Technical Note

Minimally Invasive Surgical Approach for Open Common Peroneal Nerve Neurolysis in the Setting of Previous Posterior Schwannoma Removal

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Abstract: The common peroneal nerve (CPN) runs laterally around the fibular neck and enters the peroneal tunnel, where it divides into the deep, superficial, and recurrent peroneal nerves. CPN entrapment is the most common neuropathy of the lower extremity and is vulnerable at the fibular neck because of its superficial location. Schwannomas are benign, encapsulated tumors of the nerve sheath that can occur sporadically or in cases of neurocutaneous conditions, such neurofibromatosis type 2. In cases with compressive neuropathy resulting in significant or progressive motor loss, decompression and neurolysis should be attempted. We present a technical note for the treatment of CPN compressive neuropathy in the setting of a previous ipsilateral schwannoma removal with a minimally invasive surgical approach and neurolysis of the CPN at the fibular neck.

Common peroneal nerve (CPN) entrapment is the most common neuropathy of the lower extremity and is vulnerable at the fibular neck because of its superficial location.[1,2] The nerve runs laterally around the fibular neck and enters the peroneal tunnel, where it

divides into the deep (DPN), superficial (SPN), and recurrent peroneal nerves.[3,4] The DPN innervates the anterior compartment of the lower leg and provides sensation to the first web space, whereas the SPN innervates the lateral compartment of the lower leg and provides sensation to the anterolateral aspect of the distal leg and dorsum of the foot.[5]

A variety of causes have been reported in the literature for common peroneal nerve entrapment, including knee trauma, presence of fibrous bands at the origin of peroneus longus, external compression, intraneural ganglion tumors, peripheral nerve tumors, and iatrogenic injury following surgery.[6-8] Recently, Hohmann et al.[9] performed a cadaveric analysis of the CPN and its associated branches in relation to bony landmarks during posterolateral reconstruction and found the rate of CPN injury during fibular tunnel entry to be 33% compared to 24% during fibular tunnel exit. Patients presenting with CPN injuries demonstrate weakness with ankle dorsiflexion and eversion with a resultant foot drop. Additionally, symptoms may include associated pain, numbness, or paresthesia along the lateral leg, dorsum of the foot, or the first web space of the foot.[10]

Nonsurgical treatment is recommended in acute injuries with neuropraxia. Such conservative interventions may include activity modification, avoidance of provocative positions or maneuvers, physical therapy, splinting, and electrostimulation.[2] For open injuries with suspicion of
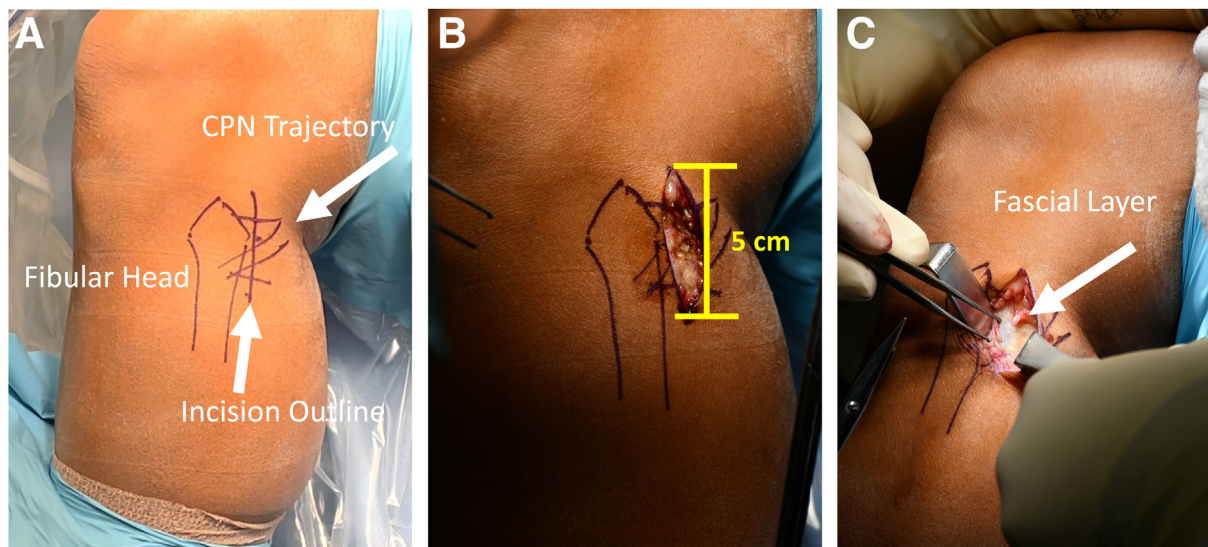
Fig 1. Surgical landmarks and approach to the left knee. (A) Pre-incision landmarks made of the left knee including the outline of the proximal fibula, common peroneal nerve (CPN) trajectory along the proximal and lateral aspect of the fibula, and the vertical incisional outline. (B) A 5 cm superficial vertical incision directly perpendicular to the common peroneal nerve trajectory is made. (C) The fascial layer is encountered deep to the skin layer and superficial to the underlying CPN sheath.

nerve laceration, optimal treatment includes exploration and primary repair within 72 hours of injury, if possible, or reconstruction with a nerve graft.[2] Horteur et al.[11] monitored 20 patients who underwent surgery using a direct suture, nerve graft, or neurolysis of the CPN at an average follow-up of 48 months and found that more than 80% of patients who underwent direct suture repair had recovered motor function.[11] In comparison, no patients undergoing nerve grafting reported recovery of motor function, whereas only 50% of patients recovered sensory function. As such, nerve grafting may result in worse outcomes, suggesting that palliative methods, such as tendon transfer, should be considered as an alternative.[11]

Schwannomas are benign, encapsulated tumors of the nerve sheath that can occur sporadically or in cases of neurocutaneous conditions, such neurofibromatosis type 2.[12] In cases with compressive neuropathy resulting in significant or progressive motor loss, decompression and neurolysis is indicated. We present a technical note for the treatment of compressive CPN neuropathy in the setting of a previous ipsilateral schwannoma removal with a minimally invasive surgical approach and CPN neurolysis at the level of the fibular neck (Video 1).

Technique

Preoperative Evaluation and Surgical Decision-Making

Patients with a history of benign schwannoma removal around the knee who present with residual numbness and radiating paresthesias should undergo a thorough physical examination. A methodical assessment of strength of the quadriceps, hamstrings, tibialis anterior, peroneals, gastrocnemius, and extensor hallucis longus

(EHL) is crucial for identifying any potential strength deficits. Provocative testing with a Tinel's test along the path of the CPN can provide additional information of entrapment pathology. Additionally, initial workup with Doppler ultrasound scanning can be used to rule out any potential for venothrombolic disease. Anteroposterior and lateral radiographs should be obtained in addition to performing magnetic resonance imaging (MRI) of the knee. In this patient population, MRI with and without contrast can identify the presence of fusiform thickening along the length of the CPN, which is concerning for possible recurrence of a schwannoma. Further workup may include coordinated management with a musculoskeletal oncologist, additional MRI imaging to rule out spinal pathology, and a confirmatory electromyogram to confirm the diagnosis of CPN entrapment. An initial trial of conservative therapy is the first-line treatment, including activity modification, gabapentin for neuropathic pain, and physical therapy. In the setting of persistent or worsening motor/sensory loss at a localized site of compression, surgical intervention to release the area of entrapment is indicated.

Before the administration of anesthesia, examination of the patient most commonly reveals significant weakness to dorsiflexion, eversion, EHL strength, mild deficits to plantarflexion, and diminished sensation to the dorsum of the involved foot compared to the contralateral extremity.

Patient Positioning and Anesthesia

After examination, the patient is placed supine on a standard operating table, and general anesthesia is administered followed by perioperative antibiotics. A
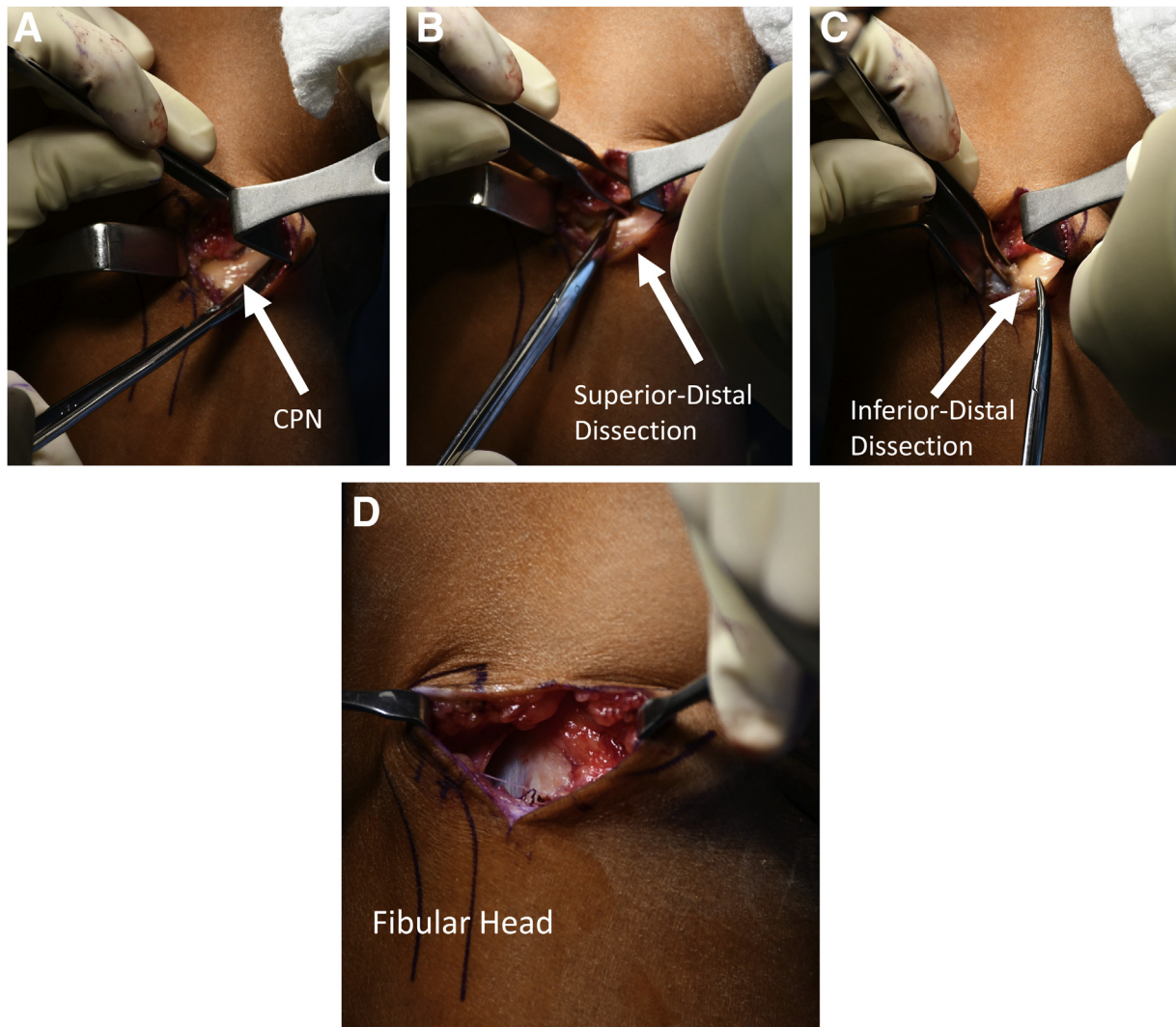
Fig 2. Common peroneal nerve neurolysis of the left knee. (A) A small opening in the fascia is made superficial to the nerve and released proximally and (B, C) distally around both the superior and inferior margins of the nerve. Surrounding fascial bands composing a fibrotic ring on the fibular neck are released proximal and distal to where the nerve is incised. (D) At the completion of neurolysis, the mobility of the nerve is confirmed without evidence of tethering.

tourniquet is placed proximally on the thigh and the lower extremity is prepped and draped in a sterile fashion.

Surgical Approach

Before incision, the proximal fibula is palpated and the borders of the bony anatomy and expected course of the peroneal nerve are outlined (Fig 1A). A 5 cm vertical incision is made posterior to the posterior border of the fibula and centered over the common peroneal nerve (Fig 1B). Soft tissue dissection is carefully performed with electrocautery followed with Metzenbaum scissors, with care taken to locate and protect any superficial cutaneous nerves within the surgical bed (Fig 1C). If the dissection is carried posteriorly, additional attention must be taken to protect and mobilize the lateral sural nerve.

The nerve is palpated running from proximal-posterior to anterior-distal just inferior to the fibular head. The nerve is located within the second layer of the lateral aspect of the knee, deep to the iliotibial band, biceps femoris and overlying fascia. Significant edema can be visualized within the nerve sheath because of reactive nerve changes from chronic entrapment. A small opening in the fascia is made superficial to the nerve and released proximally and distally. Surrounding fascial bands composing a fibrotic ring on the fibular neck are released proximal and distal to where the nerve is incised (Figs 2 A-C). Next, the posterior crural intermuscular septum is incised anterior to the nerve to ensure there are no further points of potential compression about the nerve (Table 1). At this point, the mobility of the nerve is confirmed without evidence of tethering (Fig 2D). The tourniquet is deflated and

Table 1. Pearls and Pitfalls

Pearls

    It is critical that tumors and possible recurrence are first appropriately worked up and evaluated by a trained musculoskeletal oncologist for any suspected malignancy or disconcerting characteristics.

    Preoperative workup including magnetic resonance imaging and use of electromyography are essential to providing adequate information on diagnosis, as well as a preoperative biopsy or possibly an excisional biopsy with intraoperative fresh frozen sectioning as indicated.

    The nerve will be located within the second layer of the lateral aspect of the knee deep to the iliotibial band, biceps femoris, and overlying fascia.

    If the dissection is carried out posteriorly, additional attention must be paid to protect and mobilize the lateral sural nerve.

    The posterior crural intermuscular septum is incised anterior to the common peroneal nerve to ensure there are no further points of potential entrapment about the nerve.

    As the patient awakes from anesthesia, function of the tibialis anterior, extensor hallucis longus, gastrocnemius, and peroneals are examined to confirm nerve function.

Pitfalls

    Unplanned excision of a soft tissue mass can lead to catastrophic consequences including need for amputation.

    Deflating the tourniquet and not paying careful attention to hemostasis can serve as a source of additional compression resulting in worsening injury.

careful hemostasis performed to limit bleeding that could potentially compress the nerve. The wound is then irrigated, closed in a layered fashion, and dressed with a soft compression bandage.

Rehabilitation

As the patient awakes from anesthesia, function of the tibialis anterior, EHL, gastrocnemius, and peroneals are examined to confirm nerve function. After surgery, the patient is made to bear weight as tolerated. Elevation of the operative leg is recommended to reduce swelling in the first few days after surgery, and sutures are removed 7 to 10 days after surgery. Once the sutures are removed, physical therapy is initiated, focusing on edema control, scar mobilization, ankle range of motion, ambulation, and strength. At 2 months after surgery, patients are expected to be cleared to resume full activity.

Discussion

CPN entrapment that fails to respond to nonoperative measures is best treated with neurolysis. Numerous studies have demonstrated return of function as high as 80% to 97% with a return of motor recovery nearing 80%.[2,13-15] Kim et al.[13] conducted one of the largest retrospective studies demonstrating functional recovery, defined by Grade 3 or greater muscle strength, in 88% of patients with CPN lesions treated with neurolysis alone. Operative time to surgery varies depending on the etiology of CPN injury, but surgery is generally performed after 4 to 6 months of failed conservative therapy in patients with CPN entrapment. Recovery of nerve function may take up to 6 months after an initial insult, which is why initial acute surgical intervention is often delayed.[2,10] However, in cases of acute and progressive weakness or a decrease in sensation, aggressive and earlier intervention is recommended to avoid further nerve injury and muscular atrophy. Maalla et al.[16] report intervening as soon as 3 months after onset of symptoms in patients with persistent findings and incomplete recovery confirmed by electrophysiological testing. The authors reported that neurolysis surgery was associated with a faster recovery and a low complication rate.[16]

Unlike CPN entrapment that can be addressed with isolated neurolysis, acute lacerations to the CPN from trauma, penetrating wounds, or iatrogenic causes require more advanced surgical interventions. Furthermore, open injuries with concern for nerve laceration require urgent consideration within 72 hours.[17] Techniques include nerve conduits, nerve grafts, and tendon transfers; however, direct end-to-end repair has the best reported outcomes.[13,14] When grafting is required for large defects, autologous nerve grafting of the sural nerve is preferred over veins and synthetic substitutes. Although there is some evidence supporting comparable outcomes between autologous grafting and substitutes, these are only equivalent in defects less than 3 cm.[18]

A unique and often overlooked cause of CPN injuries involve traumatic knee dislocations, with anterior knee displacement reporting the highest rate of CPN injury. Approximately 25% to 40% of high-energy knee dislocation can result in concurrent vascular and ligamentous injuries that often make it difficult to accurately diagnose a CPN injury.[19-21] These high-energy injuries generate significant tension and stretch of the nerves and soft tissue, which may result in neuropraxia or hematoma-induced nerve ischemia from rupture of the surrounding vasa nervorum.[13]

Similar findings have been reported in posterolateral corner (PLC) injuries of the knee.[22,23] In these cases, neurolysis alone provides the best outcomes for partial and complete stretch injuries, while complete nerve transection injuries often require tendon transfers or ankle-foot orthoses. As such, outcomes of CPN injuries with concomitant knee dislocations or PLC injuries are dependent on the type of nerve injury, with complete transection and older age being indicators of a poor prognosis.[20,21] Importantly, operative intervention in the setting of traumatic knee injuries must require a thorough intraoperative assessment of the peroneal nerve to assess for nerve compression and prevent the negative impact that CPN injuries can have on long-term patient outcomes.

Table 2. Advantages and Limitations

Advantages
- A minimally invasive approach to the common peroneal nerve results in less soft tissue trauma and decreases the possibility of iatrogenic induced neurovascular injury to surrounding structures.

Limitations
- Common peroneal nerve injury in the setting of posterolateral corner injury requires expert understanding of the anatomy of this region of the knee to prevent worsening of patient functional outcomes and provide appropriate surgical management in these situations.
- Adequate management of patients with concern for recurrence of a schwannoma in the ipsilateral extremity need assessment from orthopaedic oncologists who work almost exclusively in academic tertiary referral settings.
- Unplanned excision of a soft tissue mass can lead to catastrophic consequences, including higher rates of plastic surgery reconstruction involvement, as well as higher rates of local tumor recurrence.
- Peroneal nerve entrapment-like symptoms must also be evaluated for central nervous system neurologic pathology, including multiple sclerosis and spinal cord lesions, to ensure accurate and early diagnosis is made before considering surgical intervention for confounding patient presentations.

Despite being rare, mass lesions can cause CPN compression and present unique surgical challenges. Most of the literature regarding this topic consist of case reports and small case series, but a limited number of retrospective studies demonstrate a 5% to 13% rate of CPN injury from tumors.[13,24] Benign extraneural lesions, such as osteochondromas, lipomas, vascular malformation, and extraneural cysts can cause compression of the peroneal nerves.[2,25] However, the majority of tumors involved are intraneural and include ganglion cysts, schwannomas, neurofibromas, and neurogenic sarcomas.[13,26,27]

Surgical excision is the mainstay treatment for these tumors. It is important that these tumors, and possible recurrences, are first appropriately worked up and evaluated by a trained musculoskeletal oncologist for suspected malignancy. It is estimated that 25% to 50% of soft tissue sarcomas undergo an unplanned excision for a mass, which is likely due to unrecognized signs, symptoms and imaging consistent with a sarcoma.[28] Unplanned excision of a soft tissue mass can lead to catastrophic consequences. For example, studies have shown higher rates of plastic surgery reconstruction involvement and amputations with unplanned excisions,[29,30] as well as higher rates of local tumor recurrence.[31] As a result, it is highly recommended to discuss the best treatment option with a musculoskeletal oncologist. When malignancy is suspected, further advanced imaging and a preoperative biopsy or excisional biopsy with intraoperative fresh frozen sectioning is required. In the operative setting, careful attention to hemostasis can limit additional extraneural

compression and worsening nerve injury. An immediate postoperative neuromuscular examination is critical to ensuring adequate function of the nerve after any surgical manipulation (Tables 1 and 2).

In our technical note, we outline a minimally invasive approach used to manage compressive neuropathy of the common peroneal. The major advantages of our proposed technique include its technical simplicity, reproducibility, and minimal soft tissue trauma to decrease the possibility of iatrogenic neurovascular injury to surrounding structures.

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