Abstract:
Femur fractures are extremely painful injuries that frequently involve a number of transfers from the field to stretcher to imaging table to hospital bed. Prompt pain relief is essential. Traditionally, systemic analgesia has been provided orally or parenterally. Systemic medicines are frequently limited by potential deleterious effects on the patient's sensorium and hemodynamic status. Alternatively, regional anesthesia targeting the femoral nerve can control femur fracture pain. A femoral nerve block, historically placed using landmark or nerve stimulator techniques, is now easier, more effective, and better tolerated by emergency department patients with the use of ultrasound guidance. This review summarizes the current state of medical evidence regarding the use of bedside ultrasound guidance to perform femoral nerve blocks for the initial management of femur fracture pain in children as well as a review of the technique.

Keywords:
ultrasound; fracture; femur; nerve block; emergency department; pediatrics

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Ultrasound-Guided Femoral Nerve Blocks in the Initial Emergency Department Management of Pediatric Femur Fractures

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Femoral shaft fractures are among the most common diaphyseal fractures in children with an estimated annual incidence of 19 fractures per 100 000 children in the United States.[1,2] Fractures in the toddler age group tend to be related to falls, whereas motor vehicle collisions are the predominant cause of injury in adolescent groups. Fifteen percent of femoral fractures in children younger than 2 years are due to child abuse.[2,3]

Current definitive modalities used for the treatment of femoral shaft fractures include traction, spica casting, elastic nailing, external fixation, plate fixation, and conventional intramedullary nailing.[1] Most modalities require hospitalization. Indeed, the most

common pediatric orthopedic injury requiring hospitalization is a femur fracture.[3]

The care of patients with femur fractures will typically begin in the prehospital setting or the emergency department (ED). The initial management of these injuries will often require transfers from stretcher to imaging table to hospital bed within the first few hours. Prompt treatment of these patients' pain is essential.

Despite the fact that good pain control is one of the primary goals in the management of femur fractures, there is considerable variation in practice around the world. Although femoral nerve block (FNB) is common in some countries, it is still uncommon in the emergency setting in North America.[4,5]

PRINCIPLES OF FEMORAL REGIONAL ANESTHESIA

Pain messages are transmitted through electrical impulses from nerve endings to the brain. Sodium and potassium channels along the nerve fiber allow the flow of charge ions to occur through the nerve membranes and thus allow electrical impulses to flow.

Common local anesthetic agents such as lidocaine, bupivacaine, and ropivacaine (Table 1) prevent the flow of charge ions through a nerve membrane and stop the pain signal.[6,7] At high enough levels of local anesthetic, pain signals do not get to the brain.

An FNB is a regional anesthesia technique that involves injection of local anesthetic around the femoral nerve. The femoral nerve lies in a bundle next to the femoral artery and vein at the top of the thigh. A fascia iliaca compartment block (FICB) is a similar regional nerve block that involves injecting a larger volume of local anesthetic than is required for FNB into an area beneath the fascia at the top of thigh. The FICB approach often blocks the femoral, obturator, and lateral cutaneous nerves while avoiding the femoral artery. Both the more direct FNB and the indirect FICB technique control femur fracture pain by blocking pain signals directly on the femoral nerve.

The advantages of regional anesthesia for femoral fracture pain management include shorter time to pain relief, better pain control, longer duration of pain relief, and avoidance of complications associated with systemic analgesics.[8] Drawbacks of FNBs include requirement of additional equipment and pain at the injection site. Furthermore, rare complications associated with nerve blocks include accidental intravascular injection and potential cardiac effects, seizures, and delayed recognition of compartment syndrome (Table 2). However, FNB has been found to have a low rate of serious complications (2.9 episodes of peripheral neuropathy for every 10 000 blocks) with no cardiorespiratory complications or deaths.[9]

EVIDENCE BASIS FOR FEMORAL NERVE BLOCKS

The FNB was first described by Grossbard and Love in 1979 as providing rapid, effective analgesia in children with femur fractures.[10] These authors recommended its use early in the management of pediatric patients with femoral shaft fractures.

TABLE 1. Characteristics of common local anesthetic agents.

Lidocaine (various trade names)
Inexpensive, generic
Rapid onset (1-5 min)
Short duration (1-3 h)
Bupivacaine (Marcaine)
Inexpensive, generic
Intermediate onset (~10 min)
Long duration (6+ h)
Ropivacaine (Naropin)
More expensive, generic unavailable
Intermediate onset (~10 min)
Long duration (6+ h)
Less cardiotoxicity, thought to be safer than bupivacaine

TABLE 2. Trade-off considerations for FNBs.

Benefits	Drawbacks
Better pain control	Unfamiliar
Less redosing of pain meds	Additional equipment
Control of muscle spasms	Affects neurologic examination
Long lasting (6+ h)	Pain at injection site
Fewer systemic effects	Use of J-tips or subcutaneous lidocaine injection to minimize
Apnea	Rare adverse outcomes
Hypotension	Intravascular injection
Vomiting	Incomplete or failed block
Itching, rash	Infection
Delirium	
Constipation	
Urinary retention	