TRANSFER OF TWO MOTOR BRANCHES OF THE ANTERIOR OBTURATOR NERVE TO THE MOTOR PORTION OF THE FEMORAL NERVE: AN ANATOMICAL FEASIBILITY STUDY

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Femoral nerve lesions are uncommon, but very distressing at the functional level because of the absence of knee locking mechanism by the quadriceps muscle. We propose here a new neurotization procedure of obturator nerve motor branches to the motor portion of the femoral nerve in the thigh. This study was conducted on five cadavers. The motor portion of the femoral nerve and the motor branches of the obturator nerve, supplying the gracilis and adductor longus muscles, were isolated. The distance between nerve endings and diameter were measured to determine if a direct neurorrhaphy was possible between the femoral nerve and the two united branches of the obturator nerve. The overlap between the two nerve endings was 26 mm on average, and the mean diameter of the two nerve endings was 3.6 mm for the united branches of the obturator nerve and 3.7 mm for the femoral nerve. Thus, a direct suture was possible in all cases. In this anatomical study, access to the femoral nerve and two united branches of the obturator nerve was easy, in contrast to transfer in the pelvis. Moreover, direct suture without tension was possible in all cases. Thus, this transfer is simple and perfectly reproducible and may have a clinical application in proximal femoral nerve injuries. © 2012 Wiley Periodicals, Inc. Microsurgery 32:463–465, 2012.

Quadriceps palsy caused by a proximal lesion of the femoral nerve is uncommon. However, it is very distressing at the functional level because it significantly reduces walking ability. Apart from free muscle transfer restricted to cases of post-traumatic or tumor-related loss of muscle mass,[1–3] therapeutic possibilities also include nerve grafting,[4] and neurotization.[5] To our knowledge, only one neurotization procedure has been proposed, consisting of a complete obturator-to-femoral neurotization in the pelvis, above the inguinal ligament.[5] Thus, the aim of this study was to evaluate the feasibility of a transfer, in the thigh, of two motor branches of the obturator nerve to the motor portion of the femoral nerve.

MATERIALS AND METHODS

This study (approved by the European Surgery Institute ethic committee) was performed on five cadavers, or 10 thighs. The average age of the cadaver was 76.6 years old (range, 67–82 years old) and the average height of the specimens was 167.7 centimeters (range, 156–175 cm). In each specimen, a 20-cm vertical incision was made, extending proximally from the intersection of the femoral vessels and the inguinal ligament. The inguinal ligament followed a line from the anterior superior iliac spine to pubic tubercle. These two bony landmarks were easily palpated. The femoral artery was found at the junction of the medial third and the two lateral third of the inguinal ligament. After the femoral vessels were identified in the proximal part of the incision, the pectineus muscle, under the femoral vessels, was retracted upward showing the anterior division of the obturator nerve. The branch coming from the anterior division of the obturator nerve was identified and dissected at its exit from the pelvis. The adductor longus muscle was retracted downward to expose the branches supplying the adductor longus and gracilis muscles. The branches thus exposed were sectioned as close as possible to the muscle to obtain the maximum possible length. The cutaneous branch of the obturator nerve (terminal branch of the anterior part) was not included in the transfer, however this branch was not brindling the motor branches.

The femoral nerve was identified just on the lateral side of the femoral artery and released below the inguinal ligament. The motor portion was easily denoted, because the sensory branch (saphenous nerve) splits off from the main femoral nerve trunk medially. This motor branch of the femoral nerve was then sectioned immediately after the division of the sensory branch. Next, the two branches of the obturator nerve were united and placed near the motor portion of the femoral nerve (Fig. 1). Finally, the distance between the endings of both nerves was measured to examine the possibility of a direct neurorrhaphy (Fig. 2). The diameters of gracilis nerve, adductor longus nerve and femoral nerve, and the distance of the femoral nerve to the quadriceps muscle were also measured.

RESULTS

The dissection of the motor branches of the obturator and femoral nerves was possible in all cases. There was always an excess of length between the endings of the

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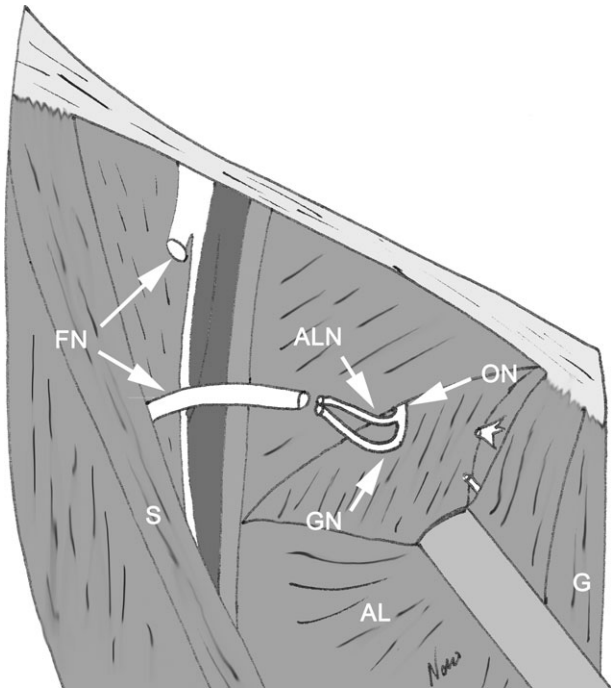

Figure 1. Diagram showing the principle of a transfer of two motor branches of the obturator nerve (supplying the gracilis and adductor longus muscles) to the proximal portion of the femoral nerve (right side). (FN, femoral nerve; ALN, adductor longus nerve; ON, obturator nerve; S: sartorius muscle; GN, gracilis nerve; AL, adductor longus muscle; G: gracilis muscle).

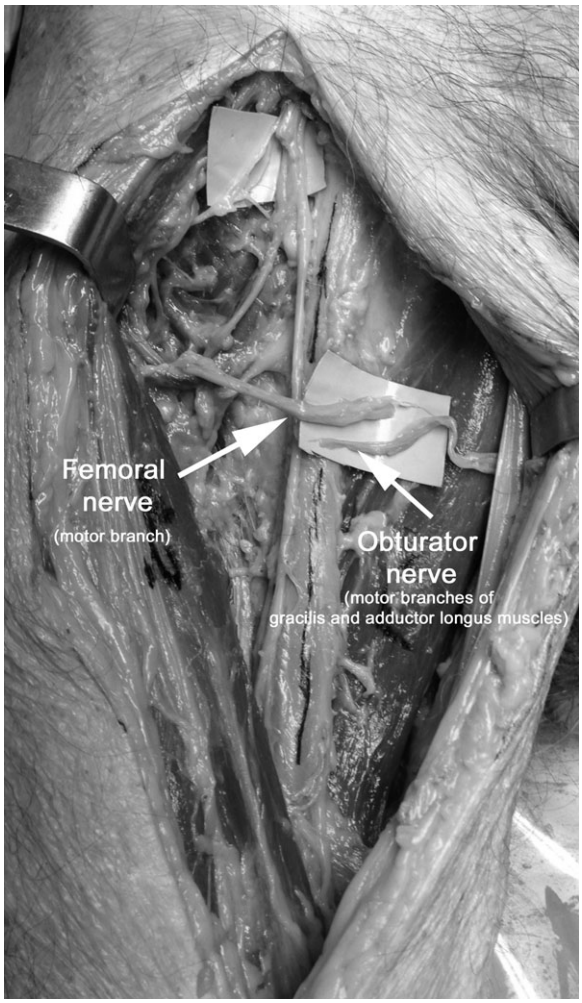

Figure 2. The length after section of the motor branch of the femoral nerve and two motor branches of the obturator nerve (supplying the gracilis and adductor longus muscles) was sufficient in all cases to perform direct neurorrhaphy (right side). The diameter of the nerves corresponded perfectly.

femoral nerve and of the two united branches of the obturator nerve. The average excess of length between nerve endings was 27 mm; therefore, direct neurorrhaphy was possible in all cases. The mean diameter of the two united branches of the obturator nerve (supplying the gracilis and adductor longus muscles) was 3.6 mm. The mean diameter of the motor portion of the femoral nerve was 3.7 mm. The average minimum residual distance from the tip of the femoral nerve and first recipient muscle motor units was 65 mm (Table 1).

Table I. Results of Cadaver Dissections

	Average (mm)	Range (mm)
Gracilis nerve diameter	2	2
Adductor Longus nerve diameter	1.6	1–2
Femoral nerve diameter	3.7	3–4
Obturator to Femoral nerves distance	27	22–35
'Suture' to Quadriceps muscle distance	65	55–72

DISCUSSION

Knee extension is critical for walking. It requires sufficient quadriceps contraction to lock the knee and sustain the body weight. In case of proximal injury of the femoral nerve (above the inguinal ligament), standing and walking become difficult. Apart from free muscle transfer, restricted to cases of post-traumatic or tumor-related loss of muscle mass,[1–3] some authors propose nerve grafting[4] and, more recently, neurotization[5] as therapeutic approaches. The latter consists of a complete suture of the obturator and femoral nerves. However, dissection and neurorrhaphy should be performed in the pelvis, which complicates the surgical procedure. Moreover, with this technique, the suture of the obturator nerve is performed on the entire femoral nerve, including its sensory component, thus leading to a loss of motor fibers. For this reason, we attempted to transfer two motor branches from the anterior branch of the obturator nerve directly to the motor portion of the femoral nerve in the thigh. Therefore, we decided to assess this technique with an

anatomical feasibility study that has been proved to provide supports for clinical application of nerve transfer procedures.[6,7]

The results confirmed the feasibility of this transfer. Indeed, thanks to the length of the nerve branches, direct neurorrhaphy was possible in all cases. The results of our study is comparable to other anatomical study concerning the nerve length of the gracilis muscle.[8] Moreover, the diameter of the obturator nerve endings corresponded exactly to the diameter of the femoral nerve ending. Therefore, this neurotization was anatomically possible. In addition, the procedure consisted of the suture of two motor nerves, so there was no loss of motor fibers in a sensory branch. Finally, the neurorrhaphy was performed near the muscle, so recovery should be faster than in the case of grafting or suture in the pelvis. Spiliopoulos performed a transfer of the femoral nerve to the obturator nerve leading to a good reinervation of adductor muscles.[9] These results showed the number of nerve fibers in obturator and femoral nerve was sufficient to provide muscle reinnervation. However, no nerve counting provided is a limitation of this study.

In fact, a study of patients after harvesting the gracilis for reconstruction of the anterior cruciate ligament of the knee showed no impact on knee function.[10] However, this study is merely an anatomical assessment, and a clinical study is currently under way to validate the clinical efficacy of this transfer and the absence of functional impairment related to the sacrifice of both the adductor longus and gracilis muscles.

This study presents the anatomical feasibility of a direct nerve transfer procedure between the adductor longus nerve, the gracilis nerve, and the femoral nerve in thigh. This simple and reproducible technique may have a clinical application in case of proximal femoral nerve injuries.

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