# Long-Term Functional Outcome After Surgical Treatment of Peroneal Intraneural Ganglion Cyst

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BACKGROUND: **Intraneural ganglia are benign mucinous cystic formations that originate within the epineurium of peripheral nerves. Different treatments have been recommended, with an overall satisfactory outcome. In this paper, we aim to evaluate the long-term outcomes of surgical treatment of peroneal intraneural ganglia by reviewing our local institutional experience.**

METHODS: **We performed a case series review of peroneal intraneural ganglia surgical treatment performed by the senior author. Demographic and surgical details were abstracted from the medical record for each patient. Electrodiagnostic studies and magnetic resonance imaging (MRI) were performed in all patients pre- and postoperatively.**

RESULTS: **Eight men were enrolled, with an average age at time of surgery of 47.5 years (range 28–68 years). Motor testing revealed a preoperative deficit of dorsiflexion, eversion, and toe extension in 7 patients, with a median preoperative Medical Research Council (MRC) score of 0/5. Sensory loss in the distribution of the common peroneal nerve was present in 7 patients. Mean clinical follow-up time was 113 months (range 32–189 months). Significant pain relief was achieved in all patients. Overall neurologic function was improved, more so for motor function. The median postoperative dorsiflexion, eversion, and toe extension at last follow-up were MRC score of 5/5. No complications occurred postoperatively. There was no clinical evidence of intraneural recurrence, as confirmed in postoperative MRI. In 2 patients, an extraneural cystic formation was visible in the anterior muscular compartment.**

CONCLUSIONS: **The data from our series support excellent long-term postoperative motor outcomes with a low recurrence rate. To avoid extraneural recurrence, resection of the superior tibiofibular joint is necessary.**

## INTRODUCTION

Intraneural ganglia (IG) are benign mucinous cystic formations that originate within the epineurium of peripheral nerves. Many peripheral nerves may be affected; however, the common peroneal nerve (CPN) at the fibular neck is the most frequently affected site.[1-6] The pathogenesis of the IG remained a controversial issue for a long time, until a unifying articular (synovial) theory was proposed by Spinner et al.[7-14] They suggested that IG formation is a dynamic process starting in a degenerating joint and subsequently extending to the nerve along its articular branch intraepineurally via a path of least resistance determined by intraarticular pressure. The IG of the CPN are an increasingly recognized occurrence in the adult population, prevailing in adult men, as reported by Consales et al.[15] and Wilson et al.[16] Symptoms and signs include pain and motor and/or sensory deficits in the CPN territory. Different treatments have been recommended, with an overall satisfactory motor outcome and no risk of intraneural recurrence when the cystic articular branch is resected.[9,17,18] In this paper, we aim to evaluate the long-term outcomes of surgical treatment of the IG of the CPN by reviewing our local institutional experience.

**Key words**
- Foot drop
- Ganglion cyst
- Peroneal ganglia
- Peroneal palsy

**Abbreviations and Acronyms**
CPN: Common peroneal nerve
EMG: Electromyography
IG: Intraneural ganglia
MRC: Medical Research Council
MRI: Magnetic resonance imaging
STFJ: Superior tibiofibular joint

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*Citation: World Neurosurg. (2019) 132:e217-e222. https://doi.org/10.1016/j.wneu.2019.08.195*

*Journal homepage: www.journals.elsevier.com/world-neurosurgery*

*Available online: www.sciencedirect.com*

*1878-8750/$ - see front matter* 

## PATIENTS AND METHODS

After institutional review board approval, we performed a case series review of peroneal IG surgical excision performed by the senior author at our institution between January 2004 and December 2017. Patients with isolated CPN IG and combined extraneural and CPN IG were included. Isolated extraneural ganglion cysts were excluded. All included cysts were shown to arise from the superior tibiofibular joint (STFJ). For the patient cohort, the following data were abstracted from the medical record: sex, age at operation, side, personal history of trauma or sport, whether the cyst was previously operated on at another institution, presence of fluctuating preoperative symptoms, preoperative neurologic examination, ankle-foot orthosis usage, preoperative electromyography (EMG), and magnetic resonance imaging (MRI) studies.

Pain intensity was assessed with the visual analog scale. Motor grading was according to the Medical Research Council (MRC) grading scale.[19]

The operation was prompted primarily by the presence of a neurologic deficit, pain, a mass, or a combination of these. In each patient, the CPN was dissected from the head of the fibula to the bifurcation of the common sciatic trunk to perform a complete surgical exploration and ensure removal of any possible compression along the nerve, which could have been undiagnosed on the MRI. The ganglion was ligated in the joint area, and its communication with the nerve branch, and removed. Neurolysis was performed in the CPN path and articular branch neurectomy, whereas the articular capsule was not resected. All histologic specimens were reviewed.

Clinical examination, control EMG, and MRI were performed in each patient postoperatively.

## RESULTS

Eight men were enrolled in the study; their demographics and surgical details are summarized in **Table 1**. The average age of the participants at the time of surgery was 47.5 years (range, 28–68 years). The patients shared a common presentation, including clinically and electromyographically confirmed loss of predominantly CPN function and characteristic MRI findings. Preoperative EMG and MRI results are reported in **Table 2**. In 5 cases, peroneal ganglia were intraneural only. The average maximal diameter of the intraneural cyst on preoperative MRI was 17 mm (range 9–26 mm). Symptoms were present for a mean of 11 months (range 1–30 months). Knee or proximal lateral leg pain preceded the neurologic symptoms of motor weakness and/or sensory disturbance in 2 patients. Symptoms arose acutely after trauma in 2 cases. An additional 5 individuals had a history of microtrauma to the knee region related to leisure pursuit. One patient had previously undergone 2 operations at other institutions before undergoing our evaluation.

Physical examination demonstrated neurologic deficit in all patients. Motor testing revealed a preoperative deficit of dorsiflexion, eversion, and toe extension in 7 patients (87.5%), with an MRC score of 3 or less (out of 5). The median preoperative dorsiflexion, eversion, and toe extension MRC scores were 0 of 5. A sensory loss in the distribution of the CPN was also present in 7 patients. Two patients (25%) reported high intensity pain. A palpable mass was found around the fibular neck in 2 cases. Abnormalities were detected in the CPN in all 8 cases; in none of them were electrical abnormalities found in the tibial or sural nerve.

The mean clinical follow-up time was 113 months (range 32–189 months). Clinical follow-up data and outcomes are summarized in **Table 3**. Significant pain relief was achieved in all patients. Overall neurologic function was improved, more so for motor function than for sensation. The median postoperative dorsiflexion, eversion, and toe extension MRC scores at last follow-up were 5 of 5, with an interquartile range of MRC scores of 4+ to 5 (of 5), 5 to 5 (of 5), and 4+ to 5 (of 5), respectively. In none of the cases did postoperative neurologic function deteriorate after our operations. Histopathologic examination confirmed the diagnosis of IG in all cases. No complications occurred in the postoperative period.

In this group of patients, there was no clinical evidence of intraneural recurrence. This was confirmed in all postoperative MRI scans; in 2 patients, an extraneural cystic formation was visible in the anterior muscular compartment. In 1 patient, a hypertrophic thickening of the nerve was visible on postoperative MRI. Postoperative instrumental examination results are reported in **Table 2**.

## DISCUSSION

IG are nonneoplastic, fluid-filled cystic lesions contained within the epineurium of peripheral nerves. First described by Beauchêne in 1810, IG affect predominantly male adults.[20,21] The pathogenesis of these lesions was a matter of debate in the literature until the early 2000s. Starting from 2003, after reviewing a large cohort of patients and analyzing accurately the literature on the topic, Spinner et al.[1] proposed, discussed, and substantiated the unified articular (synovial) theory based on clinical, anatomic, radiologic, and histologic data. According to this theory, IG formation is a dynamic process: synovial fluid exits a neighboring capsular defect of a degenerating joint. Then, as Spinner et al.[1] stated, "fluid tracks along the articular branch of a nerve intraepineurally via a path of least resistance along tissue planes" and "pressure fluxes determine the extent of dissection." In CPN IG, the cyst fluid comes from the anterior portion of the STFJ, dissects tissue planes along the U-shaped articular branch, and finally reaches the deep peroneal portion of the CPN. In case of very high pressure, the cyst may extend more proximally up to the sciatic nerve. CPN IG symptoms and signs include pain, motor, and/or sensory deficits in the CPN (the deep peroneal nerve is particularly involved because of anatomic reasons) territory. Usually, a mass can be palpated in the knee's anterolateral aspect. Moreover, Tinel sign can be elicited in the same region, and history of knee trauma and/or intense physical activity can also be present. In our experience, 7 of 8 patients (87.5%) reported one or both, suggesting a possible connection between articular stress and development of IG, as previously reported in the literature.[22] EMG and imaging studies (MRI is the study of choice) are useful, respectively, to confirm CPN lesions and show the cystic nature of the lesion and its relationship with the STFJ, allowing to adequately plan surgical treatment.[5,16,23-26]

The first treatment for peroneal nerve palsy because of IG is surgery. No authors have recommended conservative treatment because surgical treatment is usually successful when performed

**Table 1.** Demographics and Surgical Details for the Included Patients with Peroneal Intraneural Ganglion Cyst

| Case Number | Age at Operation (years) | Side | History of Trauma or Sport | Previous Operation at Another Institution | Presentation with Fluctuating Symptoms | Symptoms | Pain Intensity (VAS) | Preoperative MRC Scale | | | Palpable Mass at Fibular Neck | Symptoms Onset to Surgery (months) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Dorsiflexion | Eversion | Toe Extension | | |
| 1 | 43 | Right | Football player, runner. No trauma. | No | No | Sensitive: dysesthesia without pain. Motor: none. | 0 | 4/5 | 4/5 | 5/5 | No | 18 |
| 2 | 37 | Left | Former football player, runner. Not sure about trauma. | No | No | Sensitive: complete loss of sensation below the knee. Motor: foot drop. | 0 | 0/5 | 0/5 | 0/5 | Yes | 12 |
| 3 | 28 | Right | Football player. Remembers a direct trauma to the fibular head during a match with prolonged pain. | No | No | Sensitive: at first pain, then complete anesthesia. Motor: foot drop | 8 | 0/5 | 0/5 | 0/5 | No | 5 |
| 4 | 51 | Left | Yes, both. | Yes (2) | Yes (in intensity) | Sensitive: anesthesia. Motor: foot drop. | 0 | 0/5 | 2/5 | 1/5 | No | 30 |
| 5 | 68 | Right | No. | No | No | Sensitive: none. Motor: foot drop | 0 | 0/5 | 0/5 | 0/5 | No | 12 |
| 6 | 44 | Left | Runner. No trauma. | No | No | Sensitive: dysesthesia. Motor: foot drop. | 0 | 0/5 | 0/5 | 1/5 | No | 6 |
| 7 | 43 | Right | Football player. No trauma. | No | No | Sensitive: at first pain, then complete anesthesia. Motor: foot drop. | 7 | 0/5 | 2/5 | 0/5 | No | 8 |
| 8 | 68 | Left | Former artistic gymnast. No trauma. | No, but previous knee operation for compartment syndrome. | No | Sensitive: anesthesia. Motor: foot drop. | 0 | 0/5 | 0/5 | 0/5 | No | 1 |

MRC, Medical Research Council; VAS, visual analog scale.

**Table 2.** Instrumental Examination Results and Outcomes

| Case Number | Preoperative EMG Findings | | | Postoperative EMG Findings | | Cyst Location | Maximal Axial Diameter of Intraneural Cyst (mm) | Postoperative MRI Findings | Radiologic Follow-Up (months) |
|---|---|---|---|---|---|---|---|---|---|
| | Fibrillation Potentials | Decreased Conduction at Fibular Head | Summary | Fibrillation Potentials | Decreased Conduction at Fibular Head | | | | |
| 1 | None | Yes | CPN compressive lesion | None | None | Intraneural | 10 | No evidence of recurrence. | 165 |
| 2 | EDB, EHL, TA | Yes | CPN compressive lesion | EDB, TA | Yes | Intraneural + extraneural | 15 | No evidence of recurrence. Thickening of nerve fascicles. Slight edema imbibition and fatty degeneration of TA. | 141 |
| 3 | None | Yes | CPN compressive lesion | None | None | Intraneural + extraneural | 20 | No evidence of recurrence. | 136 |
| 4 | EDB, PL, TA | Yes | SPN compression predominant | EDB, TA | None | Intraneural | 26 | No evidence of recurrence. Slight edema imbibition of TA. | 135 |
| 5 | EDB, PL, TA | Yes | CPN compressive lesion | EDB, TA | None | Intraneural + extraneural | 17 | No evidence of intraneural recurrence. Extraneural ganglion cyst in the TA. | 100 |
| 6 | EHL, TA | Yes | CPN compressive lesion | TA | None | Intraneural | 9 | No evidence of recurrence. Slight edema imbibition and hypotrophy of TA. | 69 |
| 7 | EDL, EHL, TA | Yes | DPN compression predominant | TA | None | Intraneural | 17 | No evidence of recurrence. Degenerative changes of STFJ. | 41 |
| 8 | EHL, TA | Yes | CPN compressive lesion | EHL | None | Intraneural | 23 | No evidence of intraneural recurrence. Slight edema of EDL. Degenerative changes of tibiofibular joint and proximal tibiofibular joint ganglion cyst in the anterior muscular compartment. | 21 |

EMG, electromyography; MRI, magnetic resonance imaging; CPN, common peroneal nerve; EDB, extensor digitorum brevis; EHL, extensor hallucis longus; TA, tibialis anterior; PL, peroneus longus; SPN, superficial peroneal nerve; EDL, extensor digitorum longus; DPN, deep peroneal nerve; STFJ, superior tibiofibular joint.

**Table 3.** Clinical Follow-Up Data and Outcomes

| Case Number | Surgery to Symptoms Improvement (months) | Residual Symptoms | Orthosis Foot-Ankle | Recurrence | Postoperative MRC Scale | | | Clinical Follow-Up (months) |
|---|---|---|---|---|---|---|---|---|
| | | | | | Dorsiflexion | Eversion | Toe Extension | |
| 1 | 1 | None. | No | No | 5/5 | 5/5 | 5/5 | 187 |
| 2 | 4 | Paresthesia in the lateral compartment of the leg. Occasional swelling at lateral malleolus. | No | No | 4/5 | 5/5 | 5/5 | 151 |
| 3 | 5 | None. | Yes | No | 5/5 | 5/5 | 5/5 | 145 |
| 4 | 0 | Paresthesia (hot sensation) of the plantar foot, irradiating to the whole leg. | No | No | 4/5 | 5/5 | 4/5 | 144 |
| 5 | 3 | Slight paresthesia of the ankle. | Yes | Recurrence after first operation | 5/5 | 5/5 | 5/5 | 106 |
| 6 | 14 | Knee stiffness. | No | No | 5/5 | 5/5 | 5/5 | 78 |
| 7 | 10 | Slight strength loss. | Yes | No | 5/5 | 5/5 | 5/5 | 50 |
| 8 | 7 | Slight paresthesia of the foot. | No | Palpable mass, no clinical symptoms | 5/5 | 5/5 | 5/5 | 30 |

MRC, Medical Research Council.

early. Young age, absence of nerve damage, and duration of symptoms have been reported to be associated with clinical outcomes. In particular, patients with foot drop for 4 months have shown favorable outcomes. The surgical procedure involves exploration and decompression of the CPN. However, the technique of surgical treatment for IG has been controversial because of the contention surrounding their pathogenesis.[17] In line with the articular theory, Spinner et al.[1,27-32] have suggested the 4D technique (dissection of the nerve, disarticulation of the STFJ, decompression of the cyst, and disconnection of the articular branch) to treat the articular branch connection and/or the joint. Failure to disconnect the articular branch or treat the joint pathology has been found to be a statistically significant factor for recurrence as high as 30%. According to our experience, avoiding resection of the STFJ has not shown a higher intraneural recurrence rate, as reported in the current literature.[7,33] However, this can lead to extraneural recurrence, as confirmed by our findings: because in our series 25% extraneural recurrence occurred, following the 4D technique is definitely the best choice to minimize both intraneural and extraneural recurrence risk. We think our results are valuable and warrant debate, because this is the first report to describe the long-term outcomes of surgical treatment of CPN IG, supported by MRI and EMG findings.

Because of the retrospective nature of the study, we are limited in the data that we were able to collect from the medical record and constrained in the analysis that we were able to perform. Likewise, because the study was performed at a single center, it limits the generalizability of our findings.

## CONCLUSIONS

The data from our series support excellent long-term postoperative motor outcomes with a low recurrence rate. Moreover, positive history of knee trauma and/or intense physical activity in 87.5% of the patients suggest a possible connection with the IG etiopathogenesis.

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*Conflict of interest statement: The authors declare that the article content was composed in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.*

*Received 30 July 2019; accepted 24 August 2019*

*Citation: World Neurosurg. (2019) 132:e217-e222. https://doi.org/10.1016/j.wneu.2019.08.195*

*Journal homepage: **www.journals.elsevier.com/world-neurosurgery***

*Available online: **www.sciencedirect.com***