

Case Report



Ultrasound-Guided Placement of a Permanent Percutaneous Femoral Nerve Stimulator Leads for the Treatment of Intractable Femoral Neuropathy

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Background: Femoral nerve injury is a rare complication of cardiac catheterization and is usually caused by direct trauma during femoral artery access, compression from a hematoma, or prolonged digital pressure for post-procedural hemostasis. Peripheral nerve stimulation has been used to treat different pain syndromes in the upper and lower extremities with variable success and it typically requires direct vision with open surgical approach. Since the femoral nerve can be readily seen with ultrasonography, an ultrasound-guided lead placement seemed practical.

Case Report: A 61-year-old morbidly obese male who sustained femoral nerve injury during cardiac catheterization continued to complain of intractable femoral neuropathy 18 months afterwards. He failed multiple treatment modalities and continued to complain of severe neuropathic pains that markedly interfere with his daily activities.

Two percutaneous leads were placed under real-time ultrasonography and the placement was confirmed with fluoroscopy. One lead was placed along the longitudinal axis of the nerve and the patient had good coverage over the anterior thigh but not below the knee. So another lead was placed horizontally across the femoral nerve in order to stimulate all the branches and the patient reported good coverage along the saphenous nerve distribution down to the foot.

Results: The patient continues to be pain free 20 months after the implant.

Conclusion: Here we described a novel non-invasive percutaneous approach for femoral nerve stimulation with ultrasound guidance which allowed precise placement of the stimulating lead very close to the femoral nerve without the need for surgical exploration.

Key words: Femoral nerve stimulation, femoral neuropathy, ultrasound-guided lead implant, peripheral nerve stimulation

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Femoral nerve injury is a rare complication of cardiac catheterization with a reported incidence of 0.21%. It is usually caused by direct trauma during femoral artery access, compression from a hematoma, or prolonged digital pressure for post-procedural hemostasis (1). It can be seen also after pelvic or urologic surgeries where the etiology is

secondary to positioning and unsuitable application of self retaining retractors (2). Most patients recover with early diagnosis and rehabilitation but there are few treatment options for those who do not recover.

The authors describe a novel approach for femoral nerve electric stimulations for the treatment of intractable femoral neuropathy using a percutane-

ous approach with real-time ultrasound imaging to non-invasively identify the nerve and avoid vascular injury which was the initial cause of the femoral neuropathy.

CASE REPORT

A 61-year-old obese male (BMI of 37 kg/m²) developed a right groin hematoma after cardiac catheterization for chest pain evaluation 18 months before presentation. Subsequently, he developed sharp stabbing pains in the right groin and the anterior aspect of the thigh radiating down the medial aspect of the leg to the big toe. Extensive electrodiagnostic examination of the right lower limb revealed findings most consistent with a femoral neuropathy, moderate to severe in degree electrically, with evidence of active denervation (membrane irritability) and active motor axon loss.

Patient neurological examination showed weakness of the right quadriceps muscle, decreased patellar reflex, and decreased touch sensation and paresthesias along the distribution of the saphenous nerve. He failed multiple treatment modalities (tricyclic antidepressants, different membrane stabilizers, NSAIDs, opioids, topical agents, physical therapy, TENS, acupuncture) and continued to complain of severe neuropathic pains that markedly interfere with his daily activities. After appropriate psychological evaluation, we proceeded with a trial of peripheral nerve stimulation to help alleviate the neuropathic pain component.

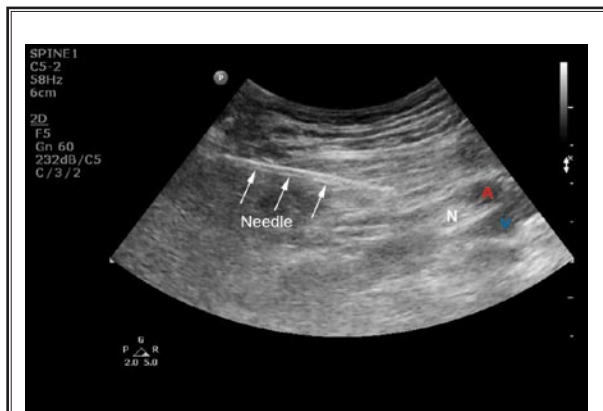


Fig. 1. Ultrasonographic short axis view with the needle (arrows) in-plane in order to pass the lead across the femoral nerve. A: femoral artery, V: femoral vein, N: femoral nerve.

We elected to use a low-frequency broad band (2-5 MHz) curvilinear array ultrasound transducer (Philips HD11-XL) as the patient was morbidly obese. Two percutaneous octad leads (Medtronic, Minneapolis, MN) were placed under real-time sonography and the placement was reconfirmed with fluoroscopy. The ultrasound machine was operated by one of the authors (SN). The transducer was applied just inferior to the inguinal ligament to obtain a short axis view of the femoral nerve which was easily seen just lateral to the femoral vessels. Then a 14-gauge blunt needle was introduced out of plane just cephalad to the transducer and was advanced at a 30 degree angle from cephalad to caudad. We were able to thread the lead beyond the tip of the needle along the longitudinal axis of the nerve and this was confirmed by rotating the transducer to obtain a longitudinal axis view. Test stimulation was performed (0.4V, 60 HZ, 120 msec.) and the patient reported paresthesias over the anterior thigh but not below the knee. So another needle was introduced about an inch lateral to the lateral end of the transducer in the short axis view in-plane with the ultrasound beam and was advanced from lateral to medial so the lead can be placed horizontally across the femoral nerve (Fig. 1) in order to stimulate all the branches of the femoral nerve. The patient reported good coverage not only over the thigh but along the saphenous nerve distribution down to the foot as well (0.5V, 60 HZ, 150 msec.). The position of the 2 leads was reconfirmed with fluoroscopy which showed proper placement (Figs. 2 and 3). The patient then underwent a permanent implant after a successful trial for 7 days using similar percutaneous leads with subcutaneous implant of a rechargeable generator (Restore®, Medtronic, Minneapolis, MN) in the right lower quadrant of the abdomen. The patient was discharged home on the same day and he continues to be pain free 20 months after the implant and he managed to be off all his pain medications; however, his weakness persisted, .

DISCUSSION

The femoral nerve is the largest branch of the lumbar plexus and it arises from the dorsal branches of the second to the fourth lumbar ventral rami. It forms in the abdomen within the psoas major muscle and descends posterolaterally through the pelvis to the midpoint of the inguinal ligament. It then passes under the inguinal ligament to enter the femoral triangle lateral to the femoral vessels and divides into anterior and posterior

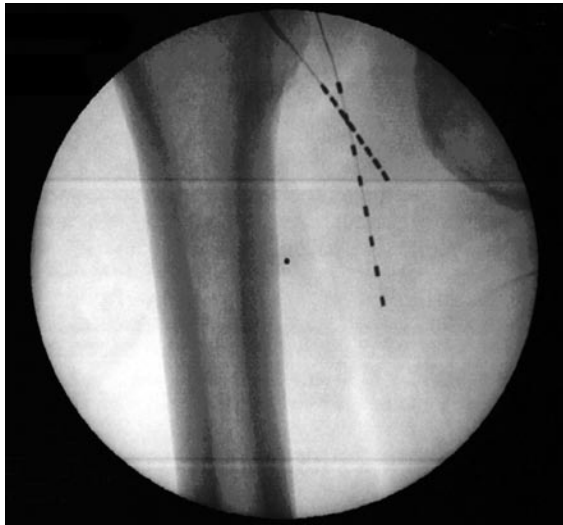


Fig. 2. AP X-ray view showing both leads. Regular octad lead (along the longitudinal axis of the nerve) and a compact octad lead (along the short axis of the nerve).

divisions. The anterior branch supplies the intermediate femoral cutaneous nerve, medial femoral cutaneous nerve, and the nerve to the sartorius. The posterior division supplies the quadriceps femoris, the knee joint, and the saphenous nerve (3).

Femoral neuropathy is the focal injury of the femoral nerve, which can occur secondary to direct trauma, compression, stretch injury, or ischemia. Patients usually present with weakness in the quadriceps muscle group with sparing of the thigh adduction, causing gait disturbances and difficulty ascending stairs. Sensory loss and paresthesias along the saphenous nerve distribution including the anteromedial leg and the medial aspect of the foot is a common presentation. Weakness of hip flexion is noted if the injury involved the proximal branches of the femoral nerve (4). The symptoms usually manifests within the first 24–72 hours following injury.

Treatment options for femoral neuropathy include early recognition and correction of any reversible etiology. An aggressive physical therapy program is recommended early in the course of the neuropathy to decrease the risk of muscle wasting and contractures (5). Electrodiagnostic studies should be considered at about 6 weeks after the injury and should be repeated every 3–6 months to monitor the course of the neuropathy. Surgical options, which include nerve

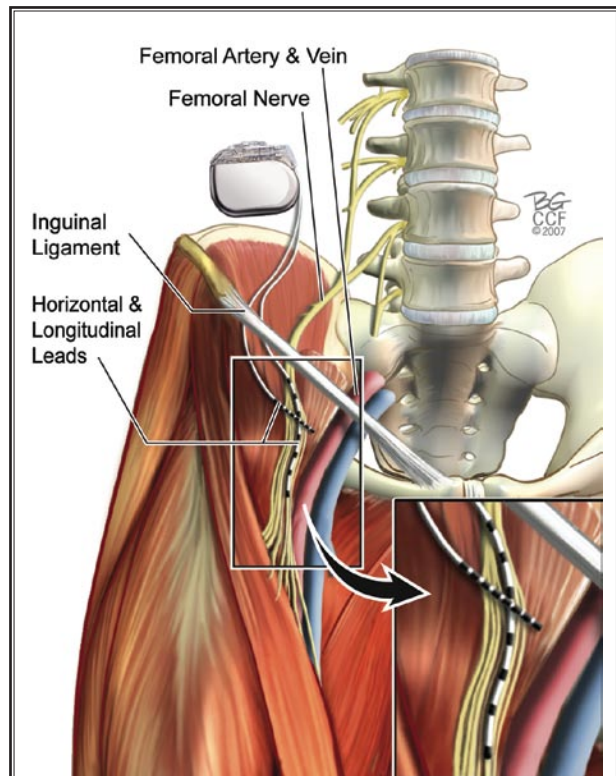


Fig. 3. Illustration showing the position of the leads in relation to the femoral nerve.

grafting and neurolysis, may be considered if the condition is shown to be refractory to conservative treatment (4).

Peripheral nerve stimulation has been used to treat different pain syndromes in the upper and lower extremities with variable success and it usually requires an open surgical approach (6,7). Though initially introduced in the 1960s the concept has had limitations in its application mainly related to electrode technology, lead fracture or displacement, and infection (8). The variability of success in combination with the associated complications and logistics of surgery make it an unattractive option at present. However recent studies have shown the effectiveness of peripheral stimulation in hastening neurological recovery after nerve injury or surgery (9,10). If there was an alternate technique for placement of peripheral stimulator leads with lesser complications and reliable lead positioning it would make peripheral nerve stimulation an attractive therapeutic option for peripheral neuropathic pain.

Ultrasound guidance for peripheral nerve blocks is now well established in the field of regional anesthesia. The potential advantages of ultrasonography are real-time visualization of needle tip advancement, neural and vascular structures, and local anesthetic spread. These advantages were manifested by shorter onset time, higher block success rates, and increased patient satisfaction, without an increase in block time or block related complications (11-14).

In the case of the femoral nerve, ultrasonography is very useful to delineate the anatomy of the nerve and allows very precise depiction and assessment of the nerve about 10 cm superior to 5 cm inferior to the inguinal ligament (15). This makes it an attractive modality to assist percutaneous placement of peripheral electrodes as described in our case report.

In conclusion, a percutaneous approach for femoral nerve stimulation lead implant with ultrasound

guidance allows precise placement of the stimulating lead very close to the femoral nerve without the need for surgical exploration.

However before this can be recommended as a common practice, a case series or other more formal studies comparing this approach to the more traditional open surgical one are warranted. Further, cadaveric or live animal model studies are appropriate to assure that the lead placement is indeed along the expected course and plane in the overwhelming majority of subjects, and that trauma to nerve and vessels are consistently avoided.

In our case transverse stimulation worked better, so in future studies, one can implant both in line perineural and transverse leads, and randomly stimulate one or the other vs. combined to state whether both are necessary or not.

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