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Transfer of the anterior branch of the obturator nerve for femoral nerve reconstruction and preservation of motor function: A case report

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ABSTRACT

INTRODUCTION: Femoral nerve lesions are uncommon but severely disrupting at the functional level, because of the inability to walk, run, and passing from sitting to standing position. Reconstruction via local nerve transfer (neurotization) is a relatively new yet promising procedure.
PRESENTATION OF CASE: We describe a case of successful restoration of rectus femoris' function after a malignant process by transfer of the anterior branch of the obturator nerve at the thigh level. At present, only few similar reports are present in the literature. Nerve gap after surgery was considerable (10 cm) and nerve grafting could have been unsatisfactory in terms of reinnervation. Therefore, reconstruction was managed with nerve isolation and transfer to the rectus femoris motor branch. The functional result was satisfactory at 1-year follow up with margins for further improvement.
DISCUSSION: This case reported favorable outcomes of neurotization of the anterior branch of the obturator nerve for femoral nerve lesion. Reports of success with this procedure are still limited, but the promising results in terms of functional recovery suggest it should be offered to patients as a viable therapeutic option.
CONCLUSION: Advantages of neurotization compared to grafts are several, including: limiting suturing sites and scarring; shortening the recovery time by decreasing the required regeneration distance; and allowing for faster muscle reinnervation. The choice to transfer the anterior branch of the obturator nerve specifically allows to preserve part of the adductor functionality in the thigh without affecting the stability of the knee joint.

1. Introduction

Damage to the femoral nerve and subsequent nerve palsy can occur as a consequence of trauma (pelvic fractures, gun-shot wounds), surgical procedures (intra-abdominal, vascular, gynecological surgery), or as an outcome of nerve sheath tumor (Schwannoma, neurofibroma, neurosarcoma)/infiltrating tumor surgery [1,2]. The resulting paralysis of the femoral quadriceps causes significant disability, with a severe impairment and reduction of the quality of life. In cases of a significant nerve gap, nerve transfer (neurotization) can be considered as a valid therapeutic option, to restore nerve continuity in order to re-donate function. We describe a case of successful restoration of rectus femoris' function after a malignant process by transfer of the anterior branch of the obturator nerve at the level of the thigh. The case has been reported in line with the SCARE criteria [3].

2. Presentation of case

A 19-year-old girl was referred to the Multidisciplinary Sarcoma Group for evaluation from another Hospital, where three months before she had undergone excision of a 'myxoid' liposarcoma located on the anterior aspect of the right upper thigh. From pre-operative RM study, the tumor was described as a 'solid, expansive, lobulated, septated mass starting from the groin, bordered by sartorius and iliopsoas muscles, causing no alterations in the common femoral artery (which for 50% of its diameter was bordered by the lesion) and vein normal permeability', with no changes in bone cortex of the right femur, and no inguinal lymphadenopathy; dimensions were $2.6 \times 6.4 \times 9.5$ cm. Excision had been performed with an incision under the inguinal ligament, and a drainage tube had been kept in place for four weeks. His-

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Fig. 1. Intra-operative photographs. *(Left)* Operative exposure. *(Right)* After transposition of the anterior branch of the obturator nerve to femoral branches to rectus femoris, the soft tissue defect is covered with a rotation of muscular flap.

tological report had revealed the liposarcoma had been excised by fragmentation. Molecular cytogenetic analysis by fluorescence in situ hybridization (FISH) had revealed gene rearrangements involving CHOP/DDIT3, supporting diagnosis. The patient had not received adjuvant radiotherapy or chemotherapy. She was otherwise healthy, had multiple allergies (cefotaxime, ceftriaxone, cefazolin, and beta-lactams), and was receiving no drug therapy; she had a positive family history of lung cancer.

A new contrast-enhanced RM scan was obtained, showing a nodular formation on tensor fascia lata muscle. The Multidisciplinary team agreed on a treatment plan of surgical revision of the groin area, with en-bloc removal of the muscles of Scarpa's triangle, the superficial and deep femoral artery and vein, and the femoral nerve.

Options for reconstruction included: exploration and nerve grafting; and nerve transfer more distally in the thigh. We estimated a final nerve gap of 9 cm, starting 1 cm under the inguinal ligament, after the 'en-bloc' removal (skin and subcutaneous tissue, fascia, sartorius, pettineus, and vastus lateralis muscle, femoral artery and vein – common, superficial and deep, and femoral nerve). Therefore, we were concerned that nerve grafting would have been unsatisfactory in terms of reinnervation. Among the options in proximity to the femoral nerve that would allow a direct transfer, the obturator nerve innervating the adductor muscle group was the most feasible potential donor nerve. Nerve transfer was performed from the anterior branch of the obturator nerve, which was isolated in a distal-to-proximal fashion up to the obturator foramen (10 cm), leaving intact the posterior branch to preserve some adductor function. The nerve was transferred to the rectus femoris motor branch of the femoral nerve, under the adductor longus muscle. Femoral arteries were reconstructed with a vein graft (great saphenous vein harvested from the controlateral lower limb), and soft tissue defect was covered with a rotational muscular flap (tensor fasciae latae muscle) and split-thickness skin grafts harvested from the anterolateral aspect of the controlateral thigh (Fig. 1). The post-operative period was uneventful. The histological examination was negative.

At one year post-operatively, there was clear evidence of active leg extension and hip flexion (Fig. 2). She had difficulties running and walking up stairs, but was continuing to improve over time.

Fig. 2. Post-operative photographs 1 year after surgery.

3. Discussion

Neurotization is a well-known reconstructive technique for proximal nerve injuries, with applications documented especially for brachial plexus lesions reconstruction [4–7]. With regard to lower limb, neurotization of the anterior branch of the obturator nerve – motor nerve to the gracilis muscle (MNG) for femoral nerve reconstruction is a recently-acquired technique that is now starting

to be more documented in the literature. Anatomical studies first showed the feasibility of a tension-free neurorrhaphy between the donor and recipient nerve, both in the retroperitoneal space and at the thigh level: average length of the MNG, from its muscular insertion up to the obturator foramen, is 11.5 cm (7.7 cm from gracilis muscle to adductor brevis margin, and 3.7 cm to the obturator foramen), with average diameter of 2 mm; average distance between the femoral nerve and MNG is 3.7 cm [8–10]. Campbell et al. were the first to describe a clinical case of delayed reconstruction of the femoral nerve after removal of a 15-cm, retroperitoneal Schwannoma [8]. The obturator nerve was transferred to the distal femoral stump, allowing for full functionality and contraction of the quadriceps femoris with complete return to normal ambulation two years after surgical intervention. Subsequently, Tung et al. reported two cases of favourable outcome of neurotization of the anterior branch of the obturator nerve for reinnervation after removal of Schwannoma, and post-traumatic injury [11]. The nerve was transferred to the motor branches of the rectus femoris and the vastus medialis, respectively, and resulted in restoration of full muscular contraction in both cases.

Our case was consistent with the previous reports: the anterior branch of the obturator nerve – MNG was isolated, rotated and sutured at the level of the motor branch to the rectus femoris, close to the muscle body. The rationale of suturing the MNG to a minor branch instead of the common trunk lies in the considerable difference in diameter, and the underlying risk of providing an insufficient number of axon fibers for complete reinnervation of the distal stump [9]. Supporting this decision is the clinical evidence in the literature that the anterior branch is able to re-donate functionality to only two out of four muscles within the femoral quadriceps [9,11]. In our case, we decided to re-innervate the rectus femoris muscle as it represents the component within the quadriceps femoris which is more involved in the act of walking, running, and passing from sitting to standing position [12].

To date, there are no studies comparing the clinical results obtained with neurotization of the anterior branch of the obturator nerve and nerve grafting for femoral nerve reconstruction. Therefore, surgical planning still needs to be planned on a case-by-case fashion relying on single studies-information. With regard to the use of nerve grafts, it is nowadays accepted that graft length up to 6 cm do not affect the quality of result [13], while grafting greater gaps produce variable results and implies an uncomfortable recovery (articular immobilization with a 30° flexion of the hip and knee for at least 3 weeks) [2,14]. On the other hand, neurotization does not come uneventfully: a healthy motor nerve is sacrificed with the simultaneous loss of function of the dependent muscle. However, advantages are several, including limiting nerve suturing sites and scarring, allowing for faster and better recovery compared to nerve grafts, especially when the gap is considerable and might preclude a satisfactory reinnervation, shortening the recovery time by decreasing the required regeneration distance, and allowing for faster muscle reinnervation [4,8–15].

Choosing MNG as the donor nerve allows to preserve part of the adductor functionality in the thigh. Moreover, sacrificing the gracile muscle has no significant impact on the functionality and stability of the knee, as also confirmed by the wide application of the muscle's tendon for anterior cruciatus ligament reconstruction [16]. As for cortical plasticity, a donor nerve holding an action that is synergistic to that of the re-innervated muscle facilitates motor learning.

4. Conclusion

In clinical practice, the anterior branch of the obturator nerve represents a feasible option for reconstruction of femoral nerve lesions with associated considerable (≥6 cm) nerve gap. Specific advantages can be outlined as: it is anatomically near the nerve to be reconstructed; it presents a number of motor axons sufficient for complete re-innervation of the distal motor stump; if completely isolated it has a good range of motion and transfer, allowing a tension-free nerve suture; and, loss of function of the effector muscle does not result in further morbidity.

Conflict of interest statement

The authors have no financial interest to declare or anything to disclose in relation to the content of this article.

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Ethical approval

The present study is not a research study. Ethical approval has been exempted by the reporting Institutions.

Consent

The authors declare that appropriate informed written consent for the use of personal details and images was obtained from the patient.

Author contributions

Dr.s Rastrelli, Tocco-Tussardi, Rizzato and Vindigni acquired the clinical data, helped drafting the article, revised critically the content, and gave final approval of the version to be submitted. Dr.s Tropea and Rossi contributed to the present work by analysing and interpreting the data and finally approving the version to be submitted. Dr.s Rastrelli, Tocco-Tussardi, Rizzato and Vindigni contributed to the conception and design of the Report, they revised critically the article content, and gave final approval of the version to be submitted.

Registration of research studies

The present study is not a research study.

Guarantor

Prof. Vindigni.

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