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Regional Anesthesia for Urgent Reconstructive Surgery

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Abstract

In polytrauma patients, the primary goal is to administer early resuscitation and effective analgesia with medications or techniques, which minimally affect the patient's physiology. Adequate pain control will reduce posttraumatic stress disorder and facilitate in early functional recovery and better wound healing. Most of these polytrauma patients are hemodynamically unstable and require anesthesia and analgesia with techniques that produce minimum hemodynamic derangements; these techniques depend on the severity of trauma. The complexity of the surgery varies from primary closure to free flap reconstruction. More complicated injuries with larger tissue loss require free flap cover for better wound healing and optimal functional outcome. Optimum care of flap is an important part of perioperative management to prevent flap failure. Regional anesthesia has been proven to prevent flap failure by increasing perfusion to injured area by blocking local sympathetic system and minimizing pain-induced vasospasm. Postoperative prevention of hypothermia maintaining normocarbia plays a vital role in maintaining perfusion of free flap and prevention of flap failure. Regional anesthesia allows safe management of these patients.

Keywords: reconstructive surgery, regional anesthesia, trauma

1. Introduction

Anesthetic management of acutely injured patients scheduled for urgent reconstructive surgery is associated with multiple challenges. These patients are hemodynamically unstable requires early resuscitation, maintaining airway and providing effective analgesia is primary goal. In trauma patients, provision of adequate analgesia is usually delayed due to critical state of patients and adverse effects of systemic analgesics on different organs, with advent of newer technology and regional anesthesia can be effectively given to all trauma victims

with minimum adverse events. Patients with polytrauma who needs emergency reconstructive surgery are associated with neurovascular injury, which requires early assessment and management which is altered by administration of narcotic based analgesics due to sedation and delirium associated with opioid analgesics.

Patients with polytrauma associated with an average of two fractures, and 5% of patients with more severe injuries are associated with five or more fractures. Most of these patients are associated with femoral fractures (16.5%) followed by tibia (12.6%) and clavicle (10.4%) fractures. The polytrauma patients who had fewer fractures are associated with severe traumatic brain injury (TBI) and lower Glasgow coma scale (GCS) and had increased in hospital mortality [1]. Since most of regional anesthesia (RA) procedures involve the extremities their role in anesthetic management for urgent reconstructive surgery seems well suited.

Polytrauma due to accident significantly activates stress hormones, inflammatory mediators and catabolism, from the time of injury extending through to rehabilitation. Pathophysiological changes after trauma may be increased by systemic opioids and other analgesics. Adverse effects of narcotic analgesics include drowsiness, respiratory depression vomiting, constipation deranged sleep and dependence [2].

Regional anesthesia in elective surgical procedure is widely used either alone or along with general anesthesia. RA has advantage of minimizing stress response to injury; these advantages are often not translated to the trauma patients. Early and late advantages of RA are often overlooked for fear of rare complications and less effective and more deleterious narcotic based analgesics predominate.

The benefit of peripheral nerve blocks (PNB) is the provision of high quality analgesia that is site specific and devoid of any systemic side effects. RA confers several other advantages over general anesthesia for trauma patient including reduction in opioid requirement and length of stay in emergency or critical care units, improved comfort and safety for transport, reduction in the stress response to injury. The capability of CPNB to provide long-term analgesia and surgical anesthesia during frequent trips to the operating room is a significant benefit of this pain management technique [3, 4].

Post traumatic patients are associated with posttraumatic stress disorder (PTSD) and chronic regional pain syndrome (CRPS) following acute injury, more than 75% of severe polytrauma patients develop chronic pain syndrome. Chronic pain syndrome is defined as pain persisting for more than 12 weeks following acute injury [5]. Development of chronic pain syndrome following acute injury is multifactorial. However, the risk factor that appears to be most predictive of eventual chronic pain is the intensity of acute pain at the time of injury. RA has been shown to significantly reduce acute pain intensity in traumatic injury. While it is attractive to assume that quality regional blockade early during an injury would prevent the development of chronic pain.

2. Rationale for regional anesthesia use in reconstructive surgery

Regional block offers many advantages of an ideal analgesic. Specific and unique advantages include superior analgesia, decreased postoperative delirium and psychosis, preserved sleep

cycle, attenuation of stress response to injury, decreased nausea and vomiting, decreased posttraumatic chronic pain syndrome, and reduced systemic side-effects of opioids. Administration of regional anesthesia averts the risk of airway complications associated with airway instrumentation during general anesthesia and positive pressure ventilation, such as failure to secure airway, aspiration pneumonia and aggravation of cervical cord injury. Anesthesiologists encounter patients with critical trauma at various times during ongoing care, from prehospital resuscitation, stabilization in the emergency department, the management of the anesthesia and the intensive care unit, to the pain treatment service. Each stage offers the opportunity to provide regional anesthesia to trauma patients [6].

3. Key points for using regional anesthesia in reconstructive surgery

- Reconstructive surgery procedures rely on different approaches to local and regional anesthesia.
- Systemic toxicity associated local anesthetics during regional anesthesia and peripheral nerve block is a major anesthetic complication in poly-trauma patients due to rapid LA absorption into the vascular system.
- Less common complications associated with regional anesthesia are direct nerve injury, hematoma, pneumothorax, inadequate block, phrenic nerve palsy, Horner's syndrome and compartment syndrome.
- RA is ideal, site-specific and high-quality analgesia without risk of respiratory depression, drowsiness and bleeding associated with opioid and non-steroidal anti-inflammatory drugs.
- Increased availability of point of care ultrasound equipment and improved technology has made the administration of RA accurate, repeatable and with fewer complications.
- Regional anesthesia provides effective analgesia in critically ill trauma patients with multiple rib fractures, hip fractures and other injuries, where administration of systemic analgesics is associated with inadequate analgesia and delayed recovery.
- Compartment syndrome associated with RA and peripheral nerve blocks due to delay in diagnosis can be prevented by judicious use of low concentration local anesthetics and early mobilization.
- Decrease in the complications associated with RA due to advances in technology and better training. It can be administered outside the operating room to provide an arrival block with analgesia superior to the beginning of patient care.

4. Application of regional anesthesia in trauma management

4.1. Thoracoabdominal trauma

Thoracic injuries include: blunt chest injuries such as rib fractures, flail chest and pulmonary contusion are common, with significant morbidity and mortality. Pain impairs with adequate

respiratory movements predisposing to atelectasis, pneumonia and retention of secretion. RA modalities include erector spinae plane block, serratus anterior plane blocks, cervical and thoracic epidural analgesia (TEA), intercostal blocks, paravertebral block and intrapleural catheters. Thoracotomy for acute chest injury is associated with excruciating postoperative pain which impairs with respiratory movement during postsurgical period, and it also associated with more than 50% chronic pain syndrome, which is debilitating. Cervical and thoracic epidural block is gold standard for managing postthoracotomy pain syndrome. Chest injury with multiple rib fractures are encountered in more than 10% of trauma patients, requiring adequate analgesia to prevent atelectasis, pulmonary infections. Thoracic paravertebral block and thoracic and cervical epidural analgesia provide excellent pain relief in these patients. However, previously reported reduction in duration of mechanical ventilation, hospital stay, and mortality rate are unequivocal [7]. Trauma patients are associated, with coagulopathy due to hemorrhage, massive blood transfusion or thromboprophylaxis and most of these patients are hypovolemic, which preclude the use thoracic epidural blocks.

4.1.1. Thoracic paravertebral block

Thoracic paravertebral block (TPVB) provides excellent unilateral analgesia in chest trauma patients. Segmental thoracic dermatomal block associated with less frequent hypotension in these hypovolemic patients as compared to TEA. TPVB may be administered in patients with anticoagulation, concomitant spinal injury, allowing adequate analgesia without interfering in neurological assessment [8].

4.1.2. Intercostal nerve block (ICNB)

Involves injection of local anesthetics around the posterior segment of intercostal nerves. Contrast studies of intercostal injections have demonstrated the spread of contrast media to adjacent dermatomes representing spread via the extra pleural or paravertebral spaces. ICNB can be used in minor chest injuries with unilateral less than three rib fractures but in major chest injuries and for thoracotomy, ICNB are less effective, these patients require more effective pain management modalities such as TPVB and TEA. Radiographic studies of intercostal injections have demonstrated the spread of injectate to adjacent dermatomes representing spread via extra pleural or paravertebral spaces [9].

4.1.3. Intrapleural analgesia (IPA)

Involves injection of a local anesthetic agent between parietal and visceral pleura through an indwelling catheter. This produces a multiple intercostal nerve block by gravity dependent diffusion of local anesthetic agent across the parietal pleura, producing unilateral analgesia at multiple dermatomal segments. Advantages of intrapleural blocks involve relatively easy technique, minimal hemodynamics derangements, no motor weakness and bowel and bladder involvement. This modality of analgesia can be used in blunt chest injury patients. IPA is associated with disadvantages like unpredictable analgesia, systemic local anesthetic toxicity, loss of local anesthetics through chest tube (loss of local anesthetics through chest tubes can be minimized by transient clamping of chest tubes). Other adverse effects of intra pleural

block includes pneumothorax, hemothorax, and decreased diaphragmatic contractility due to disproportionate diffusion of LA and adversely affecting its function [10].

4.1.4. Abdominal plane blocks

The transverse abdominal plane (TAP) block and rectus sheath block provide somatic sensory analgesia to the anterior abdominal wall. The anterior divisions of the spinal nerves T7-L1 cross between the internal oblique and the transversus abdominis muscles, and they perforate the rectus abdominis muscle. These nerves can be blocked injecting local anesthetics between internal oblique and transversus abdominis muscles (TAP), or between rectus sheath and rectus muscle (rectus sheath block). Although these blocks are widely used for postoperative analgesia, its use in trauma patients is limited. Recent data suggest that erector spinae plane block or quadratus lumborum block may be more useful abdominal trauma and pelvic fractures.

4.2. Limb trauma

Upper limb injuries are particularly suited to peripheral nerve blocks for prolonged pain management and repeated surgical interventions. Brachial plexus block (BPB) provides superior analgesia, reduced narcotic consumption and shorter hospital stay compared with general anesthesia for ambulatory upper limb trauma surgery. For bilateral upper limb injuries ultrasound guided BPB with distal approaches and peripheral nerve blocks are recommended to minimize local anesthetic toxicity and risk of diaphragmatic palsy and respiratory distress.

Options for pain management in upper limb include the following:

- Brachial plexus block (e.g. interscalene, supraclavicular, infra-clavicular and axillary approaches)
- Peripheral nerve block (e.g. radial, median, and ulnar)
- Intravenous regional anesthesia (IVRA)

4.2.1. Lower limb trauma

Regional anesthesia for managing patients with polytrauma challenging, appropriate use of regional anesthesia can complement ATLS management priorities. Peripheral nerve blocks are generally safer and more practical than neuraxial techniques in hemodynamically unstable trauma patients. The challenge of translating benefit from regional blocks to patient care pathway requires appropriate infrastructure and training. Regional block provides main attributes of an ideal analgesic. Advantages of RA include superior analgesia, attenuation of stress response decreased postoperative delirium and avoidance of systemic side-effects.

Regional anesthesia and peripheral nerve blocks are increasingly used for lower limb trauma. Advances in ultrasonography in regional anesthesia increases the percentage of block success and reduces the requirement of local anesthetics. Femoral and lumbar plexus blocks for femur fractures are effective and safe in hemodynamically unstable and elderly trauma patients.

Regional anesthesia for hip fractures is associated with less delirium and better analgesia. For lower leg injuries, sciatic nerve block by parasacral, mid sciatic or popliteal approach facilitate superior analgesia. Ankle blocks are almost replaced by popliteal nerve block with saphenous nerve block to allow surgery to the foot.

Options for pain management in lower limb include the following:

- Lumbar epidural
- Subarachnoid block
- Lumbar/sacral plexus block
- Compartment blocks (e.g. fascia iliac)
- Peripheral nerves (e.g. femoral sciatic, saphenous, and obturator)

5. Limitations of regional anesthesia in trauma

Careful risk–benefit analysis must be used while considering RA techniques. Circumstances where RA is not appropriate include: the debate on whether peripheral blocks are safer when performed on awake or anesthetized patients is unresolved. Available evidence is low-level and conflicting and expert opinion is divergent. Regional anesthesia in sedated patients hide presentation of complications associated with RA like intraneural injections and local anesthetic toxicity.

Regional anesthesia is contraindicated in the following situations:

- Trauma victims with hemorrhagic shock and threatened airway
- Traumatic brain injury
- Raised intracranial pressure (for neuraxial blocks)
- Coagulopathy
- Patient refusal for regional anesthesia
- Allergy to LA
- Lack of appropriate training, equipment, and care bundles

6. Special problems

6.1. Compartment syndrome

Compartment syndrome is the most dreaded complication following a limb trauma. Acute compartment syndrome commonly occurs following forearm and leg fractures in young

adults less than 35 years of age. Who has more tissue mass. Acute trauma leads edema of injured tissues, due to closed osteofacial compartment in forearm and leg, increased pressure following tissue swelling causes collapse of arterioles and capillaries, which leads to cessation of circulation and tissue hypoxia. Following tissue hypoxia inflammatory mediators will be released leading to increased vascular permeability and worsening tissue edema. Regional anesthesia and peripheral nerve blocks provide excellent perioperative analgesia, but few clinicians fear an anesthetized limb may delay the diagnosis of acute compartment syndrome by masking symptoms due to regional block. However, sensitivity of these subjective symptoms is less than 20% [11, 12].

There are only five case reports of compartment syndrome following peripheral nerve blocks. At present, it is difficult to make direct correlation peripheral nerve blocks to compartment syndrome. The use of lower concentration of local anesthetics, intermittent analgesic, measuring compartment pressure in high-risk patients, limb elevation and careful monitoring are key for early diagnosis and prompt treatment.

6.2. Preexisting nerve injury

The “double crush syndrome” proposes that patients with pre-existing nerve lesions are more susceptible to further injury when exposed to a secondary insult. Preexisting nerve injury in trauma victims may be exacerbated by nerve blocks, either by direct damaging nerve or due to local anesthetic induced neuronal toxicity, although the evidence of neuronal injury due to PNB is unequivocal.

Careful neurological assessment risk stratification and usage of ultrasonography for peripheral nerve blocks will substantially reduce direct nerve injury. Usage of USG during peripheral nerve blocks allows low volume and concentration of LA by precisely localizing neuronal structures, and this reduces the incidence of neuronal injury [13].

6.3. Anticoagulation

Trauma victims with multiple injuries predisposes to coagulopathy, this may be exacerbated by massive blood transfusion, hypothermia, medications and disseminated intravascular coagulation. Risk depends on the patient, mechanism of injury and medicines. In acute phase hypothermia and hemorrhage may lead to a coagulopathy. Best way is to individually weigh risk against the benefit of RA in trauma patients with coagulation abnormalities [14]. If the RA is chosen for the patients with coagulation abnormalities, extreme vigilance and monitoring for eventual side effects is mandatory.

Recommendations for performing RA should be done according to latest American Society of Regional Anesthesia and Pain Medicine guidelines [15]. Spinal and epidural anesthesia in patients the coagulopathy poses greater risk than peripheral nerve blocks since hemorrhage into the central neuraxis causes more disastrous complication. Thromboprophylaxis in trauma victims could contraindicate usage of neuraxial block. Choosing appropriate anticoagulation schedules and usage of ultrasonography for regional anesthesia provides the safer option in anticoagulated patients.

Recent advances in point-of-care coagulation testing like thromboelastography provide rapid, objective assessment of hemostatic function. This may be used before interventions, to detect type of coagulopathy and to administer specific coagulation factors.

6.4. Chronic pain

Chronic pain is more common following trauma than often realized, inadequate management of acute pain increases the risk of development of chronic pain syndrome. It may be due to nociceptive pain or often include a neuropathic component, which can be difficult to treat. There are several pain syndromes such as complex regional pain syndrome (CRPS), postamputation pain, and posttraumatic stress disorder which are specifically associated with trauma.

Early, effective and sustained analgesia and usage of peripheral nerve blocks after injury decreases the incidence and severity of chronic pain syndromes. Administration of low and therapeutic doses of antidepressants, oral ketamine and gabapentin should be considered for persistent pain [16, 17].

7. Conclusion

Trauma represents a considerable and increasing demand on healthcare resources. Early resuscitation and on-arrival block forms primary goal initial management of polytrauma patients. Advances in regional anesthesia, better training and availability of point of care sonography allowed safer administration of RA and peripheral nerve block in critically ill polytrauma patients. Early administration of peripheral nerve blocks minimizes pulmonary and cardiovascular complications, decreases incidence of posttraumatic stress disorder and chronic pain syndrome, allows prompt mobilization and significantly reduces consumption of narcotic analgesics. Careful use of regional anesthetics in polytrauma patients, reduce duration of hospital stay and delirium in elderly patients. Regional anesthesia and peripheral nerve blocks are not devoid of adverse effects like systemic LA toxicity, neurovascular injury, and compartment syndrome. Selecting proper regional anesthesia technique, usage of appropriate local anesthetic concentration and volume, these complications can be reduced. RA is more versatile and reliable than ever before, with appropriate patient selection and usage of ultrasonography, such interventions are effective and safe. When used carefully in selected polytrauma patients regional anesthesia provides a cost-effective and safer method of analgesia in injured patients in both during surgery and perioperative settings.

Conflict of interest

Nil.

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