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Ultrasound-Guided Limited-Access External Neurolysis With Hydroexpansion for Saphenous Nerve Scar Tethering After Varicose Vein Ligation: A Technical Report

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Abstract

Persistent saphenous neuropathy after venous surgery may be associated with focal scar tethering. We describe ultrasound-guided limited-access external neurolysis with hydroexpansion in a 66-year-old woman with right medial distal-leg and ankle sensory loss after varicose vein ligation. Ultrasonography showed focal fascicular enlargement and scar-directed nerve tenting. Six weekly hydrodissection procedures, each using 20 mL of 5% dextrose in water (D5W), produced no appreciable sensory improvement. Injection was associated with marked tactile resistance and severe pain; firm scar tethering and focal nerve angulation persisted despite extraneural fluid spread. After a two-year interruption of follow-up, the patient returned with persistent symptoms. Following proximal saphenous nerve blockade, 30 mL of D5W was used to expand a separable plane superficial to the nerve. Curved mosquito forceps were introduced through a 10-mm incision for ultrasound-guided blunt external neurolysis. Post-release ultrasonography showed a straightened longitudinal nerve course, and the operator observed improved relative nerve mobility. The wound had healed, and sutures were removed at two weeks. At three weeks, the patient reported sensation at approximately 80% of the contralateral side, with two noncontiguous areas of residual hypoesthesia. The sensory estimate was based on subjective bedside comparison. This report describes the use of hydroexpansion to facilitate instrument access when injection alone did not separate a focal scar attachment. This single-patient technical report, with only three weeks of follow-up and subjective sensory assessment, provides low-level evidence limited to technical feasibility and cannot establish causality, efficacy, comparative benefit, or durability.

Categories: Pain Management, Orthopedics, Neurosurgery
Keywords: external neurolysis, hydrodissection, hydroexpansion, peripheral neuropathy, saphenous nerve, scar tethering, ultrasound-guided surgery, varicose vein ligation

Introduction

The saphenous nerve is a purely sensory branch of the femoral nerve and is susceptible to injury during lower-extremity venous surgery because of its proximity to the great saphenous vein, particularly below the knee. Postoperative saphenous neuropathy may present with numbness, hypoesthesia, dysesthesia, or allodynia along the medial distal leg and ankle without a motor deficit. Persistent sensory disturbance is a recognized complication of venous procedures [1-3].

Ultrasound-guided hydrodissection uses fluid to separate a nerve from adjacent fascia, scar, or other tissue; 5% dextrose in water (D5W) is one of the injectates used for this purpose [4]. Watanabe et al. described improvement after serial hydrodissection for saphenous nerve entrapment following varicose vein stripping [5]. Fluid spread around a nerve, however, does not necessarily indicate separation of a focal scar attachment.

We describe limited-access external neurolysis for scar-tethered saphenous neuropathy after unsuccessful

therapeutic hydrodissection. The case-specific diagnostic rationale was clinical-sonographic concordance: a compatible distal medial sensory distribution, focal fascicular enlargement, scar-directed tenting, and failure of the scar-nerve interface to separate despite extraneural fluid spread. The technique uses hydroexpansion of an adjacent separable plane to permit ultrasound-guided instrument access to the resistant attachment.

Technical Report

Clinical presentation and localization

A 66-year-old woman presented with persistent numbness over the right medial distal leg and ankle. The symptoms began after right lower-extremity varicose vein ligation approximately three years before definitive neurolysis. She had no history of diabetes mellitus and was not taking any regular medications. Examination before neurolysis showed a pre-existing 10-mm longitudinal incision scar. The available record documents a focused examination of the symptomatic distal medial leg and ankle rather than a standardized whole-limb sensory map. Bedside testing showed reduced light-touch and pinprick perception across the marked symptomatic region, while the patient described complete absence of sensation in the most persistently affected subregions. Standardized monofilament, vibration-threshold, two-point discrimination, and numerical sensory grading were not obtained. A gross motor examination was documented as normal, but muscle-by-muscle Medical Research Council power grades were not recorded.

Electrodiagnostic testing was not performed; objective electrophysiologic confirmation and grading were therefore unavailable. Ultrasonography was performed with an X-CUBE 90 Elite system and SL3-19X linear transducer (Alpinion Medical Systems Co., Ltd., Seoul, Republic of Korea) and a LOGIQ e system and L4-12t linear transducer (GE HealthCare, Chicago, IL). The equipment is specified because different systems and probes were used during diagnostic, hydroexpansion, and operative imaging. Real-time assessment showed focal fascicular enlargement and scar-directed tenting, and a caudal-to-cranial sweep localized the abnormal configuration to the previous incision. In this patient, scar-associated saphenous neuropathy was diagnosed from concordance among the sensory distribution, focal sonographic nerve abnormality, and mechanically nonseparable scar attachment. These findings supported focal tethering but did not establish the mechanism of the original nerve injury or exclude a contribution from direct or thermal injury. The clinical distribution and longitudinal and transverse sonograms are shown in Figure *1*.

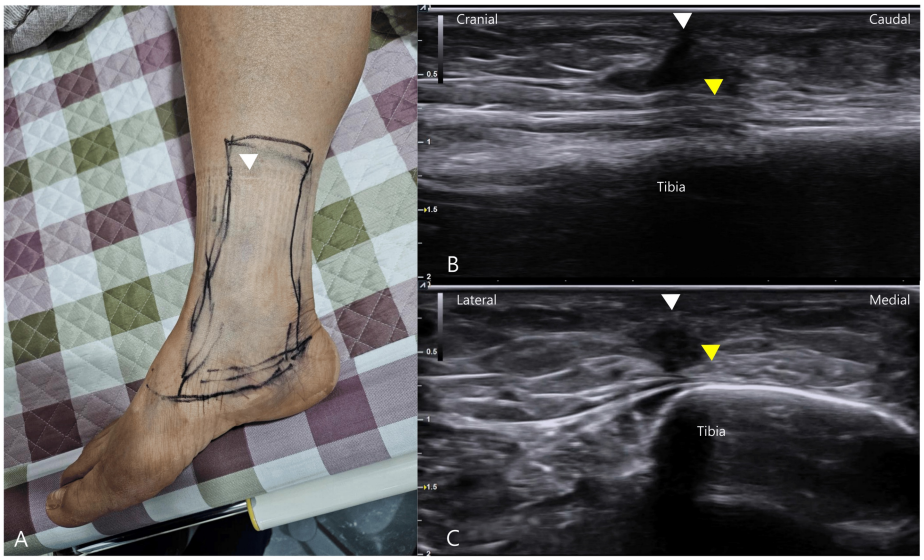


FIGURE 1: Clinical localization and preoperative ultrasonographic findings

(A) Medial view of the right distal leg and ankle before external neurolysis. Black skin markings delineate the patient-reported symptomatic area; the white arrowhead identifies the pre-existing ligation incision scar. (B) Longitudinal and (C) transverse sonograms at the scar level. Yellow arrowheads identify the saphenous nerve, and white arrowheads identify the incision scar. The tibia and scan orientations are labeled.

Prior hydrodissection and treatment escalation

The patient underwent six ultrasound-guided hydrodissection procedures at weekly intervals, using 20 mL of D5W through a 25-gauge, 2-inch needle at each session. There was no appreciable sensory improvement. Manual injection encountered marked tactile resistance and provoked severe pain. Extraneural fluid spread was visualized, but the saphenous nerve remained firmly tethered to the overlying scar, with persistent focal

angulation at the attachment site (Figures 2A-2B). Injection pressure was not measured.

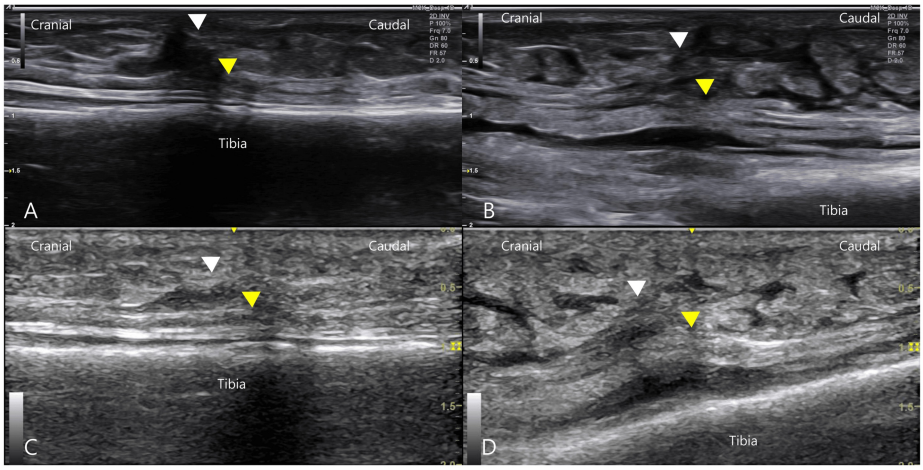


FIGURE 2: Persistent scar-related nerve deformation despite hydrodissection and hydroexpansion

Longitudinal sonograms obtained (A) before and (B) after an earlier therapeutic hydrodissection session with 20 mL of 5% dextrose in water (D5W). Despite fluid spread into adjacent extraneural planes, the saphenous nerve remained firmly tethered to the scar and focally angulated. (C) Before and (D) after operative hydroexpansion with 30 mL of D5W on the day of neurolysis. Hydroexpansion of separable planes provided instrument access but did not release the focal scar attachment or correct the nerve deformation. White arrowheads indicate the incision scar, and yellow arrowheads identify the saphenous nerve. The tibia, cranial-caudal orientation, and native ultrasound depth calibration are retained.

Procedure-related pain and insurance-related difficulties interrupted follow-up for two years. No reliable serial sensory, functional, or sonographic measurements were available during this interval, so the symptom trajectory could not be reconstructed. On returning, the patient reported persistent numbness and difficulty sensing the position of the ankle and foot during walking. This positional-awareness complaint was patient-reported; formal joint-position testing was not performed, and no objective proprioceptive deficit is claimed. The decision to perform external neurolysis was based on persistent symptoms at the return visit, intolerance of further awake hydrodissection, and the nonseparable scar attachment.

Regional block and operative hydroexpansion

Under sterile conditions, an ultrasound-guided saphenous nerve block was performed at the knee using the X-CUBE 90 Elite system. Ten milliliters of 2% lidocaine without epinephrine was administered, corresponding to 200 mg in a 60-kg patient (approximately 3.3 mg/kg). No clinical signs of local anesthetic systemic toxicity were observed.

A 23-gauge, 60-mm needle was advanced in-plane from caudal to cranial under ultrasound guidance. Thirty milliliters of D5W was injected to expand the separable tissue plane superficial to the saphenous nerve. Despite hydroexpansion of adjacent planes, the nerve remained focally angulated at its firm scar attachment (Figures 2C-2D). In this report, therapeutic hydrodissection refers to injection intended to separate the symptomatic scar-nerve interface as definitive treatment, whereas operative hydroexpansion refers to expansion of adjacent separable planes to create an instrument corridor while the focal attachment remains intact. Operative hydroexpansion images were obtained with the LOGIQ e system.

Limited-access external neurolysis

A 10-mm incision was made at the sonographically localized scar level on the distal medial leg using a No. 15 blade. Curved mosquito hemostatic forceps were introduced through the incision and advanced in the hydroexpanded plane superficial to the saphenous nerve (Figures 3A-3B). Real-time imaging during neurolysis was performed with the X-CUBE 90 Elite system. Controlled blunt spreading opened the adherent superficial scar plane without grasping the nerve; instrument manipulation remained extraneural.

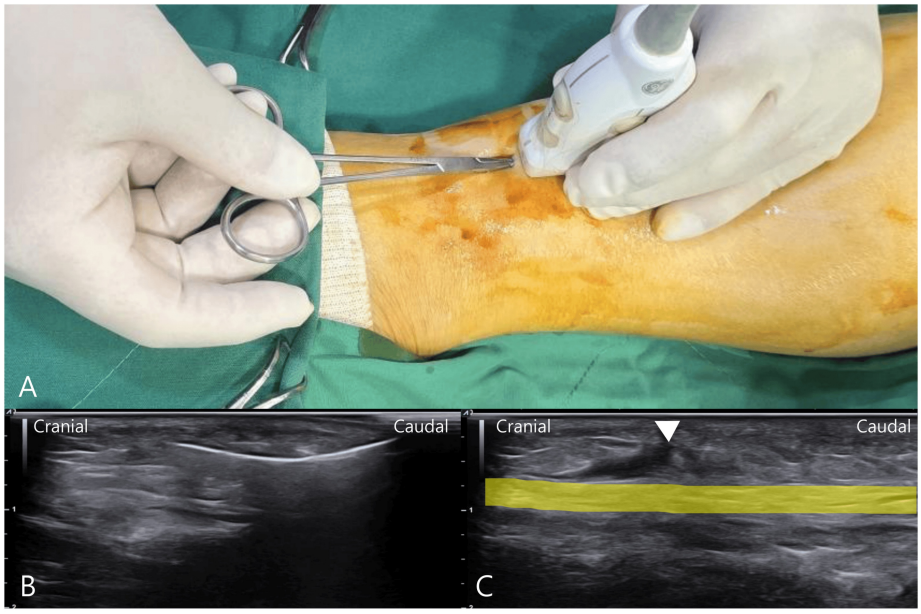


FIGURE 3: Limited-access external neurolysis and post-release straightening of the saphenous nerve

(A) Operative photograph showing the linear transducer, the curved mosquito forceps, and forceps entry through the 10-mm incision at the sonographically localized scar level on the distal medial leg. (B) Longitudinal intraoperative sonogram showing the instrument during blunt external neurolysis. (C) Post-release longitudinal sonogram showing a straightened saphenous nerve course, in contrast to the persistent focal angulation after hydroexpansion in Figure 2B and Figure 2D. Yellow shading identifies the nerve, and the white arrowhead identifies the incision scar. The shading represents nerve localization, not the hydroexpanded working space.

After blunt release, longitudinal ultrasonography showed a straightened saphenous nerve course without the previous focal scar-directed angulation (Figure *3C*). The operator also observed opening of the scar plane and improved relative nerve mobility. The post-release configuration was documented in a still image; mobility was assessed qualitatively without a dedicated post-release dynamic cine loop. The incision was closed primarily, and a two-day course of antibiotics was prescribed. No immediate neurologic, vascular, wound, or systemic complication was observed.

Postoperative assessment

Approximately three hours after the procedure, after clinical resolution of the regional sensory block, examination showed no new sensory deficit beyond baseline and no motor abnormality. At two weeks, bedside light-touch and pinprick perception were estimated at approximately 80% of the contralateral side. The patient described residual fullness or tightness rather than discrete pain; because no discrete pain was reported, a numerical pain rating was not assigned. The wound had healed, and sutures were removed.

At three weeks, the patient continued to report sensation at approximately 80% of the contralateral side, compared with previously absent sensation. This was a subjective estimate of perceived sensory intensity, not a validated quantitative sensory score. Two noncontiguous areas of residual hypoesthesia were documented by patient-applied skin markings. Follow-up ultrasound images provided qualitative documentation of the treated region. The archived examinations were not acquired using a prespecified matched orthogonal protocol at identical landmarks and settings; therefore, retrospective pre-post cross-sectional area comparison was not performed. Independent nerve excursion was also not measured. The sensory map and follow-up sonograms are presented in Figure *4*.

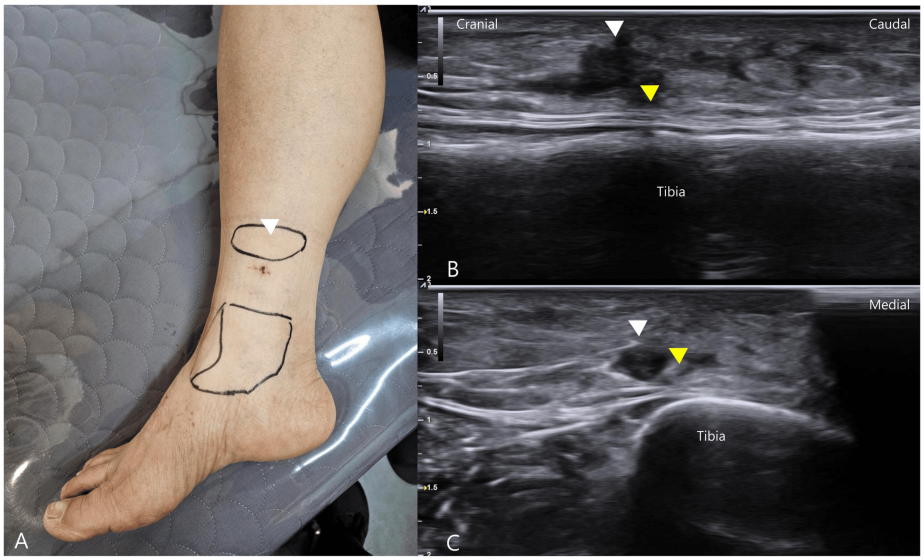


FIGURE 4: Sensory mapping and ultrasonography three weeks after external neurolysis

(A) Patient-demarcated areas of residual hypoesthesia at three weeks. Black skin markings indicate the symptomatic areas, and the white arrowhead identifies the pre-existing ligation incision scar. The patient estimated sensation at approximately 80% of the contralateral side; this refers to perceived intensity rather than the area enclosed by the markings. (B) Longitudinal and (C) transverse sonograms of the treated region. White arrowheads identify the incision scar, yellow arrowheads identify the saphenous nerve, and the tibia provides an anatomic landmark. Native ultrasound depth calibration is retained.

The clinical course, procedural parameters, and early follow-up findings are summarized in Table *1*.

Time point	Clinical event or finding
Approximately three years before neurolysis	Varicose vein ligation followed by persistent right medial distal-leg and ankle sensory symptoms.
Initial treatment course	Six weekly ultrasound-guided hydrodissections: D5W 20 mL per session through a 25-gauge, 2-inch needle. No appreciable sensory improvement; marked tactile resistance and severe procedure-provoked pain. Focal angulation persisted at the scar attachment despite extraneural fluid spread; injection pressure was not measured.
Two-year follow-up interruption	Pain and insurance-related difficulties interrupted care. No reliable serial sensory, functional, or sonographic measurements were available during the interval. Numbness persisted, and the patient reported difficulty with positional awareness on returning.
Day of external neurolysis	Knee-level saphenous nerve block; D5W hydroexpansion, 30 mL; 10-mm incision at the sonographically localized scar level; ultrasound-guided blunt external neurolysis. Post-release ultrasonography showed a straightened nerve course; improved relative mobility was observed qualitatively.
Approximately three hours	After clinical block resolution, no new sensory deficit beyond baseline and no motor abnormality.
Two weeks	Light-touch and pinprick perception estimated at approximately 80% of the contralateral side. Wound healed; sutures removed. Residual fullness/tightness was not assigned a numerical pain score.
Three weeks	Sensation remained at approximately 80% of the contralateral side. Two noncontiguous areas of residual hypoesthesia and qualitative follow-up sonograms were documented. No standardized sensory score, matched cross-sectional area comparison, or excursion measurement was available.

TABLE 1: Clinical timeline, sonographic findings, and early sensory outcomes

D5W, 5% dextrose in water. Sensory percentages are subjective bedside comparisons with the contralateral side, not validated quantitative recovery scores. No standardized baseline sensory thresholds, electrodiagnostic outcome, or matched pre-post cross-sectional area measurements were available.

Discussion

Rationale and relationship to prior reports

The temporal relationship to venous surgery, the focal incision scar, the sensory distribution, and the sonographic findings support scar-associated saphenous neuropathy [1-3]. These findings localize a plausible postoperative lesion but do not establish whether the nerve was injured directly during the original procedure or whether direct, thermal, or other mechanisms also contributed. A central procedural distinction is that injectate may enter accessible perineural planes without separating the specific symptomatic scar-nerve interface [4]. In the present patient, extraneural fluid spread occurred during both therapeutic hydrodissection and operative hydroexpansion, but the nerve remained firmly tethered and focally angulated at the scar attachment. This persistent deformity in Figure *2* contrasts with the straightened longitudinal nerve course after blunt release in Figure *3C* and supports relief of focal mechanical tethering. However, the post-release image demonstrates a morphological change and does not establish complete circumferential release or restoration of normal physiologic nerve excursion.

Watanabe et al. described improvement after serial saline-based hydrodissection, initially combined with corticosteroid administration, for saphenous nerve entrapment after varicose vein stripping [5]. Yoon et al. subsequently reported postoperative sural nerve entrapment within scar tissue after calcaneal fracture repair and hardware removal that improved after ultrasound-guided hydrodissection [6]. These reports indicate that some postoperative scar-related mononeuropathies may remain amenable to injection-mediated separation. In contrast, the scar-nerve interface in the present case remained nonseparable, with persistent angulation despite extraneural fluid spread. Song et al. similarly described a nonseparable peroneal nerve segment identified during hydrodissection that subsequently underwent surgical decompression [7]. Percutaneous scar release with fat grafting for saphenous nerve entrapment and perineural injection combined with acupotomy for infrapatellar branch entrapment provide additional examples of mechanically directed treatment [8,9]. These reports involve different nerve segments, procedures, and adjunctive treatments and therefore do not establish comparative efficacy.

In the present procedure, hydroexpansion of an adjacent separable plane created a protected corridor through which the resistant attachment could be approached with a blunt instrument. This concept is consistent with published descriptions of fluid-assisted dissection and instrument manipulation in ultrasound-guided surgery [10,11]. Hydrodissection has also been used to create a protective plane between

a nerve and an adjacent implant before instrument-assisted removal [12]. A recent clinical perspective identifies saphenous neuropathy as a potential indication for ultrasound-guided nerve hydrodissection while emphasizing that ideal injectate volumes and patient-selection criteria remain uncertain [13]. The present report therefore positions hydroexpansion as an operative adjunct rather than as the definitive means of release. Potential candidates for this approach would require clinically concordant sensory symptoms and a focal sonographically demonstrated scar attachment that remains mechanically nonseparable or cannot be managed with injection-only treatment. The six prior hydrodissection sessions in this patient represent her individual treatment history and should not be interpreted as an evidence-based threshold for surgical escalation.

Sensory outcome, procedural risks, and limitations

The two noncontiguous areas marked at the three-week follow-up should be interpreted as patient-reported localization of residual hypoesthesia rather than as anatomical maps of separate nerve lesions. Distal branching of the saphenous nerve varies among individuals [14], but specific terminal branches cannot be assigned to the outlined regions from clinical photographs alone. The change from previously absent sensation in the most affected subregions to a subjective estimate of approximately 80% of the contralateral side is compatible with an early reversible component of neural dysfunction after release. Sensory improvement within weeks has also been reported after median nerve decompression, although that evidence concerns a different nerve and entrapment disorder [15]. The timing and magnitude of the reported improvement cannot distinguish among restored conduction, remyelination, short-distance axonal recovery, overlapping cutaneous innervation, or other mechanisms. The reported percentage therefore does not establish the injury grade, the extent of axonal continuity, or axonal regeneration.

Regional blockade enabled the procedure in a patient who could not tolerate further awake manipulation, but it also reduced the usefulness of pain as an intraoperative warning signal. Procedural safety therefore depended on continuous visualization of the nerve-instrument relationship, maintenance of a superficial extraneural working plane, and avoidance of direct nerve grasping. Potential complications include neural or vascular injury, hematoma, infection, fluid extravasation, and recurrent scar formation. The use of a 10-mm incision demonstrates limited access in this patient but does not establish lower morbidity, equivalent completeness of release, or superiority over conventional open neurolysis.

This report concerns a single patient with only three weeks of postoperative follow-up. Sensory assessment was subjective and was not supported by standardized baseline thresholds, Semmes-Weinstein monofilament testing, vibration-threshold testing, two-point discrimination, quantitative sensory testing, or a preoperative percentage obtained using the same bedside scale. Electrodiagnostic testing was not performed; therefore, objective electrophysiologic confirmation, injury grading, and electrophysiologic follow-up were unavailable. Saphenous sensory responses may also be nonrecordable in healthy individuals, particularly when no reliable contralateral response is available, and electrodiagnostic testing should therefore be regarded as complementary rather than definitive in an individual distal saphenous lesion [16]. Nevertheless, the absence of electrodiagnostic data limits objective characterization of the neuropathy and recovery.

Formal joint-position testing was not performed, and the patient-reported positional-awareness complaint should not be interpreted as an objectively demonstrated proprioceptive deficit. No reliable serial sensory, functional, or sonographic measurements were available during the two-year interruption in follow-up; consequently, the interval course cannot be reconstructed, although persistent symptoms were documented when the patient returned before neurolysis. This uncertainty limits causal attribution of the early postoperative sensory change.

The archived sonograms were not acquired using a predefined matched transverse protocol at identical anatomical landmarks with standardized probe pressure, depth, machine settings, and orthogonal imaging. A retrospective cross-sectional-area comparison was therefore not performed because it would not provide a valid pre-post measurement. Injection pressure was also not measured, and the reported tactile resistance should be interpreted only as a subjective procedural observation rather than as a quantified opening-pressure measurement. No histologic specimen was obtained. Post-release straightening was documented in a longitudinal still image, whereas relative nerve mobility was assessed qualitatively without a dedicated dynamic recording or quantitative follow-up measurement.

Finally, the separate contributions of hydroexpansion volume, blunt scar release, regional blockade, the limited incision, and other perioperative factors cannot be isolated in a single uncontrolled technical report. The present findings therefore support technical feasibility and an early descriptive outcome rather than comparative effectiveness. Longer-term follow-up using standardized sensory testing, prospectively matched ultrasonography, and electrodiagnostic assessment when clinically appropriate is required to evaluate recurrent tethering, objective nerve function, and durability.

Conclusions

Ultrasound-guided hydroexpansion enabled instrument access for limited-incision external neurolysis of a

scar-tethered saphenous nerve after unsuccessful therapeutic hydrodissection. Post-release ultrasonography documented a straightened nerve course, and the patient reported early sensory improvement with residual hypoesthesia at three weeks. These findings demonstrate only the technical feasibility of this approach in a single refractory case. They do not establish causality, efficacy, comparative benefit, or durability. Validation in larger samples with standardized objective outcome measures and long-term follow-up is required before any clinical recommendation can be made.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Concept and design: Yonghyun Yoon, Youngmo Kim, Hyeongjik Kim, Dongyeun Sung

Acquisition, analysis, or interpretation of data: Yonghyun Yoon, Anwar Suhaimi, Teinny Suryadi, King Hei Stanley Lam

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Critical review of the manuscript for important intellectual content: Yonghyun Yoon, Anwar Suhaimi, Teinny Suryadi, King Hei Stanley Lam

Supervision: Yonghyun Yoon, King Hei Stanley Lam

Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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