

Preoperative intra-articular fluorescein injection to detect the articular branch at surgery on a sural intraneural ganglion cyst at the ankle: illustrative case

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BACKGROUND Intraneural ganglion cysts (IGCs) are mucinous lesions that originate from adjacent synovial joints. According to the articular theory, synovial fluid tracks from a joint into the parent nerve through an articular branch. In uncommon sites such as the sural nerve, this connection can be difficult to identify. This report illustrates the use of a preoperative intra-articular fluorescein injection as a tool to identify the articular branch during surgery.

OBSERVATIONS A 60-year-old woman presented with lateral foot pain, numbness, and a palpable mass along the left sural distribution. MRI showed a large cyst extending along the course of the sural nerve with connection to the subtalar joint. Fluorescein was injected preoperatively into this joint to detect the articular branch intraoperatively with ultraviolet illumination. The connection was transected at the joint origin, and the cyst was decompressed, preserving the parent nerve. Postoperatively, the patient had complete pain relief and sensory recovery, and MRI at 3 and 8 months confirmed resolution of the cyst.

LESSONS Sural IGCs conform to the articular theory and can be managed effectively by transection of the articular branch. Preoperative intra-articular fluorescein injection is a useful tool to detect the articular branch that can be difficult to find in sural IGCs.

<https://thejns.org/doi/abs/10.3171/CASE251018>

KEYWORDS intraneural ganglion; sural nerve; articular theory; peripheral nerve; fluorescein

Intraneural ganglion cysts (IGCs) are benign mucinous lesions that arise when synovial fluid dissects along an articular branch and accumulates within a parent nerve. Patients typically present with pain, paresthesias, or weakness, depending on the nerve involved. IGCs can occur in various nerves, but most commonly the common peroneal nerve (CPN) at the fibular neck is affected.¹ The articular (synovial) theory is now widely accepted as the unified mechanism for IGC formation. IGCs in other nerves besides the CPN have been described, including the ulnar and tibial nerves, and joint connections have been found.¹ Involvement of the sural nerve is particularly uncommon, with only a limited number of cases reported in the literature.²⁻¹⁴

In contrast to CPN IGCs in which the articular branch is often and more easily identifiable, joint connection in sural IGCs may be difficult to detect on preoperative MRI or intraoperatively. Failure to detect and treat the joint connection frequently leads to recurrence. We present a case of a sural IGC originating from the subtalar joint that was treated by transection of the articular branch. Preoperative injection of

fluorescein into the subtalar joint was used to intraoperatively visualize and detect the joint connection with ultraviolet illumination.

We also performed a review of previously reported sural nerve IGC cases and characterized patterns of joint origin, imaging findings, treatment strategies, and recurrence. This case and review together highlight the importance of accurately identifying the joint connection, while exploring the potential role of fluorescein as an operative tool.

Illustrative Case

A 60-year-old woman was referred to the Haaglanden Medical Center (The Hague, The Netherlands) for surgical treatment of a sural IGC in the left foot. She reported 1 year of pain and numbness along the lateral foot. Her past medical history included polymyalgia rheumatica with bilateral ankle pain (left greater than right) and prior surgery for an extraneural ganglion cyst of the right ankle. Neurological examination showed reduced sensation in the dorsolateral foot in the

ABBREVIATIONS CPN = common peroneal nerve; IGC = intraneural ganglion cyst; TSE = turbo spin echo.

INCLUDE WHEN CITING Published March 9, 2026; DOI: 10.3171/CASE251018.

SUBMITTED December 29, 2025. **ACCEPTED** January 26, 2026.

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sural distribution and a palpable fluctuant swelling posterior to the lateral malleolus. The Tinel sign was positive at this location.

Preoperative MRI of the left ankle demonstrated a 6-cm cystic lesion extending along the course of the sural nerve in the ankle region consistent with an IGC (Fig. 1). It was multilobulated and arose from a degenerative subtalar joint. Flexor tenosynovitis was also present.

The operation was performed by the senior author. Approximately 5 hours before surgery, the radiologist first confirmed the correct intra-articular positioning by injecting 1 mL of Visipaque 270 into the subtalar joint. Once the joint was confirmed, sodium fluorescein (Fluoresceinedinatrium, 0.5 mL, 100 mg/mL; Fresenius Kabi Nederland BV) was prepared by withdrawing 0.3 mL and diluting it in 10 mL of physiological saline. Using a three-way stopcock infusion system, 1 mL of this diluted solution was injected into the subtalar joint. Fluoroscopic images confirmed contrast tracking from the subtalar joint toward the cyst (Fig. 2).

During surgical exposure, handheld ultraviolet light revealed some degree of spillage from contrast artifact in the soft tissues, but selective fluorescence within the sural articular branch and cyst (Fig. 3). The fluorescent signal allowed precise localization of the articular branch (the neural pedicle), which was transected just proximal to the joint. The cyst was then decompressed and drained while preserving the parent fascicles (Fig. 4).

The patient was discharged the following day. Postoperatively, she developed a superficial wound infection that was treated conservatively with antibiotics. Clinically, she reported complete pain relief, resolution of ankle swelling, and full recovery of sensation in the dorsum of the foot. At 3 months and 8 months postoperatively, MRI confirmed complete resolution of the cyst with no residual lesion (Fig. 5).

Literature Review

We interrogated our prospectively maintained database containing > 1100 cases of IGCs to identify examples involving the sural nerve.¹ A targeted review of published reports was also conducted to contextualize the features of our case. Cases in which IGCs arose from more proximal joints (e.g., superior tibiofibular and tibiofemoral joints) with secondary involvement of the sural nerve were excluded.

Results

Thirteen published cases of sural IGCs in the ankle joint were identified. Supplemental Table 1 summarizes the reported cases. Patient

ages ranged from 22 to 64 years (mean 48 years), with a male predominance (7 men, 6 women). The most common presenting symptoms were sensory disturbances such as paresthesias or numbness (77%), pain (69%), and a palpable mass along the sural distribution (62%). Symptom duration varied from weeks to several years.

Imaging varied by era: 3 (23%) patients underwent no imaging, 1 was evaluated with plain radiographs, 1 was evaluated with ultrasound only, and 8 (62%) were studied with MRI. MRI consistently demonstrated tubular or lobulated cysts along the trajectory of the sural nerve.

A joint connection was identified in 7 of 13 (54%) patients. In 3 of these, the articular branch was visible preoperatively on MRI (23%),^{10,13,14} and in all 7 cases the connection was confirmed intraoperatively. The involved joints were subtalar in 4 (57%) patients,^{6,10,12,14} calcaneocuboid in 2 (29%),^{2,5} and distal tibiofibular in 1 (14%).¹³ In the remaining patients, no articular branch was identified by imaging or operative exploration.

Follow-up data were available in 9 cases (mean 24 months, median 16 months). Among patients with follow-up data, 4 (44%) developed recurrence, and in each of these cases the joint connection had not been definitively disconnected at its origin during the initial procedure (2 underwent evacuation or decompression only,^{5,7} 1 had incomplete ligation short of the joint origin,⁶ and 1 had sural resection without capsular treatment¹²). In 2 of these patients, postoperative MRI confirmed intraneural recurrence, and at reoperation the joint connection was subsequently identified and addressed.^{6,12} By contrast, no recurrences were reported in cases in which the articular branch was identified and definitively disconnected at its joint origin. A few earlier reports described cyst excision or sural nerve resection without targeted treatment of the joint connection and did not mention recurrence, although follow-up was limited or not provided, and subclinical persistence cannot be excluded.^{3,4}

Informed Consent

The necessary informed consent was obtained in this study.

Discussion

Observations

This case illustrates intraoperative confirmation of the articular theory in a sural IGC using intra-articular fluorescein injection. The dye clearly outlined the sural articular branch and its communication



FIG. 1. A–C: Preoperative serial sagittal T2-weighted turbo spin echo (TSE) images of the left ankle, showing the sural IGC (asterisks) arising from the subtalar joint (arrows).

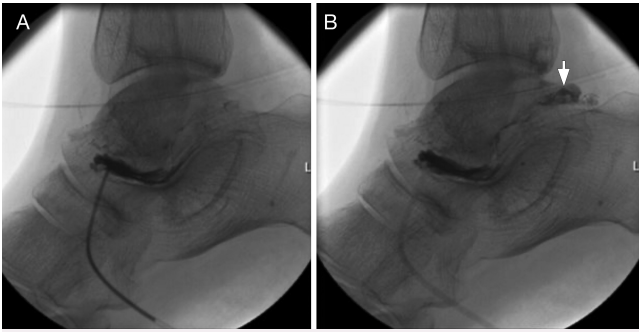


FIG. 2. Fluoroscopic images of the left subtalar joint showing intra-articular injection with the radiopaque dye (A) and contrast tracks toward the sural IGC (B; arrow).

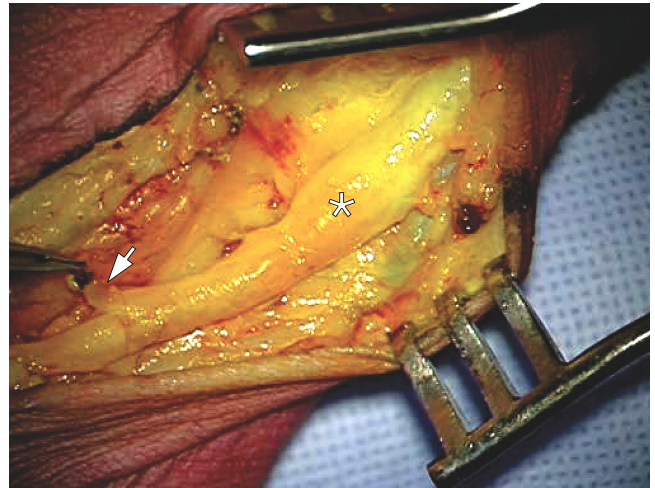


FIG. 4. Intraoperative image showing the sural IGC (asterisk) in the ankle region. The arrow indicates the fluorescein-positive articular branch to the subtalar joint.

with the subtalar joint, permitting targeted disconnection while preserving the parent nerve. Anatomical work on ankle innervation has shown that the sural nerve contributes to the dorsolateral portion of the upper ankle joint, the dorsal and lateral aspects of the subtalar joint, and the region directly anterior to the lateral malleolus, providing a plausible pathway for joint-related cyst propagation; more distally, it innervates the calcaneocuboid and fifth metatarsophalangeal joint.¹⁵ These anatomical patterns align with our review, which demonstrated that subtalar origin is the most common among reported sural IGCs, but calcaneocuboid and distal tibiofibular (talofibular) origins have also been identified.²⁻¹⁴

Because of this variability, the joint connection must be assessed carefully on preoperative MRI. When a subtalar origin is evident on imaging, targeted intra-articular fluorescein injection can assist in intraoperative identification of the articular branch. Whether similar targeted injections into other source joints such as the calcaneocuboid or distal tibiofibular joints are feasible remains unexplored but may be considered in selected cases and warrants further study. Missed

articular branch connections are the principal cause of intraneural recurrence despite technically successful cyst decompression. This case illustrates that adjuncts enhancing visualization of the articular branch can facilitate application of the same articular branch-directed surgical principles to less common IGC sites.

Intra-Articular Fluorescein

Visualization of the articular branch can be challenging during surgery, even when the joint of origin has been identified preoperatively on MRI. In this setting, tools that enhance intraoperative visualization may be helpful. Sodium fluorescein, a small hydrophilic molecule, distributes rapidly within extracellular fluid and fluoresces bright yellow-green when excited by blue-violet light (465–490 nm).¹⁶ It accumulates in areas of increased vascular permeability and in fluid-filled spaces, explaining its selective uptake in cystic or degenerative nerve tissue.

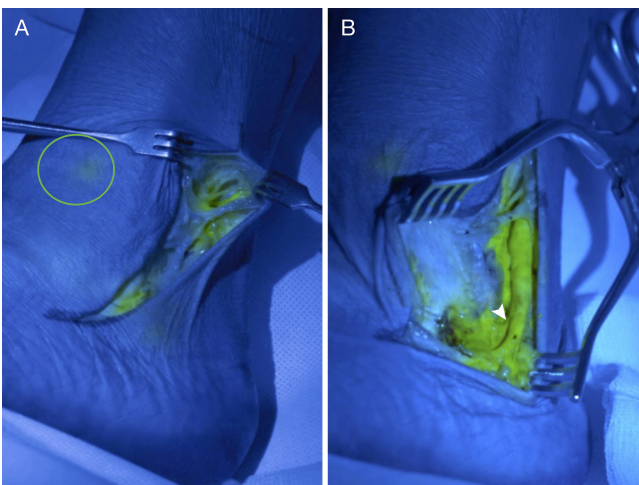


FIG. 3. Intra-articular fluorescein injection into the subtalar joint. A: The circle marks the insertion point of intra-articular fluorescein injection. B: Intraoperative ultraviolet image, with the arrowhead showing fluorescein within the sural articular branch and the sural nerve. Contrast spillage from the injection is also seen in the soft tissues following the injection.

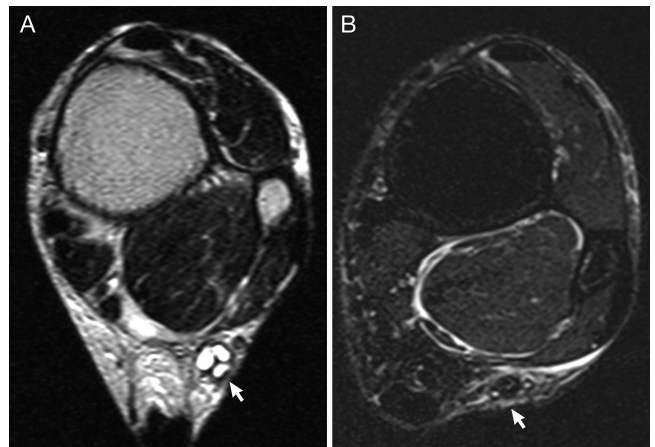


FIG. 5. Corresponding axial T2-weighted TSE images. A: The sural IGC (arrow) is seen in the ankle region preoperatively. B: The sural nerve (arrow) is seen on the postoperative imaging done at 8 months, and the cyst has resolved.

Abram et al. demonstrated this behavior experimentally, showing increased microvascular permeability in injured peripheral nerves.¹⁷ Stone et al. later applied these principles clinically using intravenous fluorescein during peroneal IGC surgery, where the cystic and articular branch segments fluoresced and guided joint disconnection.¹⁸

Delivering fluorescein intra-articularly has the advantage that the dye follows the same pathway as the cyst, from the joint through the articular branch to the parent nerve, thereby mirroring the mechanism described by the articular theory. To our knowledge, this is the first reported use of intra-articular fluorescein for an IGC. Optimization of this technique is still needed, including appropriate dosing and timing between injection and surgery. In this case, the injection was done at a different site from the articular branch to minimize dye spillage. Some extravasation was seen in the soft tissues posteriorly from the joint injection overflow (as is well known) and/or diffusion beyond the epineurium potentially through recently discovered anatomical openings.¹⁹ Interpretation should also consider that the procedure was performed more than 10 years ago, prior to the availability of microscopes with integrated 4',6-diamidino-2-phenylindole (DAPI) filters.

Fluorescein has a long record of safe use in neurosurgical and ophthalmological procedures, with rare adverse events even at intravenous doses far greater than the small intra-articular amounts used here.¹⁷ Its potential value lies in improving intraoperative identification of the articular connection, allowing more precise disconnection while minimizing unnecessary dissection of uninvolved fascicles. Further work is needed to refine dosing, timing, and illumination parameters, as well as to determine reproducibility across centers. Comparative evaluation against intravenous fluorescein and quantitative fluorescence analysis could further clarify relative advantages.

Clinical Implications

We found that all reported intraneural recurrences occurred when the articular branch was not definitively disconnected at its joint origin, and no recurrences were observed after complete disconnection. This underscores the importance of accurate identification of the joint connection. This observation validates the joint-centered treatment paradigm and highlights the potential value of adjunctive techniques to ensure definitive disconnection. We recognize that extraneural recurrences can also occur due to persistent joint pathology and increased articular pressures; the best treatment to prevent these is not known.

Although this report involves the sural nerve, the underlying principles are applicable to other nerves as well. Targeted intra-articular injection may be considered in other IGCs arising from well-defined articular origins, such as those involving the tibial, peroneal, or plantar nerves, provided that the joint of origin has been clearly identified preoperatively on MRI. Broader use will require careful patient selection and further experience, but the technique offers a potential adjunct for enhancing intraoperative confidence when treating articular branch-based nerve cysts.

Other dye-assisted approaches have been reported with intracystic injections to enable identification of joint connections of IGCs. Methylene blue has been injected into a cystic articular branch of the CPN to track to the superior tibiofibular joint.²⁰ Indocyanine green has been utilized in a median nerve IGC at the elbow.²¹ In these reports, no dye-related complications were observed. Differences in dye properties, injection sites, and delivery strategies preclude direct comparison between agents. However, awareness of these techniques is valuable and highlights the broader role of dye-assisted adjuncts to better visualize the articular branch.

Lessons

Sural IGCs are joint-related lesions that demand joint-centered treatment. This case demonstrates that intra-articular fluorescein is a safe, simple, and effective tool for visualizing the causative articular branch, guiding its targeted disconnection, and preventing intraneural recurrence. Consistent with the articular theory, this technique demonstrates the joint communication with the IGC through the articular branch and offers a practical solution for managing these rare and challenging cysts.

Acknowledgments

We utilized OpenAI (ChatGPT version 5.2) to check grammar.

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Disclosures

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author Contributions

Conception and design: Spinner, Amrami, Coercamp, de Ruiters. Acquisition of data: Spinner, Amrami, Coercamp, de Ruiters. Analysis and interpretation of data: all authors. Drafting the article: Spinner, Gogoi, Amrami, de Ruiters. Critically revising the article: Spinner, Amrami, de Ruiters. Reviewed submitted version of manuscript: all authors. Approved the final version of the manuscript on behalf of all authors: Spinner. Administrative/technical/material support: Spinner. Study supervision: Spinner.

Supplemental Information

Online-Only Content

Supplemental material is available with the online version of the article.

Supplemental Table 1. <https://thejns.org/doi/suppl/10.3171/CASE251018>.

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