Evaluation of common suturing techniques to secure implantable cardiac electronic device leads: Which strategy best reduces the lead dislodgement risk?

Saman Rezazadeh, MD, PhD
Samuel Wang, MD
Jacques Rizkallah, MD

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Correspondence to:
J. Rizkallah
C830B-1403 29 ST NW
Calgary AB T2N 2T9
Jacques.Rizkallah@
albertahealthservices.ca

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SUMMARY

Implantable cardiac electronic device lead dislodgment is a relatively common complication and carries significant comorbidities. A potential cause of lead dislodgement includes inadequate anchoring along the lead suture sleeve at the venous insertion site. We assessed which of the 3 commonly applied knot-tying techniques results in the most effective anchoring of a pacing lead along its suture sleeve, which could be associated with minimized lead motion post-implant. Following controlled traction force measurements, the anchor knot technique offered the greatest amount of lead stability when compared with the simple knot and the looping knot techniques.

During implantation of cardiac electronic devices, such as pacemakers and defibrillators, leads are commonly inserted transvenously along upper-extremity veins, such as the axillary, cephalic, or subclavian veins. After their fixation in the desired cardiac chambers, the leads are secured along their sleeves to subcutaneous tissue at the venous insertion site with sutures to minimize lead motion and the risk of dislodgement. Lead dislodgement is a common complication, occurring in around 2% of patients.[1] It is a problematic complication owing to the resultant device malfunction and the increased risk of device infection associated with reoperation for lead repositioning.[2]

There is no universally accepted suturing technique to secure leads along their sleeves at the venous insertion site. The type of suturing technique applied depends entirely on the surgeon's preference; techniques include the simple knot (Fig. 1), the looping knot (Fig. 2) and the anchor knot (Fig. 3). We compared these 3 suturing techniques to determine which technique provides the most stable and sturdy approach.

EVALUATION OF SUTURE TECHNIQUES

Standard pacing leads with suture sleeves were used in addition to 2–0 Ethibond sutures. A Spectranetics lead locking stylet was connected to the proximal end of the pacing lead to allow attachment of a manual weight scale used to apply longitudinal traction on the lead (Fig. 4). The lead was subsequently sutured along its suture sleeve with the various knot-tying techniques onto a silicon suture block. Manual longitudinal force was then applied on the weight scale handle and the registered weight recorded (in pounds) at the time of lead dislodgement; lead dislodgement was defined as any movement of the lead at the suture sleeve site during application of longitudinal force. This process was repeated 3 times for each suturing technique. The anchor knot appeared to provide the most stability, as the greatest amount of force was required to

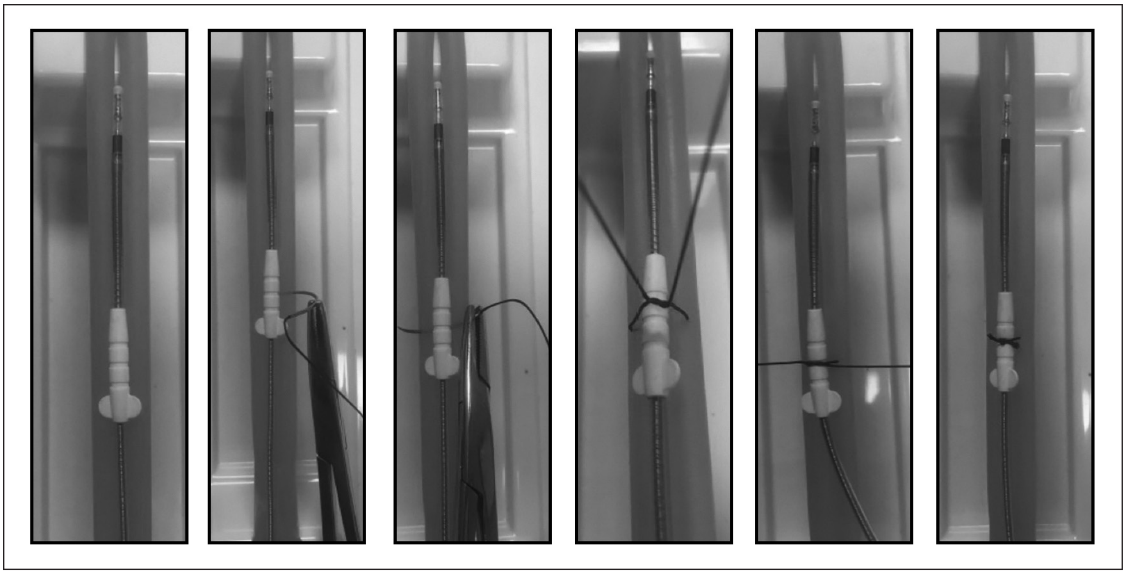

Fig. 1. Simple knot technique to secure the pacemaker lead along its suture sleeve.

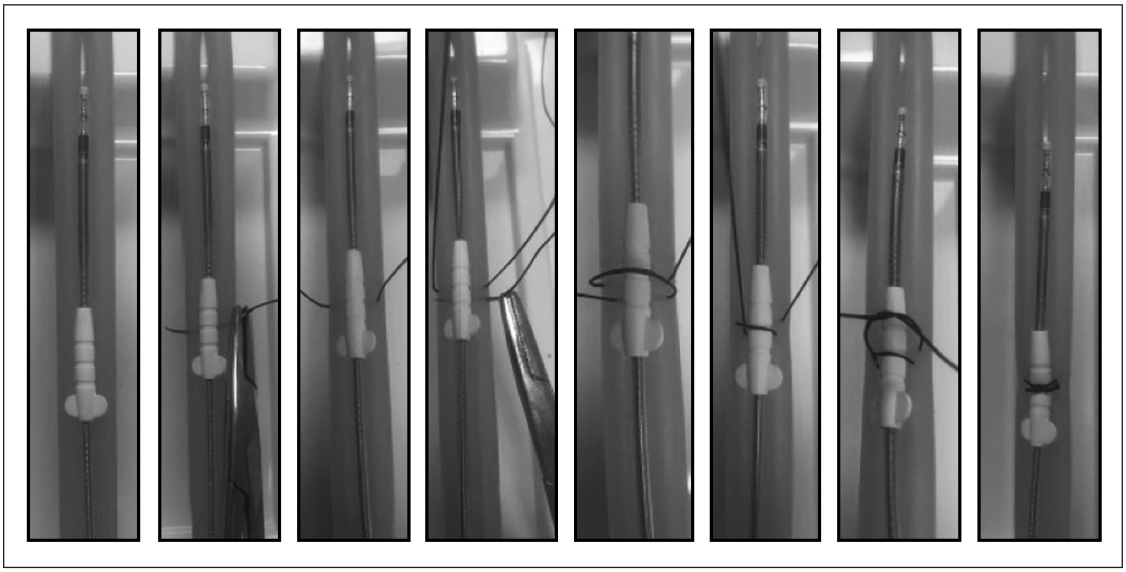

Fig. 2. Looping knot technique to secure the pacemaker lead along its suture sleeve. Following the first loop around the lead sleeve, a second is applied before tying the knot.

induce lead dislodgement; the simple knot provided the least anchoring stability (Fig. 5).

Discussion

The use of cardiac implantable devices, such as pacemakers and defibrillators, has been on the rise over the years as clinical indications continue to be validated.[3] Lead dislodgement remains a common concern, and strategies to minimize this risk are lacking. Many lead-tying techniques can be considered to secure leads along their suture sleeves during implantation; however, to date there is no consensus as to which technique conveys the greatest lead stability. Based on our evaluation of the 3 most commonly applied suturing techniques, the anchor knot appears to provide the greatest stability, and the simple knot the least; the anchor knot tolerated 3.9 ± 0.1 lbs (p = 0.0001) of weight before lead dislodgement compared with 2.7 ± 0.1 lbs (p = 0.0008) for the looping knot and 1.1 ± 0.1 lbs (p = 0.0008) for the simple knot (Fig. 5). These observations suggest that using the anchor knot to secure leads along suture sleeves could potentially reduce the risk of lead dislodgement due to increased lead anchoring stability.

The anchoring knot likely offers the greatest lead stability compared with the other techniques, because the suture material gets wrapped around the suture sleeve directly without encompassing any extraneous

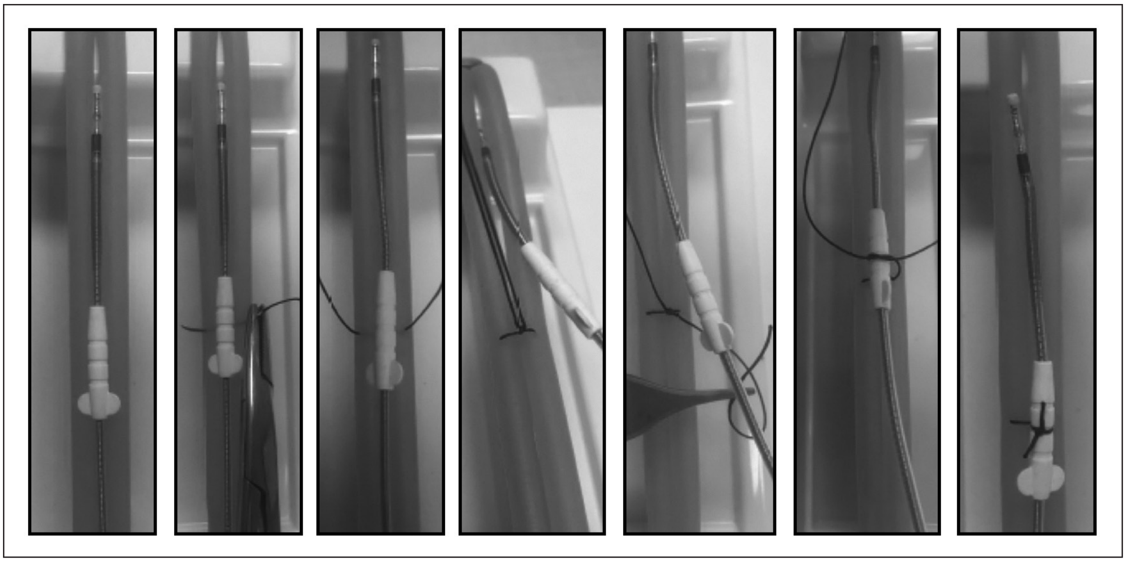

Fig. 3. Anchor knot technique to secure the pacemaker lead along its suture sleeve. Before stabilizing the lead, an anchor knot is placed underneath the sleeve.

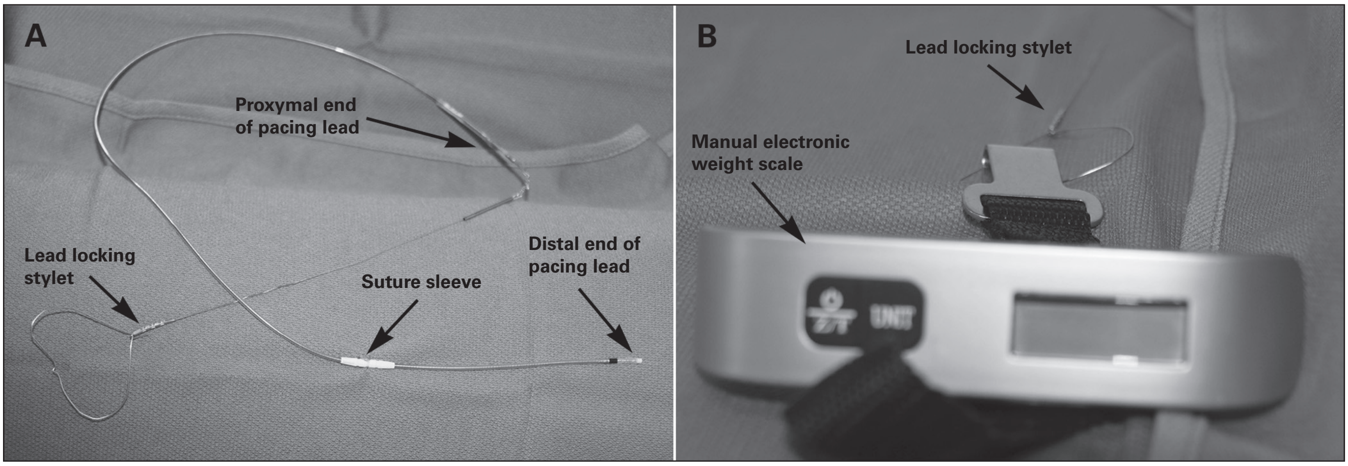

Fig. 4. (A) Lead locking stylet connected to the pacing lead to allow attachment of the manual electronic weight scale. (B) Manual weight scale attached to the back of the lead locking stylet.

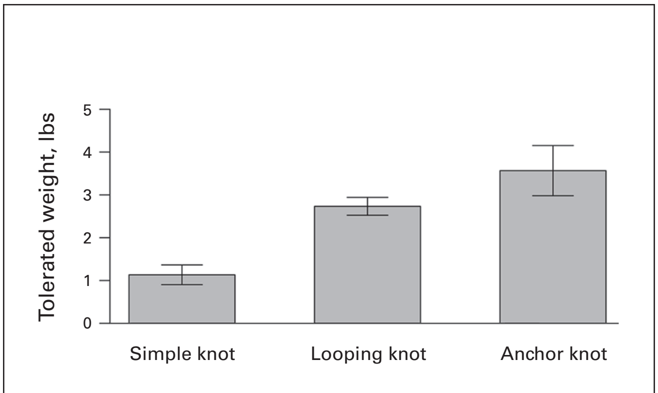

Fig. 5. Average weight measurements (in pounds) at the time of lead dislodgement for the 3 common suture techniques.

material in between that could lead to weakening of knot tension and lead slippage. In this case, the extraneous material refers to the suturing pad material, and when in vivo would refer to soft tissue near the venous insertion site where the lead is being implanted. On the other hand, the simple knot grasps the greatest amount of extraneous material between the suture and lead sleeve, rendering the knot tension the least stable.

Our evaluation of lead anchoring stability of the various suturing techniques is limited by the fact that testing was performed in vitro. Nonetheless, it is reasonable to assume similar performance of the various knot-tying types in vivo because the same principle of knot tension stability based on the degree of encompassed extraneous material within the knot would still apply. Furthermore, the described anchor knot is not very technically challenging, is already a common technique and carries no extra risk to the patient than the other knot-tying techniques.

Conclusion

Based on our evaluation, applying the anchor knot technique to secure leads along their sleeves during implantation may best reduce the risk of lead dislodgement until in vivo assessment of the various suturing techniques is undertaken.

Affiliations: From the Libin Cardiovascular Institute of Alberta, Department of Cardiac Sciences, University of Calgary, Calgary, Alta. (Rezazadeh, Rizkallah); and the Division of Electrophysiology, Saint John Regional Hospital, Saint John, NB (Wang).

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