HANDS ON

European perspective on lead extraction: Part II

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Lead extraction procedure

Locking stylets and insulation ligatures

If manual extraction is not successful, a locking stylet is used after the inner lumen is reamed using another stylet to remove debris. Use of a locking stylet with a very flexible tip is essential so that a tortuous lead can be negotiated. Equally important is locking the stylet as close as possible to the lead tip and not allowing the stylet to slip during the procedure. The risk of severing the sometimes fragile interpolar section of encapsulated bipolar leads is high if a positive lock close to the lead tip cannot be achieved. To avoid pulling out the core of the lead and leaving the outer insulation in place, a ligature is used to fasten the insulation to the rest of the lead and to the locking stylet. I recommend using a large-diameter ligature and distributing the tension using at least two separate knots to avoid cutting the insulation with the ligature (Figure 1). A long ligature (reeled) is used to avoid obstructing knots inside sheaths.

In my experience, two main factors prevent successful lead extraction: calcification and extensive fibrotic ingrowth around the lead and/or sharp bends of the lead, which prevent advancement of the locking stylet to the lead tip. If the lead is very tortuous, a locking stylet that can be unlocked is helpful. The clinician can advance the locking stylet to the obstruction, lock the stylet and free the lead obstruction, unlock the stylet, advance it to the lead tip, and lock the stylet again.

Sheaths

Pulling on the lead with the locking stylet *in situ* either will remove the lead or convince the clinician of the need for sheaths. With experience, the clinician will know when there is so little "flex" in the lead that a sheath is needed. Given my experience with other methods, especially double mechanical sheaths, I usually move to a laser sheath at this stage because I have found it more efficient than other sheaths. Sometimes a tight, fibrotic, intercostal space, medially positioned between the clavicle and the first rib, may force the use of a stainless steel sheath to enter the subclavian vein.

When severe fibrosis (Figure 2) or calcification is encountered, the main approach is upsizing. I routinely use a certain amount of upsizing at the start of the procedure. A single sheath, the size of a traditional outer sheath for a given lead diameter, is generally used. This upsizing approach is used for both mechanical and laser sheaths. The majority of pacing leads requiring sheath extraction are extracted with a 14Fr single laser sheath. I prefer a single sheath because it is more flexible without an outer sheath and is easier to handle.

After calibration, the single laser sheath is mounted over the lead, the locking stylet, and the insulation suture. The laser sheath tip is advanced under fluoroscopic guidance, ensuring that the leading edge of the beveled front of the sheath is kept on the inside when approaching the brachiocephalic curve. The lead is kept straight during sheath advancement, and too much traction on the locking stylet and suture is avoided. A limited back-and-forth rotation movement of the sheath usually adds some useful mechanical ablation to the laser energy at the sheath tip. The J shape of most atrial leads usually can be straightened before countertraction is applied to the lead and the sheath at the lead tip. To prevent unnecessary force of the sheath tip rim against the lateral vessel/atrial wall, I avoid pulling left-sided leads medially out of their usual "anatomic" position.

Almost without exception, lead tips can be freed by countertraction technique (Figure 2). This involves keeping the atrial/ventricular wall in position with the sheath while steady traction is maintained on the lead, locking stylet, and suture for several minutes, if necessary. For safety reasons, laser energy must be stopped before the lead tip is reached; the laser sheath must be used mechanically only while freeing the lead tip.

For ventricular leads, care must be taken when passing the tricuspid valve. I usually keep the leading edge of the laser sheath in a medial/superior position. Ventricular lead tips are freed the same way as atrial lead tips. Unscrewing active lead tips before applying countertraction is useful.

Special situations

If leads with different implantation times are extracted, I prefer to start with the most recently implanted lead because

KEYWORDS Lead extraction; Lead endocarditis; Pocket infection; Superfluous lead; Extraction technique (Heart Rhythm 2008;5:320–323)

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1547-5271/$ -see front matter doi:10.1016/j.hrthm.2007.09.014

Figure 1 Leads ready for extraction with locking stylets inserted and insulation sutures attached.

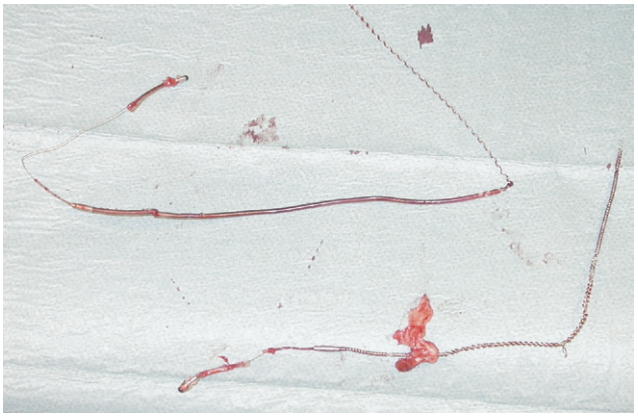

Figure 3 Severely fibrosed leads, damaged by a previous extraction attempt, completely extracted with laser technique. The leads had been implanted for approximately 7 years.

that lead usually is the easiest to free if multiple leads that are fibrosed together are targeted.

Tight adhesions often occur at the level of the superior vena cava, sometimes involving leads implanted from both the right and left sides. In such situations, advancement of the sheath may come to a halt. Moving the laser sheath from one lead to the other and back again usually breaks up the bindings. Having locking stylets attached to all target leads makes stabilizing them easier while working with the sheath on alternative leads.

If the alternating technique is unsuccessful, the next step is using a larger sheath, usually a larger laser sheath. I previously used a matched mechanical outer sheath if I had problems with the 14Fr laser sheath; however, I have found it illogical to rely on mechanical ablation in cases where laser ablation is most needed. I now change to a 16Fr laser sheath but rely on wider mechanical sheaths as a last resort given that 16Fr is the widest laser sheath presently available.

If the sheath cannot be advanced over a lead, the reason usually is severe fibrosis or calcification; a more unusual reason is insulation damage or a sleeve left at implant. The sheath tip may force a flap of insulation distally and stop movement of the sheath by increasing the diameter of the lead. The solution is to back off, turn the sheath, and try to get over the flap. If this method does not work, upsizing is again the answer. Some older, thin leads without an inner lumen and with a large lead tip will require a 16Fr sheath from the start to get the tip out.

Occasionally free-floating lead parts, either totally free floating or attached at one or more points, occur. Free-floating leads preferably should be grabbed before they reach a pulmonary artery branch. I have found the Byrd Workstation femoral intravascular retriever (Cook Vascular, Leechburg, PA, USA), the Dotter intravascular retriever, (Cook Vascular) the Curry loop snare (Cook Vascular), the Needle's Eye snare (Cook Vascular), and Amplatz snare (Microvena Co, White Bear Lake, MN) useful in these situations. A quick burst of powerful suction applied to the sheath at the right spot has also proved successful. Remnants may migrate to the pulmonary artery, and if treatment is not delayed too long, these lead parts nearly always can be extracted with patience and a small gooseneck catheter. Free-floating leads are extracted with either a right jugular or a femoral approach, depending on how the leads are positioned. If a lead in the ventricle is targeted, I usually prefer a right jugular approach.

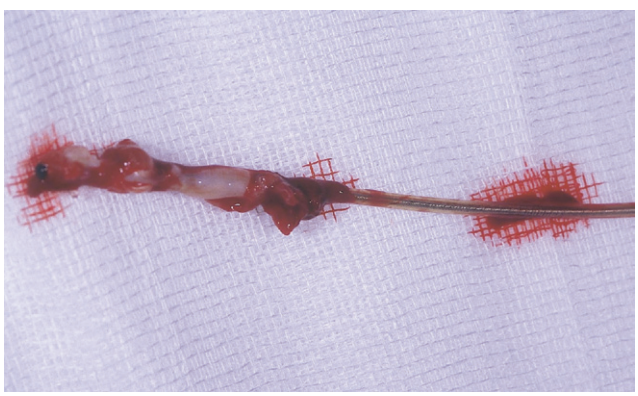

Figure 2 Ventricular lead tip fibrosis; lead extracted with laser technique. The leads had been implanted for approximately 8 years.

Damaged leads

Leads previously damaged or damaged during the procedure may pose problems (Figure 3), and referring centers should avoid lead damage before sending patients to other institutions. Too much tension applied to a lead will easily stretch the coils, especially in the area between the poles of a bipolar lead. Such damage may prevent the locking stylet from reaching the lead tip and eventually may be the factor determining complete or partial success of the procedure. A reaming stylet should be used with care. If the stylet is pushed too hard, the lead can be easily perforated from the inside out at sharp bends. Such damage may prevent the locking stylet from reaching the lead tip.