Transfer of the lateral head of the gastrocnemius muscle for correction of drop-foot deformity after regenerated complete sciatic nerve injuries

Ahmed E. Kandil

Department of Orthopaedics and Traumatology, Faculty of Medicine, Cairo University, Cairo, Egypt

Correspondence to Ahmed E. Kandil, Department of Orthopaedics and Traumatology, Faculty of Medicine, Cairo University, Cairo, Egypt
Tel: +20 35733987;
e-mail: mohammedghool@eoa.org.eg

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Objectives

To evaluate the effectiveness of transfer of the lateral head of the gastrocnemius for treatment of drop-foot deformity after regenerated complete sciatic nerve injuries.

Patients and methods

The study included nine patients (one woman, eight men, mean age 30 years). The mean time delay between surgery on the sciatic nerve or trauma was 3 years (range, 2–6 years). Delay was necessary to allow for gastrocnemius ± peroneal recovery after trauma, microsurgical reconstruction, or neurolysis or spontaneously. The lateral head of the gastrocnemius was harvested together with its longitudinal extension into the lateral tendoacilles; this complex was passed through the peroneal tendon and divided into two, a lateral half sutured to the extensor digitorum longus and extensor hallucis longus and a medial half sutured to the tibialis anterior tendon. The patients were assessed according to the Stanmore system questionnaire.

Results

According to the Stanmore assessment system, the results were poor in one foot, fair in two feet, good in four feet, and very good in four feet. The mean ankle dorsiflexion in patients was +6° (range, −5 to +10°). Claw-toe and drop-toe deformities were restored. No early complications were encountered apart from the complaints of two patients of the bulge because of tendon and suture material on the dorsum of the foot. There was no medial arch flattening or weakness in plantar flexion.

Conclusion

Transfer of the lateral head of the gastrocnemius for correction treatment of drop-foot deformity after regenerated complete sciatic nerve injuries is a valuable reconstructive option.

Keywords:

drop foot, sciatic nerve injuries, tendon transfer/methods

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Introduction

It is well known that sciatic nerve injuries, whether at the level of the acetabulum, the hip, or the midthigh, require a long period of time to regenerate. Regeneration is often incomplete. The gastrocnemius muscle regenerates before the muscles supplied by the peroneal nerve [1]. All sciatic nerve injuries lead to drop-foot deformity. Drop-foot deformity is a life-limiting clinical manifestation characterized by loss of ankle dorsiflexion and eversion [1–6]. In drop-foot deformity, both the swing phase and the toe-contact phase are problematic because of the malfunctioning of the dorsiflexors of the ankle. Steppage gait is only possible through excessive hip and knee flexion. It becomes difficult to transfer the body weight to the ground. Equinus may develop in the ankle in the long term, through passive lengthening of the ankle tendons that lack the dorsiflexion function. In peroneal nerve palsy, numerous studies have been carried out on the transfer of the tibialis posterior tendon in part or as a whole to various receiving [7–12]. However, in sciatic nerve injuries waiting for regeneration of the peroneal part of the sciatic nerve will mean putting patients off activity for a long period of time. As the gastrocnemius regenerates earlier and better than the tibialis posterior [1], it might be a better alternative for tendon transfer.

The aim of this study is to investigate the use of the lateral head of the gastrocnemius for reconstruction of drop-foot deformity consequent upon complete sciatic nerve injuries.

Patients and methods

Patients

A prospective study was carried out on nine patients with a complete sciatic nerve injury who underwent a tendon transfer surgery in Kasr Al Ani hospital between 2006 and 2009. The mean age of the patients was 30 years (range, 10–44 years), with one woman and eight men. Causes of nerve injury included a hip fracture dislocation in five patients, a fracture of the acetabulum in two patients, an injection injury in one patient, and a bullet injury in one patient.

Table 1 Patient data

Patient numbers	Age (years)	Sex	Causative mechanism of sciatic nerve lesion	Associated injuries	Previous operations on the sciatic nerve	Duration from operation/trauma to tendon transfer (years)	Muscles which had regenerated (spontaneously, because of neurolysis or because of nerve grafting) before the tendon transfer and their preoperative motor power	Postoperative muscle power	Preoperative range of ankle dorsiflexion	Postoperative range of ankle dorsiflexion	Preoperative range of ankle plantar flexion	Postoperative range of ankle plantar flexion
1	11	M	Injection injury	–	Neurolysis	6	Gastrocnemius 4, peronei 4, tibialis posterior 3, tibialis anterior 0, extensor digitorum 2–3	Lateral head gastrocnemius transferred to tibialis anterior 3, peronei 4, tibialis posterior 3, extensor digitorum 2–3	0	0–10	0–20	0–30
2	44	M	Hip fracture dislocation	–	Neurolysis	2	Gastrocnemius 4, peronei 3, tibialis 3 posterior	Lateral head gastrocnemius transferred to tibialis anterior 3, peronei 4, tibialis posterior 3	0	0–5	0–10	0–15
3	30	M	Fracture of the acetabulum	–	Neurolysis	2	Gastrocnemius 4, peronei 3, tibialis posterior 2–3	Lateral head gastrocnemius transferred to tibialis anterior 3, peronei 4, tibialis posterior 3, extensor digitorum 2	0	0–10	0–10	0–10
4	30	F	Fracture of the acetabulum	–	Nerve grafting	2	Gastrocnemius 4, peronei 3, tibialis posterior 2–3	Lateral head gastrocnemius transferred to tibialis anterior 3, peronei 4, tibialis posterior 3	0	0	0–10	0–10
5	32	M	Hip fracture dislocation	–		2	Gastrocnemius 4, peronei 3	Lateral head gastrocnemius transferred to tibialis anterior 3, peronei 4, tibialis posterior 3, extensor digitorum 2	0	0–10	0–10	0–10
6	24	M	Bullet injury	–	Nerve grafting	2	Gastrocnemius 4, peronei 3	Lateral head gastrocnemius transferred to tibialis anterior 3, peronei 4	−5	0	5–10	0–10
7	40	M	Hip fracture dislocation	–		4	Gastrocnemius 4, peronei 3, tibialis posterior 3, extensor digitorum 2	Lateral head gastrocnemius transferred to tibialis anterior 3, peronei 4, tibialis posterior 3, extensor digitorum 2	0	0–10	0–20	0–30
8	30	M	Hip fracture dislocation	Dislocated knee		3	Gastrocnemius 4, peronei 3, tibialis posterior 3, extensor digitorum 2	Lateral head gastrocnemius transferred to tibialis anterior 3, peronei 4, tibialis posterior 3, extensor digitorum 2	0	0–10	0–20	0–30
9	30	M	Hip fracture dislocation	Pott's ankle fracture		3	Gastrocnemius 4, peronei 3	Lateral head gastrocnemius transferred to tibialis anterior 3, peronei 4, tibialis posterior 3, extensor digitorum 2	0	0–10	0–10	0–10

Figure 1

The gastrocnemius muscle and the tendoachilles were exposed through two longitudinal midline incisions.

Figure 2

Both the lateral head of the gastrocnemius and its prolongation into the tendoachilles were extracted as a unit from the upper incision.

Before tendon transfer, three patients had undergone neurolysis of the sciatic nerve; the sciatic nerve had been grafted in two other patients (Table 1). Associated injuries included a dislocation of the knee in one case and ankle fracture in another. The mean time delay between surgery on the sciatic nerve or trauma to tendon transfer was 3 years (range, 2–6 years). This time delay was necessary to allow for gastrocnemius ± peroneal recovery after trauma, microsurgical reconstruction, or neurolysis or spontaneously; during this time, progression of Tinel's sign, muscular contractions, and nerve conduction studies were evaluated before considering tendon transfer [13–15]. The gastrocnemius had regenerated to grade 4 and peronei to grade 4 or 3 in all cases, the tibialis posterior had regenerated in six cases, and the extensor digitorum in three cases. All patients were using ortheses. All ankle and foot deformities were passively correctable. Active and passive ranges of motion in the joint were measured during the preoperative period, using the 'Neutral-0' method with the patient in a supine position and with the knee in extension [2].

Table 2 Stanmore assessment questionnaire

Pain	15 points
Never	15
Occasionally	10
Sometimes	5
Serious pain	0
Need for orthosis	15 points
No need	15
Rarely (once a week)	10
Sometimes (twice a week)	5
Frequent (>twice a week)	0
Ability to wear normal shoes	5 points
Yes	5
Only special models	3
No	0
Functions	10 points
Normal daily activity and normal recreation	10
Normal daily activity and limited recreation	6
Limited daily activity and limited recreation	3
Seriously limited daily activity and recreation	0
Degree of active dorsiflexion	25 points
Grades 4–5	25
Grade 4	20
Grade 3	10
Grade 2 and lower	0
Degree of active dorsiflexion	25 points
More than 6°	25
0–5°	20
−5 to −1°	10
−10 to −6°	5
< −11°	0
Foot posture	5 points
Plantigrade, balanced, no deformity	5
Plantigrade; mild deformity	3
Obvious deformity, misalignment	0
100–85 points: very good; 84–70 points: good; 69–55 points: fair; 55 points: poor	

Surgical technique

All patients were positioned supine under a tourniquet, with a pad under the hip of the affected side. The gastrocnemius muscle and the tendoachilles were exposed through two longitudinal midline incisions (Fig. 1). Through the upper midline incision, the sural nerve and the cleavage plane between the two heads of the gastrocnemius were located. The nerve and vascular supplies to the lateral head of the gastrocnemius were secured; the lateral head of the gastrocnemius was followed distally to its insertion into the tendoachilles. Through the lower midline incision, the tendoachilles was exposed and divided longitudinally. The lateral division of the tendoachilles was disinserted from the calcaneus and, working subcutaneously through both longitudinal incisions, followed to the lateral head of the gastrocnemius. Both were extracted as a unit from the upper incision (Fig. 2). Next, through an inferior anterolateral incision, the peroneal tendons, the tibialis anterior tendon, and the extensor digitorum and extensor hallucis longus tendons were exposed. Through a subcutaneous tunnel from the upper to the anterolateral incision, the extracted tendon was passed through the peroneal tendon and divided into two: a lateral half sutured to the extensor digitorum longus and extensor hallucis longus and a medial half sutured to the tibialis anterior tendon. In the meantime, the ankle was positioned at 10° dorsiflexion and at maximum possible eversion. The tourniquet was then released to check for hemorrhage and a lower leg circular cast was applied

Figure 3

Posterior view of the leg after surgery.

Figure 4

Range of plantar flexion of the ankle after surgery.

maintaining the position of the foot. The circular cast on the lower leg was removed after 6 weeks with the subsequent use of an ankle foot orthosis. In the first 4 weeks of 8-week ankle foot orthosis usage, the patients were trained on recognizing the direction of movement and putting it into action. Full weight bearing with ankle foot orthosis was allowed in the subsequent 4-week period. The patients were assessed using the Stanmore assessment system (Table 2) [2,10].

Results

According to the Stanmore assessment system, the results were poor in one foot, fair in two feet, good in four feet, and very good in four feet. All our patients were satisfied with the results of the surgery. The patient with poor results who also had limited recreation was partially relieved of the requirement to use orthosis. The mean ankle dorsiflexion in patients was $+7^\circ$ (range, -5 to $+10^\circ$) (Figs 3 and 4). Three ankles had an average of 10° active dorsiflexion and a range of motion of 40°, whereas four ankles had 5–10° active dorsiflexion and 20° average range of motion. Two ankles lacked dorsiflexion, with the foot in a plantigrade position and with a range of motion below 10°. Claw-toe and drop-toe deformities were restored, which were observed in two cases and that were attributed to stretching because of uncompensated toe flexors and the impact from the stretched long extensors. No early complications were encountered apart from the complaints of two patients of the bulge because of tendon and suture material on the dorsum of the foot. Throughout the follow-up period, there was no medial arch flattening or weakness in plantar flexion because of tibialis posterior insufficiency. The individual preoperative and postoperative muscle powers and preoperative and postoperative ranges of ankle dorsiflexion and plantar flexion are shown in Table 1.

Discussion

The lateral head of gastrocnemius transfer was used successfully on patients with drop-foot deformity after a sciatic nerve injury with a partial improvement in ankle dorsiflexion and plantar flexion and correction of toe deformities.

Claw-toe and drop-toe deformities are restored through the strengthening of the long extensors of the toe and by attaining plantigrade transfer of body weight onto the floor [16]. In a similar study [12], no early complications were encountered other than the complaints of the bulge because of tendon and suture material on the dorsum of the foot. Throughout the follow-up period, there was no medial arch flattening or weakness in plantar flexion associated with tibialis posterior insufficiency [12,17–19]. In this respect, our results are similar to those of subcutaneous tibialis posterior transfer for correction of drop-foot deformity consequent upon peroneal nerve palsy [2]. The risk of vascular injuries and late-term contraction in the subcutaneous passage are the key problems with all subcutaneous tendon transfers [2,8]. Wagenaar and Louwerens [11] used to split the tibialis posterior tendon into two parts before the subcutaneous transfer process and, using tendon-to-tendon fixing, they reported excellent results for 10 feet out of 13 in their study with a follow-up period of 3 years. In a study carried out by Özkan *et al.* [8], the tibialis posterior tendon was split into two parts, with one strip transferred to the tibialis anterior tendon and the other to the extensor hallucis longus, extensor digitorum, and peroneal tendons. A total of 70% successful results were reported in this study. In this study, the lateral half of the tendoachilles transferred in conjunction with the lateral head of the gastrocnemius was split longitudinally into two parts. Although the subcutaneous transfer of the tibialis posterior tendon to the dorsum of the foot by taking it around the tibia medial fascia is an easier and less risky method, it provides a lesser degree of range of motion in the joint [8,11]. For this reason, we used the lateral head of the gastrocnemius. Transferring the tendon superficially over the retinacular flap of the dorsal extensor is reported to reduce the transfer route and enhance biomechanical efficiency [4,7]. The ankle was maintained in a lesser degree of dorsiflexion (10°) during fixation. This resulted in a relatively limited strength in active dorsiflexion while leading to a lesser extent of achilloplasty requirement [8,17,20].

Another significant issue is defining the tenodesis point of the lateral head of the gastrocnemius on the receiving field. Transfers to various tarsal bones and to tendons have been reported in the literature [2–4,9–12]. The transfer of the lateral head of the gastrocnemius onto the extensor hallucis longus, extensor digitorum, and peroneal tendons provides a strong pronator impact and facility in fixation. It furthermore enables dorsiflexion in the hallux through the tenodesis effect. However, the drawbacks with the extension of the lateral head of the gastrocnemius over to the transfer location include the technical challenges caused by tendon and suture tensions in the dorsal foot [2]. However, it should be noted that it is superior to the transfer of the tibialis posterior not only because of limited and delayed regeneration of the tibialis posterior after sciatic nerve injury but also because the transfer of the tibialis posterior tendon as a whole might lead to flattening of the medial arch of the foot and weakening of the plantar flexion in the long term [18]. Limited number of patients and the short duration of the follow-up period are the shortcomings of our study. In conclusion, the subcutaneous transfer of the lateral head of the gastrocnemius onto the structures in the foot dorsal in drop-foot deformity is a method that considerably enhances the quality of life of the patient by allowing unproblematic walking without the use of orthoses.

Conclusion

Transfer of the lateral head of the gastrocnemius to the long extensor tendons of the toes and to the peroneus tertius tendon for correction of drop-foot deformity after regenerated complete sciatic nerve injuries is an efficient and low-risk method that allows easy fixation in the recovery of the dorsiflexion and eversion ranges of motion of the foot, and is also efficient in terms of further pathologies.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

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