Orthopedic procedures can cause severe intra-operative and post-operative pain. It is important to achieve optimal post-operative pain control since this will facilitate more rapid achievement of functional outcomes. The current analgesic techniques being used to control pain after major orthopedic surgery are discussed in this article.

**Intravenous Opioids**

Intravenous (IV) opioids have not been as effective for post-operative pain control in orthopedic surgery as they have been noted to be in major abdominal surgeries. Frequent side effects of nausea, sedation, and confusion have also been associated with the use of IV opioids. However, the advantage of IV patient-controlled analgesia is that it allows patients to titrate analgesics in amounts proportional to perceived pain stimulus and provide improved analgesic uniformity.

**Regional Anesthesia**

The common regional techniques in orthopedic surgery include spinal blocks, epidural blocks, axillary brachial plexus blocks, IV regional anesthesia, and femoral nerve block. Currently, spinal anesthesia is the anesthetic technique of choice for surgery of the lower extremities. No outcome differences regarding major morbidity parameters can be shown between the use of spinal anesthesia compared with general anesthesia for orthopedic surgery of the lower extremities.

It has been reported that the post-operative pain relief from epidural analgesia is superior to pain relief from IV opioids; therefore, epidural analgesia is widely used for lower limb surgeries. Post-operative pain control after knee surgery is one of the most painful orthopedic procedures. Post-operative pain after knee arthroplasty has been controlled by oral or intramuscular opioids, patient-controlled IV opioids, patient-controlled epidural analgesia (PCEA) or single-dose/continuous-dose femoral nerve blocks (CFNB). It has been observed that intra-

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**References**

operative and post-operative epidural anesthesia results in early rehabilitation after knee arthroplasty.\(^{11}\)

It has also been found that epidural ropivacaine combined with morphine provided improved pain relief in comparison with patient-controlled anesthesia (PCA) morphine.\(^{7}\) The patients had numerically lower pain scores when they received higher doses of ropivacaine at rest and on movement compared with those patients receiving lower doses of ropivacaine. Although motor block was greater in patients receiving higher doses of ropivacaine, the mobilization was similar in both groups of patients. Another study showed that the combination of 0.0625% bupivacaine with fentanyl 3\(\mu g/ml\) was more cost-effective and produced better patient satisfaction than PCEA with 0.15% alone.\(^{7}\) Neuraxial analgesia provided by epidural and spinal administration of local anesthetics and opioids therefore provide the highest level of pain control. It must be kept in mind that this mode of treatment is highly invasive and labor-intensive.\(^{1}\)

**Peripheral Nerve Blocks in Lower Extremity Orthopedic Surgeries**

It is possible to use peripheral nerve blocks alone and achieve adequate pain relief without any form of neuraxial analgesia. It has been found that continuous femoral nerve block plus a sciatic nerve block caused less nausea and resulted in more patients with no pain when compared with patients who received epidural analgesia after total knee arthroplasty (TKA).\(^{12}\) However, analgesia after CFNB without a sciatic nerve block was equivalent\(^{12}\) or inferior to epidural analgesia.\(^{12}\) YaDeau et al.\(^{10}\) evaluated the combination of femoral nerve blockade and combined spinal–epidural analgesia after TKA. The epidural catheter was not used during surgery. They found that a single injection femoral nerve block combined with epidural analgesia using a low concentration of local anesthetic (0.06% bupivacaine + 10\(\mu g/ml\) hydromorphone) improved pain relief with physical therapy. It significantly improved analgesia for the first two post-operative days after TKA and improved knee flexion on post-operative day (POD) 2.

**Continuous Local Infusion and Plexus Blockade**

Bedside femoral nerve block has been found to be a useful adjunct to other pain methods on POD 1 following primary knee arthroplasty (PKA).\(^{14}\) Nerve blocks and pain infusion pumps in the knee joint may be used after TKA or after anterior cruciate ligament reconstruction.\(^{13}\)

**Regional Anesthesia in the Upper Extremity**

Regional anesthesia in the upper extremity can be carried out as a single dose-brachial plexus block or as a continuous infusion to provide a longer duration of post-operative pain relief. Continuous plexus and peripheral neural blockade offer excellent analgesia without the side effects associated with neuraxial and parenteral opioids.\(^{1}\) This is particularly true in orthopedic surgery for the upper extremities.

Brachial plexus blocks are increasingly being carried out with a nerve stimulator and the trend has been to use large volumes of local anesthetic solutions to fill the plexus-containing compartment, achieving rapid onset of the block. Continuous brachial plexus blocks are used for reimplantation of the peripheral parts of the arm via an axillary brachial plexus block,\(^{16}\) and as interscalene brachial plexus blocks for shoulder surgeries.\(^{17}\) Recent developments also include the use of brachial plexus patient-controlled continuous infusions of low doses of local anesthetics via perineural, intra-articular, subacromial, and axillary approaches.\(^{18}\) These continuous block catheters can usually be removed on POD 2 or POD 3.

**IV Regional Anesthesia**

IV regional anesthesia (RA) utilizes large amounts of local anesthetic, 200–250mg of lidocaine or prilocaine, and has been effective for short duration peripheral orthopedic surgeries of the hand or forearm. The mechanism of action appears to be on the non-pharmacological effects of ischemia and compression.  

**Thromboembolic Prophylaxis in Orthopedic Surgery**

Thromboembolic prophylaxis and continuous epidural infusion after lower limb surgery may result in the rare complication of epidural hematoma. Caution has to be taken in patients receiving thromboembolic prophylaxis while performing blocks for surgery and for post-operative pain control. Currently, commonly used drugs that increase the risk of spinal hematoma include warfarin, various forms of heparin (such as low molecular heparin), long-acting thrombolytic and fibrinolytic drugs, and drugs that inhibit platelet aggregation. With the emergence of new absolute and relative contraindications for spinal and epidural analgesia there has been an increased interest in the use of peripheral nerve blocks of the lower extremities.

**Adjuncts**

Epidural mixtures usually consist of a dilute local anesthetic and a low concentration of an opioid. Adjuncts such as clonidine epinephrine have been added with favorable, but controversial, results. Other adjuncts may be used as a supplement via the parenteral or the enteral route. Acetaminophen has been used effectively as an adjunct for patients undergoing orthopedic surgery. Sinatra et al. reported that 1g of IV acetaminophen administered over a 24-hour period in patients with moderate to severe pain after orthopedic surgery provided rapid, effective, well-tolerated analgesia. Opioid dose may also be reduced by the coadministration of cyclooxygenase-2 (COX-2) type non-steroidal analgesics. Buvanendran et al. found that the perioperative use of an inhibitor of COX-2 is an effective component of multimodal analgesia that reduces opioid consumption, pain, vomiting, and sleep disturbance, with improved knee range of motion after TKA.

**Ultrasound-guided Pain Management Techniques for Orthopedic Surgery**

There has been increased interest in the use of the ultrasound wave with the >20kHz beam-guided placement of block needles. Brachial plexus anatomy has been studied and block needles have been successfully placed with ultrasound imaging guidance. There has not been as much success in the area of the lumbar plexus and the sciatric nerve with this method of the identification of nerves.

**Conclusion**

In conclusion, there are several recently developed analgesic techniques that control pain effectively after major orthopedic surgery. It appears that refinement of regional anesthesia for orthopedic surgery will depend on how anesthesiologists use current medications and techniques in finding the appropriate analgesia drug mixtures, appropriate concentrations, and the route of administration for each type of surgery for the individual patient. In addition, continued research should focus on how best to use the nerve detection techniques, needles, catheters, and pumps to improve the administration of regional anesthesia for orthopedic surgery.

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