Immediate Nerve Transfer for Treatment of Peroneal Nerve Palsy Secondary to an Intraneural Ganglion: Case Report and Review

Le transfert nerveux immédiat pour traiter la paralysie du nerf fibulaire commun causée par un kyste mucoïde nerveux : rapport et analyse de cas

Plastic Surgery
2018, Vol. 26(2) 80-84
© 2018 The Author(s)
Reprints and permission:
sagepub.com/journalsPermissions.nav
DOI: 10.1177/2292550317747844
journals.sagepub.com/home/psg

Imran Ratanshi, MD, MSc¹, Tod A. Clark, MD², and Jennifer L. Giuffre, MD¹

Abstract

Intraneural ganglion cysts, which occur within the common peroneal nerve, are a rare cause of foot drop. The current standard of treatment for intraneural ganglion cysts involving the common peroneal nerve involves (1) cyst decompression and (2) ligation of the articular nerve branch to prevent recurrence. Nerve transfers are a time-dependent strategy for recovering ankle dorsiflexion in cases of high peroneal nerve palsy; however, this modality has not been performed for intraneural ganglion cysts involving the common peroneal nerve. We present a case of common peroneal nerve palsy secondary to an intraneural ganglion cyst occurring in a 74-year-old female. The patient presented with a 5-month history of pain in the right common peroneal nerve distribution and foot drop. The patient underwent simultaneous cyst decompression, articular nerve branch ligation, and nerve transfer of the motor branch to flexor hallucis longus to a motor branch of anterior tibialis muscle. At final follow-up, the patient demonstrated complete (M4+) return of ankle dorsiflexion, no pain, no evidence of recurrence and was able to bear weight without the need for orthotic support. Given the minimal donor site morbidity and recovery of ankle dorsiflexion, this report underscores the importance of considering early nerve transfers in cases of high peroneal neuropathy due to an intraneural ganglion cyst.

Résumé

Les kystes mucoïdes nerveux du nerf fibulaire commun sont rarement responsables d'un pied tombant. La norme actuelle pour traiter ce type de kystes consiste à 1) décompresser le kyste et 2) ligaturer le rameau nerveux pour éviter les récurrences. Les transferts nerveux doivent être effectués rapidement pour récupérer la dorsiflexion de la cheville en cas de paralysie importante du nerf fibulaire commun. Toutefois, cette intervention n'a jamais été effectuée en cas de kyste mucoïde nerveux. Les auteurs présentent le cas d'une femme de 74 ans atteinte d'une paralysie du nerf fibulaire commun causée par un kyste mucoïde nerveux. Cette femme a consulté parce qu'elle souffrait depuis cinq mois dans la distribution du nerf fibulaire commun droit et que son pied tombait. Elle a subi simultanément une décompression du kyste, une ligature du rameau nerveux artériel et un transfert nerveux du rameau moteur du muscle long fléchisseur de l'hallux au rameau moteur du muscle tibial antérieur. Au dernier suivi, la patiente avait totalement retrouvé la dorsiflexion de sa cheville (M4+), ne présentait plus de douleurs ni de manifestations de récurrence et pouvait soutenir son poids sans orthèse. Étant donné la morbidité minimale au site du donneur et la récupération de la dorsiflexion de la cheville, ce rapport fait ressortir l'importance d'envisager un transfert nerveux précoce en cas de neuropathie fibulaire importante causée par un kyste mucoïde nerveux.

¹ Department of Surgery, Section of Plastic Surgery, University of Manitoba, Winnipeg, Manitoba, Canada

² Department of Surgery, Section of Orthopaedic Surgery, University of Manitoba, Winnipeg, Manitoba, Canada

Corresponding Author:

Jennifer L. Giuffre, Department of Surgery, Section of Plastic Surgery, University of Manitoba, 75 Poseidon Bay, Winnipeg, Manitoba, Canada R3 M 3E4.
Email: jgiuffre@panamclinic.com

Keywords

nerve transfer, peroneal nerve palsy, intraneural ganglion

Introduction

Peroneal neuropathy results in loss of sensation to the dorsum of the foot as well as gait altering paralysis of the tibialis anterior and the peroneus muscles. Intraneural ganglion cysts are benign mucinous cysts that occur within the epineurium of peripheral nerves.¹ They are a rare cause of peroneal neuropathy and can result in foot drop.² The diagnosis is made on magnetic resonance image (MRI), wherein tubular structures are seen within the affected nerve that appear hyperintense on T2-weighted images and hypointense on T1-weighted images.¹ Some uncertainty surrounds the mechanism explaining intraneural ganglion cyst formation. Historically, surgeons attributed the pathogenesis of intraneural ganglia to the “de novo” theory of formation, where degenerative changes within the epineurium and perineurium gave rise to cyst formation.³⁻⁵ Currently, the most accepted hypothesis is the articular (synovial) theory proposed by Spinner et al⁶⁻⁸ who suggested that through a capsular rent, there is a connection between the joint space and the articular nerve branch. Joint fluid dissects through this connection along an intraepineurial path of least resistance to form an intraneural cyst in response to changes in pressure and pressure fluxes.⁶⁻⁸ Neurological deficits arise from the compression of nerve fascicles by the accumulation of cyst material. In the lower extremity, the common peroneal nerve is the most common site of occurrence. Here, the cyst pedicle is thought to originate from the proximal tibiofibular joint.

As a relatively rare and obscure pathology, it can be difficult for a centre to accumulate a sufficiently large series of patients to critically appraise surgical outcomes used to treat intraneural ganglia. Outcomes depend largely on the duration and extent of cystic destruction, early recognition, and timely intervention.¹ Extraneural decompression and epineurotomy have been the mainstay of surgical management; however, it has been suggested that the cyst decompression and resection alone leads to recurrence and poor neurological recovery.⁶ In their clinical series, Spinner et al⁹ demonstrated that the combination of (1) cyst decompression and (2) ligating the articular branch resulted in significant improvements in neuropathic pain while eliminating intraneural cyst recurrence in 24 of 27 patients. All patients in this series who did not undergo articular branch ligation ($n = 3$) demonstrated intraneural cyst recurrence. This study is the first to provide clinical support for the theory that disruption of the pedicle stalk is essential to prevent intraneural recurrence.¹⁰ Unfortunately, while the combination of cyst decompression and articular nerve branch ligation offered excellent resolution of pain, patients in this series regained mild improvements in their motor deficits at 1 year follow-up.⁹

Contrary to the discouraging functional recovery seen in Spinner’s series, Naam et al³ in their series of 15 patients with

intraneural ganglia in the hand and wrist, demonstrated functional recovery and no recurrence at final follow-up (average 57 months) in all but 1 patient (persistent muscle atrophy) using a combination of nerve decompression, articular branch ligation (where possible), and sensory nerve excision.³ Additionally, there are a number of case reports that have shown complete functional recovery following extraneural decompression with or without articular branch ligation in various anatomic locations.^{1,11,12} The concern in cases that involve the common peroneal nerve, should surgical decompression with articular ligation fail, is that the resulting foot drop will render patients with a permanent and debilitating gait abnormality due to loss of ankle and toe dorsiflexion.

Current treatment modalities for recalcitrant foot drop offer limited restoration of function. Ankle foot orthosis (AFO) remain the mainstay of treatment; however, patients are often unsatisfied due to discomfort, hygiene, and mobility issues.¹⁰ Tendon transfers are a reasonable surgical treatment option in which the tibialis posterior tendon is rerouted to the dorsum of the foot for dorsiflexion. Although tendon transfers provide limited ankle dorsiflexion, they may result in undesirable hind foot valgus deformity, flatfoot deformity, or arthritis.^{13,14} More recently, autologous nerve transfers have been proposed as a treatment for high peroneal neuropathies. The principle is based on transferring a functional but less important donor nerve to reinnervate a more critical target muscle.¹³ Nerve transfers are time dependent in that the regenerating nerve must reach the motor end-plate by approximately 1 year post injury for optimal outcomes.¹⁴ Patients with peroneal neuropathies are often not candidates due to their delayed presentation.

Given that the cyst decompression and articular branch ligation have reportedly resulted in poor functional recovery, and the recovery time of this approach may close the window on potential nerve transfers, we propose a simultaneous intraneural ganglion cyst decompression, articular nerve branch ligation, and nerve transfer to increase the likelihood of recovering ankle dorsiflexion.

Materials and Methods

Ethics approval for this study was obtained from the University of Manitoba Health Research Ethics Board. A case report of a patient with an intraneural ganglion cyst treated with simultaneous (1) cyst decompression, (2) articular nerve branch ligation, and (3) nerve transfer of the motor nerve of flexor hallucis longus (FHL) into a motor nerve branch of tibialis anterior muscle is described. Measured outcomes included pre- and post-operation British Medical Research Council (BMRC) muscle grade of anterior tibialis muscle and FHL, pain measured on a Visual Analogue Scale, donor site

Figure 1. A magnetic resonance image of right knee indicating multiple internal cysts within the common peroneal nerve located proximal to the fibular head extending 2.8 cm (longitudinal) by 6 mm (anteroposterior) by 4 mm (transverse). T1-weighted axial (A) and sagittal (B) views of the knee. C, T2-weighted axial image demonstrating multiple intraneural cysts. White arrows indicate the location of the common peroneal nerve in images (A) to (C).

deficits and complications including infection, hematoma, seroma, and dehiscence.

Case Report

A 74-year-old female presented with a 5-month history of progressive pain within her right superficial and deep peroneal nerve distributions and foot drop requiring an AFO. Clinical exam revealed that without an AFO, the patient ambulated with a high step gait. There was a palpable mass posterior to the right fibular head. A Tinel sign was absent at the fibular head. The patient demonstrated BMRC grade M0 ankle dorsiflexion, eversion, and toe extension. She had grade M5 ankle plantar flexion, inversion, and toe flexion. Sensory deficits were appreciated in both the superficial and deep peroneal nerve distributions. Reflexes were symmetric (2+) at the knees and ankles bilaterally. Straight leg test was negative for lumbosacral nerve root compression.

A magnetic resonance image of her right knee demonstrated an intraneural cyst (6 mm anterior–posterior $\times$ 4 mm transverse $\times$ 28 mm longitudinal) within the common peroneal nerve (Figure 1A–C). There were no elicitable motor units on electromyography (EMG) in the peroneal nerve distribution, and nerve conduction studies demonstrated that the nerve was in continuity. Computed tomography and MRI of the lumbar spine were performed and were unremarkable.

Foot drop correction was obtained by (1) decompressing the intraneural cyst, (2) ligating the articular nerve branch, and (3) performing a nerve transfer in which the tibial motor nerve branch to FHL was transferred into the deep peroneal motor nerve branch to anterior tibialis muscle. At 6 months post-operation, the patient demonstrated M3 anterior tibialis muscle strength and M4 FHL muscle strength. At final follow-up (>1 year), the patient demonstrated M4+ anterior tibialis, M5 FHL, normal gait, no need for orthotics, no pain, and no evidence of cyst recurrence (Figure 2A and B). There were no tibial nerve deficits and no perioperative or post-operative complications.

Figure 2. Pre-surgical (A) and post-surgical (B) restoration of ankle dorsiflexion at final follow-up (1 year). The patient demonstrates complete recovery (British Medical Research Council [BMRC] grade M5) of ankle dorsiflexion, normal gait, and no need for orthotics.

Discussion

We present a case report of an elderly patient with a 5-month history of severe high peroneal nerve palsy secondary to an intraneural ganglion. The accepted articular theory recommended ligating the articular branch in a timely fashion to obtain optimal recovery and to reduce the risk of recurrence.⁹ Motor nerve recovery is ideal if the nerve reaches the motor

endplates of the muscle by 1 year.¹⁵ Given that this elderly patient was presenting with a proximal peroneal nerve lesion and a 5-month history of a dense foot drop with no elicitable motor units on EMG, we decided to augment the cyst decompression and ligation of the common peroneal articular nerve branch with a distal tibial to peroneal nerve transfer to improve her chances of recovery. We were able to successfully restore her foot function without any donor deficits. We believe the combination of ligating the articular branch and performing a distal nerve transfer may augment the likelihood of a full recovery.

Until recently, managing intraneural recurrence and pain has been the primary goal of treatment. Herein, understanding the importance of the articular branch in the pathophysiology of intraneural ganglia has been critical. Although ligation of the articular branch with the cyst decompression has been shown to substantially improve neuropathic pain, functional gains have been limited and less predictable.⁹ Persistent foot drop despite decompression and articular nerve branch ligation may be due to the delayed time of the patient's first presentation with an established foot drop, or the long distance the regenerating nerve must traverse by approximately 1 year into the anterior tibialis muscle. Prognostic factors of motor recovery have been reported to include (1) duration of symptoms, (2) extent of compression, (3) duration of the mass, (4) length of the cyst, and (5) the neural anatomy of the tibialis anterior branch, namely, if it arises directly from the articular branch.⁹ Nerve regeneration occurs at a rate of 1 to 3 mm/d and is, therefore, time dependent. If the regenerating nerve does not reach the motor end-plate within the tibialis anterior by approximately 1 year, the motor end-plate will atrophy and nerve function will not likely recover.¹⁵ If the nerve does not recover from cyst decompression and articular branch ligation alone, it is too late to perform the nerve transfer. In addition to addressing the challenge of temporal urgency in nerve regeneration, nerve transfers have a role in augmenting functional recovery.

Multiple options have been reported for possible donor nerves for foot reanimation. White et al found adequate axon counts in the motor branches to the lateral gastrocnemius, extensor hallucis longus, and FHL that would be capable of restoring ankle dorsiflexion following nerve transfer.¹⁶ The motor branch to the soleus muscle has also been postulated as a donor nerve but was found to confer poor (M2 or less) ankle dorsiflexion.¹⁷ To our knowledge, no single nerve transfer has been proven to be superior in this setting. The choice of transfer in our case was governed by previous experience utilizing the nerve branch to FHL.¹³

We acknowledge that the nerve may recover from the decompression alone. Should the nerve regenerate on its own, there are negligible morbidities or donor site deficits as a result of the surgery; however, if the nerve fails to recover on its own, the nerve transfer will allow for the restoration of function not otherwise routinely obtained with the combination of cyst decompression and articular branch ligation alone. Although not performed in this case, a strategy to identify if the nerve transfer was powering tibialis anterior function could involve

placing an EMG needle in the tibialis anterior muscle belly and observing if the number of motor unit action potentials improved with plantar flexion of the great toe.

Conclusions

Given the possibility of delayed diagnosis and uncertain functional recovery in this patient population, early nerve transfer may be a reasonable adjunct to the current standard of care of the cyst decompression and articular nerve branch ligation.

Authors' Note

This abstract has been previously presented at the American Society of Peripheral Nerve (ASPN) Annual Meeting, Kauai, HI, USA (2014) and the 69th Canadian Society of Plastic Surgery (CSPS) Annual Meeting, Victoria, BC, Canada (2015).

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

References

- Colbert SH, Le MH. Case report: intraneural ganglion cyst of the ulnar nerve at the wrist. *Hand (N Y)*. 2011;6(3):317-320.
- Van den Bergh FR, Vanhoenacker FM, De Smet E, Huysse W, Verstraete KL. Peroneal nerve: Normal anatomy and pathologic findings on routine MRI of the knee. *Insights Imaging*. 2013;4(3):287-289.
- Naam NH, Carr SB, Massoud AH. Intraneural ganglions of the hand and wrist. *J Hand Surg Am*. 2015;40(8):1625-1630.
- Allieu PY, Cenac PE. Peripheral nerve mucoid degeneration of the upper extremity. *J Hand Surg Am*. 1989;14(2):189-194.
- Jaradeh S, Sanger JR, Maas EF. Isolated sensory impairment of the thumb due to an intraneural ganglion cyst. *J Hand Surg Br*. 1991;16(1):94-95.
- Spinner RJ, Atkinson JL, Tiel RL. Peroneal intraneural ganglia: the importance of the articular branch. A unifying theory. *J Neurosurg*. 2003;99(2):330-343.
- Spinner RJ, Hébert-Blouin MN, Rock MB, Amrami KK. Extreme intraneural ganglion cysts. *J Neurosurg*. 2011;114(1):327-224.
- Spinner RJ, Scheithauer BW, Amrami KK. The unifying articular (synovial) origin of intraneural ganglia: evolution-revelation-revolution. *Neurosurgery*. 2009;65(4 suppl):A115-A124.
- Spinner RJ, Atkinson JL, Scheithauer BW, et al. Peroneal intraneural ganglia: the importance of the articular branch. Clinical series. *J Neurosurg*. 2003;99(2):319-329.
- Muramatsu K, Hashimoto T, Tominaga Y, Tamura K, Taguchi T. Unusual peroneal nerve palsy caused by intraneural ganglion cyst: pathological mechanism and appropriate treatment. *Acta Neurochir*. 2013;155(9):1757-1761.

11. Consales A, Pacetti M, Imperato A, Valle M, Cama A. Intraneural ganglia of the common peroneal nerve in children: case report and review of the literature. *World Neurosurg.* 2016;86:510.e11-e17.
12. Lee YS, Kim JE, Kwak JH, Wang IW, Lee BK. Foot drop secondary to peroneal intraneural cyst arising from tibiofibular joint. *Knee Surg Sports Traumatol Arthrosc.* 2013;21(9):2063-2065.
13. Giuffre JL, Bishop AT, Spinner RJ, Shin AY. Surgical technique of a partial tibial nerve transfer to the tibialis anterior motor branch for the treatment of peroneal nerve injury. *Ann Plast Surg.* 2012;69(1):48-53.
14. Johnson KA, Strom DE. Tibialis posterior tendon dysfunction. *Clin Orthop.* 1989; February (239):196-206.
15. Scheib J, Höke A. Advances in peripheral nerve regeneration. *Nat Rev Neurol.* 2013;9(12):668-676.
16. White CP, Cooper MJ, Bain JR, Levis CM. Axon counts of potential nerve transfer donors for peroneal nerve reconstruction. *Can J Plast Surg.* 2012;20(1):24-27.
17. Flores LP, Martins RS, Siqueira MG. Clinical results of transferring a motor branch of the tibial nerve to the deep peroneal nerve for treatment of foot drop. *Neurosurgery.* 2013;73(4):609-616.