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Critical overview

Regional anesthesia for trauma patients

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Abbreviations:
RA – regional anaesthesia

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Abstract

Trauma patients demands special medical care. Pain is frequently undertreated in the early phase of trauma. Pain is a major symptom of surgical conditions and minimizing pain could lead to misdiagnoses and technical facilities are not appropriate for adequate pain treatment. Consequences of inappropriate pain treatment could aggravate stress response, increases oxygen demand and led to myocardial ischemia Analgesia with parenteral opioids is effective but carries a risk of respiratory depression, nausea and hypotension. Regional anesthesia (RA) is well established method for analgesia in surgical patients for intraoperative and postoperative pain relief. Neuroaxial and peripheral nerve blocks are effective procedures for acute pain treatment. Nerve stimulation and advances in ultrasound guide nerve blocks make those procedures safer and even more desirable. Advantages of RA over systemic analgesia in trauma patients are numerous. Application of local anesthetics produce excellent pain control with decreased stress response and minimal systemic effects is applied properly. Main indications for RA include patients with rib fractures and lower and upper extremities injuries. Anesthesiologist performing RA must be aware of pathophysiology changes in trauma patients especially addressing compartment syndrome and coagulation abnormalities. Best way is to weighed risk against the benefit of RA in trauma patients individually with increased vigilance and monitoring for eventual side effects.

INTRODUCTION

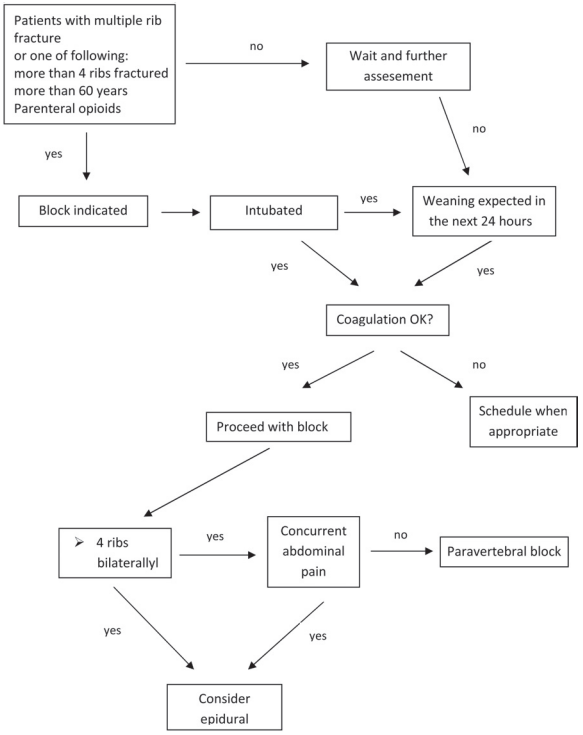
Trauma patients demands special medical care. Life threatening conditions (e.g. hemorrhage shock, neurotrauma, severe blunt or crush injury) demands emergency treatment and in the early phase of trauma resuscitation and life saving measure takes priority. But traumatic injury produces severe stress response and pain that have major impact on the morbidity and mortality *(1)*. Stress response and pain activate neuroendocrine and immune system producing systemic inflammatory response increasing oxygen consumption and catabolic state *(1, 2)*. On the other side, our body develops counter acting systemic response that attenuates first hit, or activation of neuroendocrine and immune system *(1, 2)*. If those reactions are severe patient will develop complication like sepsis and multiple organ failure. Multiple organ dysfunctions occur in 11–50% of trauma patients with high mortality rate (27–100%) *(2)*. As a pain estimation and treatment takes no priority in the initial treatment of the early phase of trauma, pain is frequently undertreated *(3, 4)*. Sometimes pain is undertreated on purpose because response to pain stimuli is use as important physical signs in patients assessment (e.g. in abdominal trauma or as a signs of consciousness in neurotrauma). Other reason for inadequate pain treatment includes lack of knowledge, fear of addiction and inappropriate pain estimation of medical staff *(4)*. Consequences of inappropriate pain treatment could

aggravate stress response, increases oxygen demand and led to myocardial ischemia *(4, 5)*. Also patient with inadequate pain therapy could develop chronic pain and post-traumatic stress disorder *(6)*. Mainstays of pain treatment in trauma patients are opioids IV, especially in the emergency department. Although effective therapy their disadvantages are risk of respiratory depression, nausea and hypotension especially if used in a high doses *(4, 6, 7)*. Beside systemic analgesics administration, pain could be treated with regional anesthesia (RA) techniques. Today, RA is well established method for analgesia in surgical patients for intraoperative and postoperative pain relief *(4, 5, 6)*. Neuroaxial and peripheral nerve blocks are effective procedures for acute pain treatment and nerve stimulation and advances in ultrasound guide nerve blocks make those procedures safer and even more desirable *(5, 6)*. Advantages of RA over systemic analgesia in trauma patients are numerous. Application of local anesthetics produce excellent pain control with decreased stress response and minimal systemic effects is applied properly. Several studies showed that RA hasten recovery, decrease intensive care unit and hospital length of stay, improve cardiac and pulmonary function, decrease infection rates, decrease sympathicus activation and promote earlier return of bowel function *(7, 8)*. Lack of systemic effects of parenteral opioids and influence on mental status and hemodynamic stability is especially appropriate for trauma patients *(4, 6, 7)*. Continuous RA techniques with catheter placement and newer local anesthetics and opioids drugs enable frequent adjustment of analgesia intensity according to patients needs therefore decreased that risk of masking pain as it is important signs of surgical disease. Another advantage of RA is that simple peripheral nerve blocks could be done in the early phase of trauma in prehosiptal setting or in the emergency department decreasing pain and stress to trauma that improves patients comfort and decrease probability for chronic pain development *(4, 6, 7, 9, 10)*.

Several RA techniques are optional for trauma patients. Neuroaxial techniques such as continuous epidural catheter are suggested for bilateral rib fractures and stable patients but are not the best choice if the patient is in shock and with multiple extremity fracture (*5, 6*). On the other hand peripheral nerve blocks are easy to perform for single extremity fracture in stable patients with low risk of adverse effect *(5, 6)*. Standard contraindication and measure of precaution with application of epidural analgesia and peripheral n nerve blocks to minimize side effects also refers to trauma patients as well *(4, 5, 6)*. Patient must be compliant, delay of block onset must be acceptable, RA must not jeopardize patient safety and a survey of block quality and duration, especially if continuous techniques applied, must be assured.

REGIONAL ANESTHESIA FOR RIB FRACTURES

Rib fractures are common in thoracic blunt trauma and if there are more than three ribs involved are associated with increased morbidity and mortality (up to 16 %)



Picture 1. *Algorithm for RA in rib fracture.*

(9, 10). Mainstay of therapy is good pain control with chest physiotherapy and mobilization *(5, 6)*. Optional RA techniques for rib fractures include thoracic epidural, paravertebral block and intercostal block. Method of choice for rib fractures, especially bilateral, is thoracic epidural analgesia with best pain control and possibility of continues application through catheter placements. Studies showed that thoracic epidural doubles vital capacity, reduced paradox chest movements and avoid side effects of systemic opioids for analgesia *(6, 9, 10)*. There is also 6 times lower risk of pneumonia in contrast to use of systemic opioids for pain relief *(9, 10)*. Algorithm for RA for multiple rib fracture is shown in figure 1 *(5)*. Percentage of patients treated with thoracic epidural are only about 22% because frequently other factors like lack of expertise, threat of infection, coagulopathy, spinal fractures, hemodynamic instability and patients compliant disables its application *(5, 6)*. There is also concern of placement epidural catheters in patients with risk of elevated intracranial pressure such as neurotrauma (5,6). Thoracic paravertebral block, either as a bolus injection of local anesthetics or as a continuous catheter blocks represent valuable alternative when indicated *(5, 6)*. Few studies found no advantages of thoracic epidural over thoracic paravertebral catheterization for treatment of rib fracture pain *(11, 12)*. Although, effective for pain treatment, drawbacks of paravertebral blocks includes possible side effect of unintentionally epidural spread of local anesthetic and need for bilateral block. One paravertebral blockade produce reliable analgesia for five dermatomes and some authors recommended second para-

vertebral catheters with more than four ribs fracture *(11, 12)*. Techniques for paravertebral blocks includes advancing needle at pretermineted fixed distance (1–1, 5 cm) beyond the transversus process, loss of resistance, peripheral nerve stimulation or ultrasound guided techniques. Application of paravertebral block in trauma patients could be difficult even with guidance by nerve stimulation or ultrasound because subcutaneous emphysema and hematoma could disrupt orientation. Additional information about the best place and depth of paravertebral blocks could be obtained from CT scan improving the margin of safety *(5)*. Other technique for pain relief in patients with rib fractures include intercostal block, simple and effective method for initial pain therapy but with limited duration of maximally 4–6 hours *(13)*. Insertion of catheters may prolong analgesic effects but also increase danger of side effect of systemic absorptions of local anesthetics.

HIP AND LOWER EXTREMITY BONE FRACTURES

Long bone fractures are associated with severe pain that is frequently left undertreated in emergency department *(4, 8)*. Several studies described better pain control, decrease incidence of DVT, decrease postoperative confusion and decrease incidence of postoperative pneumonia in patients with femur and hip fractures treated with RA *(8, 14, 15)*. Proximal femur is predominately innervated by femoral nerve with contribution of sciatic nerve and obturator nerve that also should be blocked if total analgesia for surgery is needed. A types of RA used for hip and proximal femoral fractures includes femoral nerve block and fascia iliaca compartment block *(14, 15)*. Femoral nerve is blocked either by bolus dose or continuously with placement of catheter. Femoral nerve could be easily visualized by ultrasound and obvious local anesthetics spread could be followed thus avoiding unpleasant nerve stimulation. Femoral block spear parenteral analgesics, improve analgesia and help to optimize patients positioning for neuroaxial block if surgery is planned *(5, 6, 8, 14)*.

Fascia iliaca compartment block (fascia pop techniques) is performed by single blunt needle puncture one centimeter bellow point between distal and medial part of a line drawn between spine iliaca anterior superior and pubic bone *(15)*. While advancing needle two pops should be felt and local anesthetics is injected after confirmation of no intravascular injection. Lumen of local anesthetics of about 20 ml has been used successfully.

Sciatic nerve block is indicated for more distal femur fracture and fractures of leg and ankle. Sciatic nerve block technique for femur fracture includes classic Labat or supragluteal approach *(5, 16)*. Sciatic nerve identification is done by ultrasound or nerve stimulation.

For successfully analgesia and surgical repair of proximal tibia and fibula fracture necessary is to block femoral and sciatic nerves *(5, 15)*. For fibula fracture, sciatic nerve block should be complemented with saphenous nerve block depending on the medial cutaneous involvement *(5)*. For lower leg and ankle fractures a popliteal block is indicated and ultrasound visualization of nerve poses a great margin of safety with high efficiency *(5, 6)*. Continuous techniques are utilized because of severe pain after surgical stabilization.

TABLE 1

Signs of acute compartment symptom:

Exaggerate pain
Paresthesia
Pain with forced dorsiflection
Palpation
Paralysis
Pulselessness

TABLE 2

Most common cause of compartment syndrome

Tibia plateau fracture
Crush injury
Distal radius fracture
Soft tissue injury
Diaphyseal fracture of ulna or radius
Prolonged extrication

UPPER EXTREMITY FRACTURE

Humerus received innervations from brachial plexus that could be officially blocked at several places: supraclavicular, infraclavicular and in the interscalene grove. Ultrasound and nerve stimulation techniques are both used successfully minimizing the risk of nerve injury, intravascular injection, pneumothorax and inadequate block *(4, 5, 6)*. Direct visualization of local anesthetic enables using low doses reducing risk of side effects *(5, 6)*. Catheter positioning with continuous approach is recommended because humerus fracture is very painful even after surgical stabilization *(5)*. Prior to performing RA of the most importance is to determine if there are nerve injury that should be documented. Valuable option for shoulders displacement represent interscalene block that offers excellent pain relief and muscle relaxation *(17)*. For the clavicle fracture nerve blocks of of C5/C6 nerve roots are utilized for distal fracture and C4 root for more medial fracture *(5)*. In the patients with clavicle fracture there is risk for injury of supraclavicular nerve and brachial plexus that should be investigated before RA. RA techniques for the repair of lower arm bones fractures (radial/ulnar bones) includes brachial and axillar plexus blocks *(5)*. Comparing to general anesthesia, patients with ultrasound guided low dose axillary blocks had excellent analgesia, reduction in parenteral

opioids, shorter recovery room times and earlier hospital discharge that makes Ra techniques of choice *(4, 5, 6)*. Both blocks can be performed easy and safe with ultrasound visualization ensuring adequate pain control and blockade of all branches of brachial and axillary plexus for successful pain control.

CONCERNS OF REGIONAL ANESTHESIA TECHNIQUES IN TRAUMA PATIENTS

Like any medicine procedure RA has its own risk and limitations. Main disadvantages are technical complexity of procedure and training and repetition to achieve and maintain proficiency in RA procedures *(5, 6)*. As an invasive procedure, RA poses risks of infection, nerve injury, vascular injury, pneumothorax and local anesthetic toxicity *(4, 5, 6)*. Anesthesiologist must be aware of all drawbacks of RA, like needing of appropriate environment and technical condition for block performing (compliant patient, compliant surgeon, quite environment, enough time). Through knowledge of anesthetics pharmacology is crucial so that timing of surgery could be well planned enabling block to be effective when surgery start. It is prudent to choose general anesthesia over RA when multiple blocks and catheters are needed *(4, 5, 6)*. Examples are patients with multiple fractures and extensive trauma whiteout sufficient time when care for the patient should be done immediately. In such situation, RA could be introduced after surgery for analgesia. Anesthesiologist performing RA must have through knowledge of pathophysiology changes in trauma patients especially addressing compartment syndrome and coagulation abnormalities. Compartment syndrome is of primary concern because patient with forearm or leg injuries are especially prone to development of that syndrome that, if left untreated, could result in amputation of extremity or in MOF with lethal outcome *(5, 6, 18)*. Disadvantages of RA are that complete analgesia could mask pain and paresthesiae, main symptoms of compartment syndrome or nerve injury (Table 1). There are several reports of delayed diagnosis of nerve injury and compartment syndrome in literature, especially with subarachnoidal block and epidural *(19, 20, 21)*. Patient in the grates risk for compartment syndrome includes tibiae plateau fracture, crush injuries and prolonged extrication (Table 2) *(18)*. Patients with hip and femoral fracture are less prone to compartment syndrome. Early diagnosis is sine qua non for management of compartment syndrome with extensive fasciotomy *(5, 18)*. For successful diagnose of compartment syndrome crucial is high index of suspicion, frequent evaluation of pain and RA quality and patient assessment, and compartment pressure measurement *(18, 23)*. Risk for misdiagnose compartment syndrome is decreased by using continuous RA techniques, with decreased local anesthetics concentrations and using newer local anesthetics drugs with short duration time *(19, 20, 21)*. When performing RA in trauma patients, practitioner must be aware of increased chance for coagulation abnormalities *(23, 24)*. Recommendations for performing RA should be done according to latest American Society of regional anesthesia and pain medicine guidelines. Best way is to individually weigh risk against the benefit of RA in trauma patients with coagulation abnormalities *(25)*. If the RA is chosen for the patients with coagulation abnormalities, extreme vigilance and monitoring for eventual side effects is mandatory.

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