Intraoperative Nerve Stimulation as an Approach for the Surgical Treatment of Genitofemoral Neuralgia

ACDEF 1 David A. Zuckerman
BE 1 Jared B. Cooper
BE 2 Nitin K. Sekhri
BE 3 Matthew Bronstein
ABE 3 Ilya Shnaydman
BE 4 Logan Carr
ABE 4 Ammar Siddiqui
ABCEF 1 Jared M. Pisapia

Corresponding Author: Jared M. Pisapia, e-mail: Jared.Pisapia@wmchealth.org
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Patient: Male, 49-year-old
Final Diagnosis: Genitofemoral neuralgia
Symptoms: Pain • pain in right medial thigh • pain in right testicle
Clinical Procedure: Intraoperative nerve stimulation • neurectomy • neurolysis
Specialty: Anesthesiology • Neurosurgery

Objective: Rare coexistence of disease or pathology
Background: Genitofemoral neuralgia is a pain syndrome that involves injury to the genitofemoral nerve and is frequently iatrogenic. We report intraoperative nerve localization using ultrasound, nerve stimulation, and the cremasteric reflex in the surgical treatment of genitofemoral neuralgia.
Case Report: A 49-year-old man with a history of extracorporeal membrane oxygenation with cannulation sites in bilateral inguinal regions presented with right groin numbness and pain following decannulation. His symptoms corresponded to the distribution of the genitofemoral nerve. He had a Tinel’s sign over the midpoint of his inguinal incision. A nerve block resulted in temporary resolution of his symptoms. Due to the presence of a pacemaker, peripheral nerve neuromodulation was contraindicated. He underwent external neurolysis and neurectomy of the right genitofemoral nerve. Following direct stimulation and ultrasound for localization, the nerve was further localized intraoperatively using nerve stimulation with monitoring for the presence of the cremasteric reflex. At his 1-month postoperative visit, his right medial thigh pain had resolved and his right testicular pain 50% improved; his residual pain continued to improve at last evaluation 3 months after surgery.

Conclusions: We report the successful use of nerve stimulation and the cremasteric reflex to aid in identification of the genitofemoral nerve intraoperatively for the treatment of genitofemoral neuralgia.

Keywords: Electric Stimulation • Intraoperative Care • Neuralgia • Peripheral Nerves

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Background

Genitofemoral neuralgia (GFN) is a chronic pain syndrome due to genitofemoral nerve compression along the cutaneous region in the groin and inner thigh. Typically, this condition is caused by iatrogenic injury [1]. The genitofemoral nerve is a component of the lumbar plexus, and the motor portion of the cremasteric reflex is controlled by the genital branch of this nerve [2]. The nerve is small and overlaps with other nerves in the area that arise from the lumbar plexus, making it difficult to identify at the time of surgery. While the incidence of chronic pain after inguinal hernia surgery involving neuroectomy of the ilioinguinal, iliohypogastric, genitofemoral, or lateral femoral cutaneous nerve is estimated to be around 12% to 20% [3], in a study of 54 patients involving surgical treatment of neuromas following inguinal surgery, only 4 patients had involvement of the genital branch of the genitofemoral nerve, and the success rate in this population was 50% [4]. Many patients with GFN experience debilitating pain, resulting in depression, difficulty with activities of daily living, and decreased quality of life [5]. Due to the multiple nerves arising from the lumbar plexus present in the inguinal region and the relatively infrequent nature of surgery on the genitofemoral nerve, there is a need for improved methods of identifying the genitofemoral nerve intraoperatively.

Direct electrical stimulation is routinely used to identify nerves intraoperatively, especially in surgeries around the head and neck [6]. It is also used in tumor resection cases, whereby intraoperative mapping enables surgeons to monitor the functional integrity of nerves in real time in an effort to minimize damage to normal neural structures during resection of lesional tissue [7]. Moreover, intraoperative nerve stimulation is the criterion standard to detect intact or damaged nerve function in surgeries involving the brachial plexus [8]. A nerve is directly stimulated, and the end muscle movement can be observed intraoperatively, or an electromyogram signal can be detected in a monitored muscle. Thus, there is a precedent for using direct electrical stimulation on nerves in multiple anatomical regions.

Previous work has shown that the cremasteric reflex can be used to identify the genitofemoral nerve and treat GFN through neuroectomy in patients with GFN after conservative therapy has failed [9]. We, however, report a case of a patient with GFN in whom peripheral neuromodulation was contraindicated due to the presence of a pacemaker. As a result of this, the genitofemoral nerve was localized using intraoperative nerve stimulation with relation to the cremasteric reflex; this patient’s successful treatment was then accomplished through neurolysis followed by neuroectomy of the genitofemoral nerve.

Case Report

A 49-year-old man with a history of myocardial infarction leading to use of extracorporeal membrane oxygenation (ECMO) presented with persistent right groin numbness and pain that began following decannulation. On examination, he had a Tinel’s sign at the right medial proximal thigh overlying the prior incision site used for ECMO, such that tapping on the region reproduced radiating pain from the level of the incision to the medial thigh and right testicle. He was treated with neuropathic pain medication under the supervision of a pain management physician. He subsequently underwent a block of the right genitofemoral nerve, which provided complete relief of his symptoms for several days. Peripheral nerve neuromodulation was contraindicated due to the patient’s pacemaker, which was implanted after his myocardial infarction. Due to the persistent and medically refractory nature of his symptoms, surgical treatment was recommended. The patient gave informed consent to proceed with the surgery and to be included in this case report. Institutional review board approval was not required; nerve decompression was performed as part of clinical care.

The patient was positioned supine. An ultrasound was used to identify the genitofemoral nerve in the region of the spermatic cord above the inguinal ligament. A 22-gauge, 10-cm radiofrequency ablation needle was advanced to the region of the nerve. Stimulation at 0.2 V and 50 Hz was applied to multiple regions around the nerve. While awake under moderate sedation, the patient reported the single site of maximal reproducible pain. The site was marked with an arterial line wire, which was then secured to the skin with skin glue and steri-strips (Figure 1A). The location of the wire exiting the skin coincided with the midpoint of the prior inguinal incision (Figure 1B).

The patient was then intubated and underwent total intravenous anesthesia. The right groin was re-prepped and draped using Betadine with the previously placed needle in the field. The right scrotum was included in the surgical field to assess intraoperatively for the cremasteric reflex upon intraoperative nerve stimulation. To access the inguinal region, the existing right inguinal incision, located superior to the level of the inguinal ligament, was reopened. Significant scar tissue related to prior ECMO cannulation was encountered during the dissection, down to the level of the previously placed wire. Due to this scar tissue, the anatomy was significantly altered such that it was not possible to localize the nerve solely using normal landmarks alone; thus, direct electrical stimulation was used to help identify the nerve. The patient did not provide informed consent to obtain an intraoperative or postoperative video of the cremasteric reflex, owing to privacy concerns. Following nerve stimulation along the superior aspect of the spermatic...
The cremasteric reflex was observed. Further dissection identified a neural structure overlying the spermatic cord in the region of stimulation, consistent with the genital branch of the genitofemoral nerve (**Figure 2**). It appeared fine and filamentous. A plastic loop was positioned around the nerve, and it was placed under gentle tension to facilitate dissection more proximally. External neurolysis was performed along the course of the genitofemoral nerve through the region of scarring. There was no focal neuroma identified. Thus, the genitofemoral nerve was sectioned at the proximal extent of the exposure. The wound was then closed in a layered fashion.

The patient tolerated the procedure well. At the 1-month follow-up, he reported resolution of his medial thigh pain and 50% reduction in preoperative right testicle pain. His residual pain continued to improve at follow-up 3 months after surgery.

**Discussion**

The genitofemoral nerve arises from the first and second lumbar segments of the vertebral plexus. It courses through the psoas muscle and then bifurcates into the genital and femoral branches [10]. The genital branch travels through the inguinal canal and supplies sensation to the skin of the scrotum and the motor component of the cremasteric reflex. The femoral branch travels under the inguinal ligament in the femoral canal to provide sensory innervation to the skin of the upper, anterior, and medial aspect of the thigh. Both of these branches are important for the cremasteric reflex; although the specifics are disputed, many agree that the femoral branch provides...
the afferent pathway and the genital branch provides the efferent pathway [11]. Others posit that the ilioinguinal nerve serves the afferent pathway. In this reflex, stroking of the inner thigh results in cremaster muscle contraction with subsequent elevation of the ipsilateral testicle [2]. In this case report, we demonstrate a rare approach in which intraoperative nerve stimulation in relation with the cremasteric reflex was used to identify the genital branch of the genitofemoral nerve.

Multiple anatomic variations of the genitofemoral nerve exist, which can influence surgical treatment and outcome. One study suggests that when describing the branches of the genitofemoral nerve, using the terms “medial branch” and “lateral branch” is favorable to using “femoral branch” and “genital branch” because of the extra subdivisions that sprout from these initial divisions of the genitofemoral nerve [12]. Thus, intraoperative nerve stimulation can be advantageous, especially when considering how common anatomical variations are within the inguinal region [13]. Furthermore, another study recommends dissecting to the medial edge of the psoas muscle to rule out an independent genital branch, which can occur in up to 25% of cases [14]. It is possible that an independent genital branch may account for the reported patient’s residual testicular pain. In addition, intraoperative stimulation may identify the genital segment at a point distal to the bifurcation of the genitofemoral nerve into the genital and femoral divisions. In this reported case, after identification of the genital branch of the nerve, dissection proceeded proximally. Postoperatively, full or partial pain relief in the femoral and genital nerve distributions, respectfully, suggests that both branches of the nerve or a point along the nerve proximal to its bifurcation was exposed.

Alternative methods exist for treating GFN. One such treatment is peripheral nerve neuromodulation. This can be especially useful for patients with chronic pain that is refractory to other medical interventions, such as nerve blocks, medications, and physical therapy. Instead of using opioids, one can use peripheral nerve neuromodulation to manage pain through wired or wireless means [15]. One drawback to the wired approach is battery replacement, as general maintenance is required to provide proper upkeep. Additionally, there could be a chance of infection when replacing or fixing the battery, with an estimated risk of about 5% [16]. Nonetheless, peripheral nerve neuromodulation was contraindicated in this case due to the patient’s pacemaker.

There are several limitations to consider with our reported approach. First, it is possible that the observed cremasteric reflex could dampen with repeated intraoperative stimulation. Therefore, nerve stimulation was used sparingly and intermittently during surgery. Second, the outcome measure of symptom relief in this case was subjective, and the placebo effect may have contributed.

Conclusions

In conclusion, this case report provides an effective approach for treatment of a 49-year-old male patient with GFN and contraindications to peripheral nerve neuromodulation. Through the use of intraoperative nerve stimulation, the genitofemoral nerve and its branches were identified by monitoring the presence of the cremasteric reflex. Subsequent treatment with neurolysis and neuroectomy was associated with symptom improvement.

Department and Institution Where Work Was Performed

Westchester Medical Center within the Department of Neurosurgery, Valhalla, NY, USA.

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