Adductor Canal Block for Post-Operative Pain Relief in Knee Surgeries: A Review Article

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Abstract

The adductor canal block (ACB) is newer compartment block of the saphenous nerve, which is a branch of femoral nerve, performed at the level of lower third of the thigh so that much of the motor innervation of the quadriceps group is spared, thus preserving much of the quadriceps strength making early ambulation and rehabilitation safer. The most significant advantage of the ACB over femoral nerve block and other techniques is that it is predominantly a sensory block and reduces the incidence of fall after knee surgeries.

Keywords: Adductor canal block; Post-operative analgesia; Quadriceps strength; Knee surgery

Introduction

Postoperative pain is an important consequence of knee surgeries that can affect early ambulation, range of motion and duration of stay in hospital. Advance surgical techniques like arthroscopies and early mobilization after surgery have made knee surgeries more patients friendly.

As we know pain is considered as fifth vital sign. Unrelieved postoperative pain may result in clinical and psychological changes that increase morbidity and mortality as well as costs and that decrease quality of life [1]. Inadequate pain control can lead to secondary medical sequela such as venous thromboembolic and cardiac events. Adequate control of pain is therefore paramount to a successful outcome and to patient satisfaction [2].

Adequate analgesia with motor preservation has become the prime goal after orthopedic surgeries to enable shorter hospital stay, early physiotherapy and faster recovery.

Many options are available for the treatment of postoperative pain, including systemic (i.e., opioid and nonopioid) analgesics and regional (i.e., neuraxial and peripheral) analgesic techniques. Multimodal analgesia is achieved by combining different analgesics that act by different mechanisms and at different sites in the nervous system, resulting in additive or synergistic analgesia with lowered adverse effects of sole administration of individual analgesics [3].

In knee surgeries, epidural analgesia faces has become the prime choice for orthopedic surgeries to enable shorter hospital stay, early physiotherapy and faster recovery.

In knee surgeries, epidural analgesia faces a relatively high failure rate [4] and can produce adverse effects such as urinary retention and motor block [5], the latter potentially hindering early mobilization.

Femoral nerve block (FNB) is a well-established treatment for postoperative pain, however, invariably followed by reduced quadriceps muscle strength [6,7] and associated with the risk of falling [8-10].

Periarticular multimodal drug injection (PMDI) and adductor canal block (ACB) are associated with good analgesia and preservation of motor function. PMDI is periartricular injection of a mixture of medications during surgery, usually consisting of ropivacaine, ketorolac and adrenaline delivers drugs directly to the source of pain, particularly the posterior capsule of the knee or hip joint [11,12].

Adductor canal block (ACB) is a highly successful approach to the saphenous nerve (also k/a saphenous nerve block), that was first described by Vander Wal [13]. Compared with FNB, ACB results in less reduction in the quadriceps muscle strength [14] as only the motor nerve to the vastus medialis of the quadriceps muscle traverses the adductor canal [15].

Relevant Anatomy

The adductor canal (also known as Hunter's canal or “subsartorial canal”) is bordered by 3 muscles: anterolaterally the quadriceps muscle vastus medialis); posteriorly adductor magnus, and medially the sartorius muscle. It extends from the upper/anterior thigh femoral structures to the lower/medial thigh adductor hiatus – the distal opening in the adductor magnus muscle approx. 13 cm proximal to the knee. The femoral vessels leave the canal at the adductor hiatus, where they dive deeply, and this abrupt change in femoral artery depth is a useful indicator of the distal limit of the canal, and therefore the optimal level for LA placement. The surrounding muscles and in particular the artery, is useful landmark to guide LA placement [16].

The sensory saphenous nerve, the nerve to the vastus medialis, the medial femoral cutaneous nerve, the medial retinacular nerve, and the articular branches from the obturator nerve travel within the adductor canal [17]. In addition, the femoral artery and vein also travels within the canal.

Cadaver studies have shown that 15 ml of LA is sufficient to fill the adductor canal although an MRI study supported the use of 30 ml volume [18] (Figure 1).

Technique

Adductor canal block does not provide complete surgical anesthesia. So, surgery is carried out under general anesthesia or spinal anesthesia.
and for providing post-operative analgesia, block is administered at the end of the surgery.

Patient is placed in supine position. The operative leg is slightly flexed at the knee and externally rotated into a stable position (frog leg position). After draping the leg, sterile ultrasound gel is applied on the medial aspect about midway down the thigh. An 8-14 mHz linear ultrasound transducer is placed transversely on the medial part of the thigh, halfway between the superior anterior iliac spine and the patella. Femoral artery is identified. The femoral vein will be just beneath the artery and will be easily compressed by downward pressure on the ultrasound probe.

After identifying the femoral artery, the femoral nerves will be seen on either side of the artery as bright, echodensities. An 18-gauge, Contiplex tuohy needle is inserted in-plane from the lateral side of the transducer. The local anesthetic solution is injected on each side of the artery at the points of the bright densities. A 20-gauge catheter can be placed to enhance the duration of the block which is generally advanced 1-2 cm beyond the tip of the needle (Figure 2).

Indications
Adductor canal block (ACB) is used as postoperative analgesia in low volume (5-10 ml) after knee arthroscopy, anterior cruciate ligament reconstruction (ACLR), lower leg, foot and ankle surgery involving areas of skin supplied by the saphenous nerve and in high volume (20-30 ml) after total and uni-compartmental knee replacement.

Contraindications

Absolute
- Patient refusal
- Inflammation or infection over injection site
- Allergy to local anesthetics

Relative
- Anticoagulation or bleeding disorders
- Pre-existing peripheral neuropathies

Complications
These are the same as for any regional anesthetic technique like block failure, bleeding/bruising, infection, local anesthetic toxicity, nerve injury, etc.

Pharmacological Considerations
Adductor canal block can be performed using variety of short and long acting local anesthetics in varying concentrations. In general, the duration of action is affected by the concentration of the local anesthetic as well as the volume injected. Duration of action can also be prolonged with additives such as epinephrine or a corticosteroid, typically dexamethasone [19]. Bupivacaine and ropivacaine are most commonly used long-acting local anesthetic agents. Bupivacaine has the risk of cardiotoxicity causing hypotension, arrhythmias and even cardiac arrest. Ropivacaine has very close pharmacodynamic profile to equipotent doses of bupivacaine. They have similar anesthetic and analgesic effects. The benefit of ropivacaine is its lower risk of cardiotoxicity in the event of inadvertent intravascular injection, significantly faster onset time and higher therapeutic index leading to an improved safety profile [20]. So, ropivacaine can be preferred over bupivacaine.

Differential sensory and motor block with ropivacaine is only apparent at low concentrations (0.2% and less). The 0.20% or higher doses provided satisfactory postoperative analgesia, but a significantly higher rate of motor blockade is seen with concentrations above 0.50% [21]. Thus, for adductor canal block 15 to 30 ml of 0.20-0.50 % ropivacaine is optimal for achieving adequate analgesia with preserved motor power.

Numerous studies compared adductor canal block with femoral nerve block in terms of motor power and analgesia. Kwofie et al. [22] used 15 ml of 3% chloroprocaine to compare ACB with FNB on volunteers and found ACB results in significant quadriceps motor sparing and significantly preserved balance but they did not compared analgesia by above techniques. Patterson et al. [23] used 15-30 ml bupivacaine and found adductor canal block provides equally effective analgesia when compared with a femoral nerve block and improves
postoperative physical therapy performance. Kim et al. [24] used same volume of 0.5% bupivacaine with epinephrine 5 ug/ml and found analgesia and strength were both satisfactory. Sayed El Ahl [25] also used 15 ml of 0.5% ropivacaine and found that quadriceps strength is maintained with ACB but it provides inferior analgesia as compared to FNB.

Higher volumes have also been used by some authors like Jaeger et al. [26] used 30 ml of 0.5% ropivacaine and found that adductor canal block preserved quadriceps muscle strength better than FNB, without a significant difference in postoperative pain. Jenstrup et al. [27] also used 30 ml of 0.75% ropivacaine and found reduction in morphine consumption and pain scores but this large dose if used in higher concentration can cause quadriceps weakness from proximal spread.

Continuous Versus Single Dosing

Postsurgical pain lasts for many days whereas the action of local anesthetic lasts for 18 to 24 hours after a single shot injection. So, alternate delivery methods were developed for continued postsurgical pain management. Indwelling nerve block catheters can be placed adjacent to the nerve and a local anesthetic is infused through an infusion pump [2]. Perineural nerve blocks may be continued following hospital discharge on an ambulatory basis using a portable infusion pump [28,29] (Ambulatory pump). These have shown to decrease the time to reach discharge criteria, provide adequate analgesia, reduce intravenous opioid consumption and facilitate early ambulation.

Patient controlled analgesia (PCA) through catheter can also be used to maintain peripheral nerve block like ACB. PCA provides superior postoperative analgesia and enhances patient satisfaction. It can be programmed for several variables like bolus dose, lock-out interval and continuous or basal infusion. In a study, Mudumbai et al. [30] used an infusion of ropivacaine 0.2% with basal rate of 6 ml/hour, patient-controlled bolus of 5 ml and 30-minute lockout interval and found early post-operative ambulation without reduction in analgesia.

Advantages over Other Techniques

The use of peripheral nerve blocks in the lower extremity has not been as widespread as in the upper extremity. This is due to anatomic considerations as well as the predominance of neuraxial anesthesia [31]. Unlike brachial plexus, the nerves supplying lower extremity are not clustered where they can be easily blocked with a relatively superficial injection of local anesthetic. But advances in needles, catheters, nerve stimulator and ultrasound technology have facilitated localization of neural structures and improved success rates [2].

Femoral nerve block is the most common peripheral nerve block used for providing post-operative analgesia in lower limb surgeries nowadays. The most noted complication of FNB is decreased quadriceps strength [32] which might increase the fall risk. Such incidences may need reoperation for injuries, including ligamentous rupture; fracture, wound dehiscence, and mobile-bearing dislocation have a 0.4% incidence [32]. Additional complications of FNB include vascular injury, hematoma, femoral neuritis (0.59%), and a 0.2% risk of permanent nerve injury [33]. However, large retrospective outcome database study by Memtsoudis et al. [34] found no association between elevated fall risk and peripheral nerve block.

The adductor canal block is another block of the femoral nerve further down the thigh so that much of the motor innervation of the quadriceps group has already departed the nerve, well above the position of the local anesthetic. This preserves much of the quadriceps strength making early ambulation and rehabilitation safer. The most significant advantage of the ACB is that it is predominantly a sensory block [18].

Limitations

The sensory innervations of the knee joint is not only from nerves passing through the adductor canal, but also from articular filaments arising from the nerves to the vastus lateralis and intermedius, which both arise from the posterior division of the femoral nerve proximal to the adductor canal, and in fact only just distal to the inguinal ligament. Therefore, ACB may not provide post knee surgery analgesia as effective as that produced by a combined femoral and obturator block [16].

Being a compartment block, it is likely that intermittent boluses are required to block all nerves within the canal. This will necessitate either nurse administered boluses or a pump enabling relatively high bolus volumes. As the site of catheter placement is close to the knee, there is increased risk of catheter displacement [35].

Conclusion

Adductor canal block is a new technique for postoperative analgesia after knee surgeries with promising results and can be developed as a routine part of anesthesia technique for these surgical procedures.

References


