

Contralateral Obturator to Femoral Nerve Branch Transfer for Multilevel Lumbosacral Plexus Avulsion Injury

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Summary: We report successful restoration of quadriceps function following contralateral obturator to lateral branch of the femoral nerve transfer (with intervening autograft) in two patients with multilevel lumbosacral root avulsions, resulting in severe unilateral motor and sensory deficits. Three years postoperatively, patient 1 had regained Medical Research Council grade 3 knee extension with the ability to extend against 10 pounds of resistance. At 28 months postoperatively, patient 2 had regained Medical Research Council grade 2 knee extension. Treatment options for severe lumbosacral plexus injuries with multiple root avulsions are limited. This approach offers a new option for these devastating injuries. (*Plast Reconstr Surg Glob Open* 2021;9:e3997; doi: [10.1097/GOX.0000000000003997](https://doi.org/10.1097/GOX.0000000000003997); Published online 10 December 2021.)

Repair of lumbosacral plexus injuries through exploration and nerve grafting is often associated with poor outcomes and is not an option in cases with root avulsions.¹ Nerve transfers provide an alternative option for treatment; however, ipsilateral donor nerves are not available with multilevel injuries.² Here we report two cases of contralateral obturator nerve transfer to lateral branch of the femoral nerve for treatment of multilevel lumbosacral plexus injury with root avulsions. Extensive preoperative discussion with the patient would be required due to the necessity for use of long nerve grafts and significant risk of variable recovery of function.

CASE REPORT

Case 1

A 20-year-old man was involved in a motorcycle accident and sustained an open pelvic fracture as well as severe injury to the right lower extremity with a laceration to the external iliac artery which required an external iliac artery to common femoral artery bypass. Two years after injury, he was referred for reconstruction of his right lumbosacral plexus injury. He was only able to ambulate

with difficulty with a walker. Physical examination revealed MRC grade 3/5 hip abduction and extension, no hip adduction or flexion, and no movement in the knee and distal. He had no sensation below the L2 dermatome. Magnetic resonance imaging revealed extensive injuries to the right lumbosacral plexus with avulsion of right L3, L4, S1, S2, and S3 nerve roots and pseudomeningoceles within the spinal canal. The L5 nerve root appeared intact but had evidence of injury in the presacral region. Electromyography (EMG) showed denervation of all muscles innervated by the right lumbosacral plexus except the lumbar paraspinals.

Poor prognosis for recovery with nerve surgery due to time since injury was discussed. Nevertheless, the patient and his family opted for contralateral obturator nerve transfer to lateral branch of the femoral nerve, with a planned intervening vascularized right deep peroneal nerve graft, to attempt to regain some knee extension to aid ambulation.

Intraoperatively, the lateral branch of the right femoral nerve innervating the rectus femoris and vastus lateralis was exposed (Fig. 1). There was extensive scarring as a previous sartorius muscle flap had been used to cover the right groin vessels. Therefore, a vascularized nerve graft could not be performed due to a lack of recipient vessels. On the left, the anterior division of the obturator nerve incorporating distal branches to the gracilis and adductor longus was dissected out, transected distally and sutured to a nonvascularized 22-cm-deep peroneal nerve graft

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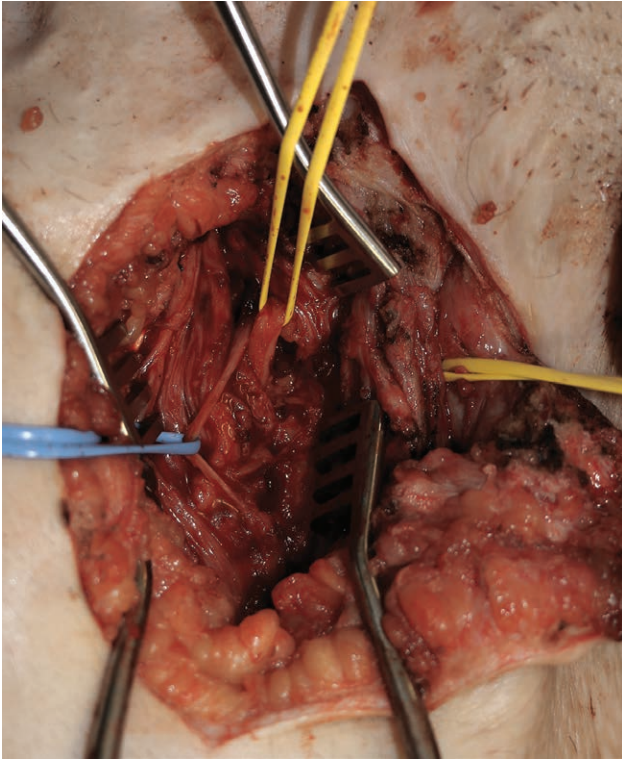


Fig. 1. Case 1: Intraoperative photograph. Right groin exposure. The right femoral nerve (superior yellow vessel loop) and lateral branch of the right femoral nerve supplying the rectus femoris and vastus lateralis (blue vessel loop) are visible.

harvested from the right leg. The nerve graft was passed through a subcutaneous pubic tunnel with the aid of a curved vascular tunneler (Fig. 2) and sutured to the right lateral branch of the femoral nerve.

At 2 months postoperatively, the patient had a positive Tinel's sign in the left groin and at 6 months postoperatively, the Tinel's sign had advanced to the mid pubic region. Nine months postoperatively he had MRC 2/5 right knee extension with palpable contraction of the quadriceps muscles. At that time, he had also regained MRC grade 3/5 right hip flexion. Three years

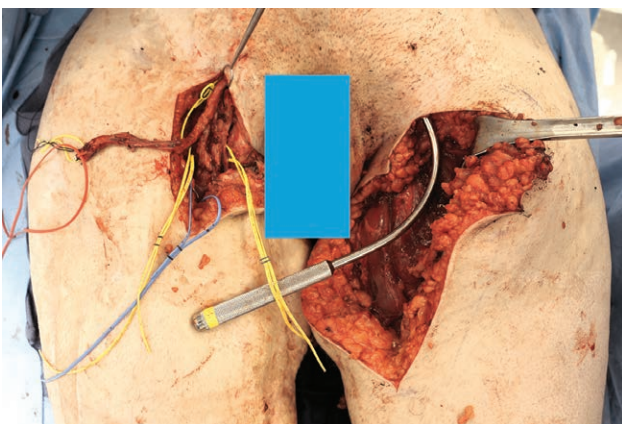


Fig. 2. Case 1: intraoperative photograph. Vascular tunneler was used to pass the deep peroneal nerve graft from right to left.

postoperatively he had MRC grade 3 knee extension and was able to actively extend his right knee against 10 pounds of resistance. (See Video 1 [online], which shows the active right knee extension against 10 pounds of resistance.) He was also able to ambulate with the aid of a stance control brace. Supplemental Video 2 shows how he is able to extend the knee and get from a standing to kneeling to standing position with the aid of a stance control brace. (See Video 2 [online], which shows the active right knee extension while kneeling as well as transition from standing to kneeling and back to standing position.)

Case 2

A 16-year-old boy presented with left lower extremity weakness following a motor vehicle accident 11 months prior. Examination revealed MRC grade 4/5 hip abduction, flexion and extension, no hip adduction, MRC grade 4/5 knee flexion, no knee extension, MRC grade 2/5 ankle plantar flexion with no other movement in the ankle and foot. He had no sensation below the L1 dermatome on the left side. Magnetic resonance imaging revealed avulsion injuries involving the left L3-S1 nerve roots with pseudomeningoceles. EMG demonstrated fibrillations and positive sharp waves with no motor unit potentials or recruitment in the quadriceps muscles and tibialis anterior.

A transfer of the right gracilis branch of the anterior division of the obturator nerve (Fig. 3) to the left lateral branch of the femoral nerve (Fig. 4) with a 20 cm intervening vascularized sural nerve graft was performed.

Three months postoperatively, Tinel's sign had advanced to the mid pubic region. Eleven months postoperatively he started having palpable contractions in his left quadriceps muscles. EMG at this time showed motor unit potentials in the rectus femoris muscle with discrete recruitment. Twenty-eight months after surgery, knee extension remained at MRC grade 2. The patient was able to ambulate with a brace.

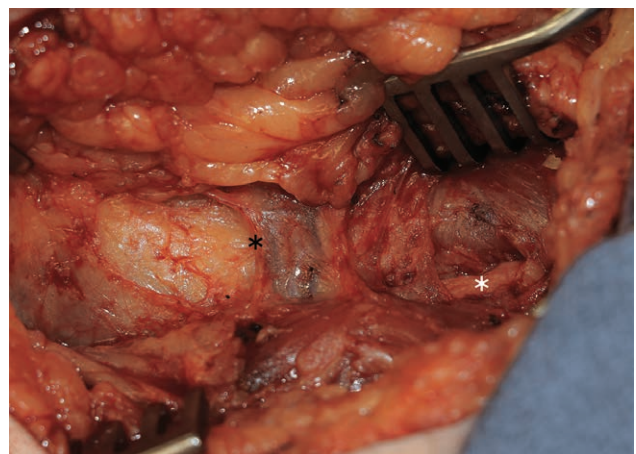


Fig. 3. Case 2. Intraoperative photograph. Right obturator nerve exposure. The nerve to the gracilis can be seen (white asterisk), along with the pedicle to the gracilis (black asterisk). An end-to-end coaptation was performed between the gracilis branch of the anterior division of the obturator nerve and the sural nerve graft.

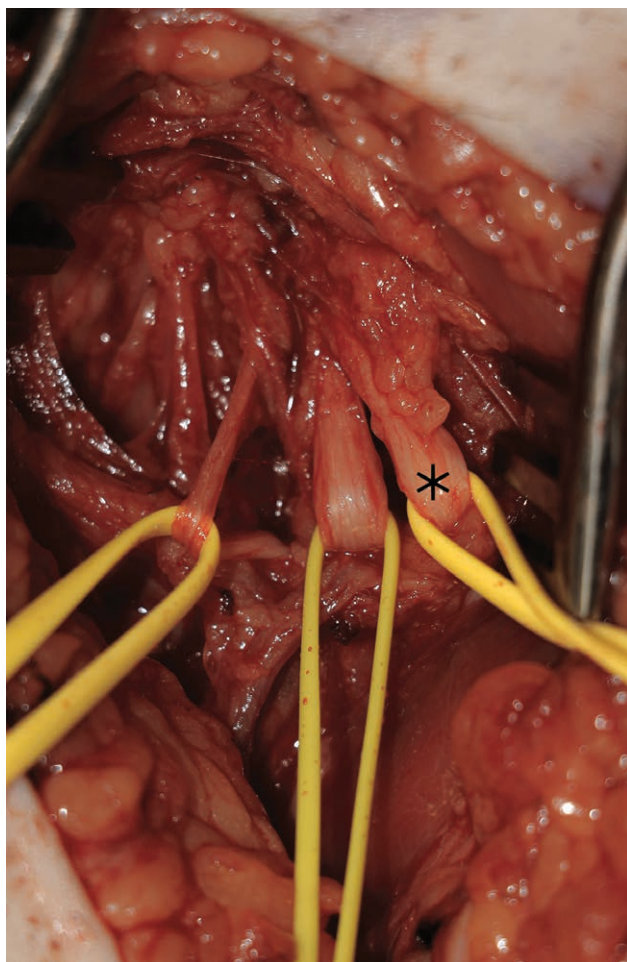


Fig. 4. Case 2. Intraoperative photograph. Left groin exposure. Yellow loops showing branches of the femoral nerve. The lateral branch of the femoral nerve innervating the rectus femoris and vastus lateralis is marked with the black asterisk.

DISCUSSION

The incidence of root avulsions in lumbosacral plexus injuries has been reported to be lower than in brachial plexus injuries.³ The contralateral S1 nerve root has been proposed as a donor for reconstruction and successfully used to reinnervate the glutei and hamstrings with an intervening long nerve graft in a child.^{4,5} A donor nerve used successfully for ipsilateral reconstruction of the femoral nerve is the obturator nerve.⁶ However, in extensive lumbosacral plexus injuries, as in our cases, the ipsilateral obturator nerve often cannot be used as a donor.

A direct contralateral obturator to femoral nerve transfer has been reported in a 7-year-old boy for restoration of knee extension after acute flaccid myelitis.⁷ Another case was reported in a young adult.⁸ Table 1 summarizes published surgical interventions for extensive lumbosacral plexus injuries with no available ipsilateral donors. Here we report a more targeted neurotization of the lateral branch of the femoral nerve, which in anatomical studies⁹ has been shown to consistently innervate the rectus femoris and vastus lateralis. The rectus femoris muscle is

Table 1. Published Surgical Interventions for Lumbosacral Plexus Injuries with No Ipsilateral Donors

Procedure	Age (y)	Etiology	Outcome (MRC grade)	Last Follow-up (Mo)	Reference
Contralateral S1 root with a 25-cm common peroneal nerve graft to inferior gluteal nerve and sciatic nerve branch to hamstrings	10	Pelvic fracture	3	38	5
Contralateral obturator to femoral nerve transfer	7	AFM	4	31	7
Contralateral obturator to femoral nerve transfer	30	Stab injury	3	23	8

*AFM, acute flaccid myelitis.

vitaly important in the sit-to-stand transition and is active during the loading response and swing phases of the gait cycle, where it acts to propel the limb forward.¹⁰ Hence, we felt that reinnervating the rectus femoris among the quadriceps muscles was most important. This approach has the advantage of not wasting limited donor axons.

Spontaneous recovery of knee extension in both patients cannot be ruled out. However, this is less likely due to preoperative MRIs, which showed multiple root avulsions and preoperative EMGs showing denervation in all tested muscles. In addition, the nerve transfer was done in an end-to-end fashion to the femoral nerve branch to the rectus femoris and the vastus lateralis. Hence, any reinnervation of these muscles should occur through the nerve transfer.

In conclusion, contralateral obturator nerve transfer to lateral branch of the femoral nerve was demonstrated to successfully reinnervate the quadriceps and restore knee extension in two patients following extensive lumbosacral plexus injury with multilevel root avulsions. In the absence of ipsilateral nerve donors for grafting or transfer with multilevel root avulsions, this procedure provides a possibility for functional recovery of knee extension. Careful patient selection is important as the time to reinnervation of the target muscle is long due to the need for a long intervening nerve graft.

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