Femoral branch to obturator nerve transfer for restoration of thigh adduction following iatrogenic injury

Case report

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Obturator nerve injury is a rare complication of pelvic surgery. A variety of management strategies have been reported, with conservative measures being the preferred treatment in most cases. While nerve transfer has become more commonly used for restoring brachial plexus injuries, it has rarely been applied to the lower extremities. To the authors’ knowledge, this is the first report of an obturator nerve neurotization. A patient presented 7 months after an iatrogenic right obturator nerve palsy due to pelvic surgery for gynecological malignancy. She underwent a femoral branch to obturator nerve transfer to restore right thigh adduction. Ten months after the neurotization procedure, there was electromyographic evidence of almost complete obturator nerve reinnervation. At 1 year postoperatively, the patient had regained full muscle strength on thigh adduction and a normal gait. Nerve transfer could therefore be a good option in patients with obturator nerve injury whose symptoms fail to respond to conservative medical therapy.

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Key Words • femoral nerve • neurotization • obturator nerve • peripheral nerve • nerve transfer

The obturator nerve is a mixed motor and sensory nerve that originates from the anterior division of the ventral rami of the second, third, and fourth lumbar spinal nerve roots. It emerges from the medial side of the psoas muscle, crosses the lesser pelvis, and passes through the obturator foramen into the medial thigh. It innervates the adductor longus, brevis and magnus; gracilis; obturator externus; and pectineus muscles, whose main action is to adduct the thigh. It also provides sensation to a small area along the medial thigh.

Major pelvic surgeries, including those for gynecological malignancies, can result in obturator nerve injury and are often associated with weakness on thigh adduction as well as sensory deficit. Although peripheral nerve repair has become commonly used in the treatment of traumatic brachial plexus and more distal injury in the upper extremities, its application to the lower extremities remains more limited. Available options for the treatment of complete or nonconductive injury include direct nerve-to-nerve suture repair, interpositional cable nerve grafting, and neurotization. Direct nerve-to-nerve suture repair, or coaptation, involves attaching each end of a sectioned nerve together and is the preferred option for treatment when it can be performed.

When direct repair is not possible because of the length or extent of injury, interpositional nerve grafting can be used. However, interpositional nerve grafts, especially those of long length, often lead to poorer results because two interfaces rather than one must be sutured, and the distance the regenerating axons need to travel to reach the muscle end-organ is longer. Therefore, neurotization, or nerve transfer, offers an important alternative to direct nerve repair, whereby a healthy donor nerve that does not naturally supply the muscle of interest is coapted to a nonfunctional nerve. The benefit of this approach is that the functional donor nerve can be sutured in immediate proximity to the muscle end-organ of interest and thus provide earlier innervation. Moreover, recovery does not rely on the extent or location of injury of the nonfunctional nerve and can therefore frequently offer more consistent and reliable results.

A number of repair strategies have been described in the lower extremities, most of which concern the use of direct nerve-to-nerve suture repair and interpositional nerve grafting. A few articles have also described the application of nerve transfer. For example, recently reported the use of the obturator nerve as a donor for neurotization. Nath et al. transferred a fascicle of the superficial peroneal or tibial nerve to a branch of the deep peroneal nerve. Here, we present the case of a right femoral branch to obturator...
nerve transfer in a patient who sustained a right obturator nerve injury related to pelvic surgery for gynecological malignancy. To our knowledge, this is the first report of an obturator nerve neurotization in the English literature and demonstrates a potential option in the treatment of obturator nerve injury.

Case Report

History and Examination. This 56-year-old woman underwent an exploratory laparotomy with total abdominal hysterectomy and bilateral salpingo-oophorectomy in addition to a right external iliac and obturator lymph node dissection for Stage IA endometrial and Stage IB ovarian adenocarcinoma. Shortly after the surgery, she noticed a complete inability to adduct her right leg and numbness along the anteromedial portion of her right thigh. She underwent initial conservative medical management with physical therapy and a repeat examination. During that interim, she received adjuvant chemotherapy with carboplatin and paclitaxel. Radiation therapy was not used.

On referral, 7 months following surgery, the patient noted no recovery of thigh adduction. She reported outward swinging of her right leg and frequent tripping. The numbness along the anteromedial portion of her right thigh remained unchanged. On examination, we used the British Medical Council system to assess her muscle strength. She had full 5/5 muscle strength on thigh flexion, extension, abduction, and internal/external rotation; knee flexion and extension; and foot dorsiflexion and plantarflexion bilaterally. However, she had 0/5 strength on right thigh adduction and diminished sensation to light touch and pinprick along the anteromedial aspect of the thigh.

Nerve conduction studies of the right sural and superficial peroneal sensory nerves, and the right tibial and common peroneal motor nerves were normal. Needle EMG studies of the right vastus lateralis, iliopsoas, and adductor magnus muscles were normal. The right adductor longus muscle, on the contrary, had increased insertional activity and fibrillation potentials and no recruitment of motor unit action potentials.

Operative Intervention. Given the lack of improvement on physical examination and EMG, two options were considered for surgery. The first was direct intrapelvic exploration of the obturator nerve with an attempt at primary repair. The second was a femoral branch to obturator nerve transfer. While the first option would provide direct identification and repair of the injury, the patient had undergone extensive intrapelvic resection and postoperative treatment that would make identifying and repairing the nerve difficult and risk injury to surrounding structures. Moreover, it had already been more than 7 months from the time of her initial surgery, making a more proximal repair less likely to succeed. The latter option, on the other hand, would provide direct access to the nerve close to the end organ as well as a potentially quicker recovery with less morbidity.

After considering the above options, the patient underwent a femoral to obturator nerve transfer (Fig. 1). A linear paramedian incision was made approximately 3 cm below the right inguinal ligament. First, the obturator nerve was identified as it exited from the obturator foramen proximally. Direct stimulation under neural monitoring produced no muscle contraction. The nerve was skeletonized and transected at the level of the obturator foramen. Several branches of the femoral nerve were identified and stimulated. A small medial branch of the
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femoral nerve that innervated a proximal portion of the quadriceps muscle and had approximately the same diameter as the cut end of the obturator nerve was skeletonized and transected distally. The distal end of the femoral nerve branch was then curved inward, passed below the femoral artery and vein, and directly sutured to the proximal end of the obturator nerve using epineural 6-0 Prolene stitches under microscope magnification. The neurorrhaphy was covered with a collagen matrix tube and Tisseel.

Postoperative Course. Following the surgery, the patient maintained full 5/5 strength on knee extension. Four months after surgery and approximately 1 year after her initial obturator nerve injury, the patient had significant improvement in her right thigh adduction and gait. She demonstrated limited outward swinging of her leg for balance while walking. However, the numbness along the anteromedial portion of her right thigh was persistent. On examination, she had full muscle strength in both lower extremities, except for 3/5 strength on right thigh adduction.

Nerve conduction studies of the right sural, superficial peroneal, tibial, and common peroneal nerves were normal again. Needle EMG of the right vastus lateralis and iliopsoas muscles was normal, as in the preneuropathic study. On the contrary, the right adductor brevis muscle had increased insertional activity and fibrillation potentials along with reduced recruitment of motor unit action potentials, while the amplitude and duration of the latter were normal. Of note, the adductor brevis rather than the adductor longus muscle was examined this time. A second postneurotization electrophysiology study performed 10 months after the surgery revealed complete electromyographic recovery of the right adductor brevis muscle, demonstrated by the absence of abnormal spontaneous activity and normal motor unit action potentials, suggesting almost complete functional obturator nerve regeneration. One year following nerve transfer, the patient had full 5/5 strength on thigh adduction with normal gait, and there was subtle improvement in the numbness along the distribution of the obturator nerve.

Discussion

Traumatic injury of the obturator nerve is uncommon largely because the nerve lies in a protected portion of the pelvis and medial thigh. However, iatrogenic obturator nerve injury has been described in the setting of radical or retroperitoneal surgery for gynecological malignancy. It has also been reported in the setting of urological or orthopedic procedures, such as radical prostatectomy and total hip replacement, as well as during isolated pelvic lymphadenectomy. According to one study, 1.9% of female patients who underwent major pelvic surgery suffered postoperative neuropathy. The obturator nerve was the most frequent nerve involved, constituting 39% of cases. A broad range of mechanisms for obturator nerve injury has been described, including inadvertent division, accidental clamping of the nerve, compression by retractors, stretch injury, entrapment due to postoperative fibrosis, encasement by cement, and sacrifice of the nerve during total pelvic exenteration procedure.

Although the diagnosis of obturator neuropathy can be made on clinical grounds, EMG is sometimes necessary to confirm it. A number of factors may influence the extent of thigh adduction compromise due to obturator nerve injury. The pectineus and adductor magnus muscles receive part of their innervation from the femoral and the sciatic nerves, respectively, in addition to their innervation from the obturator nerve. This fact may explain why the adductor magnus muscle was not compromised on the initial EMG evaluation in our case. Furthermore, an accessory obturator nerve exists in approximately 13% of patients.

There is no universal approach to the management of obturator nerve injuries. Different strategies have been described, depending on the type of injury and the surgeon’s preference. Immediate repair with direct end-to-end coaptation has been used, for example, when a complete disruption of the continuity of the nerve was recognized during surgery, providing an average reported recovery of 3–4/5 strength on thigh adduction at 6 months. However, the obturator nerve is not easily mobilized, and in the setting of pelvic surgery, direct end-to-end repair may become a significant challenge. Interpositional nerve grafting has been used successfully when direct repair was not feasible. For example, performed a graft repair of the obturator nerve using a 3-cm sural nerve graft after immediate recognition of an inadvertent transection during pelvic surgery. Postoperatively, the patient had 2/5 strength on thigh adduction, while at 10 months she had full muscle strength.

In stretch injuries and in compression injuries due to excessive retraction, nerve damage is often discovered postoperatively. In such cases, most patients respond adequately to conservative medical management consisting of physical therapy. Rarely, complete nerve transection goes unnoticed during surgery. Overall, the majority of patients who postoperatively suffer an acute onset of obturator neuropathy experience improvement with conservative management. Therefore, surgery should only be considered in patients with persistent symptoms after a few months and with no clinical and electrographic evidence of recovery. A prolonged delay in surgical intervention can prove deleterious since the regenerating motor axons should reach the target muscles within approximately 1 year after the injury for satisfactory functional recovery.

Neurotization offers a number of potential advantages over interpositional nerve grafting and sometimes even over direct end-to-end repair. It enables the surgeon to avoid the exploration of extensive adhesions and scarred tissue due to an initial surgery, risking injury to surrounding organs, nerves, and vessels. Neurotization also often minimizes the overall distance and time required for the reinnervation of the end organ. In the present case, the patient had suffered an obturator nerve injury caused by extensive pelvic surgery for malignancy several months prior to her presentation to us. In such cases, the obturator nerve is commonly hard to find, heavily encased in scar tissue and often impossible to repair by primary end-to-
end means. Furthermore, because nerve disruption frequently occurs far proximal to the muscle end-organ, the results of a local repair at the site of injury can be less favorable. Neurotization therefore offered a potential alternative to direct nerve repair.

In the preneurotization setting the right adductor longus muscle was tested, whereas after the neurotization the right adductor brevis muscle was tested instead. The fact that the adductor brevis muscle had abnormal electromyographic characteristics 4 months following the nerve transfer while at 10 months it had full electromyographic recovery proves that the neurotization worked. Furthermore, there was complete weakness on right thigh adduction before the neurotization procedure despite the fact that 7 months had elapsed from the iatrogenic obturator nerve injury. This result makes the 3/5 strength 4 months after the nerve transfer along with the full muscle strength at 1 year difficult to attribute to a possible compensatory recovery of some adductor muscles that are also innervated by other nerves in addition to the obturator nerve.

In the present case, we selected a branch of the femoral nerve because of its proximity to the obturator nerve at the level below the inguinal ligament. In addition, the femoral nerve consists of multiple branches that supply the quadriceps muscle providing redundant innervation for knee extension. Branches of the femoral nerve can therefore offer an adequate potential source for neurotization of the obturator nerve, which was a major consideration for its use in the present case. Four months after the nerve transfer, the patient had marked improvement in thigh adduction. Ten months after neurotization and approximately 18 months following the obturator nerve injury, there was evidence of essentially complete electromyographic obturator nerve regeneration, whereas at 1 year the patient had normal ambulation and full muscle strength on physical examination. Data in the present case suggest that neurotization can be applied with good results in patients who suffer traumatic obturator nerve injury, therefore offer an adequate potential source for neurotization of the obturator nerve, whereas at 10 months it had full electromyographic recovery proves that the neurotization worked.

**Disclosure**

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author contributions to the study and manuscript preparation include the following. Conception and design: Williams. Acquisition of data: Williams. Analysis and interpretation of data: both authors. Critically revising the article: both authors. Reviewed final version of the manuscript and approved it for submission: both authors.

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