

Chapter 18

MULTIMODAL ANALGESIA FOR SPECIFIC INJURY PATTERNS

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INTRODUCTION

It is clear from earlier chapters in this book that developments in patient care and especially resuscitation have advanced considerably during the conflicts of the last decade. Similar advances have also taken place in the fields of acute pain management and regional anesthesia. Pain relief in recent conflicts has become an area of acute deployed medicine that has rightly received considerable attention from the chain of command in

both the United Kingdom and the United States. Other chapters describe the benefits of analgesia (Chapter 17, Why Pain Relief is Important: The Physiological Response) and the pain medications (Chapter 20, Pain Medications) available to the deployed anesthesiologist. This chapter will consider the application of the combined techniques of regional anesthesia and pain medications to common combat injuries.

BASICS OF MULTIMODAL ANALGESIA

Casualties of military operations sustain the complete spectrum of injuries from the very minor to the most serious and complex injuries imaginable, and a multimodal approach to analgesia is recommended from the start of treatment. The multimodal approach includes using regular doses of simple analgesics with differing mechanisms of action as well as opioids and adjuvants (described in Chapter 20). The World Health Organization (WHO) pain ladder (Figure 18-1)¹ describes the generally accepted approach to prescribing simple analgesics and opioids in painful conditions, with a stepwise increase in strength and dose of opioid as the degree of pain increases. This approach is the foundation of multimodal analgesia. When there are no contraindications, patients should receive regular doses of nonopioid analgesics such as paracetamol (acetaminophen) and a nonsteroidal antiinflammatory drug (NSAID) by the oral or intravenous route as available.

Opioid analgesics and the options for the deployed environment are described in Chapter 20. The use of regular doses of weaker opiates should be guided by the degree of pain a patient is experiencing. In some situations regular doses of codeine phosphate are appropriate; however, as the amount of pain increases, it may be better to begin regular doses of a more potent opioid, such as tramadol, in a lower dose. Regular

doses of tramadol should also be considered as part of a multimodal approach for acute pain, especially if there may be nerve injury. Tramadol has a number of actions. It is a μ -opioid receptor agonist, a serotonin-releasing agent, a norepinephrine reuptake inhibitor, an *N*-methyl-D-aspartate receptor antagonist, and a 5-HT_{2C} receptor antagonist. It is metabolized to *O*-desmethyltramadol, which has stronger μ -opioid agonist action (as well as actions on norepinephrine reuptake and 5-HT).² Because of its useful spectrum of action, tramadol is particularly appropriate in patients with actual or potential nerve injury.

As the degree of pain increases, it is appropriate to add morphine to the prescription. The route chosen will obviously depend on the amount of pain patients are experiencing and whether they have a functioning gastrointestinal tract. Intravenous morphine will be required for the most severe acute pain and to keep side effects, patient satisfaction, and nursing workload at the optimum Patient-controlled analgesia (PCA) is the recommended approach. Oral morphine, as a liquid or tablet, can be used for lesser degrees of pain as well as for weaning patients from PCA. Ketamine is also very effective in treating acute pain; doses of 10 to 30 mg are a useful starting point. Ketamine works well on its own or in combination with conventional opioids.

ADVANCED TECHNIQUES

PCA is a well established technique available to US and UK military medical services. Its well known advantages of effective analgesia with reduced side effects and less pain breakthrough, along with reduced nurse workload, are as applicable in the deployed setting as in civilian practice. For PCA to work effectively, the patient must be instructed in the technique and understand the concept, so it is usually prescribed to adults only. Current experience is that many local nationals do not understand the concept of PCA even when instructed directly through a translator. Alternatives

to PCA include the use of a morphine or ketamine infusion, which may make it necessary for the patient to be cared for in a medium- to high-dependency setting postoperatively.

Adjuvant drugs other than analgesic medications should also be considered. It is important to address phantom or neuropathic pain as well as conventional acute postoperative pain. The adjuvants most often prescribed for injuries that may cause this type of pain are tricyclic antidepressants and anticonvulsants. If nerve injury is obvious or likely, it is appropriate to

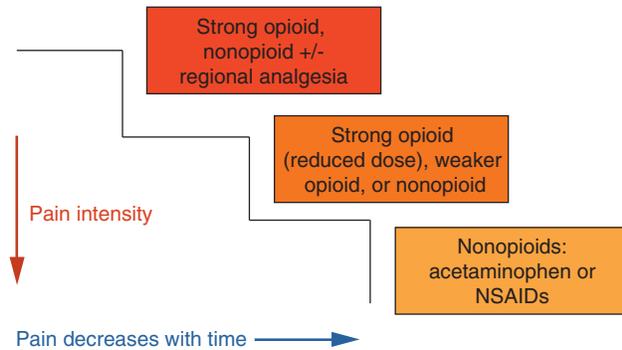


Figure 18-1. Decreasing ladder of acute pain, based on the World Health Organization pain ladder.

NSAID: nonsteroidal antiinflammatory drug
Adapted with permission from: World Health Organization. *Cancer Pain Relief*. 2nd ed. Geneva, Switzerland: WHO; 1996: 15.

MULTIMODAL APPLICATIONS

Simple or Single Injuries

Isolated Upper Limb Injury

For many injuries of the upper limb, regional anesthesia via the supraclavicular approach to the brachial plexus is recommended. This technique is often and accurately described as the “spinal” anesthetic of the arm. The approach is particularly suitable for single injections or catheters and can be performed on an anesthetized patient (for postoperative pain relief) or on an awake patient either as the sole anesthetic or prior to a general anesthetic. If the block is performed in the emergency room prior to a general anesthetic, requirements for analgesia are simplified as well. The axillary approach to the brachial plexus is useful for hand injuries; however, even with an intercostobrachial block (which is appropriate with the supraclavicular approach as well), tourniquet pain may be an issue for the awake patient after 1 or 2 hours. The interscalene approach is a useful block for surgery to the shoulder and proximal upper limb.

A working knowledge of individual nerve blocks at the elbow or wrist is valuable for surgery in these areas as well as for rescuing a failed block performed more proximal. The choice of block will depend on a number of factors, including area of injury, access to the limb, and the experience of the anesthetist. As above, the supraclavicular approach is often a good choice.

The decision to use a single injection or to insert a continuous peripheral nerve block (CPNB) catheter will depend on factors previously discussed. Generally, an approach that can be recommended for most isolated limb injuries is that of regional anesthesia alone

start amitriptyline and gabapentin or pregabalin in the early postoperative period.

The use of regional anesthesia in the deployed environment has grown over the last 5 to 10 years. The introduction of portable ultrasound technology and improved regional anesthesia needles and catheters into the deployed environment has made a significant impact. For some injuries single-injection regional anesthetic blocks to a particular nerve or plexus can provide excellent operating conditions and all the analgesia needed. However, many trauma patients require ongoing pain relief, particularly during evacuation, so it is always appropriate to have a low threshold for inserting a catheter. Often combat casualties have multiple injuries, so a mixture of simple analgesia, PCA, and regional blocks are brought to bear (ie, multimodal analgesia).

or, as is quite often the case, general anesthesia with addition of a supraclavicular block (single injection or catheter as appropriate) for postoperative pain relief.

Isolated Lower Limb Injury

For the majority of cases with injuries confined to a single lower limb, anesthesia and analgesia should be provided by blockade of the femoral and sciatic nerve. Some controversy remains regarding the use of regional analgesia in patients with the potential to develop compartment syndrome (CS), as discussed below. For injuries or operations above the knee, femoral and sciatic nerve blocks are effective and appropriate. For injuries below the knee, the sciatic nerve can be blocked in the popliteal fossa above the division into the tibial and common peroneal nerves. Catheter techniques are effective in all of these locations. When short-term pain relief is required below the knee, a saphenous nerve block can be effective without producing the motor weakness associated with blockade of the femoral nerve at the groin.

Abdominal Injuries

A number of approaches to pain relief are required due to the variety of abdominal surgical procedures, ranging from groin incisions for extraperitoneal vascular control to extended midline laparotomy incisions. The choice of regional analgesia technique usually rests between epidural and transversus abdominis plane (TAP) block. Although the thoracic epidural remains the gold standard for abdominal surgery,³ an epidural may not always provide perfect analgesia

for an incision from xiphisternum (T6) to pubis (T12). When performing a thoracic epidural for a laparotomy incision, many anesthesiologists insert the needle half to two-thirds of the way along the dermatomal range (eg, T7/8 or T8/9). Although catheters placed lower can be bolused to improve spread, this may be associated with greater hemodynamic instability and unnecessary pain between boluses. If patient-controlled epidural anesthesia is available, lower insertion may be acceptable. For incisions below T10, the conventional TAP block is very satisfactory; however, it is unusual for the block to spread much above T9. For upper abdominal incisions, a subcostal TAP block can be performed, but with this approach it is unlikely there will be significant block below T10. A recent paper comparing TAP blocks to epidural analgesia for upper abdominal surgery (incision at or above T10) found little difference in pain scores but an increased opioid consumption in the TAP group, potentially reflecting increased visceral pain.⁴

Although TAP blocks are commonly used as a single-injection technique, they also work well with CPNB catheters.⁵ A key factor in the choice between TAP blocks and epidural in the combat casualty is likely to be coagulation status. Clearly, an epidural is contraindicated in the patient with coagulopathy (see Chapter 22, Regional Anesthesia and Coagulopathy of Trauma Shock, for detailed information including guidance on ROTEM [TEM International GmbH, Munich, Germany] results). The use of rectus sheath catheters, placed by the surgeon prior to wound closure, has also received attention recently in civilian practice and may be worth attempting in the deployed environment, particularly in the patient with coagulopathy.⁶ Specially designed catheter systems are available and their use is being investigated.

Although PCA alone is not likely to be associated with acceptable pain scores during movement, it may well be required in addition to a regional technique (eg, for controlling visceral pain when TAP blocks have been performed). If an epidural is used with PCA, the local anesthetic solution should be opioid free to avoid the risk of delayed respiratory depression with central and intravenous opioids.

Thoracic Injuries

As with abdominal surgery, the choice of postoperative pain relief for thoracic injuries depends on the operation performed and therefore the incision used. Once again the gold standard is almost certainly a thoracic epidural. As before, concerns over coagulopathy may delay an epidural until any coagulation defect has been corrected, or another approach may

be used. Alternative approaches also depend on the incision. Paravertebral injections are one option. Although sometimes used only for unilateral surgery, bilateral paravertebral blocks (both single-injection and catheter) are regularly performed. Single-injection techniques have been well described,⁷ as have catheter techniques,⁸ although the available space is small and inserting a catheter is not always as easy as an epidural. It is recommended that only 2 cm of catheter be advanced, which does not leave much room for error postoperatively. If more than four dermatomes need to be blocked, more than one injection site is required, which tends to rule out the option of continuous infusions. A simpler alternative is asking the surgeon to place a catheter in the interpleural space posteriorly in the chest cavity. Although pain relief can be extremely effective using this technique, if multiple chest drains are inserted as well the catheter may be adversely impacted. Once again, a combination of a regional technique with PCA is often required.

Compartment Syndrome

CS has been reviewed by UK medical subject matter experts,⁹ and more recently a US clinical practice guideline has been published on the subject.¹⁰ CS is a well described complication of severe traumatic limb injury. Definitive treatment is surgical release of compartments,¹¹ but this treatment is not without complications. Although the decision is obvious in some cases, fasciotomy is not immediately necessary in others. As with any other injuries, optimal analgesia is a requirement. Past controversy has occurred about the correct route of analgesia for limb injuries, particularly in lower limbs. Although regional blocks are a very effective option for analgesia in these cases, some orthopedic surgeons have been concerned that such blocks can mask CS signs and symptoms. The literature contains case reports¹²⁻¹⁵ in which CS has been masked by conventional analgesia, including PCA morphine. There seems to be no appetite to restrict the use of morphine in these cases.

Similarly, there is no evidence in the literature that regional analgesia has masked CS more than other forms of pain relief. A review of 28 case reports¹⁶ of CS found classic signs and symptoms of CS in the presence of epidural analgesia in 32 of 35 patients, including 18 patients with documented breakthrough pain. These results strongly suggest that regional anesthesia techniques are not very effective in treating ischemic pain from CS in the presence of epidural analgesia. Good analgesia of any kind could potentially mask CS, so avoiding regional analgesia on this basis is illogical. It is also important to distinguish between dense blocks

with high concentrations of local anesthetic agents and blocks using lower concentrations. In this situation the use of 0.2% ropivacaine is recommended. Monitoring of motor function should be part of the standard observations on any patient with an epidural or CPNB.

The military casualty population differs from the civilian population in the requirement for evacuation, sometimes over long distances. During this period surgical decompression of CS is not possible. It is therefore necessary for attending surgeons to make the decision to decompress prior to transfer. In US facilities, the trauma surgeon and acute pain anesthesiologist should discuss in detail any cases that are at high risk for CS. In UK facilities the Deployed Medical Director may need to be involved. Pain treatments may be withheld briefly for diagnosis of CS. Ultimately the treatment for CS is surgery.

Complex Injuries

A signature injury of the current conflict is traumatic bilateral lower limb amputations, often with upper limb injuries and potentially perineal or abdominal injury as well. The abdomen is often opened in casualties with these severe injuries, usually to gain vascular control. American and British service personnel who sustain injuries of this severity will often be transferred to a Role 4 facility as a matter of urgency. Patients who will remain ventilated on infusions of opioids and sedatives clearly require no regional anesthesia at this stage. However, there are advantages to extubating a ventilated patient as early as possible.¹⁷ Benefits include reduced morbidity (eg, for ventilator-acquired pneumonia) as well as the ability to begin decompression.

Casualties also often complain about long periods of “amnesia” from being sedated (commonly for several days) following their return from the operating room. For patients who can be extubated, it is necessary to provide the best pain relief possible to support maximum respiratory effort in this situation. As mentioned above, the patient’s coagulation status is often a major concern, especially if epidural analgesia is being considered. Because many such patients will be sedated and ventilated for hours in the immediate postoperative period, it is important to discuss their management with the intensive care physician, aiming to correct coagulation and then insert an epidural prior to weaning and extubation, which may take place 12 to 24 hours after surgery.

Although discrete nerve blocks are extremely useful in multiply injured patients, the number of blocks or catheters inserted in a single patient should be limited to avoid toxic doses of local anesthetic. As a rule it is

recommended that no more than two or occasionally three catheters be inserted. For bilateral lower limb injuries, when coagulation issues have been resolved, epidural is the obvious choice. If upper limb injuries are also present, it is possible to insert a supraclavicular catheter for the worst affected side. In this situation opioid-free local anesthetic solutions should be used for the epidural, with additional pain management using PCA morphine.

Injuries to Local Nationals

Injuries to local national civilians and combatants on both sides are common, and despite attempts to remove such patients from the military care system through various “eligibility matrix” policies, experience shows that these patients will be received. Such patients raise difficult ethical decisions (see Chapter 42, Ethical Challenges of Deployed Military Critical Care), but all patients should be treated equally in the provision of adequate pain relief. Additionally, by reducing morbidity it may be possible to speed up their recovery and move these patients into the local medical system, thus relieving pressure on beds in what are usually small medical facilities.

The usual pain relief techniques are appropriate with local nationals; however, as described above, PCA may not be well understood, despite the use of an interpreter. There have also been problems with recreational drug use among local nationals, which can affect pain management. The management of children often causes concern for military clinicians who tend to be doctrinally focused on adults. However, within the bounds of experience and competency, many of the techniques described above may be used in the pediatric population. Epidurals remain appropriate for abdominal and bilateral lower limb injuries. If an epidural is not considered appropriate because of a patient’s age and size, TAP catheters or even rectus sheath catheters may be inserted. PCA is unlikely to be appropriate in this age group, but in a medium- to high-dependency setting morphine infusions are appropriate and ketamine infusions have been used. Full regular doses of paracetamol and an NSAID should be prescribed as for adults when there are no contraindications.

Treatment Facilities

Current practices for regional anesthesia may vary according to type of facility or role of care. In the deployed environments, Role 3 facilities are permanent structures where infection control is adequate and the clinical environment is clean. In tented medical facili-

ties (Role 2), practice has differed between UK and US clinical staff, especially over the insertion of epidural catheters. The UK view has been that this environment is more contaminated, so epidural insertion has been avoided. However, there is little evidence for this position, and US staff have continued to insert epidurals in Role 2 facilities with little evidence of harm. The greatest source of contamination is the patient, and use

of a standard sterile approach (skin decontamination, gown, gloves, mask, drapes, etc) should minimize risk. As with any clinical procedure, a risk-benefit assessment should be made. There is good evidence of safety for CPNB catheters based on recent experience in a variety of medical treatment facilities. The risk of infection can also be reduced by tunneling catheters, which is recommended.

CASE STUDIES

Local National Combatant With Isolated Forearm Gunshot Wound

The operating room was busy and no tables were free, but surgery was urgently required. It was expected that this casualty would be unlikely to use PCA properly, but his acute pain had to be addressed and his requirement for an anesthetic in the near future considered. A supraclavicular CPNB was performed. The patient was made comfortable, allowing transfer to the ward to wait for operating room space. In due course he was brought to the operating room and his surgery carried out under the regional block.

Local National Child With Penetrating Abdominal Injuries

A 9-year-old local national child was admitted

with fragmentation injuries to the abdomen, and an exploratory laparotomy was undertaken. Post-operative pain relief was initially managed with bilateral TAP blocks as single injections under US guidance. These worked well, and the patient was returned to an intermediate-dependency area with bolus intravenous morphine as rescue analgesia. Approximately 12 hours later, the Role 3 acute pain service was asked to review the patient due to large morphine requirements and high pain scores. The pain service team decided to return to the operating room and insert a thoracic epidural. This was performed in the lateral position uneventfully and the patient's pain was well controlled thereafter. This case demonstrates the potential problems associated with single-injection techniques as well as the benefit of a dedicated acute pain service.

SUMMARY

It is clearly important to manage acute pain in a timely and effective fashion for reasons of simple humanity, practicality (ie, easier patient management), reduced morbidity, and reduced incidence of chronic pain and long-term opioid consumption. A decade's experience with combat injuries shows that

even relatively advanced techniques, including PCA and regional blocks, are not sufficient when used on their own to provide the degree of pain control these patients require. A multimodal and multidisciplinary approach, however, provides exceptional pain relief in the majority of these casualties.

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