoral crease and then moved lateral to femoral artery. FI is identified above the oval or triangular shaped FN. More laterally, triangular shaped Sartorius muscle is identified on top. In a lateral to medial orientation, the needle is inserted in-plane to enter the plane between FI and iliopsoas muscle and deposit 30-40 ml LA which tends to spread cranially to cover the branches of the lumbar plexus. However, the blockade of ON, and LFCN is inconsistent and variable in this approach.

Supra-inguinal Longitudinal FICB: In this approach, high frequency linear probe is placed over anterior superior iliac spine (ASIS) in a longitudinal manner (Figure 8). Then the probe is moved medially till the typical “bow-tie pattern” is appreciated in the ultrasound. The iliacus muscle, with FI covering it is appreciated, and subsequently internal oblique and sartorius muscle as cephalad and caudad to the FI respectively. This forms a classic bow-tie appearance (Figure

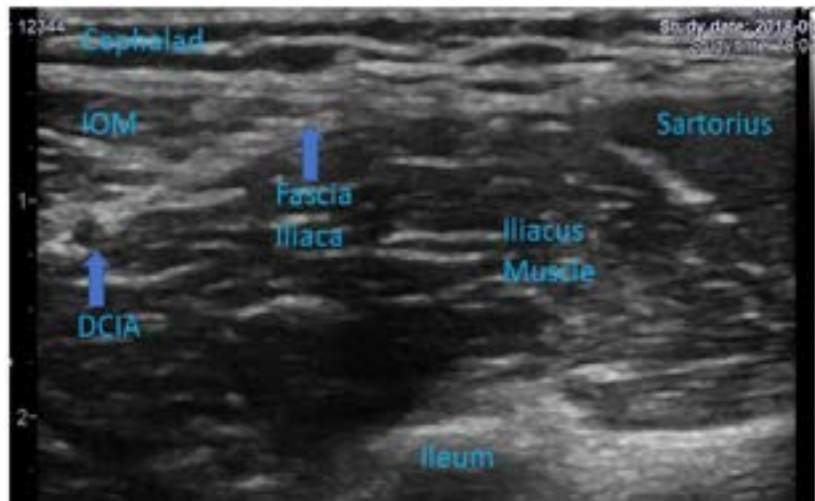


Figure 9: Suprainguinal FICB



Figure 10: FICB with LA just below FI

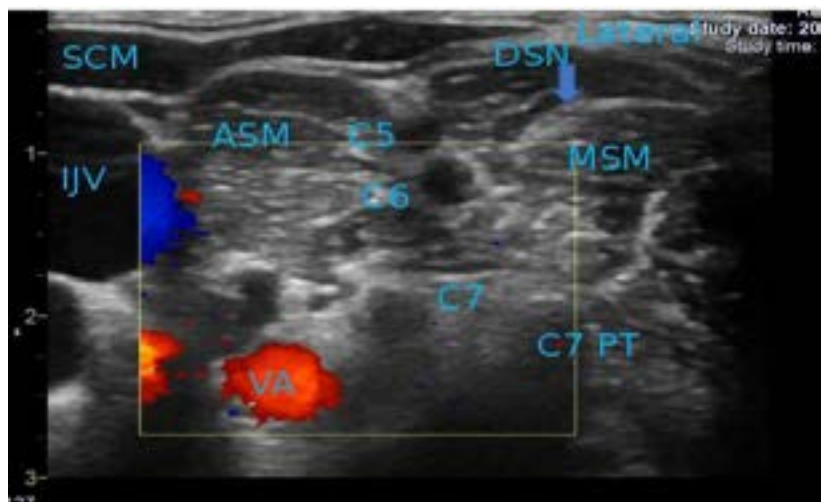


Figure 11: ISB



Figure 12: Supraclavicular BP

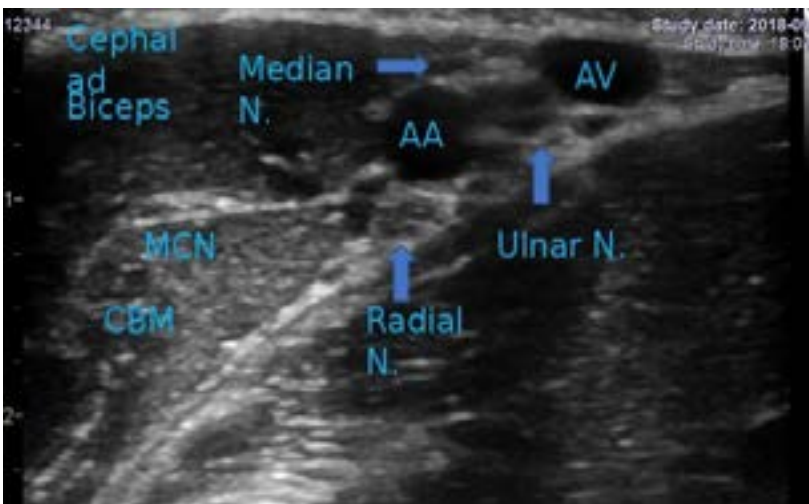


Figure 13: Axillary block

9). Another sonographic finding is deep circumflex iliac artery (DCIA) lying just above the FI. The needle is inserted from caudad to cephalad to deposit the LA below FI in its supra-inguinal part (Figure 10). Similarly, around 40 ml of LA is deposited where LA is expected to spread proximally to block all 3 branches of lumbar plexus. While inserting the needle, care has to be taken to make sure that over zealous proximal insertion is avoided as bowel can be found further proximally beyond IOM.

Desmet et al. found sensory blockade in FN, ON, LFCN territory after 1 hour following surgery in 93%, 76%, and 95% patients respectively in the above described approach.³¹ Similarly, they found motor blockade in FN, and ON in 88% and 86% respectively. This appears better and promising than previously described classical approach.

8. Brachial plexus block (BPB):

Indications: Trauma to upper limb, burns of upper limb.

Technique: Various approaches to BPB has been described, viz: interscalene (ISB), supraclavicular (SCB), infraclavicular (IC) and axillary approaches which blocks the plexus at the level of roots/trunk, trunks/division, cords and individual nerves respectively.

Interscalene Block (ISB): A high frequency linear probe is used and placed transversely over neck. The scanning can start beginning from above clavicle by identifying subclavian artery (SCA) or from midline at cricoid level. After identifying SCA, the probe is moved cranially to identify anterior scalene muscle (ASM) medially and middle scalene muscle (MSM) laterally. Similarly, from cricoid level, the probe is moved laterally, and the same muscles can be easily identified.

The roots of C5,6 and C7 can be identified sandwiched between these muscles arranged in what is described as a traffic light (Figure 11). The needle is inserted in-plane from lateral to medial targeting the area just next to brachial plexus, which is popularly known as peri-plexus

approach.^{32, 33} Care should be taken avoid injuring other small nerves like dorsal scapular and long thoracic nerve passing through MSM.³⁴

Supraclavicular (SCB): In supraclavicular approach, the trunks and/or divisions can be identified as a characteristic bunch of grapes appearance anterolateral to SCA (Figure 12). The block needle is inserted in-plane from lateral to medial targeting corner pocket first for lower trunk and then needle is redirected to finish the block.³⁵

The cords of brachial plexus can be blocked by IC approach which is by placing the transducer medial to coracoid process just below the clavicle with the arm abducted and face turned to other side. The axillary vessels are identified. The cords: lateral, medial

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and posterior are identified here in same relation to the axillary artery and LA is injected after negative aspiration of blood.

Axillary block: With the extremity in the same position as described for ICB, the probe is positioned in short axis orientation and axillary artery is identified.³⁶ The median, radial and ulnar nerves are identified as hypoechoic round-to-oval structures at 11-12 o'clock, 5-6 o'clock, and 1-2 o'clock to axillary artery respectively (Figure 13). A separate injection is required around musculocutaneous nerve which is a bright, hyperechoic flat structure located between coracobrachialis and biceps muscle.

CONCLUSION

Providing pain relief to patients admitted in ICU is of paramount importance. RA techniques when utilized in ICU patients reduce surgical and trauma stress

response. It facilitates faster weaning from ventilation and reduces morbidity. RA techniques are under-utilised for managing pain in ICU setting because of poor training and perceived myths about risks among ICU physicians. Pain relief makes patients' more comfortable, reduces use of opioids and other drugs which can have negative impact on other organs. Once adequate analgesia is provided using RA techniques, the patient can sleep well, perform chest physiotherapy and incentive spirometry adequately, thus can recover faster. With the increasing use of US in performing PNB, the blocks have not only become safer but have become very effective with lesser volume of drug. Anesthesiologist ICU physicians should take the lead and make these RA techniques popular and better utilized in ICU setting.

Conflict of interest: Nil

Authors' contribution: All authors took equal part in preparation of this manuscript

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