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Traumatic injuries of the common peroneal nerve and current surgical strategies for improving foot drop. A clinical series and literature review.

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Abstract

Background: Common peroneal nerve injuries are the most frequent nerve injuries in the lower extremity. They may produce severe gait deficits because of weakness or absence in ankle dorsiflexion. Functional improvement after injury, despite any intervention, remains unpredictable. There are various surgical strategies aimed to restore foot drop, but no consensus exists regarding the best surgical treatment.

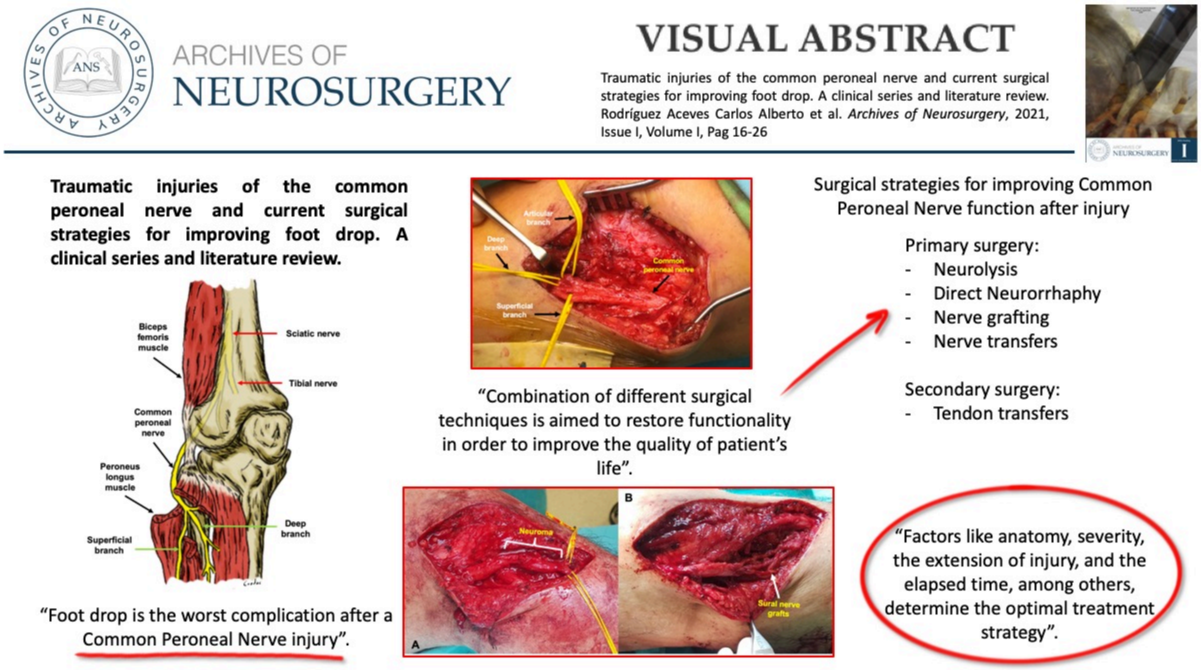
Objective: In this article, we report our experience and reviewing general aspects of common peroneal nerve anatomy and lesions, current surgical strategies to restore functionality, and the overall outcomes previously published in the literature.

Methods: Retrospective review of patients with foot drop secondary to common peroneal nerve injuries between 2017-2019 treated by the authors in The ABC Medical Center and the North PEMEX Hospital. Results were evaluated using the British Medical Research Council (BRMC) grading system and analyzed using IBM SPSS Statistics v26 software. We performed a literature review using PubMed Central, NIH, Cochrane Library, LILACS, and Medline Plus from the last two decades.

*Results:*Six patients were lost to follow up. Of the remaining 11 patients, spontaneous functional recovery (BMRC $\geq$3) after injury was present in 4 patients (36.4%) and sustained nerve lesion (BMRC

Conclusion: Spontaneous functional recovery after common peroneal nerve injuries are unpredictable and attend to a variety of circumstances related to comorbidity, age, the severity of the injury, and surgical timing. Recent advances in microsurgery allow us for the proper reconstruction of injured nerves. However, outcomes after reconstruction of foot drop still being unsatisfactory in some cases using nerve surgery alone. A combination of nerve microsurgical reconstruction and tendon transfers improve foot drop in selected patients.

Visual Abstract



Keywords

Common peroneal nerve injuries; Direct neurorraphy; External neurolysis; Foot drop; Nerve graft; Tendon transfer.

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ORIGINAL RESEARCH

Traumatic Injuries of Common Peroneal Nerve and Current Surgical Strategies for Improving Foot Drop: Clinical Series and Literature Review

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Abstract

Background: **Common peroneal nerve injuries are the most frequent nerve injuries in the lower extremity. They may produce severe gait deficits because of weakness or absence in ankle dorsiflexion. Functional improvement after injury, despite any intervention, remains unpredictable. There are various surgical strategies aimed to restore foot drop, but no consensus exists regarding the best surgical treatment.**

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Results: **Six patients were lost to follow up. Of the remaining 11 patients, spontaneous functional recovery (BMRC ≥3) after injury was present in 4 patients (36.4%) and sustained nerve lesion (BMRC <3) in 7 patients (63.6%), which were treated surgically. The median observation time before surgery was 5 (IQR 4–14) months. The surgical techniques employed were: neurolysis in 5 patients (71.4%), nerve grafting in 2 patients (28.6%), and posterior tibial tendon transfer in 2 of these patients. Postoperative outcomes were considered good (BMRC ≥3) in 5 patients (100%) after neurolysis, and bad (BMRC <3) in those 2 with nerve grafting, but tendon transfer improved functionality in one of these patients.**

Conclusion: **Spontaneous functional recovery after common peroneal nerve injuries are unpredictable and attend to a variety of circumstances related to comorbidity, age, the severity of the injury, and surgical timing. Recent advances in microsurgery allow us for the proper reconstruction of injured nerves. However, outcomes after reconstruction of foot drop still being unsatisfactory in some cases using nerve surgery alone. A combination of nerve microsurgical reconstruction and tendon transfers improve foot drop in selected patients.**

Keywords: Common peroneal nerve injuries, Direct neurorrhaphy, External neurolysis, Foot drop, Nerve graft, Tendon transfer

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1. Introduction

Common peroneal nerve (CPN) injury is the most widespread traumatic mononeuropathy in lower limbs, comprising 15–33% of all peripheral nerve lesions [1,2]. Loss of CPN function ranges from mild to severe disabilities, because of neuropathic pain, dorsal foot sensation impairment, and foot drop deformity caused by weakness in ankle eversion, toes extension, and ankle dorsiflexion, representing the most severe clinical consequence of CPN injury. Impaired ability to walk develops a gait recognized as steppage gait, [2] reducing the quality of patient's life, increasing the risk of falls, and causing pain in other regions due to compensation [3,4].

2. Objectives

The present paper aims to

1. Report authors experience,
2. Describe general aspects of CPN anatomy and injuries,
3. Describe current surgical techniques used for nerve repair and functional recovery, and
4. Review the published overall rates of functional recovery.

3. Methods

We conducted an observational, longitudinal and retrospective review of patients diagnosed with foot drop after CPN injury, treated by the authors in The American British Cowdray Medical Center and the Central North PEMEX Hospital (Mexico City), between 2017 and 2019 (Fig. 1). We evaluated results applying descriptive statistics, using the IBM (R) SPSS(R) 26.0 statistical analysis software.

Before surgical interventions, we performed a complete clinical, neurophysiological, and radiologic evaluation for each patient. For evaluating the functional status of ankle dorsiflexion, we applied The British Medical Research Council (BMRC) grading system as follows: good functional status if BMRC ≥ 3, and bad functional status if BMRC <3. We documented every case with video before and after the surgery FOR follow-up as part of a routine workup. All patients were adequately informed preoperatively regarding surgical goals, risks, and prognosis, and signed informed consent.

Abbreviations

ATT	Anterior tibial tendon
CPN	Common peroneal nerve
BMRC	British Medical Research Council
MIOM	Multimodal intraoperative monitoring
NAP	Nerve action potential
PTT	Posterior tibial tendon

The indications for surgery were the absence of recovery beyond three months after the injury or persistent neuropathic pain. Our two indications for Posterior tibialis tendon (PTT) transfer were the absence of functional recovery after one year of follow-up, except for a patient with a lesion over 15 cm, where we used PTT transfer and neurolysis in one stage. For primary surgery, we performed Multimodal Intraoperative Monitoring (MIOM), and direct electrical stimulation with the IGFA III Stim™ nerve stimulator device by BEIC. All primary procedures were carried out by the senior author.

3.1. Surgical technique

The surgical position for the patient was in the supine position with the affected limb slightly flexed, or in the prone position when a more proximal nerve injury was identified preoperatively. The procedure was carried out with total intravenous anesthesia without the use of tourniquets or muscle relaxants, and for hemostasis, we used bipolar coagulation. We performed a curvilinear incision centered at the fibular head, extended as proximally as was necessary (according to the level of injury) and distally to CPN divisions. After proximal dissection at the fibular head, we exposed the subcutaneous tissue and the edge of the biceps femoris tendon. The CPN trunk was identified visually and by direct electrical stimulation, just below and medial to this tendon, and encircled with a vessel-loop. Distally, the peroneus longus muscle was divided to expose CPN divisions; superficial and deep branches were dissected and encircled separately.

At this stage, if only exposure of the CPN at the knee region was necessary, the surgery was finished (Fig. 2). When a more proximal exposure was needed, we traced the CPN proximally to the sciatic nerve division. Fibrosis and scar tissue should be resected circumferentially when necessary (Fig. 3). We also resected in-continuity neuroma after confirming a lack of electrical conduction with MIOM (Fig. 4A). For nerve grafting (Fig. 4B), we used the ipsilateral sural nerve, approached with separate

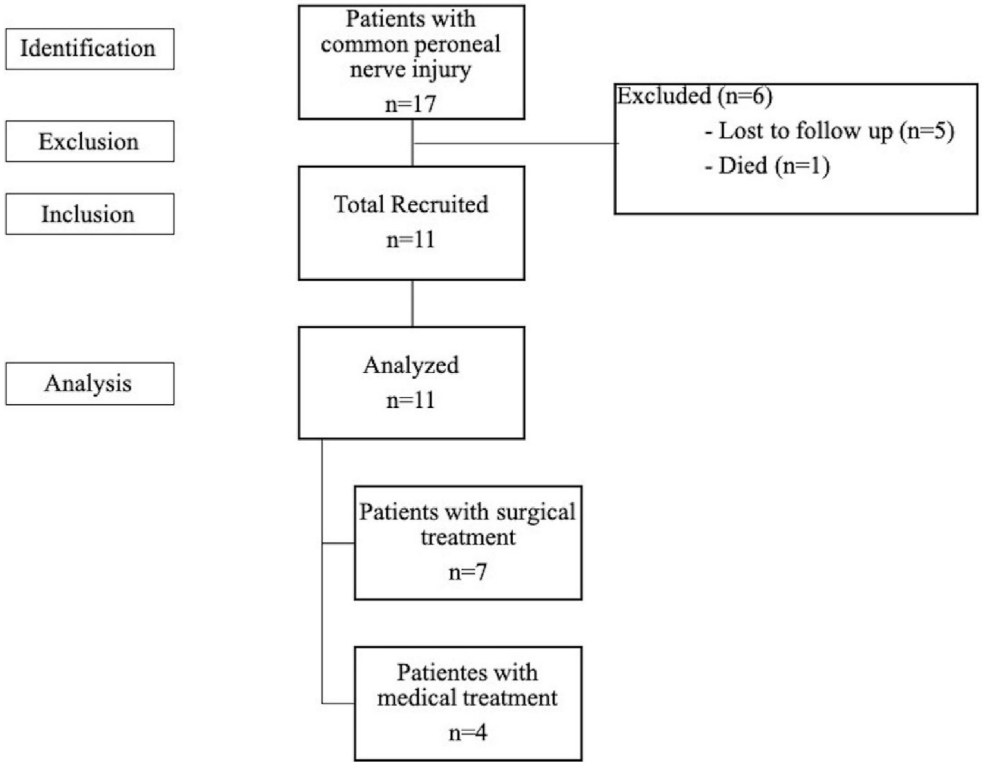

Fig. 1. Flow chart of current series.

incisions at the distal leg. Coaptation was performed using 10-0 non-absorbable micro-sutures and fibrin glue under a surgical microscope.

For PTT transfer, we performed four incisions: at the medial foot for PTT detaching, at the medial ankle for PTT extraction, at the anterolateral ankle for interosseous re-routing, and at the dorsum of the foot for PTT bone fixation with a screw. Selected tarsal bone was identified by fluoroscopy, and ankle position was arranged at 15-20° of dorsiflexion before fixation (Fig. 5A to 5D).

After simple decompression, there was no need for immobilization, whereas, after nerve reconstruction and tendon transfer, we immobilized the limb for three and six weeks, respectively. In all cases, surgery was followed by an intensive rehabilitation program.

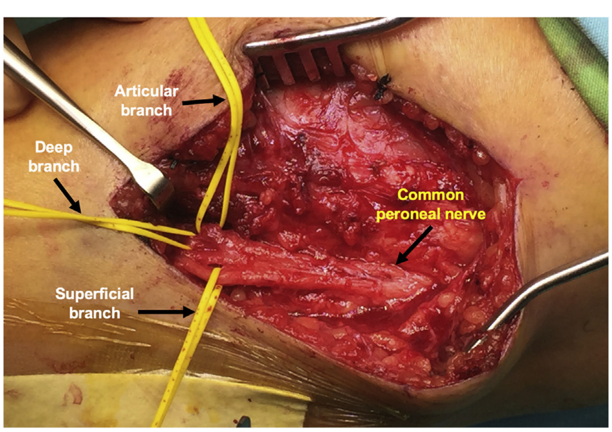

Fig. 2. Neurolysis after iatrogenic injury in the left common peroneal nerve.

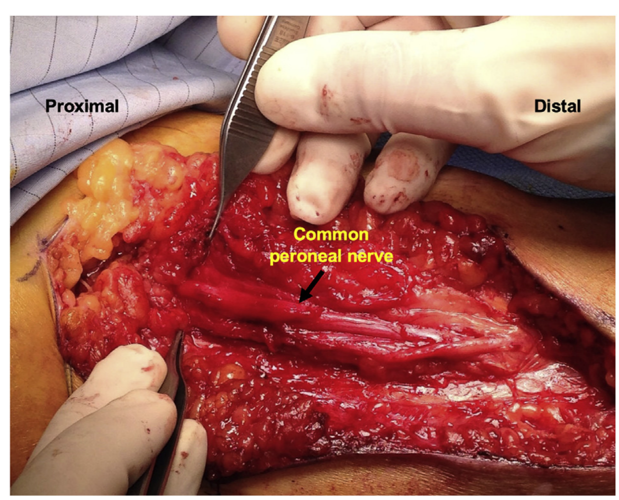

Fig. 3. Surrounding scar removal in the left common peroneal nerve after a gunshot wound.

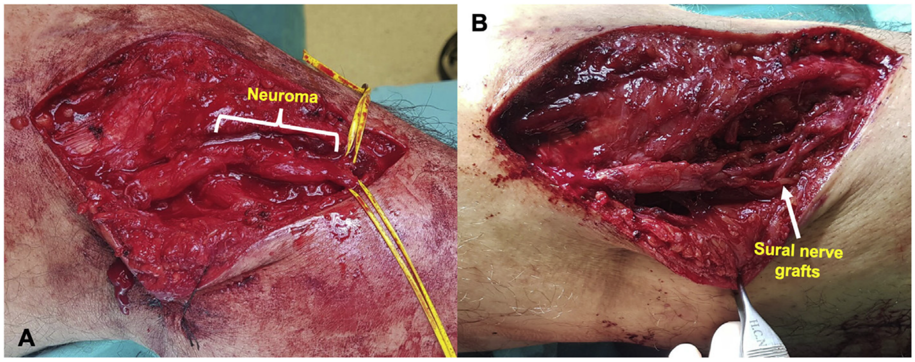

Fig. 4. ***A)*** *In-continuity neuroma in the right common peroneal nerve after blunt trauma.* ***B)*** *Reconstruction with ipsilateral sural nerve grafts (>6 cm) after the neuroma resection.*

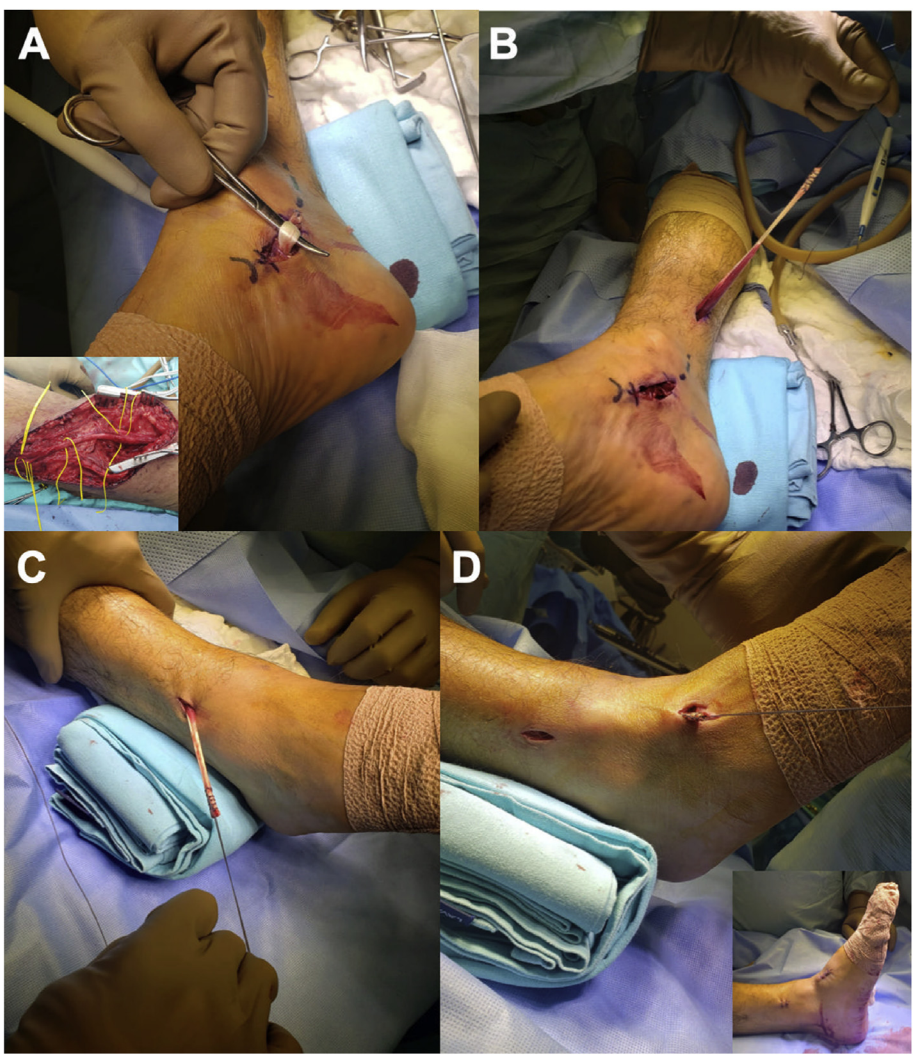

Fig. 5. One-stage reconstruction with posterior tibial tendon transfer (interosseous route) in right CPN after knee dislocation. ***A)*** *PTT detachment,* ***B)*** *PTT extraction,* ***C)*** *PTT interosseous rerouting, and* ***D)*** *PTT bone fixation. CPN, common peroneal nerve; PTT, posterior tibial tendon.*

Table 1. Patients demographics, clinical assessment and treatment.[a]

No.	Age (yr)	Gender	Affected side	Level of injury	Severity	Pain	Etiology	Time from trauma to treatment (months)	Initial DF BMRC	Treatment
1	63	Female	Left	Thigh	C	Yes	GSW	14	0	Surgery
2	30	Male	Left	Thigh	C	No	GSW	5	0	Surgery
3	48	Male	Right	Thigh	P	Yes	Penetrating trauma	34	3	Surgery
4	22	Male	Right	Knee	C	No	Fracture	4	0	Surgery
5	54	Female	Left	Knee	C	Yes	Iatrogenic	1	0	Surgery
6	22	Male	Left	Knee	P	No	Contusion	2	3	Conservative
7	19	Male	Right	Leg	C	No	Fracture	4	0	Conservative
8	31	Male	Right	Knee	C	Yes	Subluxation	5	0	Surgery
9	28	Male	Right	Knee	P	No	Contusion	6	3	Conservative
10	64	Female	Left	Knee	P	Yes	Iatrogenic	7	3	Surgery
11	44	Female	Right	Leg	C	No	Iatrogenic	2	0	Conservative

[a] C, Complete; P, Partial; GSW, Gunshot Wound; DF, Dorsiflexion; BMRC, British Medical Research Council.

The literature review was performed using PubMed Central, NIH, Cochrane Library, LILACS, and Medline Plus from the last two decades.

4. Results

We analyzed 17 cases; six patients lost follow-up. Therefore, we included eleven patients in the final analysis (four women and seven men) with a variable degree of foot drop after CPN injuries (Table 1). The mean age was 38.6 ± 16.6 years (range 19–64 years). Four patients received only medical treatment (36.4%) and seven patients, surgical treatment (63.6%). The median interval between trauma and surgery was 5 (IQR 4–14) months (we experienced longer periods because of delayed referral).

The etiologies of injuries included: gunshot wounds in 2 patients (18.2%), fractures in 2 patients (18.2%), direct contusion in 2 patients (18.2%), knee subluxation in 1 patient (9%), penetrating injury in 1 patient (9%), and iatrogenic injury in 3 patients (27.2%). The injuries localization involved the distal thigh in 3 patients (27.2%), the knee region in 6 patients (54.6%), and the leg in 2 patients (18.2%). Partial injuries were present in 4 patients (36.4%), whereas complete injuries in 7 (63.6%).

Table 2 exposes the surgical techniques that we performed. We treated five patients with neurolysis (71.4%), and two patients received nerve grafting (>6 cm) in 2 patients (28.6%). Additional PTT transfer by the interosseous route and tarsal screw fixation in one-stage was required for patient

Table 2. Outcomes.[a]

Surgical Treatment				
Case number	Initial BMRC	Strategy	Final BMRC	Comments
1	0	Neurolysis	4	
2	0	Nerve grafting	0	Rejected PTT transfer
3	3	Neurolysis	5	
4	0	Nerve grafting + PTT transfer (after 1 year)	0	PTT transfer improved functional recovery to 4
5	0	Neurolysis	5	
8	0	Neurolysis + PTT transfer (in one-stage)	4	PTT transfer in one-stage due to >15 cm length injury
10	3	Neurolysis	5	

Conservative Treatment		
Case number	Initial BMRC	Final BMRC
6	3	5
7	0	5
9	3	5
11	0	5

[a] BMRC, British Medical Research Council; PTT, Posterior Tibial Tendon.

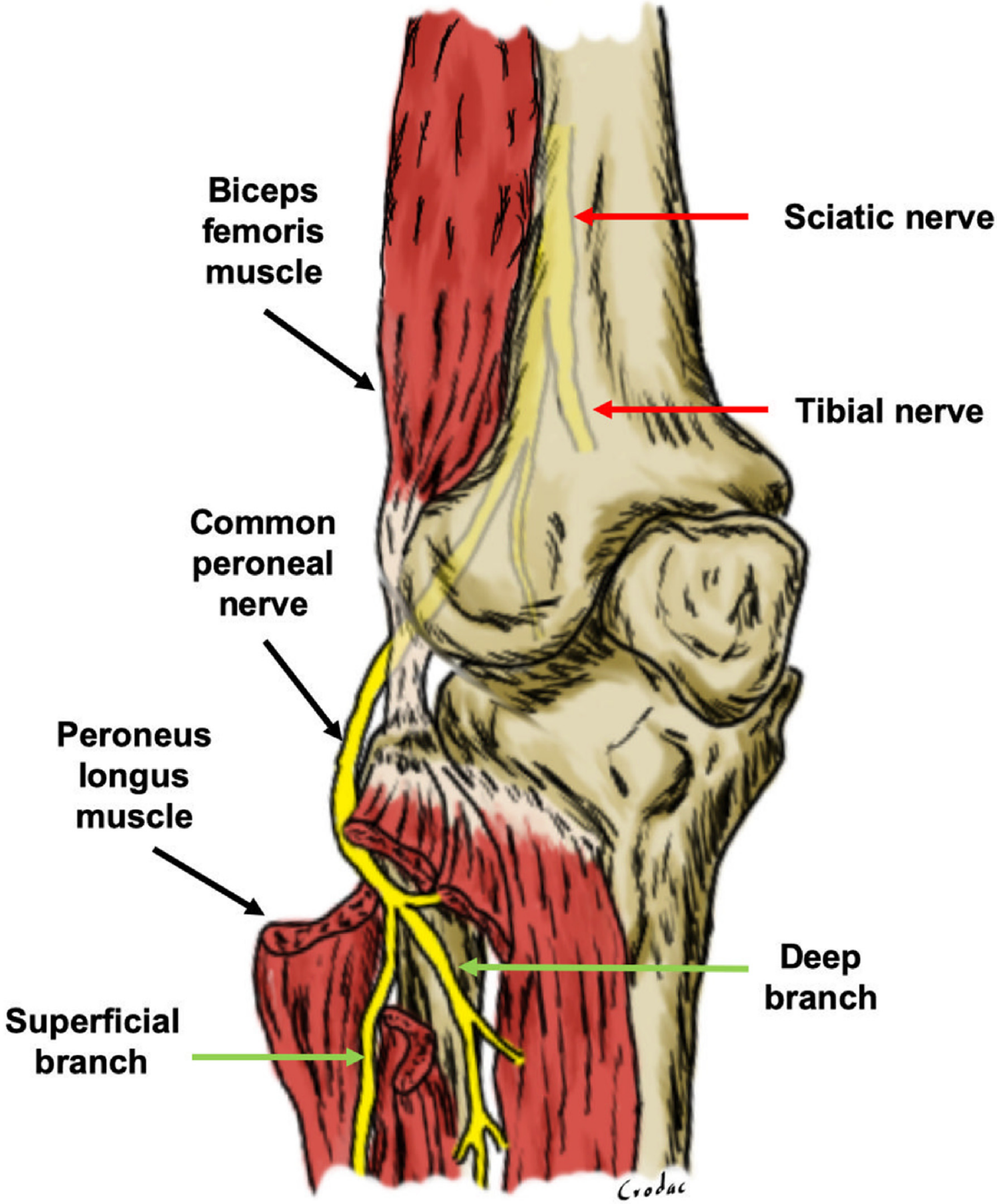

Fig. 6. Schematic representation of the anatomy at the knee region.

number 8 in combination with neurolysis and in two-stages for patient number 4 after one year of nerve grafting.

After surgery, we followed them up at six months and one year. Final functional status was considered good (BMRC >3) in all five patients having neurolysis and bad (BMRC <3) in those two having nerve grafting. PTT transfer improved functionality in one of these patients, and the other one rejected a second surgery for tendon transfer. Neuropathic pain was solved in all patients who presented it preoperatively. Outcomes are summarized in Table 2.

Table 3. Etiology of traumatic common peroneal nerve palsy.

Common peroneal nerve injuries
Direct trauma:
• Open trauma – lacerations.
• Blunt trauma – contusions, knee dislocations, adduction injuries, fibular fractures, tibial fractures, ankle dislocations or strains, gunshot wounds.
• Iatrogenic – knee arthroscopy, knee arthroplasty, other surgery in knee, surgery in popliteal fossa, varicose vein surgery, hip and pelvic surgery (affecting sciatic nerve).
External compression:
• Prolonged position as in anesthesia or others, casts, braces, leg crossing, kneeling, etc.
• Entrapments.

5. Discussion

Historically, functional recovery outcomes after CPN injuries are significantly less compared with other nerve injuries. The suggested factors that influence the CPN's poor intrinsic ability for recovery after injury are its internal anatomy, scarce blood supply, and anatomical relationships.

5.1. Basic anatomical aspects

The CPN derives from the lateral aspect of sciatic nerve, it is composed of axons predominantly from the posterior divisions of the ventral L4 and L5 nerve roots with a minor contribution from S1 and S2 nerve roots [5,6]. After branching from sciatic nerve at the distal thigh, the CPN travels laterally and obliquely in the popliteal fossa, below the insertion of biceps femoris muscle; distally at this region, the nerve winds laterally around the fibular head, entering the peroneal tunnel, underneath the origin of peroneus longus muscle. Proximally at the popliteal fossa, the CPN gives off the lateral sural cutaneous nerve, which contributes to sural nerve formation, and the lateral cutaneous nerve to the calf, which provides sensory innervation to lateral calf and knee. Distally at the fibular head, within the peroneal tunnel, gives off its terminal branches, the lateral articular branch, and the superficial and deep branches (Fig. 6).

The superficial branch innervates the peroneus longus and brevis muscles, providing sensory innervation to the anterolateral distal two-thirds of the leg and dorsum of the foot, controlling ankle eversion. The deep branch innervates the tibialis anterior, extensor hallucis longus and brevis, extensor digitorum longus and brevis, and peroneus tertius muscles. This branch provides sensory innervation to the first interdigital space and controls ankle dorsiflexion and toes extension [7–9].

Many anatomical factors are responsible for damage susceptibility (2,10,11):

1. The CPN has reduced mobility at two points (sciatic notch proximally and peroneal tunnel at knee distally), this anatomical disposition increases nerve tension when limb undergo stretch forces.
2. The CPN fibers are located laterally within the sciatic nerve; this external arrangement increases the nerve exposure to external forces.
3. Its superficial location at the knee region, just covered for a thin subcutaneous tissue and fat pad layers, also in this region a profound rerouting from posterior to anterior is present.
4. The nerve is in direct contact with the fibular head and fibers to the anterior tibialis muscle runs medially, increasing the risk of crushing and compression.
5. Its scarce blood supply and internal organization (connective tissue/neural tissue ratio), reduce the nerve capacity to support ischemia and compressive forces.

5.2. What injures the nerve?

Several traumatic and non-traumatic causes have been reported as an etiology for CPN injuries (Table 3). Despite the many etiological factors described before, compression, stretching, and laceration are the three primary mechanisms identified; they can be isolated or in combination with focal ischemia [7,9–16]. High-velocity and high-energy mechanisms such as vehicular accidents, falls, and sports injuries are more prone to present related nerve injuries. Traction and compression injuries, as seen in blunt trauma, may cause a more extended zone of injury than lacerations, leading to neuroma formation; nerve involvement less than 6–7 cm has better outcomes than longer injured segments. Pure lacerations occur less commonly [7,17]. Thus, associated damage in bone, vessels, and soft tissue, the mechanism, severity and type of injury, extent of nerve lesion, and denervation time affect functional outcomes [2]. Some authors described that partial injuries have better recovery rates compared with complete injuries [18].

5.3. Which are the surgical options?

Traditional treatment options for CPN injuries include conservative measures, neurolysis, direct nerve repair, nerve grafting, nerve transfers, and tendon transfers as a salvage procedure. The election of surgical strategy should be supported on clinical, neurophysiological, and pathological characteristics of nerve injury. Hence, defining an algorithm is difficult because of the variable nature of nerve injuries, unpredictable outcomes, and prognosis [19,20].

As a general rule, lacerations must be surgically explored immediately. For blunt trauma, if functional recovery is not present after 3–6 months of injury, surgical exploration is indicated, and in persistent neuropathic pain.

Neurolysis consists of myofascial and scarring/fibrosis decompression around the nerve. When MIOM shows improvement in electrical conduction across the lesion, this surgical technique may by itself improve function. As injury at the knee region is one of the most common injury sites in compressive and traction injuries, decompression at this site and down to nerve divisions should be performed [19,21–23].

Direct nerve repair is indicated in laceration injuries, which is an uncommon presentation; for contusive and stretching injuries, it is rarely indicated, since nerve lesion may involve several centimeters of length. However, if the gap is small and nerve stumps can be re-approximated without tension, an end-to-end suture can be performed. In the associated musculoskeletal injuries, the need for a workable immobilization should be evaluated because nerve anastomosis must be maintained in place and without movement for lengthy periods [2,24,25].

Nerve grafting is used after resectioning a non-conductive in-continuity neuroma, or when nerve stumps cannot be reapproximated without tension. Sural nerve, if not injured, is often an optimal donor nerve source for autologous nerve reconstruction. The best outcomes are observed with grafts less or equal than 6 cm of length [2,11,19,26].

Nerve transfers recently have become an object of study in CPN injuries reconstruction by using tibial nerve branches. Outcomes in most recently reported series remain inferior as compared to other reconstructive techniques [27–30].

Tendon transfers by transferring PTT to different tendinous targets (anterior tibial tendon [ATT] alone or ATT plus toes extensors and peroneus tendons) or anchoring the tendon to tarsal or metatarsal bones. Many years ago, this technique was used as a salvage procedure when nerve reconstruction failed. However, in recent works, its use is advocated for early reconstruction in combination with nerve surgery [10,31–34].

Some interventions described before, and which have shown usefulness previously, were employed to treat patients in this cohort. Despite the sample size presented and lack of randomized control trial, retrospective analysis allows identifying relevant data regarding CPN injuries.

In agreement with previous publications, we identify that partial injuries have more successful rates for spontaneous recovery after conservative management, in contrast with complete injuries [18–20,35].

We observed that the resulting partial or complete lesion will depend on the primary mechanism and the amount of energy applied during trauma, such that the higher the energy, the more severe nerve injury [36]. We also observed good spontaneous recovery after conservative treatment in those patients with low-energy trauma. Even though this does not necessarily mean that conservative management influenced improvement since maybe spontaneous recovery was just part of the natural history of this injury.

Anatomy, severity, and the extension of injury, and the elapsed time also determine the surgical strategy to employ [2,7,19]. In our study, we did not have laceration injuries. Closed injury by compression and stretching at knee level, was the most common type of injury encountered.

Neurolysis, as we described before, is employed to decompress CPN partial injuries after low-energy trauma, usually at knee region, in the absence of in-continuity neuroma and positive nerve action potentials (NAP). Outcomes reported by many authors with this technique showed good functional recovery rates in partial injuries, and in this series [7,11,13,14].

Closed injury of CPN involves lesions of variable length, commonly associated with in-continuity neuroma formation. Surgical proceed requires the use of MIOM and NAP to determine if the affected segment conduces nerve impulse. When NAP is negative, it is necessary to resect that segment and to perform nerve reconstruction, just as we did. Whenever is possible, direct nerve repair should be the reconstructive technique of choice. There are few reports which described favorable outcomes with this technique, but the overall rates remain unpredictable [2,7,11,14,37].

If the nerve gap is too wide, and tensionless anastomosis is not possible, even if nerve stumps can be re-approximated with 90° knee flexion, but immobilization for prolonged periods is not recommended, nerve grafting is indicated. Consensus establishes that grafts larger than 6 cm have very low functional recovery rates [7,11,14,26,37,38]. A previous work reported improvement in functional recovery and reinnervation when nerve grafting was combined with tendon transfer in a one-stage procedure. These authors argue that early correction of foot drop with PTT transfer promotes reinnervation by diminishing flexion forces of the non-injured tibial nerve [32]. We performed nerve grafting in two young patients within 4 and 5 months of a severe injury; nevertheless, no one showed functional motor recovery after one year of follow-up, but they reported partial sensory improvement. These results follow previously reported poor outcomes from longer nerve grafts. When primary repair is indicated (direct nerve repair or nerve grafting), it is imperative to perform surgery as early as possible, since surgical timing is a well-known determining factor in peripheral nerve surgery [2,7,10,11].

PTT transfer remains the gold standard for foot drop correction in delayed referral cases or failed primary nerve reconstruction surgery, even when dorsiflexion cannot be restored completely [39,40]. Nowadays, there are some questions to answer regarding this technique: When should it be done? What is the best route for transferring the tendon? What is the best target to transfer the tendon? As mentioned before, commonly, PTT is reserved for unimproved cases. However, in agreement with some authors [7,34] for in-time referred cases, factors like mechanism, type of injury, severity (length of injury), age, and associated injuries should be considered. Despite the sample in this work, we argue that these factors will guide an early indication for performing tendon transfer in association with nerve surgical exploration. This means that even when CPN injuries are unpredictable, the negative add-on factors related to the lesion would tip the balance towards a worse prognosis. Therefore, PTT transfer should be indicated earlier [41]. As we did in one case, operated with PTT transfer in combination with neurolysis in an injured nerve more than 15 cm of length, who showed good recovery.

The international literature describes an interosseous route, towards interosseous membrane and a circumferential route, by surrounding the tibia subcutaneously. Previous works have described advantages and disadvantages for each technique, though comparison between the effectiveness of both routes remains uncertain [10,39,42].

The election of targets to be transferred is related to physiological factors to achieve appropriate tension and to correct inversion deformity besides getting ankle dorsiflexion. Current literature describes tendon transfer to tarsal or metatarsal bones with screw fixation and tendon transfer to ATT isolated or with a modified split technique that attaches the PTT to ATT and toes extensors/peroneus tendons [10,39,42,43]. Some authors establish that tendinous-tendinous transfer provides a more physiological correction of foot drop than tendinous-bone transfer, by correcting inversion deformity and improving toes extension [10]. Nevertheless, elongation of the Achilles tendon, combined with tendinous-bone transfer, may correct inversion deformity by improving in-flexion/inversion contracture [7].

We performed two PTT transfers by the interosseous route and tendon attachment with a screw to the second metatarsal bone plus elongation of Achilles tendon. The election of this technique maybe is questionable, but even with the advantages and disadvantages described for this technique [7], we consider that interosseous transposition and attachment between soft (elastic) and rigid structures (tendon-bone), increases leverage forces in a more strength and physiologic manner. However, these concepts should be demonstrated with future comparative controlled trials.

6. Conclusions

After severe CPN injuries, prognosis remains challenging to predict and attend to a variety of uncontrolled and controlled factors. Minor injuries have better recovery rates. The microsurgical reconstruction of CPN offers better results when surgery is performed early; however, outcomes after reconstruction of CPN when a long segment of the nerve is injured using nerve surgery alone to improve foot drop are sometimes unsatisfactory. A combination of nerve reconstruction and tendon transfers enhances results in selected patients.

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Disclosure of interest

The authors declare that they have no competing interest.

Publication comment

The authors are commended for providing a concise and relevant review of traumatic common peroneal nerve (CPN) injuries, both from their own experience and from published literature. Their results demonstrate the current best of practice, applying a structured approach for evaluation and treatment. A third of patients were followed for recovery/regeneration, and two-thirds underwent nerve repair with possible adjunctive tendon transfers. This represents a balanced and measured approach for lesions that may improve with time. Furthermore, they demonstrate the impressive benefit of nerve decompression for a select group of patients. The authors are also commended on their use of tendon transfers to augment recovery when the prospect of achieving meaningful recovery from nerve surgery alone is diminished in cases of severe nerve injuries. However, nerve reconstruction should not be abandoned in these severe cases, as a benefit may be achieved for pain, sensation as well as additional power or proprioception.

One element that deserves comment and consideration is that most stretch injuries of the CPN have the most damage at the bi/trifurcation of the CPN from the sciatic nerve. This phenomenon has been demonstrated in our laboratory nerve stretch trauma models1 and in countless MRIs of our patients. This feature helps explain why many nerve grafts fail – as the zone of maximal injury is often many centimeters above the knee.

1. Mahan MA, Yeoh S, Monson K, Light A. Rapid Stretch Injury to Peripheral Nerves: Biomechanical Results. Neurosurgery. 2019;85(1):E137-E144.

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