Review Article

Fascial plane blocks in pediatric anesthesia: A narrative review

ABSTRACT

Regional anesthesia techniques have become a cornerstone of pain management in the adult population, providing adequate analgesia while minimizing systemic side effects. Despite the numerous benefits demonstrated in pediatric studies, the implementation of regional anesthesia in children remains insufficiently adopted in clinical settings. One primary concern preventing broader application is the potential for complications of these techniques in pediatric patients, which understandably raises apprehension among clinicians. However, the introduction of fascial plane blocks in the literature has led to a significant advancement in this field. These regional anesthesia techniques are increasingly being incorporated into routine clinical practice, as they are relatively easy to learn and apply and safe techniques. Fascial plane blocks provide adequate pain management while minimizing opioid consumption, which not only helps reduce the risk of opioid-related side effects but also contributes to a more comfortable perioperative and postoperative experience for young patients. These blocks can significantly enhance patient recovery and satisfaction by facilitating analgesia. This narrative review briefly summarizes different indications of fascial plane blocks and their effectiveness in managing pain among pediatric patients, illuminating critical points to consider when applying these techniques.

Key words: Fascial plane block, pediatric population, postoperative pain

Introduction

Despite numerous studies showing the advantages of pediatric regional anesthesia (RA) in clinical practice, the rate of practical implementation is still low.[1,2] Complications that may arise after regional anesthesia cause greater concern in pediatric patients, which hinders the use of pediatric RA techniques. However, with appropriate training and increased experience, these concerns can be managed.

Fascial plane blocks (FBPs) aim to broaden the application of RA by reducing the practitioner's learning curve, expanding their skills, and increasing patient access. This situation has led to an increase in interest in these blocks day by day. FPB applications in adult patients have begun to take their place in routine practice. It has also increased RA applications in the pediatric patient group.[3]

Traditional pediatric pain management relies heavily on opioid use. In this patient group, the use of RA techniques is an important option that improves postoperative pain management by reducing systemic opioid use and, in addition, supports faster postoperative recovery and improved awakening.[4] Reduced opioid use helps avoid the

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Nur N. Yucal[1], Can Aksu[2]

[1]Department of Anesthesiology and Reanimation, Başakşehir Çam and Sakura City Hospital, Istanbul, Türkiye, [2]Department of Anesthesiology and Reanimation, Kocaeli University, Faculty of Medicine, Kocaeli, Türkiye

Address for correspondence: Dr. Can Aksu, Department of Anesthesiology and Reanimation, Kocaeli University Hospital, Izmit, Kocaeli, Türkiye.
E-mail: dr.aksu@gmail.com

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adverse effects associated with these drugs, and it has been shown that a comfortable perioperative process, lower pain scores, and better postoperative analgesia are provided with the use of appropriate RA techniques.[5]

Furthermore, the comfortable analgesia achieved by RA provides more ideal psychological conditions for the child and the family.[4]

Ultrasound Guidance in Pediatric Regional Anesthesia

Pediatric RA is considered to be technically more challenging than in adults. However, in the pediatric population, interpretation of ultrasound images and visualization of the needles are easier.[4] The use of ultrasound has been shown to increase block success rates and reduce complication rates along with the number of needle passes.[6] Additionally, in the pediatric population, the use of ultrasound for peripheral nerve blocks compared to traditional methods has been shown to result in faster block onset and longer sensory blockade.[7] Moreover, visualizing the spread of local anesthetic (LA) under ultrasound guidance (USG) allows practitioners to reduce the required dose of LA for successful block application.[8]

Differences in Pediatric Patients-Related Age and Anatomy

The fascial plane can be defined as the layers between the muscle and connective tissue layers.[9] These fascial planes contain sensory nerves, and a successful block can be achieved by spreading the LA in these planes. It should be kept in mind that the dimensions of fascial planes may vary with age. The characteristics of fascial planes are critical factors influencing the effectiveness and safety of blocks in pediatric patients. When evaluating the pediatric patient group, it is necessary to evaluate the anatomical features of the fascial plane structures depending on age. For neonates, the connective tissue is known to be looser and more elastic, which can affect the spread of LA. These anatomical differences can pose challenges in applying regional techniques and necessitate patient-specific dose adjustments. Therefore, understanding anatomical features and planning the application accordingly is crucial for clinical success.[10] This narrative review aims to summarize fascial plane block techniques, their indications, areas of use in the literature, and points to consider.

Transversus Abdominis Plane Block

The transversus abdominis plane (TAP) block is a RA technique that was first used in abdominal surgeries. The TAP is the superficial fascial plane over the transversus abdominis muscle. Within the TAP, subcostal, intercostal, and L1 segmental nerves are present.[11] This technique was first described by Rafi in 2001.[12] When performed under USG, it has been reported to reduce opioid consumption and enhance postoperative comfort by providing somatic analgesia to the anterolateral abdominal wall.[13]

TAP block is used as an effective RA technique in postoperative pain management after abdominal surgeries in pediatric patients. In the randomized prospective study of Carney *et al*.[14] in 2010, when the effectiveness of TAP block was first evaluated in the pediatric population, it was found that morphine consumption and pain scores were significantly reduced within the first 48 hours in the TAP block group in pediatric patients undergoing appendectomy. Additionally, in 2017, Ahıskalıoğlu *et al*.[15] reported that TAP block applied in pediatric inguinal hernia surgery provides intraoperative and postoperative analgesia and reduces opioid use.

In a meta-analysis comparing TAP block with caudal anesthesia, Hafeman *et al*.[16] reported that TAP block provided longer-lasting analgesia than caudal block in lower abdominal surgery, and that there was less need for rescue analgesic in the first 24 hours in the TAP block group. The TAP block offers analgesia equivalent to central blocks like epidural and caudal blocks and is preferred due to its ease of application and lower complication risk when performed under USG.[17]

Studies in the literature show that TAP block is an effective method for postoperative pain management in the pediatric patient group and reduces opioid use.[17] In clinical practice, TAP block can be performed as a part of multimodal analgesia, considering the patient characteristics and surgical procedures.

Indications

It can be used as part of multimodal analgesia in lower abdominal surgeries in pediatric patients, such as appendectomy, inguinal hernia repair, and undescended testicle operations.[14,18,19]

Points to Consider

Although blocks in pediatric patients are performed under USG, the anatomical structure varies with age, posing a risk of iatrogenic injury.[20] TAP block requires high-volume injections, so attention should be paid to local anesthetic systemic toxicity (LAST).[21] Temporary femoral nerve paralysis may occur after a TAP block.[22]

Transversalis Fascia Plane Block

The transversalis fascia plane block (TFPB), first described by Hebbard, involves injecting a LA into the plane between the transversus abdominis fascia and transversalis fascia to block the proximal branches of T12 and L1.[23] The anterior and lateral branches of these nerves will be blocked, and T11 may also be blocked.

TAP block and TFPB are both techniques used to provide postoperative analgesia in abdominal surgeries. However, TFPB is thought to reach deeper fascial planes and block the ilioinguinal and iliohypogastric nerves.[23] In parallel, Chin *et al*.[24] showed that TFPB applied to patients who underwent iliac bone grafting reduced perioperative and postoperative opioid consumption and decreased pain scores, claiming that this effectiveness of TFPB was due to the blockage of ilioinguinal and iliohypogastric nerves.

Since TFPB targets the nerves between TAP and the lumbar plexus, the effectiveness of TFPB and quadratus lumborum block (QLB) for postoperative analgesia after developmental hip dysplasia in pediatrics has been compared, and it has been shown that TFPB can be used as a part of multimodal analgesia.[25]

Indications

In the pediatric patient group, it can be planned as a part of multimodal analgesia in anterior iliac bone graft harvesting, inguinal hernia repair, lower abdominal surgeries, and cecostomy operations.[24,26,27]

Points to Consider

In abdominal wall blocks, there is a risk of needle-related visceral organ injury, vascular injuries, and hematoma due to proximity to visceral organs. Systemic toxicity due to LA may occur.[28]

Serratus Anterior Plane Block

Serratus anterior plane (SAP) block was first defined for chest wall surgeries in 2013. There are two types of SAP blocks, depending on the needle tip position and the fascial plane, where local anesthetics are injected, deep and superficial. In superficial injections, the LA is administered between the latissimus dorsi and serratus anterior muscles, while in deep injections, it is administered into the fascial plane between the serratus anterior muscle and the ribs. It can be applied at the level determined between the 2nd and 7th ribs at the level of the anterior and posterior axillary line.[29] It provides analgesia between the T2–T9 dermatomes of the thorax by blocking the lateral branches of the intercostal nerves.

The analgesic efficacy of SAP block in pediatric patients has been investigated, especially in children undergoing thoracotomy. A randomized controlled study conducted in 2021 examined 70 pediatric patients between 6 months and 3 years who were scheduled for thoracotomy. In this study, a decrease in postoperative pain scores was detected in the intraoperative fentanyl group in patients who underwent SAP block.[30] In a meta-analysis of 418 pediatric patients evaluating SAP block efficacy in cardiovascular surgeries, it was reported that SAP block reduced postoperative opioid consumption within 24 hours compared to the control group.[31]

In the current literature, SAP block is shown to be a safe and effective method for postoperative pain management in thoracic and cardiovascular surgery in pediatric patients. It is preferred in clinical practice due to its ease of application and low complication risk with the use of ultrasound.

Deep SAP was used in the studies mentioned above regarding the application areas of SAP. This also reveals the ease of SAP application and the low risk of complications. We believe that deep SAP will increase its use in the clinic for postoperative analgesia with the ease of application with the use of USG, as well as providing effective analgesia in the pediatric patient group.[31]

Indications

In pediatric patient groups, the indications for SAP block continue to expand, including Nuss procedures, coarctation repair, and thoracoscopic surgeries.[32]

Points to Consider

Superficial injection technique may pose less risk of pneumothorax. As it is a fascial plane block, it may cause LAST due to using high volume. Care must be taken to avoid puncturing the thoracodorsal artery, a small artery visible during ultrasound imaging in between the serratus anterior and latissimus dorsi muscles.

Rectus Sheath Block

Rectus sheath block (RSB) is used for analgesic effect in umbilical and midline surgical incisions. The rectus abdominis muscle is an anterior abdominal wall muscle, which is divided

at the midline by the linea alba, and is surrounded by the rectus sheath.[33] RSB blocks the terminal branches of the 9th, 10th, and 11th intercostal nerves within the rectus sheath.

It was first used in umbilical hernia surgery without USG in the pediatric patient population.[34] In a case series of 22 pediatric patients, bilateral RSB was performed under USG and showed that no additional analgesic was required postoperatively.[35] It was stated that the increased use of USG, visualization of anatomical structures, and monitoring of drug distribution have resulted in the safer application of the block.[35]

In a study comparing RSB with caudal block and surgical site LA infiltration in 39 pediatric patients, intraoperative and postoperative analgesic use for all blocks was similar.[36] RSB is found to be particularly effective in umbilical and midline abdominal surgeries. Compared to caudal block and surgical site LA infiltration, the advantages of RSB are that it does not affect motor functions and reduces the dose of LA which lowers the risk of LAST.

RSB application with USG in clinical practice has increased recently because this relatively straightforward technique provides a low risk of complications and adequate analgesia.

Indications

Umbilical and epigastric hernia repair, pyloromyotomy, midline incisions, and laparoscopic surgeries are indications for use.[37-40]

Points to Consider

The block is performed by scanning anatomical structures with ultrasound to ensure optimal imaging. However, care must be taken to avoid the epigastric vessels located in the posterior rectus sheath, as intravascular injection or hematoma may occur.[41] In addition, care must be taken to avoid peritoneal puncture and injection.

Erector Spinae Plane Block

The erector spinae plane (ESP) block, first described by Forero in 2016,[42] is a RA technique used in postoperative pain management and chronic pain management in pediatric patients, especially in thoracic and abdominal surgeries.[43] This block is applied by injecting the LA into the interfascial plane between the erector spinae muscle (which includes the iliocostalis, longissimus, and spinal muscles) and the transverse processes of the spine.[44]

In studies on its efficacy in pediatric patient groups, it has been reported that the ESP block provides effective analgesia in various surgical procedures. In the current literature, the protocols and indications for the use of the ESP block vary.[45]

In 2021, a study involving 30 patients aged 1–12 years who underwent thoracotomy showed that the application of ESP block with 0.25% bupivacaine reduced postoperative pain scores and decreased the need for additional analgesics.[46] ESP block has been used as an alternative to thoracic epidural in cardiovascular surgeries because it is considered safe due to the injection made distant from important structures such as pleura and vessels.[47]

In the study of Aksu *et al*.[48] comparing ESP and QLB in 60 pediatric patients aged 1 to 7 years undergoing lower abdominal surgeries, both techniques were shown to provide similar postoperative analgesia. The choice of block was left to the clinician's preference. In another study on unilateral inguinal hernia repairs, ESP was compared to ilioinguinal/iliohypogastric block. ESP was found to be more effective, with lower postoperative pain scores and a longer duration before rescue analgesics were required.[49]

Studies have shown that ESP reduces intraoperative and postoperative opioid use.[50] In parallel with current findings, case studies and case series have reported the use of ESP block as part of multimodal analgesia in various types of surgeries, including thoracotomy, chest wall surgery, sternotomy, abdominal surgery, genital surgery, and hip joint surgery.[51-55]

Indications

The erector spinae muscle extends along the thoracolumbar spine, allowing for the craniocaudal spread of LA. This makes ESP block suitable for use in rib fractures, thoracic surgery, cardiac surgery, abdominal surgery, and upper and lower extremity surgeries as part of multimodal analgesia.[47-52]

Points to Consider

The use of ultrasound in the pediatric patient population, the relatively superficial injection site of the block, and its simplicity have made the ESP block an easily applicable and favorable regional technique in clinical practice. The ESP block is a superficial block away from critical structures such as the pleura and vessels, making it safe to use. In parallel with this, it has been reported that it can be used safely in patients with coagulopathy.[56]

As with any peripheral block, complications such as LAST, allergic reactions, or motor block are possible. As the pleura is visible in the ultrasound image, pneumothorax could be considered a potential complication. However, while advancing the needle to the injection site, which is distant from the visceral structures, it should be viewed and advanced directly toward the transverse process.

Quadratus Lumborum Block

QLB is a fascial plane block used among trunk blocks for somatic and visceral pain after abdominal surgery.[57] Described by Blanco in 2007, it involves injecting LA adjacent to the quadratus lumborum (QL) muscle to affect thoracolumbar nerves.[58]

The "Shamrock view" described for lumbar plexus blocks can be used for the block application.[59] Numerous studies have demonstrated the analgesic effect of QLB in adult patients. There are also many studies showing its use in pediatric patients for analgesia after surgeries for congenital hip dysplasia, lower abdominal surgeries, and renal surgeries.[25,60] Furthermore, compared to the TAP block in pediatric patients undergoing lower abdominal surgeries, the QLB group has been shown to have lower postoperative pain scores and require fewer rescue analgesics.[61]

Different approaches to QLB include lateral, posterior, and anterior techniques, depending on the injection site relative to the QL muscle:

Lateral QLB – LA is injected into the anterolateral aspect of the QL muscle;

Posterior QLB – LA is injected into the posterolateral aspect of the QL muscle;

Anterior QLB – LA is injected into the deep fascia between the QL and psoas muscles by passing the needle tip through the QL muscle; studies evaluating these approaches in pediatric patients have found varying levels of efficacy.[44]

Cadaveric studies have been conducted to evaluate the spread of LA for different types of QLB.[62,63] It was found that the transmuscular approach (anterior QLB) through the quadratus lumborum muscle resulted in the spread to the lumbar nerve roots. Although the spread of different types of QLBs varies, each has its own indications in clinical practice.

Dr. Hussein conducted[64] a study in 2018 that compared the analgesic effectiveness of two different approaches in the pediatric population. In this study, intramuscular QLB was defined, and the effectiveness of intramuscular QLB was found to be low. It was revealed that the transmuscular approach provided more effective analgesia, but in this study, side effects such as quadriceps muscle weakness were reported to be common in the transmuscular group. However, although this technique was defined for QLB, the suitability of intramuscular LA injection is controversial.

As it is a common approach to compare new techniques with a well-known standard technique, QLB was also compared with caudal block in a study conducted in 2023 with 40 patients aged 2–11 years. It was found that the time to the first analgesic requirement was longer in the QLB group, and postoperative pain scores were lower compared to the caudal block group.[65]

Indications

QLB can be effectively used in lower abdominal and pelvic surgeries, along with nephrological procedures, and laparoscopic surgeries.[66-69]

Points to Consider

In pediatric patients, the spread of LA may differ due to variations in muscle and fascia structures compared to adults. Care must be taken to avoid vascular structures near the QL muscle to prevent hematoma. Therefore, USG is essential for planning and performing the block. Appropriate dosing based on age and weight is critical to prevent LAST. Especially in anterior QLB, the lumbar plexus may be affected and may cause temporary muscle weakness.[70]

Conclusion

Fascial plane blocks play an important role in postoperative pain management in pediatric patients as part of multimodal analgesia. Studies in the literature have shown that fascial plane blocks are successful in achieving postoperative analgesia in different pediatric surgeries [Table 1]. Fascial plane blocks provide safe and effective analgesia by reducing systemic opioid use in the pediatric population while accelerating the postoperative recovery process and increasing patient and parent satisfaction.

USG increases block efficacy while minimizing complications. However, further researches are needed to evaluate the long-term efficacy, ideal dosing protocols, and potential side effects of pediatric fascial plane blocks.

Table 1: Fascial Plane Blocks, their indications, and local anesthetic injection sites

Block type	Indications	Local anesthetic Injection site
Transversus abdominis plane (TAP) block	- Lower abdominal surgeries (e.g., appendectomy, inguinal hernia repair) - Undescended testicle operations	Superficial fascial plane over the transversus abdominis muscle
Transversalis fascia plane block (TFPB)	- Anterior iliac bone graft harvesting - Inguinal hernia repair - Lower abdominal surgeries - Cecostomy	Between the transversus abdominis fascia and transversalis fascia
Serratus anterior plane (SAP) block	- Thoracic surgeries (e.g., thoracotomy, thoracoscopic procedures) - Cardiovascular surgeries - Nuss procedures	*Superficial*: Between latissimus dorsi and serratus anterior muscles *Deep*: Between serratus anterior muscle and ribs
Rectus sheath block (RSB)	- Umbilical hernia repair - Pyloromyotomy - Midline abdominal incisions - Laparoscopic surgeries	Within the rectus sheath, surrounding the rectus abdominis muscle
Erector spinae plane (ESP) block	- Rib fractures - Thoracic surgeries - Abdominal surgeries - Upper and lower extremity surgeries	Interfascial plane between the erector spinae muscle and transverse processes of the spine
Quadratus lumborum block (QLB)		
Lateral QLB	- Lower abdominal surgeries - Pelvic surgeries	Local anesthetic injected into the anterolateral aspect of the quadratus lumborum muscle
Posterior QLB	- Renal surgeries - Laparoscopic surgeries	Local anesthetic injected into the posterolateral aspect of the quadratus lumborum muscle
Anterior QLB	- Can be used for hip surgeries additionally	Local anesthetic injected into the deep fascia between the quadratus lumborum and psoas muscles

Based on clinical experience and the current literature, we believe that pediatric fascial plane block applications will continue to be a part of multimodal analgesia, improving the quality of postoperative recovery processes, and will become more widely used in pediatric patients.

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Conflicts of interest
There are no conflicts of interest.

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