Regional anesthesia outside the operating room: indications and techniques

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Purpose of review
Regional anesthesia is not only performed in the operating room. There are indications for the use of these techniques for pain relief in the emergency department and for anesthesia support of procedures outside the operating room. In this review, we will provide an overview of the indications for the regional techniques performed in the out-of-operating room environment.

Recent findings
In the emergency department, patients may experience significant pain, and adequate analgesia is not always provided. Regional analgesia is effective and indicated for many trauma situations including hip fracture, reduction of shoulder dislocation, treatment of upper limb fractures and multiple rib fractures. Ultrasound guidance makes the performance of regional blocks more accessible and safer for use in the emergency department setting.
For therapeutic procedures outside the operating room, regional anesthesia is possible for uterine artery embolization and for postoperative analgesia after implantation of cervical brachytherapy needles.

Summary
Regional anesthesia is a valuable option for analgesia in trauma patients, enabling improved pain control in the emergency department and has benefits in the anesthetic management of therapeutic procedures outside the operating room. For many blocks, ultrasound guidance is useful.

Keywords
cervical brachytherapy, hip fracture, multiple fractured ribs, regional anesthesia, shoulder dislocation, uterine artery embolization

INTRODUCTION

Regional anesthetic techniques have well known benefits for the surgical patient and are well established in the operating theatre for perioperative and postoperative care.

Their use during surgery and in the postoperative period offers excellent pain control, and decreases the need for systemic analgesics [1▪]. Outcome studies demonstrate benefits of regional anesthetic techniques with faster recovery, decreased length of hospital stay [2] and improved cardiac and pulmonary function postoperatively [1▪]. The use of regional anesthesia is associated with decreased neuroendocrine stress responses in the perioperative period [3▪].

Although the same benefits and favorable outcomes of regional anesthesia are also valid outside the operating theatre, the use of these techniques is less common.

In this review, we will focus both on the use of regional anesthetic techniques in the emergency room and in locations outside the operating room in which patients undergo diverse procedures, for which anesthesia is sometimes needed.

REGIONAL ANESTHESIA IN THE EMERGENCY ROOM

Trauma patients presenting in the emergency room generally experience significant levels of pain and stress. Analgesia is therefore an important part of the care of these patients, even before the definitive treatment, operative or otherwise, of their injuries [4].

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KEY POINTS

- Regional anesthesia is beneficial for patients with a wide variety of trauma, including hip fracture, shoulder dislocation and multiple fractured ribs.
- With the use of ultrasound guidance, many blocks can be safely performed in the emergency department.
- In patients with multiple rib fractures, regional analgesia techniques allow for a significant reduction in the duration of mechanical ventilation when compared with systemic opioid analgesia.
- Local anesthetic systemic toxicity is a risk with certain regional techniques, and resuscitation equipment including lipid emulsion should always be readily available in areas where these procedures are performed.
- Regional anesthesia has a role for therapeutic procedures outside the operating room.

Recent surveys have demonstrated great variation in the use of analgesics and analgesic strategies in different emergency rooms, with the majority of trauma patients receiving inadequate pain relief [5]. Terms such as 'hypoanalgesia' are used in describing the status of pain control in the emergency rooms [6▪▪].

Systemic analgesia may be avoided in trauma patients because of concerns about hemodynamic and respiratory function. Furthermore, an adequate assessment of mental status can be hindered by the use of systemic sedative analgesics such as opioids.

Regional anesthetic techniques can prove beneficial for trauma patients, even before they arrive in the operating theatre. Early, effective analgesia can provide better conditions and reduce the stress response during transport and the initial examination of trauma patients [7▪▪].

Theoretically, better pain control achieved with the use of regional techniques can have a positive impact on the eventual outcome of the patient, reducing the chance of developing chronic pain and post-traumatic stress disorders.

Lower extremity trauma

Fractures of the hip are associated with severe pain, and often occur in the elderly patient population making the use of systemic opioids challenging [8]. In this population, the use of regional analgesia has been shown to improve analgesia with fewer side-effects than systemic analgesia [9▪].

Neuraxial techniques such as epidural block can provide excellent analgesia for hip fractures, however their use is limited due to difficulties in positioning of the patient and the hemodynamic side-effects of a more extended block. Also an increased risk of serious neurologic side-effects has recently been reported, especially in the elderly [10].

Peripheral nerve blocks lack these disadvantages; useful techniques include the femoral nerve block and the fascia iliacae compartment nerve block (FICB). Both can be administered in a supine patient and only block the affected limb, limiting the possibility for hemodynamic disturbances. They can be placed with or without ultrasound.

Femoral nerve block

The femoral nerve block is well established in the perioperative pain control of hip fracture repair. The aim of the three-in-one femoral nerve block is to anesthetize the lateral cutaneous, obturator and femoral nerves using a single injection [11]. It can be performed using a landmark-based technique. In patients with a fractured femoral neck, the femoral nerve may be easier to approach at the mid-inguinal crease [12]. When only landmarks are used there is a risk of injecting local anesthetic into the femoral artery or vein, resulting in local anesthetic systemic toxicity (LAST) [13▪]. Nerve stimulation to localize the nerve reduces the risk for intravascular injections, but can be painful in the traumatized patient, due to induced muscle movements. Ultrasound guidance for femoral nerve block is feasible in the emergency room and helps minimize the pain associated with this procedure. [14]. This technique is also useful for pediatric patients [15▪].

Care has to be taken, especially in high-impact injuries, that compartment syndrome of the thigh is not masked or overlooked when using a femoral nerve block [16▪▪].

Fascia iliaca compartment block

The fascia iliaca compartment block is an alternative to the femoral nerve block for analgesia after a fracture of the femoral neck. It appears to be equally effective, and easy to learn for emergency room physicians, without a background in anesthesiology [17▪]. The fascia iliaca compartment block is a landmark-based technique with identification of the fascia iliaca compartment by a 'double-plop' technique. There is no need for identification of the nerve, because the local anesthetic spreads in the fascia iliaca compartment where the femoral nerve also passes [17▪]. Cephalad spread of the local anesthetic is enhanced by manual compression on the thigh distal to the injection site.

The fascia iliaca compartment block is also effective for analgesia in pediatric patients, using a similar technique [18].

Ultrasound guidance is possible when the 'double-plop' technique is difficult to perform, especially in children [19] and increases the efficacy and success rate of the block [20]. The use of ultrasound also allows placement of a catheter in the fascia iliaca compartment, for long-lasting pain relief [21▪].

Other peripheral nerve blocks for the lower limb

For below-knee pain management, such as in fractures or wounds of the foot, the popliteal sciatic nerve block can be performed [22]. Usually the patient has to be positioned in a prone position for this block, which is not always feasible. With the use of ultrasound guidance, however, techniques for performing this block in a supine patient have been described [23].

Shoulder and upper extremity trauma

As in postoperative pain control following shoulder surgery, regional blocks of the brachial plexus are useful for analgesia in shoulder and upper extremity trauma. The approach depends on the site of the trauma and the accessibility of the plexus.

Interscalene brachial plexus block

The interscalene brachial plexus block is a well tolerated alternative to procedural sedation for the reduction of a dislocated shoulder [24]. For procedural sedation, patients have to be fasted for at least 4–6 h to reduce the risk of aspiration. Close monitoring during and after the reduction is also necessary to avoid the respiratory complications from procedural sedation. The use of an interscalene nerve block for shoulder reduction can shorten emergency room stay and the need for intensive nursing care [25▪▪].

The use of ultrasound guidance has opened the possibility for interscalene nerve block in more emergency departments wherein a nerve stimulator is not always available [26].

Other nerve blocks of the upper extremities

A variety of upper extremity nerves are accessible for performing nerve blocks, and several techniques have been described for use in the emergency department.

The supraclavicular nerve block can be used for treatment of different fractures, dislocations and evacuation of abscesses of the upper extremities [27]. Ultrasound guided supraclavicular nerve block is an alternative to the interscalene brachial plexus block and can be performed without nerve stimulation. The supraclavicular nerve block has a lower incidence of recurrent laryngeal nerve and phrenic nerve paralysis compared with the interscalene approach, making this technique preferable in selected patients. The use of ultrasound guidance also reduces the risks of pleural or vascular punctures.

The suprascapular nerve block can be used as an alternative for the interscalene brachial plexus block for the reduction of a dislocated shoulder or the treatment of adhesive capsulitis of the shoulder [28]. The use of ultrasound permits visualization of the suprascapular nerve beneath the transverse scapular ligament in the scapular notch. A block of this nerve produces analgesia in the shoulder joint and muscle relaxation of the shoulder without complete motor block of the upper extremity.

Ultrasound guided blocks of the different forearm nerves permit the treatment of small hand lesions in the emergency department without the use of procedural sedation [29]. Ultrasound guided blocks of the radial, ulnar and median nerves provide effective analgesia for different hand procedures, such as reduction of fractures, exploration and treatment of hand wounds and the evacuation of abscesses. The use of ultrasound guidance has several advantages over landmark-based techniques, such as avoidance of vascular structures and the direct visualization of the nerves, with improved success rates of the block.

The supracondylar radial nerve block can be used for analgesia in the treatment of distal radius fractures [30]. Distal radius fractures often need closed reduction and splinting and are usually performed under procedural sedation in the emergency department. A block of the radial nerve, performed under ultrasound guidance above the elbow, proximal to the bifurcation of the nerve into deep and superficial branches, is effective for analgesia for reduction of this type of fracture.

Trauma of the thorax and rib fractures

Thoracic trauma with multiple rib fractures is associated with significant pain. Good analgesia is not only important for patient comfort, but reduces the incidence of respiratory complications. When more than three to four ribs are fractured, regional analgesia is superior to systemic analgesia.

With multiple traumatic rib fractures, there is often concomitant lung injury. Pain from the fractured ribs impairs effective breathing by guarding

and shallow breathing. This causes atelectasis, possibly leading to secondary pneumonia with lung consolidation. The ensuing respiratory failure, with a need for intubation and ventilatory support, is associated with significant morbidity and mortality.

Systemic analgesia is not only less effective than regional analgesia, but also adds to respiratory depression, enhancing the pulmonary complications. The use of systemic opioids also makes the assessment of possible concomitant head injuries more difficult.

Disadvantages of regional analgesia are the technical difficulties related to placement of the block, as some degree of patient cooperation is required. Indwelling catheters may also be an infection risk and can be dislodged. Contraindications for regional analgesia are infection at the entry point or systemic infections and coagulopathy [31▪▪].

Thoracic epidural analgesia

Thoracic epidural analgesia for multiple rib fractures, as for thoracic surgery, is superior to systemic analgesia for both pain relief and respiratory function. The level of the thoracic epidural must correspond with the level of the fractured ribs. The risks of LAST and inadvertent pneumothorax are low [31▪▪].

The benefits of thoracic epidural analgesia for multiple rib fractures are well established [32] and were recently reaffirmed [33]. However, a meta-analysis, comparing the effects of epidural analgesia to other analgesic modalities, failed to show statistically significant differences in mortality, ICU and hospital length of stay. Thoracic epidural analgesia with local anesthetic was associated with a significant reduction in duration of mechanical ventilation when compared with opioid analgesia [34].

Disadvantages of thoracic epidural analgesia are its technical complexity, the risk for dural puncture and spinal cord injury, motor block and hypotension. When epidural opioids are administered, there is a risk for pruritus and urinary retention.

Contraindications to thoracic epidural analgesia in thoracic trauma are hypotension and hypovolemia, altered level of consciousness making patient cooperation impossible, head and/or spinal injuries, systemic infections and hemostatic abnormalities.

Thoracic paravertebral block

Thoracic paravertebral block provides analgesia that is comparable to thoracic epidural analgesia [35], but the block is technically less complicated to perform. It produces minimal hemodynamic changes, and can be performed in cases of moderate hemodynamic instability. Opioids are not needed, avoiding pruritus and the risk of urinary retention.

Thoracic paravertebral block has a small risk for pneumothorax and inadvertent epidural administration of the local anesthetic is possible. When more than one catheter is placed, as in the case of a bilateral paravertebral block, care has to be taken to avoid local anesthetic toxicity [31▪▪]. Ultrasound guidance can improve safety of the block [36].

Intercostal nerve block

An intercostal nerve block delivers effective analgesia for a fractured rib, but in cases of multiple fractured ribs, multiple injections are needed to cover the area of the trauma. Single-shot injections provide analgesia for 4–8 h, so for longer lasting analgesia, catheters are needed or repeated injections have to be performed. Each injection has the risk for pneumothorax or intravascular injection, and the risk for local anesthetic toxicity is larger than with other techniques [31▪▪].

Ultrasound guidance can help to identify the pleura, minimizing the risk for pleural puncture [37].

Intrapleural block

Analgesia for fractured ribs is possible with intrapleural administration of local anesthetics, but the analgesia is less effective when compared with other regional techniques. In the presence of a chest drain, the injected local anesthetics are drained off, and in the event of a hemothorax, the local anesthetics are diluted, with less analgesic effect. Due to the rapid absorption of local anesthetics, the risk for toxicity is high. The intrapleural block is thus not the first choice for analgesia [31▪▪].

Challenges of regional analgesia for trauma patients

When performing regional techniques, sufficient training and experience is necessary as these techniques are more invasive than systemic analgesia, and each type of block has specific associated risks. The risks of infection, nerve injury, pneumothorax, and local anesthetic toxicity both by intravascular injection or absorption of large volumes of local anesthetic have to be understood and anticipated.

Specific to trauma of the extremities, care has to be taken that the use of regional analgesia does not mask the symptoms of compartment syndrome, in which swelling and increased tissue pressure in muscle compartments can lead to ischemia and muscle necrosis. An increase in pain is often one

of the first symptoms of compartment syndrome, making some practitioners reluctant to use regional anesthesia in extremity trauma. A high index of suspicion, frequent patient assessment and compartmental pressure monitoring are essential for early detection of compartment syndrome. Breakthrough pain in a patient with a previously well functioning regional nerve block should trigger further investigations to rule out this significant complication [38].

Peripheral nerve injury is a rare complication when an experienced practitioner performs the block and the risk can be further reduced with the use of ultrasound guidance.

Ultrasound is available in most emergency departments, but not all emergency physicians are sufficiently trained to perform regional techniques under ultrasound guidance. This practice lies more within the expertise of anesthesiologists working in the operating room. One possible solution to the need for regional anesthesia in the emergency department is a mobile ultrasound guided regional block team that can be dispatched from the operating room to the emergency department, if needed [39▪].

Infection after placement of a regional nerve block is a concern when the nerve block is placed in less ideal circumstances, such as the prehospital setting. Risks of infection need to be balanced against the potential benefits of the nerve block, such as a reduction in opioid administration.

The risk of systemic toxicity from the local anesthetic increases when large volumes or high concentrations of local anesthetic are used in a regional nerve block. Using low-volume techniques with ultrasound guidance increases the success rates of the nerve blocks while decreasing the risks for local anesthetic systemic toxicity. Whenever regional analgesia is performed resuscitation equipment and a local anesthetic toxicity rescue kit, including lipid emulsions, should be available [13▪,40].

REGIONAL ANESTHESIA FOR THERAPEUTIC PROCEDURES OUTSIDE THE OPERATION ROOM

Many therapeutic and diagnostic procedures that are performed outside the traditional operating room require anesthetic support. In some hospitals, mobile anesthesia teams are available to deliver anesthetic care, wherever it is required throughout the hospital [41].

Anesthetic support does not always have to be general anesthesia. For some procedures, regional anesthesia can provide the required levels of analgesia, sometimes supplemented with minimal sedation for patient comfort. For other procedures, in which general anesthesia is used, a regional technique can be used for postoperative analgesia.

Uterine artery embolization

Uterine artery embolization has become a reasonable alternative to a hysterectomy for patients with large or symptomatic uterine fibroids. One of the advantages of uterine artery embolization over hysterectomy is earlier postoperative recovery [42].

Uterine artery embolization is not pain-free, ischemic pain in the uterine segments occurs when the first branches of the uterine artery are embolized. Many regimes for analgesia have been proposed, with analgesics being administered before or during the procedure, together with procedural sedation or even general anesthesia [42–44]. Spinal or epidural analgesia is sometimes considered. In our institution, combined spinal epidural anesthesia (CSE) is performed and patient controlled epidural analgesia (PCEA) is employed for 24–48 h. Often the CSE is combined with mild propofol sedation.

Brachytherapy

Brachytherapy for cervical neoplasms can be achieved with needles placed either intraluminally in the cervix, or with interstitial needles. When interstitial brachytherapy needles are used, there is significant postoperative pain. Patient controlled epidural analgesia is an effective method for controlling this postoperative pain [45].

CONCLUSION

Regional analgesia and anesthesia techniques do not have to remain confined to the operating theatre. Regional techniques are very useful for the treatment of trauma-related pain in the emergency department in selected patients. Improved patient outcomes can be demonstrated especially in the case of thoracic trauma with multiple rib fractures.

Successful application of regional techniques in the emergency department requires adequate training of the emergency physicians. This includes the techniques for the different nerve blocks, the use of ultrasound guidance and the prevention and treatment of local anesthetic toxicity. A mobile team with trained anesthesiologists, working mainly in the operating room but available for the emergency department, can help when the resources for providing regional analgesia in the emergency department are limited.

Some therapeutic procedures performed outside the operating room may also benefit from regional anesthesia or analgesia and a mobile anesthesia team is one model for providing this type of anesthesia support.

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Conflicts of interest

There are no conflicts of interest.

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