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Repositioning of Supraorbital Nerve Stimulation Electrode Using Retrograde Needle Insertion: A Technical Note

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Introduction: With growing interest and acceptance of peripheral nerve stimulation (PNS) approach, there is now an increasing need in developing clear procedural details to resolve frequent complications and minimize associated tissue injury. Migration and suboptimal positioning of PNS electrodes are one of the most commonly observed complications of PNS approach.

Materials and Methods: We present a simple technique for repositioning a supraorbital electrode using retrograde insertion of introducer needle that allows one to place percutaneous (cylindrical) PNS electrode into appropriate anatomical location with minimal additional injury to surrounding tissues.

Results: This approach has been successfully used in multiple cases. An illustrative case of electrode revision with proposed technique is described in detail.

Conclusion: This technically simple approach to repositioning of cylindrical supraorbital electrodes using retrograde needle insertion eliminates the need for a more elaborate and invasive procedure. The technique can be used for electrode repositioning in most PNS applications.

Keywords: Migration, neuromodulation, peripheral nerve stimulation, revision, supraorbital nerve

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INTRODUCTION

Peripheral nerve stimulation (PNS) has been used for treatment of chronic pain for more than 40 years (1), and since 1999 this technique has been gaining rapid acceptance mainly due to introduction of a percutaneous electrode insertion approach by Weiner and Reed who used it in a series of patients with occipital neuralgia (2). Subsequently, multiple reports described use of similar approach with cylindrical stimulation electrodes in a variety of anatomical locations and clinical indications (3–26). However, epifascial and therefore superficial location of PNS electrodes seems to be associated with very high complication and revision rates, and incidence of electrode migration has been quoted between 9% and 12% (5–7). In a recent review of patient series with occipital nerve stimulation, migration of electrodes was the most frequent complication occurring in 25% of patients (26), and in one long-term study, all patients developed lead migrations when followed up for three years (9).

The usual approach for revision of migrated or malpositioned electrodes is to explore the anchoring and connection points and then reinsert each electrode into new location using same percutaneous technique. In the absence of extension cables, this means that the generator pocket has to be re-opened and the tunneling has to be repeated. And even though most electrodes are located in a relatively accessible epifascial plane, this need in multiple incisions, significant tissue dissection, and re-tunneling makes revision surgery difficult and traumatic. Reported here is our solution to decrease invasiveness and trauma associated with electrode revision procedure.

TECHNICAL DESCRIPTION

In order to avoid multiple incisions needed to expose the entire electrode and reinsert it, we developed a simple technique of retrograde supraorbital electrode insertion through a needle placed from beyond the stimulation target following the desired electrode trajectory.

The technique described in this report may be utilized for the PNS devices almost anywhere in the body as it allows one to reposition the PNS electrode without disturbing connections between it and the generator. We employed this simple technique on multiple occasions, mainly for trigeminal branch and occipital nerve stimulation electrodes. Here we present an illustrative case where this

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proposed technique was used in the management of a malpositioned supraorbital nerve stimulation electrode.

Use of described technique appears straightforward for those PNS electrode locations where electrodes are not positioned against bony prominence, and may be recommended for all instances of distal PNS revisions in supraorbital, occipital, inguinal, and lumbar regions. It may, however, be difficult to utilize in some other cases, for example, infraorbital nerve stimulation as the electrode tip is frequently placed against nasal bones and putting the needle in retrograde fashion may not be feasible.

REPORT OF AN ILLUSTRATIVE CASE

A 46-year-old Caucasian woman presented with complaints of severe pain in the right supraorbital region as well as in the ipsilateral occipital area that led to a diagnosis of right supraorbital and occipital neuralgia. After failure of medical management, she was implanted with a neurostimulation device that included two electrodes, one over the right supraorbital nerve (SON) and one over the right occipital nerve. The patient's surgery was done in a large academic institution in another state with good symptomatic improvement following device implantation. She presented to us nine months after the device was implanted with complaints of pain in the right supraorbital region stating that her stimulation covers most of the painful region but misses an area over the eyebrow and immediately above it. Her SON stimulation was delivered with the following settings: pulse width 450 msec, frequency of 65 Hz, amplitude of 1.0 mAmp, and contact polarity of 0 + − + 0 0 0 0 (case "off"). These were the settings that were useful after original implantation and, according to the device readout, this program was used 80% of the time.

The possibility of electrode malfunction was ruled out by checking stimulation settings and impedances for each electrode contact. Electrode migration was ruled out by comparing implantation radiographs with the current ones. It was obvious, however, that the electrode position 2–2.5 cm above the eyebrow was inadequate for her pain pattern. Therefore, a repositioning of the electrode was suggested. Instead of exposing the anchoring point in the retroauricular region and the generator pocket in the infraclavicular region, we decided to reposition the electrode using our retrograde needle insertion technique.

The patient was anesthetized with a laryngeal mask and the area of maximum pain was marked on the skin. She was kept supine and a fluoroscopy device was positioned for an anteroposterior radiographic view of the patient's forehead. The location of the right SON stimulation electrode was clearly seen on the fluoroscope screen and the desired position for the electrode was defined below and slightly medial to the existing electrode location. After sterile preparation, local anesthetic was injected and a small incision was made in the right temporal area, just inferior to the course of the existing electrode (Fig. 1). Once the electrode was identified above the incision, it was gently pulled towards the skin opening. After it was pulled out through the incision, all eight contacts were checked for integrity and confirmed to be intact.

A slightly bent Tuohy needle was inserted (Fig. 2) through a separate stab incision at the other side of midline, medial to the inner edge of the left eyebrow, and then advanced in the epifascial plane (between the skin and underlying glabellar and frontalis muscles) under fluoroscopy guidance over the glabella and under the right eyebrow until the needle tip reached the right temporal incision. The needle was bent to accommodate a natural curvature of the human forehead. Once this was done, the stylet was removed from the needle and then the right SON stimulation electrode was inserted into the needle (Fig. 3) in a retrograde fashion and advanced under fluoroscopic guidance until the midline was reached. After that, the needle was gently pulled out leaving the electrode in place, and appropriate position of the electrode was confirmed using fluoroscopy (Fig. 4).

Following electrode repositioning, the patient developed better pain relief that was linked to more concordant coverage of her painful regions with stimulation-induced paresthesias. Her SON stimulation parameters after the electrode repositioning were very

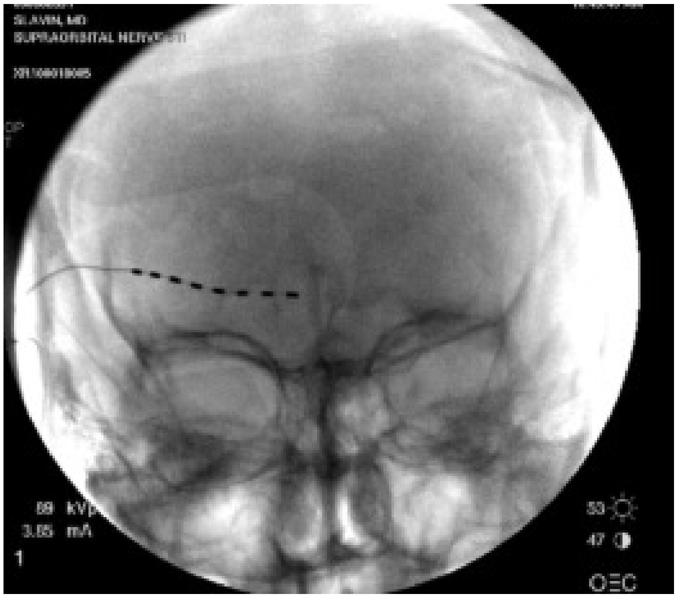

Figure 1. Skull radiograph showing suboptimal location of supraorbital nerve stimulation electrode.

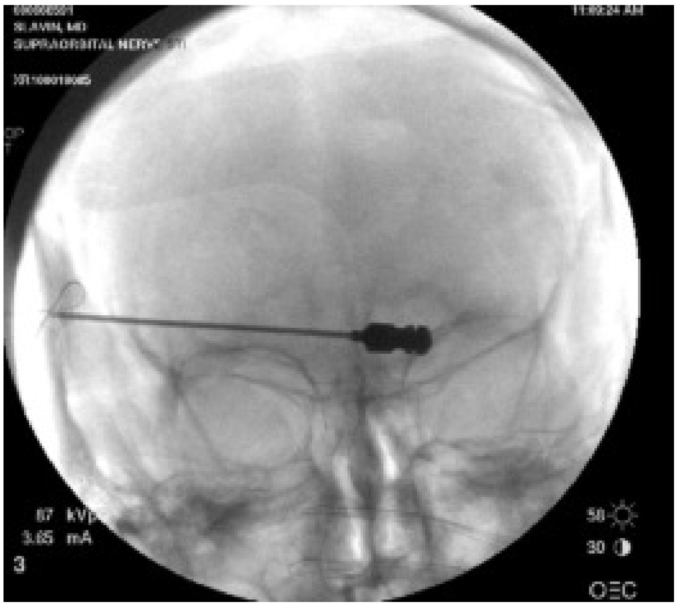

Figure 2. Radiograph illustrating the needle in place introduced from above the glabella and reaching the incision through which the electrode was pulled out.

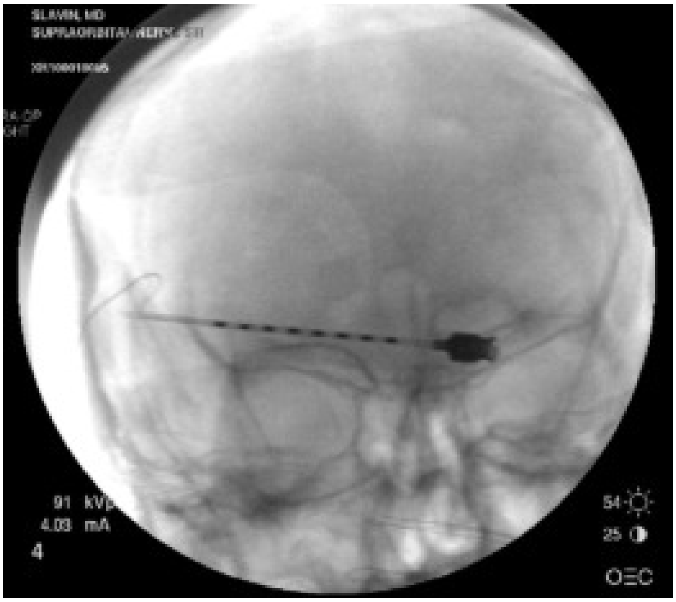

Figure 3. Radiograph showing the needle without the stylet and the cylindrical electrode inserted into the needle in retrograde direction.

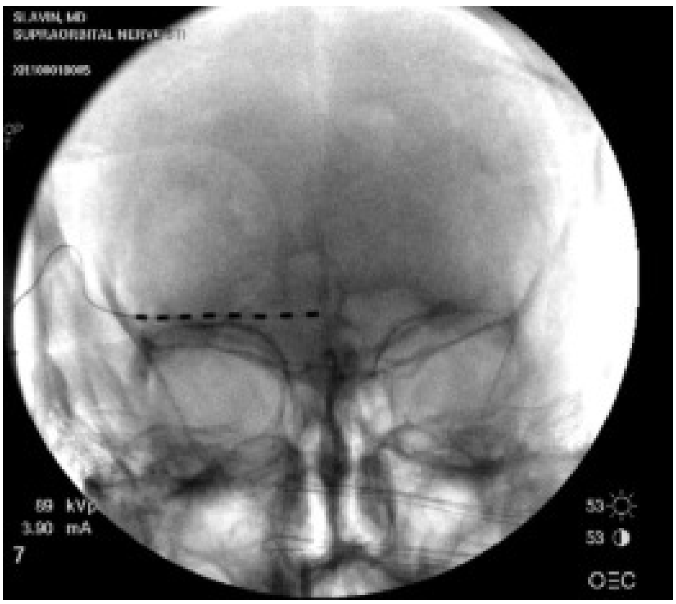

Figure 4. Skull radiograph with final position of the stimulation electrode after the needle was removed.

similar to preoperative setup: pulse width of 240 msec, frequency of 60 Hz, amplitude of 0.6 mAmp, and contact polarity of 0 0 – + 0 0 0 0 (case "off"). The patient remained satisfied with stimulation effects and did not require oral or parenteral pain medications at the time of her 3-month follow-up visit.

DISCUSSION

Peripheral nerve stimulation using percutaneously inserted electrodes has become an accepted modality for a variety of indications, including occipital neuralgia (2–5), cervicogenic headaches (6–8), trigeminal neuropathic pain (10–12), cluster headaches (13), post-herpetic neuralgia (9,14), and all kinds of peripheral neuropathic pain syndromes in the lumbar area (15), inguinal region (16), abdomen (17), neck (18), chest wall (19) and upper (20,21) and lower extremities (22,23). It is now a subject of investigation as treatment modality for migraines (24) and even fibromyalgia (25).

Migration and/or malpositioning of PNS electrodes have been consistently encountered in most reported surgical series. In a systematic review of implanted occipital nerve stimulators (*N* = 150) by Jasper and Hayek, lead displacement was frequently reported with percutaneous cylindrical leads, occurring in 30/115 patients, and, to a lesser extent, with implanted paddle electrodes, where it was observed in 2 out of 35 patients (27). The incidence of migrations requiring surgical revision increases with the length of follow-up, and in one report such revisions had to be performed in 33% of patients at the six month mark, 60% at one year, and 100% at three years (9).

Various approaches have been suggested to minimize migration rates. The most accepted approach is to use paddle electrodes instead of percutaneous ones (4,28–31). However, this approach reduces but does not eliminate risk of migration as two out of eight patients developed migration in one series, one due to a fall, and another one for no obvious reasons (30). The approach using paddle electrodes is, however, significantly more invasive, and is unlikely to become adopted in some anatomical locations, such as the supraorbital region.

Recently, a technique utilizing ultrasound guidance for insertion of electrodes in the occipital region was described (32), specifically aimed at detection of the nerve path in the subcutaneous/epifascial plane and improving accuracy of electrode placement as the shorter distance between electrode and nerve appears to be critical for adequate paresthesia production. This issue is probably less relevant for SON stimulation where variability of nerve course is significantly lower compared with the occipital nerve anatomy.

The regular Touhy-type needle described here may, obviously, be replaced with blunter instruments such as a specially designed blunt introducer. Alternatively, one may use peel-away catheter sheaths or needles with detachable hubs for antegrade electrode insertion. Our approach, however, appears more attractive as it uses standard equipment that is widely available in neuromodulation practice.

Retrograde needle insertion has been proposed in the past for occipital electrode implantation and anchoring. As early as 2004, Gofeld suggested this approach in revision of a migrated occipital PNS electrode (33). It was suggested to insert the needle from one occipital region to another crossing the midline and allowing one to place a single electrode for bilateral occipital stimulation. Later, a similar technique was described by an Italian group but in this case needles were inserted from the lateral direction to the midline, and two electrodes, one in each side, were anchored in the midline incision (34).

To the best of our knowledge, this technique has not been used outside occipital nerve stimulation procedures and in the past reports it was primarily used to allow another anchoring point and to prevent future migrations. We, on the other hand, suggest it as an alternative for electrode revisions when larger intervention may present an unacceptable degree of invasiveness and trauma to the body, or when a standard revision procedure would jeopardize other functional electrodes in place.

Authorship Statements

Both authors created the concept, analyzed material, and wrote the article. All authors approved the final manuscript and had complete access to the study data.

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COMMENTS

Dr. Slavin has presented us with a clear idea of a new technical approach to a problem that is often identified in those with peripheral nerve leads in the head and neck. Many times we perform a revision that is more difficult than the original implant. One could argue that changing to a paddle lead may alleviate migration, but in our experience that construct can lead to erosion and fracture and is not without risks at the time of revision. We are hopeful that new devices will achieve success in clinical studies that make the need for separate IPG devices obsolete. Until that time comes this technical note will change my practice and improve the care of my patients. I am hopeful that will be the case for our readership as well.

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Migration has become a bane of PNS subcutaneous electrode position management. This simple technique should help reduce the incidence of post op wound infection which can occur with redo surgery and simplify the migration correction in general.

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Peripheral nerve stimulation, particularly for occipital and trigeminal distribution nerves has gained prominence over the past several years (1–4), largely due to the decreased morbidity and increased efficacy of techniques based on cylindrical percutaneous electrode arrays (3–7) compared to older paddle techniques for peripheral stimulation (8–9). The use of such electrodes, however, has been associated with a fairly high rate of lead migration (4, 9–11). The authors clearly relate the problems of traditional revision techniques and describe an elegant technique to minimize the tissue trauma in a substantial subset of revision surgeries. This technique will undoubtedly become very widespread in revision surgery.

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Comments not included in the Early View version of this paper.