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

Le transfert immédiat de nerfs pour traiter une paralysie du péronier proximal après un kyste intraneural de ganglion : rapport de cas et analyse

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Abstract

Intraneural ganglion cysts that 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 presents 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 the flexor hallucis longus to a motor branch of the anterior tibialis muscle. At final follow-up, the patient demonstrated complete (M4+) return of ankle dorsiflexion, no pain, and no evidence of recurrence and was able to weight bare without the need of 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 intraneuraux de ganglions qui se forment sur le péronier proximal sont une rare cause de pied tombant. La norme actuelle du traitement de ce type de kyste sur le péronier proximal comprend 1) la décompression du kyste et 2) la ligature de la ramification du nerf artériel pour éviter une récurrence. Le transfert des nerfs est une stratégie limitée dans le temps pour récupérer la dorsiflexion de la cheville en cas de paralysie importante du péronier. Cependant, cette modalité n'a pas été utilisée pour traiter des kystes intraneuraux du ganglion touchant le nerf du péronier proximal. Les auteurs présentent le cas d'une paralysie du péronier proximal causée par un kyste intraneural de ganglion chez une femme de 74 ans. La patiente a consulté parce qu'elle ressentait une douleur dans le péronier proximal droit et avait un pied tombant depuis cinq mois. Elle a subi une décompression du kyste, une ligature de la ramification du nerf artériel et le transfert du nerf de la ramification motrice du long fléchisseur de l'hallux à une ramification motrice du muscle du tibia antérieur. Au dernier suivi, elle présentait une récupération complète (M4+) de la dorsiflexion de la cheville, ne souffrait plus d'aucune douleur et n'avait aucune trace de récurrence. Elle pouvait supporter son poids sans orthèse. Compte tenu de la morbidité minime au site du donneur et de la récupération de la

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dorsiflexion de la cheville, le présent rapport fait ressortir l'importance d'envisager le transfert précoce des nerfs en cas de neuropathie importante du péronier causée par un kyste intraneural de ganglion.

Keywords

Intraneural ganglia, footdrop, nerve transfer

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 imaging (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 intraepineural path of least resistance to form an intraneural cyst in response to changes in pressure and pressure fluxes.⁶⁻⁸ Neurological deficits arise from 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 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, although the combination of cyst decompression and articular nerve branch ligation offered excellent resolution of pain, patients in this series regained nil to 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 al,³ 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 orthotics (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, flat foot 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 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 the flexor

Figure 1. A magnetic resonance image of the right knee indicating multiple internal cysts within the common peroneal nerve located proximal to the fibular head extending 2.8 cm (longitudinal) $\times$ 6 mm (anteroposterior) $\times$ 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).

hallucis longus (FHL) into a motor nerve branch of the 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 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 examination 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.

An MRI 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 the FHL was transferred into the deep peroneal motor nerve branch to the 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 peri- 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 end plates 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 ganglia 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 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 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.

Conclusion

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 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, 2014, Kauai, HI and the 69th Canadian Society of Plastic Surgery (CSPS) Annual Meeting, 2015, Victoria, British Columbia, Canada.

Declaration of Conflicting Interests

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