Removal of Vagus Nerve Stimulator Leads and Reuse of Same Site for Reimplantation: Technique and Experience

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OBJECTIVE: **This report describes the authors' experience and technique in removing vagus nerve stimulator leads, including coils, and reuse of the same site on the vagus nerve for implantation of new coils.**

METHODS: **The charts of all patients who underwent complete removal by the authors of vagus nerve stimulator leads between 1 September 2001 and 1 July 2015 were retrospectively reviewed.**

RESULTS: **Thirty patients underwent 31 surgeries for removal of vagus nerve stimulator leads. Complete removal, including proximal coils around the vagus nerve, was achieved in all cases. Reimplantation was performed immediately at the same location in 24 patients, delayed in 1 patient, and never replaced in 6. Long-term vocal cord paralysis followed 2 of 9 surgeries performed with sharp dissection and followed one of 22 surgeries in which dissection was performed with monopolar microneedle electrocautery.**

CONCLUSIONS: **Vagus nerve stimulator coils can be removed from the vagus nerve, via monopolar microneedle electrocautery, and the same site reused for immediate reimplantation with relative safety.**

INTRODUCTION

The number of people of all ages who have a vagus nerve stimulator (VNS) is steadily increasing as a result of the expanding number of maladies for which vagus nerve stimulation is beneficial (particularly epilepsy), the dissemination of knowledge on the therapeutic effectiveness of this modality, and the low surgical morbidity, compared with other surgeries.[1-4] As the number of patients having these devices increases, the number who require removal or replacement of their leads will steadily increase.[5-7]

Patients in whom VNS has proved to be ineffective often choose to leave the device implanted; however, some request removal of the generator and a few insist on removal of all hardware.[8] Patients in whom VNS has proved to be effective and then lose benefit because of fracture of the lead, as confirmed by high lead impedance, require surgery to reestablish VNS functionality. The surgeon may choose to 1) abandon the old coils and attach the new lead to a fresh location along the vagus nerve; 2) remove the nonfunctional lead, including coils, and implant the new lead at a new location along the nerve; or 3) remove the nonfunctional lead, including coils, and implant a new lead at the same location as the original. Infection, particularly if purulent, is usually considered to be a strong indication for removal of the helical coils attaching the lead to the vagus nerve, but there are reports of successful management of infection with antibiotics alone.[9] Also, VNS coils may require removal in patients who require magnetic resonance imaging for further evaluation of their epilepsy.[10] Removal of the helical coils attaching the lead to a vagus nerve is often an unfamiliar, stressful, and tedious subroutine, understandably influenced by the surgeon's experience, intuition, fear of injuring the vagus nerve, and perhaps a desire to choose the simpler and faster course. Surgical techniques for removal of the helical coils of VNS leads from around vagus nerves include a sharp surgical technique and a technique in which most, if not all, of the dissection near the coils and nerve is accomplished with electrocautery.[11] In this article, a surgical technique for removal of VNS coils from the nerve and our experience with reimplantation at the same site are described.

Key words
- Electrocautery
- Epilepsy
- Vagus nerve stimulator
- Vagus nerve stimulator removal

Abbreviations and Acronyms
VNS: Vagus nerve stimulator

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Citation: World Neurosurg. (2016) 91:190-194.
http://dx.doi.org/10.1016/j.wneu.2016.03.085

Journal homepage: ***www.WORLDNEUROSURGERY.org***

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

METHODS

All patients who underwent removal of VNS coils from the vagus nerve by the senior author between 1 September 2001 and 1 July 2015 are the basis for this report. All patients in whom VNS proved to be ineffective and who chose to have their leads remain in place were excluded. Data were collected from existing medical records with the approval of the Colorado Multi-Institutional Review Board (COMIRB14-0578).

Technique

Positioning and Skin Incision. The patient, while under general anesthesia with muscle relaxation, is positioned with a small transverse roll beneath the shoulders and the head is rotated approximately 15° to the right. Excessive extension or rotation can make the dissection unnecessarily difficult.

Skin and Platysma Muscle. An incision is made through the existing scar in the anterior cervical region. Skin and adipose tissue are undermined in a semicircular fashion superiorly by approximately 3 cm and inferiorly by approximately 1.5 cm. If the platysma muscle is intact, it is protected and never transversely cut. This muscle is then incised with scissors in a line parallel to its longitudinally coursing fibers and undermined to expose the stimulator lead.

Dissecting Near the Jugular Vein and Internal Carotid Artery. The dissection is continued around the medial edge of the sternocleidomastoid muscle by following the course of the stimulator lead as it passes generally toward the jugular vein and internal carotid artery. The lead usually has a double loop in its course to the vagus nerve and this knowledge is helpful in guiding the dissection. The jugular vein can be held laterally with a blunt-tipped self-retaining retractor. The location of the carotid artery is often identified only by palpation but care should be taken to not compress the artery with a retractor. Dissection to expose the lead is usually relatively simple until it separates into its 2 proximal insulated components of 25 cm length. Commonly 1 or 2 polymeric silicone tie-ons are found in this region and can be easily removed.

Dissecting Coils from Nerve. An operating microscope adjusted to high magnification must be used for this part of the surgery. All dissection close to the vagus nerve is performed with monopolar microneedle electrocautery, with the cutting current in blend mode and the power adjusted to 3–5. The lower value should be tried first because the performance of electrocautery machines, even those of the same brand and model, vary significantly at very low settings. It is also important that the bipolar electrocautery machine be set to a very low value and not used directly on or very near the vagus nerve.

Fibrous tissue along the 2 insulated wires is cut longitudinally with the electrocautery until the most caudal silicone coil is encountered. The most caudal coil, which contains no electrode, is usually seen first. With the electrocautery needle in direct contact with the polymeric silicone coil, the encasing fibrous tissue overlying the anterior approximate two thirds of the coil is cut. The small string on the tip of each coil, if not removed at time of implantation of the lead, tends to be tightly tethered by fibrous tissue, and traction on the coil can deeply indent and injure the nerve before the string is identified and cut. The fibrous tissue about the vagus nerve is cut with the electrocautery, using constantly moving short longitudinal strokes and never holding the cautery needle in firm contact with the nerve. The coil can be gently unwound from the nerve.

After the first coil is removed, the vagus nerve can be directly visualized. The electrocautery is then used in the same manner to clear the fibrous tissue from the 2 more rostral coils (Figure 1). A rubber vessel loop passed around the nerve often facilitates gentle retraction and exposure while fibrous tissue is cut with the electrocautery.

We prefer to not remove the coils in a piecemeal fashion but to gently tug on the lead to assist the exposure as each coil is identified, cleared of fibrous tissue, and unwound. After the second coil is found, the course of the nerve becomes more obvious. Dissection is continued in the same manner to clear and remove the third coil. Occasionally, the lead loops beneath or around the nerve and failure to recognize this rotated orientation could lead to making an incision into the nerve.

Preparing Nerve for Attachment of New Stimulator Coils (If Needed). If a new lead is to be immediately attached to the nerve, approximately 3 cm of nerve must be circumferentially cleared. It is not necessary to remove all visible scar, but enough must be removed so the new coils do not constrict or fit snugly around the nerve and are not bunched together. We always use the 3-mm coils for reimplantation to minimize the risk of injury to the vagus nerve.[12]

Caveat. Attempts to extend the exposure along the vagus nerve by longitudinally stretching the encompassing fibrous tissue with

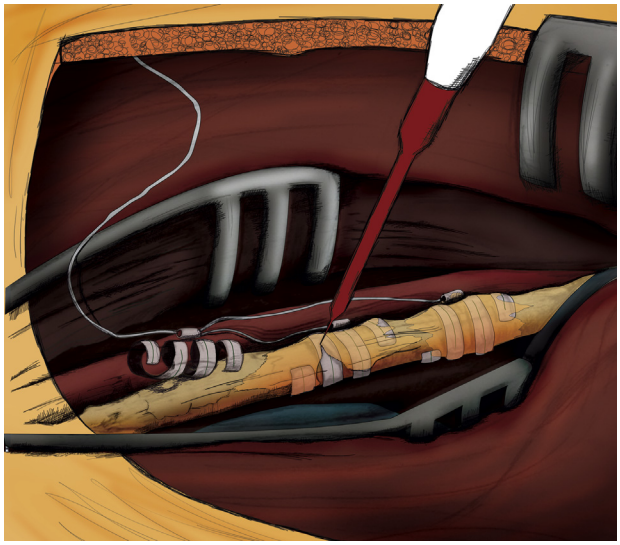

Figure 1. A micro-needle electrocautery is shown meticulously dissecting the coils from around the vagus nerve under high magnification. The caudal set of coils are completely free and the electrocautery is shown dissecting scar from the middle set of coils. The rostral set of coils remains surrounded by scar.