Regional anesthesia in pediatric trauma

Svetlana Kotzeva

U.O.C. Anestesia e terapia del dolore acuto e procedurale

IRCCS Giannina Gaslini Genova

European Journal of Trauma and Emergency Surgery (2023) 49:451–459
https://doi.org/10.1007/s00068-022-02088-6

ORIGINAL ARTICLE

Epidemiology, patterns, and mechanisms of pediatric trauma: a review of 12,508 patients

Raffael Cintean[1] · Alexander Eickhoff[1] · Jasmin Zieger[1] · Florian Gebhard[1] · Konrad Schütze[1]

- ✓ **WHO: more than 830,000 under 18s are killed in accidents worldwide every year**
- ✓ **~100 children die worldwide every hour due to accidental injuries (90%are unintentional)**

Mechanism of injury	
Leisure activity	2862 (22.9%)
Sports-related activity	2664 (21.3%)
Falls	2411 (19.3%)
Blunt trauma	1908 (15.3%)
Road traffic accidents	1138 (9.1%)
Force/violence	591 (4.7%)
Cutting/stabbing	417 (3.3%)
Burns	76 (0.6%)
Misc./no documentation	441 (3.5%)

Anesthesia Management of Pediatric Victims After the February 6, 2023, Kahramanmaraş Earthquake at a Third-Level Hospital

Sengül Özmert[1] | Melike Demir Işıktekin[2] | Tuğba Nur Taygurt[1] | Sema Civelek[1] | Tuba Bayir[3] | Rabia Bayar[1] | Süleyman Arif Bostancı[4] | Niyazi Erdem Yaşar[5]

Pediatric Anesthesia, 2025; 35:969–976
https://doi.org/10.1111/pan.70039

quakes [11, 12]. In disaster settings, the preference for RA may be influenced by certain factors, including a shortage of experienced anesthesiologists, limited availability and variety of anesthetic agents, and a lack of technical equipment and materials

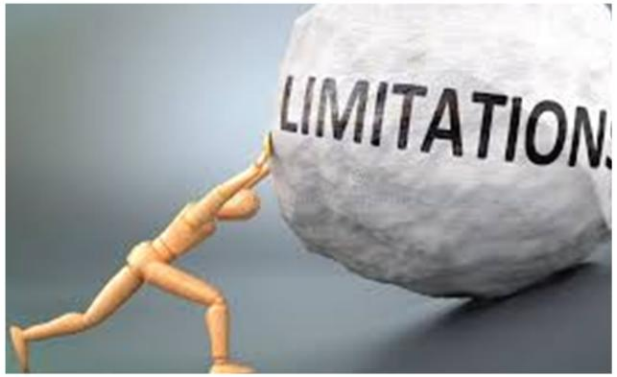
Trauma regions	
Extremity[a]	42 (70.0%)
Burn	8 (13.3%)
Thoracic	4 (6.7%)
Head	4 (6.7%)
Facial	1 (1.7%)
Abdominal	1 (1.7%)
Surgical procedures	
Dressing	250 (69.1%)
Debridement	35 (9.7%)
Fasciotomy	33 (9.1%)
Grafting	23 (6.3%)
Vacuum	13 (3.5%)
Amputation	4 (1.1%)
Stabilization	2 (0.6%)
Hemostasis	1 (0.3%)
Tracheostomy	1 (0.3%)
Anesthesia method	
Group S	123 (34.0%)
Group K	122 (33.7%)
Group I	104 (28.7%)
Group P	12 (3.3%)
Group LA	1 (0.3%)
Airway device	
Nasal kanül	159 (44.0%)
SGA	156 (43.2%)
ETT	40 (11.1%)
T	6 (1.7%)

Barriers for RA in trauma patients

- ✓**Competition with resuscitation** objectives has resulted in analgesia given **lower priority status** in acute management
- ✓ **Lack of appropriate equipment and training**, especially in emergency department and pre-hospital care
- ✓**Inconvenience of timing administration** of analgesia

Fleming I, Egeler C. Regional anaesthesia for trauma: an update. Contin EducmAnaesthesia, Crit Care Pain 2014; 14:136–141

Limitations of RA in pediatric trauma



- ✓Injuries mandating general anesthesia for definitive surgical treatment (e.g. neurosurgery)
- ✓Inability to position the patient for procedure
- ✓When consent cannot reliably be obtained
- ✓Polytrauma patients
- ✓ Standard contraindications (refusal, allergy to LA)

- ✓ ⬆**Reliability and safety of RA**, improvements in training and technology
- ✓ ⬆**Recognition of pain as a disease process**, leading to detrimental functional and psychological outcome if poorly managed
- ✓Short comings and **side-effects from administration of systemic analgesics**

Fleming I, Egeler C. Regional anaesthesia for trauma: an update. Contin Educ Anaesthesia, Crit Care Pain 2014; 14:136–141

Chest trauma

3 types of chest trauma

1 Cardiovascular

- Aortic rupture
- Cardiac tamponade
- Cardiac laceration
- Subclavian artery injury
- Intercostal artery injury

2 Visceral

- Pneumothorax
- Haemothorax
- Pulmonary contusion
- Ruptured diaphragm
- Oesophageal injury

3 Skeletal

- Rib fracture
- Flail chest
- Verbetral/spinal injury
- Clavicular fracture
- Scapular fracture

AJ Konnakottu, James Baker, Owen Hibberd 2025

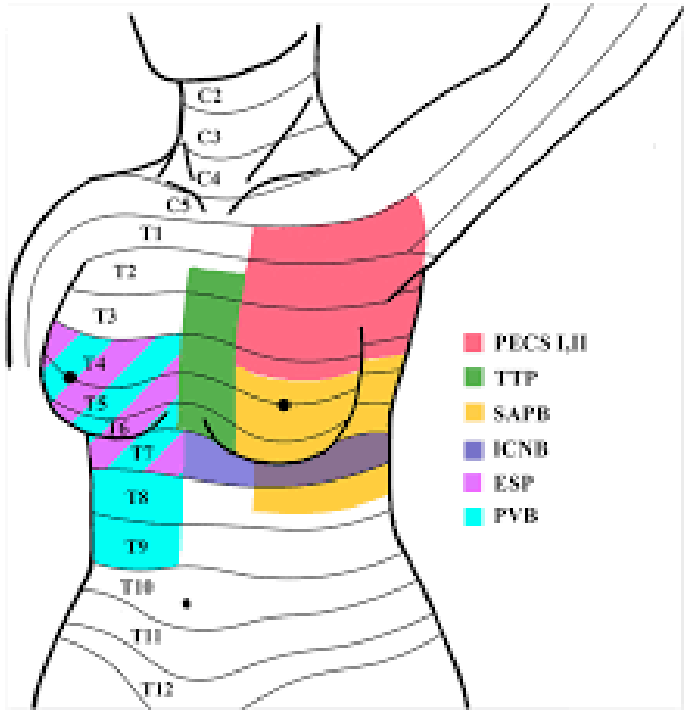


Table 3. Regional analgesia for rib fractures

Block	Indications	Benefits	Special Considerations in Acute Trauma
Thoracic Epidural (TEA)	• flail chest • >3 rib fractures • sternal fracture	• reliable coverage • musculofascial pain • visceral pain	• sympathectomy may cause hypotension • contraindicated in anticoagulated or coagulopathic patients • contraindicated in traumatic brain injury • relative contraindication if nearby spinal fractures
Paravertebral Block (PVB)	• unilateral rib fractures • or bilateral blocks for bilateral rib fractures	• lower risk of sympathectomy • lower risk of epidural hematoma	• relative contraindication in anticoagulated or coagulopathic patients • bilateral injuries can be addressed with bilateral blocks • possible neuraxial spread could cause sympathectomy • pneumothorax risk • possible less visceral coverage than TEA
Erector Spinae Plane Block (ESPB)	• posterior rib fractures • lateral rib fractures • potential coverage for anterior rib fractures with larger volume	• use in patients who are anticoagulated or coagulopathic	• coverage may vary • visceral pain not covered completely • subcutaneous emphysema, dressings can impede access
Serratus Anterior (SAPB)	• lateral and anterior rib fractures	• used in patients who are anticoagulated or coagulopathic • use to bridge until definitive blocks can be done	• coverage may vary • visceral pain not covered • subcutaneous emphysema, dressings, chest tubes can impede access
Intercostal	• single or multiple injections in the posterior component of the intercostal space	• short-term improvement of pain scores and respiratory mechanisms	• increased risk for local anesthetic toxicity from increased drug uptake • can be used to bridge to more definitive analgesia if needed in anticoagulated patients

Review

Use of fascial plane blocks for traumatic rib fractures: a scoping review

Ahtsham U Niazi [1], Max Solish,[1] Aneurin Moorthy [2,3,4], Faizan Niazi,[1] Antonio Hermes Abate,[3] Catherine Devion,[5] Stephen Choi [1]

- ✓65 studies
- ✓Are thoracic fascial plane blocks effective in reducing pain, opioid consumption, and respiratory complications in patients with multiple rib fractures?
- ✓Both ESP and SAPB appear to be safe and effective in the management of traumatic rib fractures, with no clinically significant difference in opioid consumption.
- ✓ESP is a viable alternative to both TEA and PVB and similar in efficacy to other fascial plane blocks.
- ✓ SAPB is safe and effective as part of a multimodal analgesic regime for MRFs

Niazi AU, et al. Reg Anesth Pain Med 2025;0:1–15. doi:10.1136/rapm-2024-106366

Abdominal trauma

- ✓The **challenge abdominal and truncal injuries** pose is they **require prioritization of resuscitation and control of bleeding** over pain management
- ✓There is **rarely an appropriate time** to place a neuraxial or regional block preoperatively in acute abdominal trauma cases
- ✓**Post operatively**, the use of TAPB , RSB, QLB can **be technically difficult due to tissue plane distortion, poor access** to optimal injection sites impeded by incisions, dressings, drains,and postoperative subcutaneous emphysema

Regional anesthesia and analgesia for trauma Torrie Curr Opp Anest Volume 35 Number 5 October 2022

Pediatric Anesthesia, 2025; 35:338–346
https://doi.org/10.1111/pan.15074

SYSTEMATIC REVIEW

Focused Review of Enhanced Recovery After Abdominal Trauma Surgery in the Pediatric Population and Development of a Pediatric Enhanced Recovery After Trauma Surgery Pathway

Robert P. Moore[1] | Niharika Singh[2] | Madelyn Wang[3] | Alexandra Tsivitis[1] | Catherine Devitt[3] | Zhaosheng Jin[1] | Ehab Al Bizri[1] | Sunitha M. Singh[1,4] | Helen Hsieh[2]

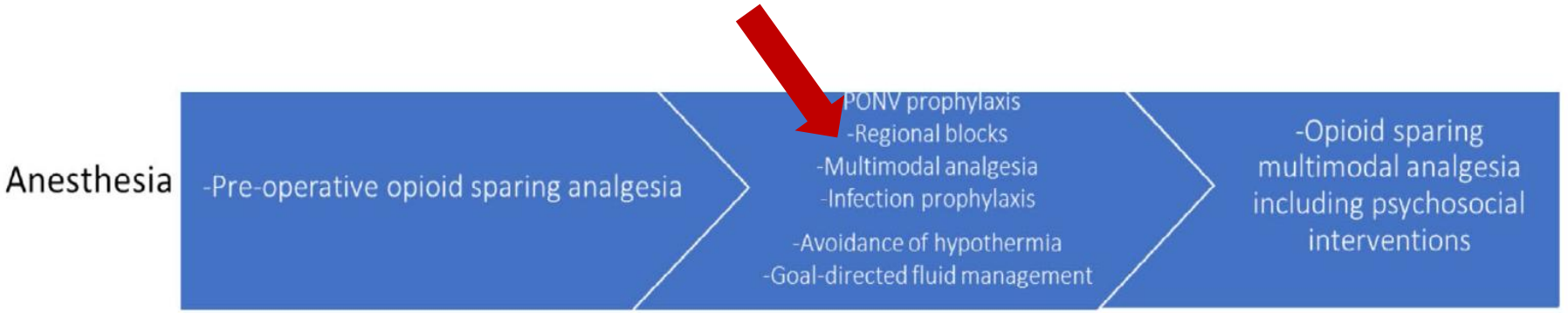
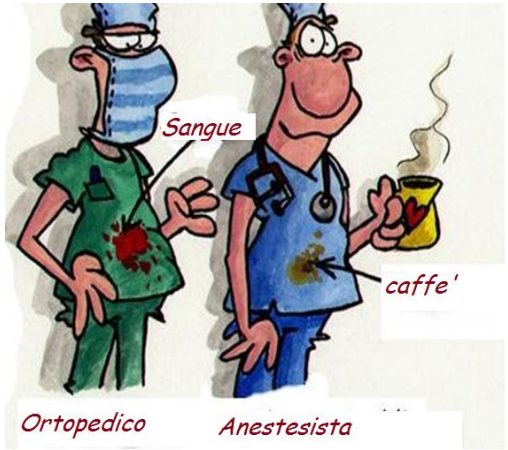


Figure 1: Enhanced Recovery After Trauma Surgery Pediatric Bundle

RA and Orthopedic trauma

- ✓RA tailor to the type of **injury and intervention**
- ✓Consider the **anatomy and innervation for the location of the trauma** as well as **surgical approach**
- ✓Variations in the operation and variances in postoperative risk concerns, warranting a **risk-benefit discussion** between the surgeon and anesthesiologist

Gadsden J, Warlick A. Regional anesthesia for the trauma patient: improving patient outcomes. Local Reg Anesth 2015; 8:45–55.



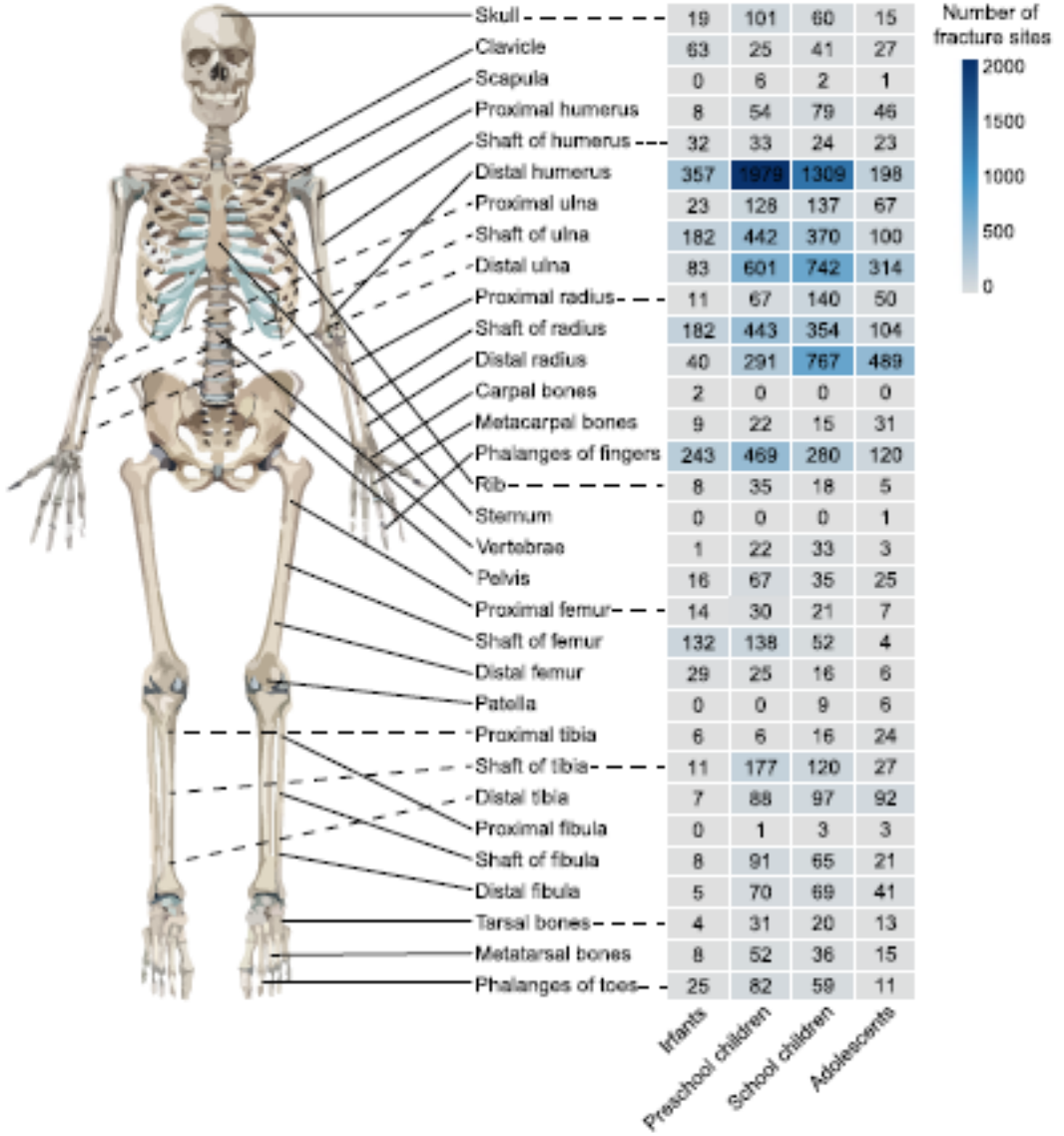
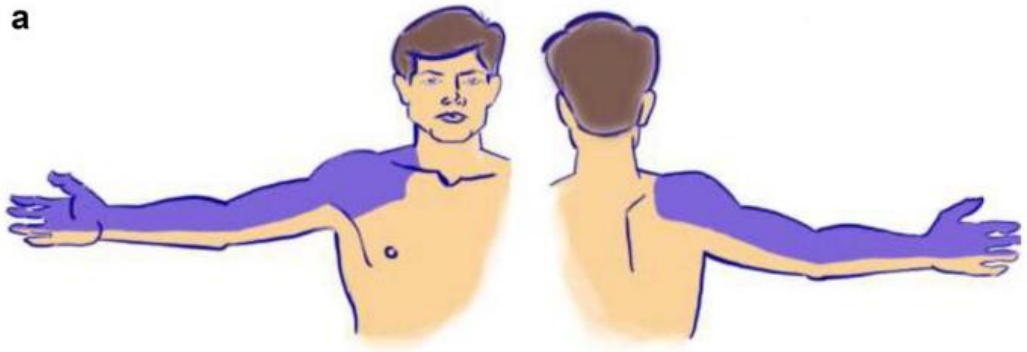


Fig. 2 The epidemiology of traumatic fractures in all age range groups. This picture shows the characteristics of common fracture sites in the infants group, preschool children group, school children group and adolescent group

Parameter	Patients
Non-surgical treatment	
Fracture site immobilization	232
External plaster fixation	1063
Open reduction subgroup	
Kirschner wire fixation	1141
Screw fixation	229
Intramedullary nailing	191
Wires nail	15
Steel plate fixation	15
Traction	13
External bracket fixation	3
Splint fixation	1
Closed reduction subgroup	
Kirschner wire fixation	5509
Intramedullary nailing	497
Traction	407
External plaster fixation	260
Screw fixation	128
External bracket fixation	9
Splint fixation	2
Open reduction subgroup	
Local anesthesia	68
General anesthesia	2027
Closed reduction subgroup	
Local anesthesia	437
General anesthesia	6659

Limb trauma

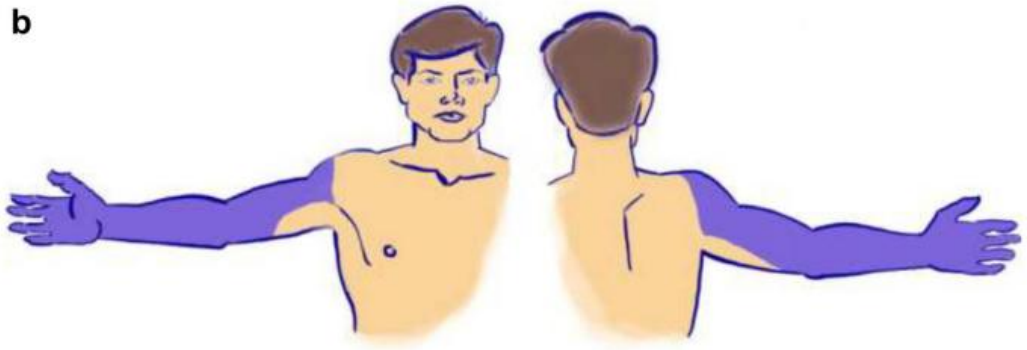
a



Notes

- Excellent coverage of the upper arm including shoulder. Comes at the expense of poor ulnar coverage, especially with catheter placement
- Risk of phrenic nerve block, causing shortness of breath
- Horner's syndrome is common

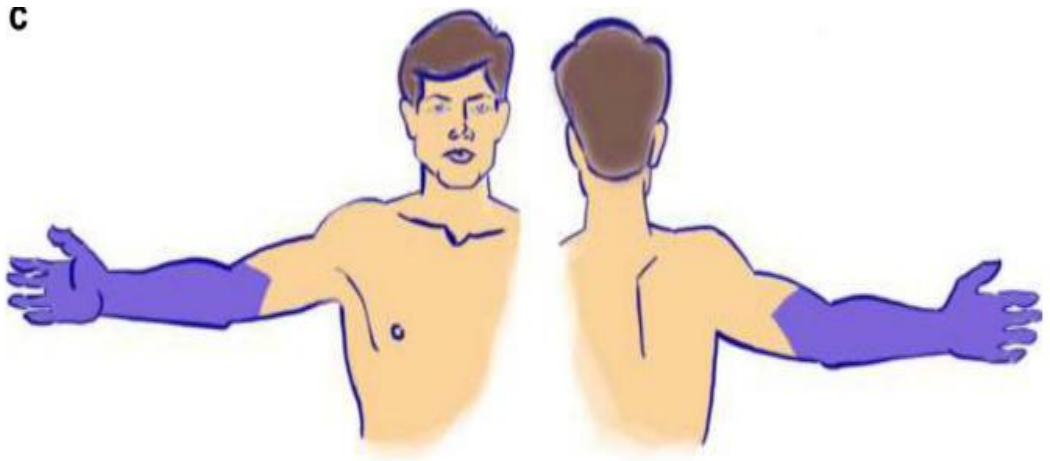
b



Notes:

- Coverage of the entire arm with the exception of the axilla (need intercostobrachial or pectoral II for axillary coverage)
- Blocks at the supraclavicular and infraclavicular provide similar analgesia, with the former providing better shoulder coverage
- More common to leave a catheter in the infraclavicular location as pectoralis muscles help prevent migration
- Lower risk of Horner syndrome or phrenic involvement with infraclavicular block

c



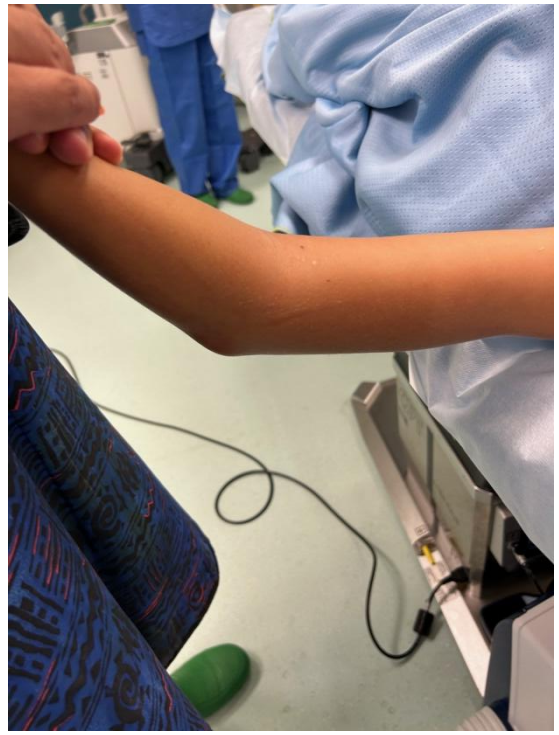
Notes:

- Suitable for procedures below the elbow, less reliable above
- Safest brachial plexus block due to easy compression of axillary vessels, and distance from phrenic nerve

Burns & Trauma, 2021, Vol. 9, tkab015

Upper Extremity	Block
Clavicle Fracture	• Superficial/Intermediate cervical plexus block with or without interscalene brachial plexus nerve block
Distal clavicle, scapula, proximal humerus	• Interscalene brachial plexus nerve block • Superior trunk brachial plexus nerve block
Shoulder girdle to Elbow	• Brachial Plexus ○ Interscalene block ○ Superior trunk block
Distal Humerus, Forearm, Hand	• Brachial Plexus ○ Supraclavicular Nerve block ○ Infraclavicular block
Elbow to digits	Brachial plexus ○ Infraclavicular block ○ Supraclavicular block ○ Axillary block
Forearm to Hand	• Brachial plexus ○ Infraclavicular block ○ Axillary block ○ Mid-humeral and forearm blocks of individual nerves: radial, median and ulnar
Hand	• Bier block - Short acting
Additional Upper Extremity Blocks	
Scapular Fractures Upper arm tourniquet	• Suprascapular nerve block – variable spread • Intercostobrachial nerve block


SIN



European Journal of Orthopaedic Surgery & Traumatology (2021) 31:871–881
https://doi.org/10.1007/s00590-021-02932-2

GENERAL REVIEW

Overview of the contemporary management of supracondylar humeral fractures in children

Sean Duffy[1] · Oliver Flannery[1] · Yael Gelfer[2] · Fergal Monsell[3]

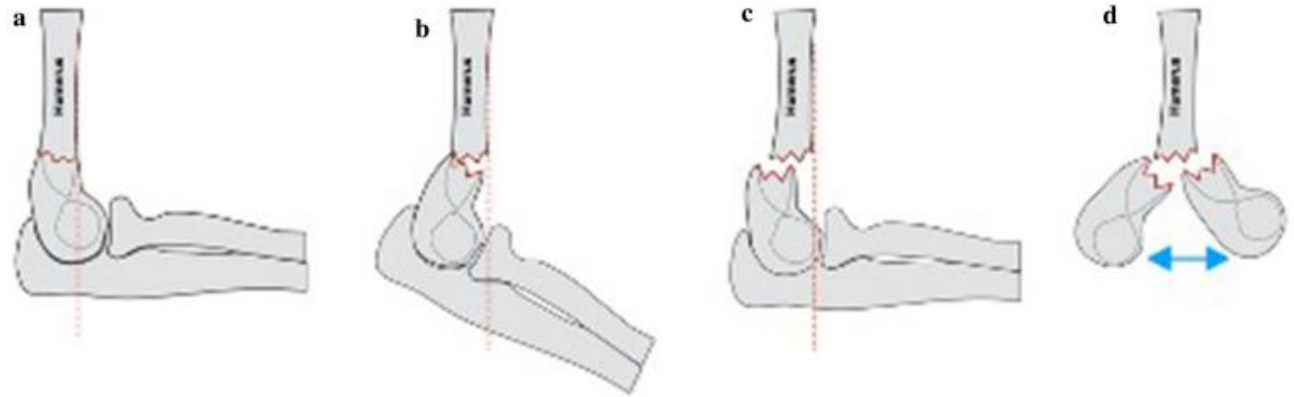
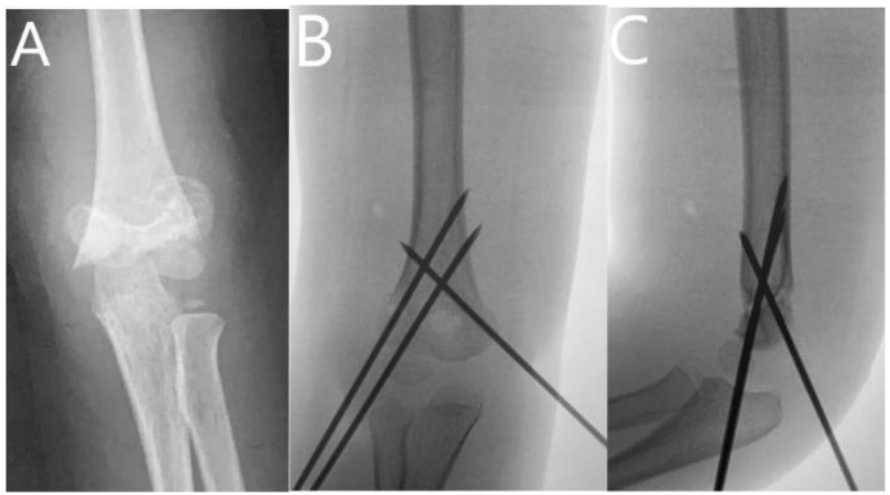
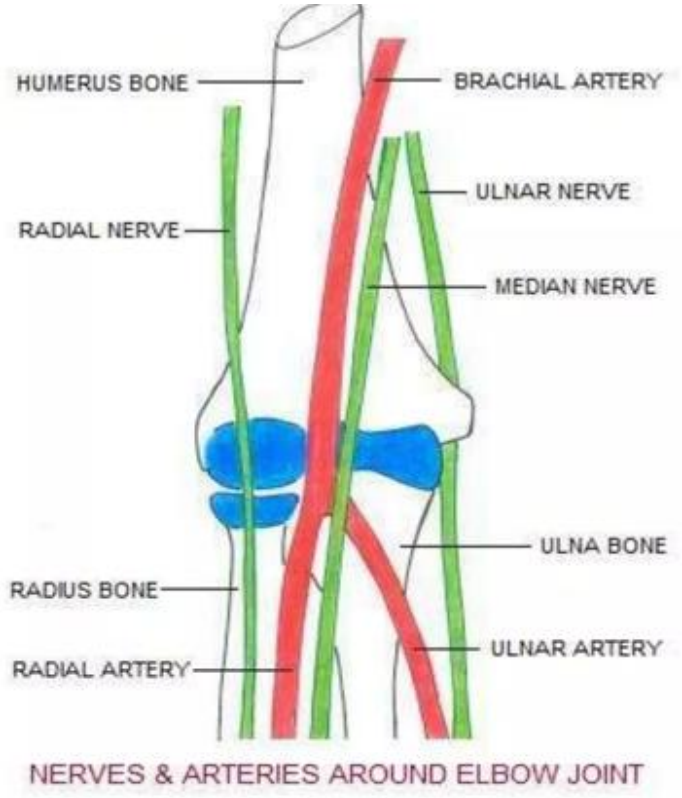


Fig. 1 The modified Gartland classification system **a** type I non-displaced, **b** type II moderately displaced, posterior cortex remains in continuity (IIa no rotation, IIb rotation), **c** type III complete displacement and **d** type IV unstable in flexion/extension (intraoperative discovery)





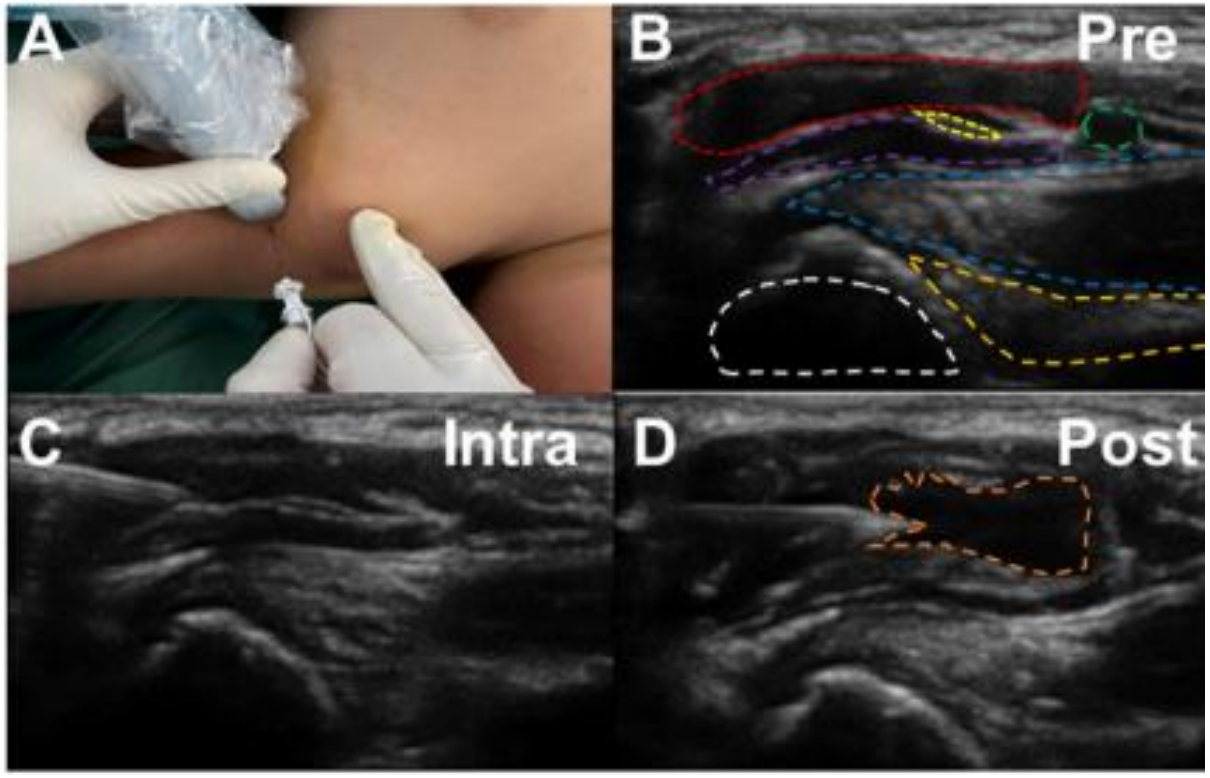
NERVES & ARTERIES AROUND ELBOW JOINT

- ✓ More common: Extension-type fractures: Median nerve (Anterior Interosseos Nerve neuropathy)
- ✓ Less common: Flexion-type fractures: Ulnar nerve Neuropathy
- ✓ Iatrogenic nerve injury

European Journal of Orthopaedic Surgery & Traumatology (2021) 31:871–881 https://doi.org/10.1007/s00590-021-02932-2

Ultrasound-guided coracobrachialis plane musculocutaneous nerve block for perioperative analgesia in pediatric Gartland type III supracondylar humerus fracture: a prospective pilot study

Tianyi Gao[1†], Zhuorun Song[2†], Shunyi Lu[2†], Nan Song[3], Wentao Yu[4], Huilin Yang[2], Jun Zou[2*], Qian Wang[2*] and Jun Ge[2*]

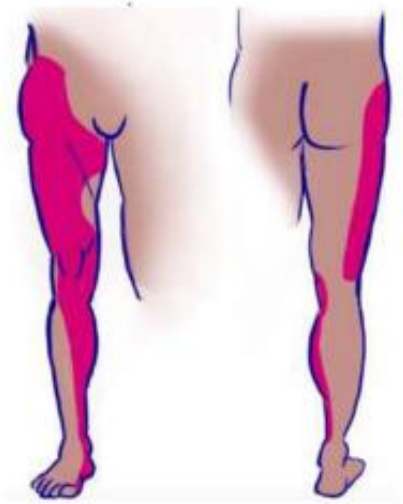


Coraco brachialis plane musculo cutaneous nerve block

- ✓ avoids direct needle contact with the nerve
- ✓ minimizing the potential interference with nerve function

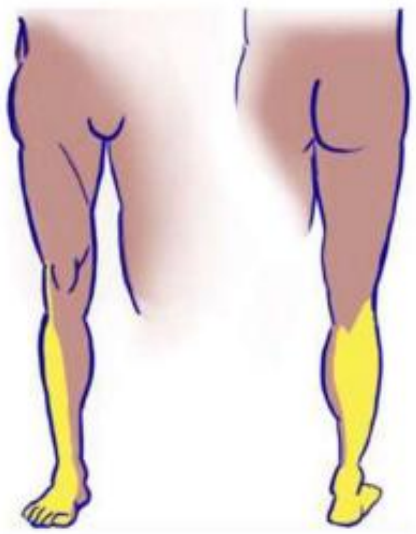
Muscle strength	Grade	Cora-MNB (n = 52)	SC-BPB (n = 53)
Thumb extension strength	Intact	45	8
	Reduced	7	30
	Absent	0	15
	P-value	<0.001 (***)	
Shoulder abduction strength	Intact	51	11
	Reduced	1	39
	Absent	0	3
	P-value	<0.001 (***)	

***$P < 0.001$.



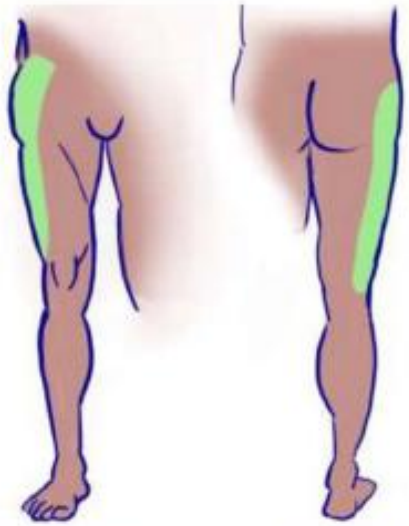
Notes:

- Common block used for both donor sites of the anterior and lateral thigh along with inner lower leg
- Single injection which covers both femoral and lateral femoral cutaneous nerves



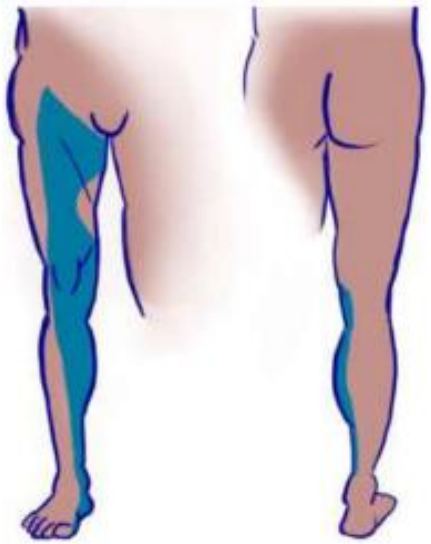
Notes:

- Multiple locations (popliteal, subgluteal, transgluteal) with variable coverage of the posterior leg above the knee
- All locations provide reliable coverage below the knee
- Motor weakness limiting mobility (plantar and dorsiflexion) can be problematic



Notes:

- Less commonly used that the fascia iliaca block for donor sites given the distribution is more lateral
- When used as a donor site block, sometimes best to place block with patient awake so that they can demarcate the exact area of anesthesia



Notes

- Targets inner thigh. Sometimes combined with a fascia iliaca when grafts are harvested from entire thigh
- Classic block covering the anterior thigh
- Risk of quadriceps weakness

Lower Extremity	

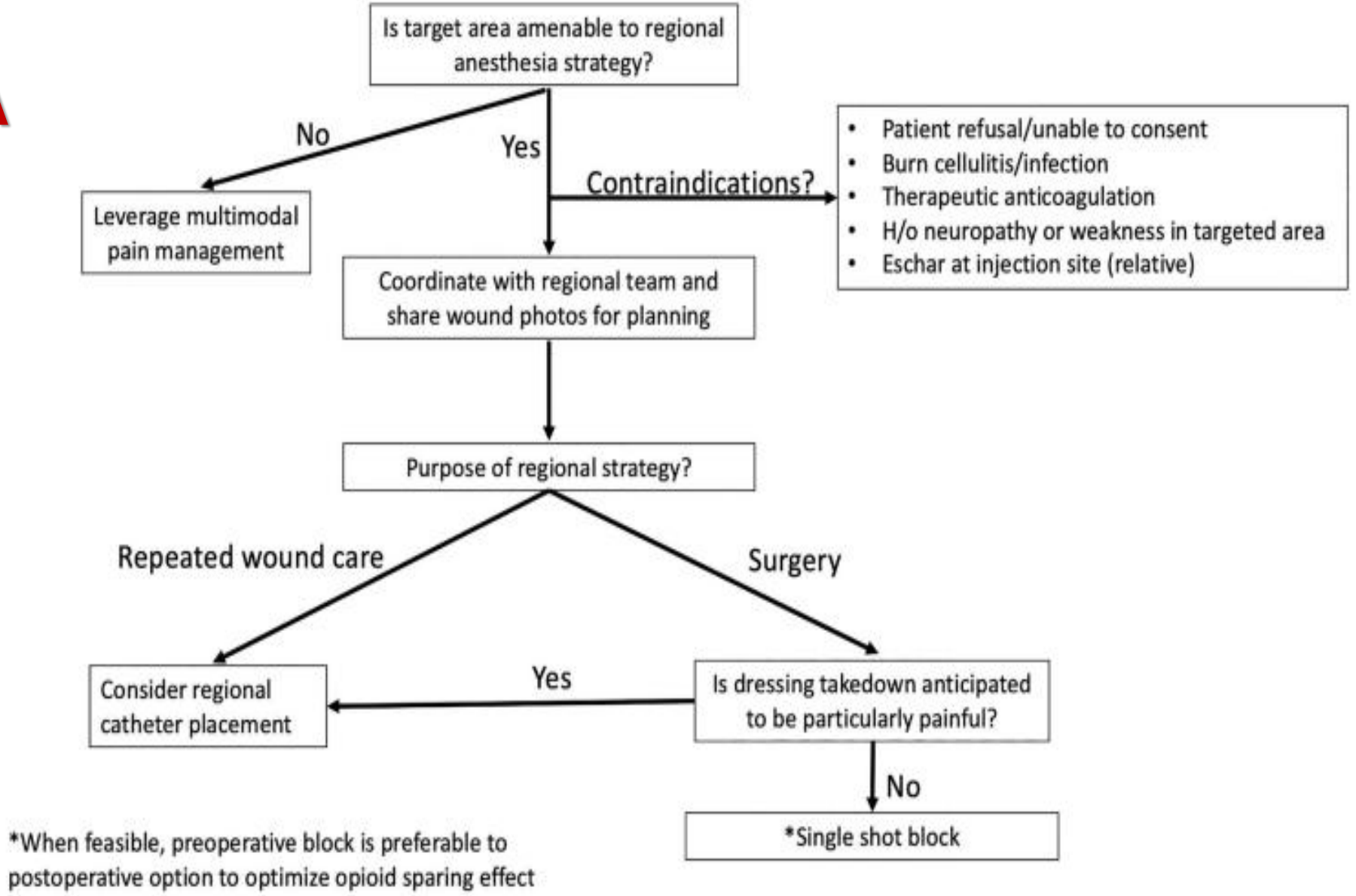
Hip fracture – head and acetabular component	• PENG (pericapscular nerve group block)
	  ○ Blocking the terminal nerves that innervate the hip joint; motor sparing
	  ○ Effective block for hip analgesia
	• SIFI (Suprainguinal Fascia Iliaca) block
	• Lateral Femoral cutaneous block
	• Femoral nerve block
	• Lumbar Plexus block
	• Neuraxial Anesthesia – Spinal, Epidural, Combined Spinal Epidural

Anterior and Lateral thigh, hip, femur, knee	• Femoral nerve block • Lateral femoral cutaneous block • Neuraxial anesthesia - Spinal, Epidural, Combined Spinal Epidural

Posterior hip, thigh, femur, knee, lower leg, foot	• Sciatic nerve
	  ○ Parasacral Approach
	  ○ Transgluteal Approach
	  ○ Infragluteal Approach
	  ○ Anterior Inguinal Approach
	  ○ Midfemoral Approach
	  ○ Popliteal Approach
	• Neuraxial anesthesia - Spinal, Epidural, Combined Spinal Epidural

Knee	• IPACK (Infiltration between the Popliteal artery and Capsule of the Knee) ○ Motor-sparing block that covers posterior knee pain • Adductor canal • Vastus Medialis Nerve Block • Intermedius Nerve Block • Genicular Nerve Blocks • Neuraxial Anesthesia – Spinal, Epidural, Combined Spinal Epidural
Lower Extremity/Ankle	• Sciatic Nerve Block • Adductor canal block – proximal vs distal • Ankle nerve block

Burns and RA



Burns & Trauma, 2021, 9, Techniques and strategies for regional anesthesia in acute burn care—a narrative Review Sheckter C. et al

Acute Compartment Syndrome

- ✓Critical pressure increase within a confined fascial compartment, with resultant microvascular ischaemia
- ✓ A compartment pressure >30 mmHg is considered critical
- ✓Definitive treatment is emergency decompression of all affected compartments
- ✓ACS is a source of morbidity, mortality, and litigation, particularly when treatment is delayed.

Pediatric Anesthesia

Pediatric Anesthesia ISSN 1155-5645

REVIEW ARTICLE

Controversial issues in pediatric regional anesthesia

Valeria Mossetti & Giorgio Ivani

Despite these evidences there are aspects still creating discussions on the best approach to avoid or prevent risks and on the way to make this techniques more and more reliable and safe. Compartment syndrome, test dose, loss-of-resistance technique and blocks performed under general anesthesia are examples of, sometimes, never-ending stories; this review without the presumption to solve every problem shows the more recent data to offer, if possible, the best updated-answer on these topics.

Children may be at greater risk of developing ACS because the normal compartment pressures in the lower leg (13–16 mmHg) are significantly higher than those of adults (0–10 mmHg).

- ✓ **5 Ps** (**Pain** out of proportion or increasing in severity, **Pain with passive stretch**, **Palpable tenseness**, **Paresthesia**, and **Paralysis**/motor weakness) in adults
- ✓**3 As in children** (**Anxiety**, increasing **Agitation**, and increasing **Analgesic** requirements)
- ✓ 4% of children sustaining an open tibial fracture
- ✓0.1%–0.3% in supracondylar humerus fractures and most commonly involves the volar compartment of the forearm

Acute Compartment Syndrome

- ✓Controversy exists concerning the potential of RA to eliminate pain as the presenting symptom
- ✓Existing literature on compartment syndrome **lacks prospective**, **randomized controlled study** results and **lacks information-rich meta-analyses.**

Advancing pain management for extremity trauma: the evolution of ultrasound-guided nerve blocks for patients in the supine position in trauma centers European Journal of Trauma and Emergency Surgery (2024) 50:1381–1390 https://doi.org/10.1007/s00068-024-02523-w

Box 1 ESRA and ASRA Joint Committee Statement

Six Best Practice Rules for Use of Regional Anesthesia in Pediatric Patients
1. A single injection peripheral nerve block or neuraxial concentration of 0.1% to 0.25% bupivacaine, levobupivacaine, or ropivacaine.
2. Continuous peripheral nerve block or neuraxial concentrations of 0.125% bupivacaine, or 0.1–0.2% ropivacaine at a rate of 0.1–0.3 mg/kg/hr.
3. Exercise caution with local anesthetic adjuvants as they can increase the duration and intensity of a block.
4. In high-risk acute compartment syndrome areas such as the tibia: restrict the volume and concentration of local anesthetic.
5.Patients should follow up regularly with the acute pain service.
6. If acute compartment syndrome is suspected, urgent compartment pressure measurement should be performed.

Ivani G, Suresh S, Ecoffey C, et al. The European Society of Regional Anaesthesia and Pain Therapy and the American Society of Regional anesthesia and pain medicine joint committee practice advisory on controversial topics in pediatric regional anesthesia. *Reg Anesth Pain Med*. 2015;40(5):526–532. doi:10.1097/aap.0000000000000280

Conclusions

- ✓Moderate to severe pain in pediatric trauma is common and RA provides optimal pain relief
- ✓RA provide early opioid sparing analgesia
- ✓Trauma represents a considerable and increasing demand on healthcare resources
- ✓Although further evidence is required, the role of RA is likely to expand to meet the growing burden of trauma