Prolapsed double-canted bipolar left ventricular lead for pacing the left atrium via the coronary sinus: experience in 11 patients

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Aims

High thresholds and frequent lead dislodgement limit pacing the left atrium (LA) from the mid to distal coronary sinus (CS). The aim of this report is to describe a method for and the results of prolapsing a double-canted bipolar lead into the mid-to-distal CS to eliminate lead dislodgement and improve pacing thresholds.

Methods and results

After CS access the 9 Fr. anatomic sheath is withdrawn to the right atrium (RA) over an extra support wire. A double-canted bipolar lead is advanced into the RA until the proximal bend is outside the tip of the sheath. With the stylet withdrawn to the proximal bend, the sheath and lead are advanced over the wire back into the CS. The lead distal to the proximal bend is prolapsed beside the sheath as the tip of the sheath enters the CS. The lead was successfully prolapsed in 11 consecutive patients. In one patient, capture was 5 V in all locations. Of the 10 successful implants, the acute thresholds were: mean 1.53 V, median 1.35 V, range 0.4–4.0 V. Chronic thresholds were: mean 2 V, median 2 V range 0.4–4.0 V. There were no displaced leads or lead fractures through 6–10 months of follow-up.

Conclusions

Prolapse of a commercially available double-canted bipolar passive fixation lead eliminates lead dislodgement and improves thresholds providing a means for permanent pacing of the LA from the mid to distal CS and provides the design principles for a dedicated lead.

Keywords

Coronary sinus pacing • Biatrial pacing • Atrial fibrillation • Left atrial pacing • Cardiac resynchronization therapy

Introduction

Delayed left atrial (LA) activation is common in atrial fibrillation (AF) and thus biatrial pacing is a logical approach to reduce AF. In support of this notion, simultaneous pacing the right atrium (RA) and mid to distal coronary sinus (CS) improves the synchronicity of regional wall motion of both atria. Further, Mirza et al. demonstrated simultaneous pacing of the high RA and distal CS to be the configuration most effective in reducing episodes of atrial AF. Unfortunately, it is difficult to obtain adequate thresholds with passive fixation leads in the mid to distal CS and once placed they dislodge in up to 42% of implants. Levy et al. reported success with active fixation but many physicians are reluctant to use screw in leads in the CS. As a result, the majority of biatrial studies report pacing the RA and ostium (os) of the CS or two sites in the RA. Because delayed LA activation is not addressed by pacing two sites in the RA or RA and CS os it comes as no surprise that there are little data to support the role of biatrial pacing to reduce AF.

Patients receiving cardiac resynchronization therapy (CRT) who have delayed LA activation are another group that might benefit from pacing the RA and mid to distal CS to ensure the LA contracts before mitral valve closure. In the process of attempting to evaluate simultaneous pacing of the RA and mid to distal CS in CRT we found it difficult to reliably pace the mid to distal CS with the Attain 2188 (Medtronic, Inc., Minneapolis, MN, USA) or the Attain 4194 (Medtronic, Inc.); we encountered high thresholds and lead dislodgement similar to that reported by Levy et al. We did not attempt the use of active fixation leads. In one patient, after multiple unsuccessfully attempts to obtain a threshold...

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of <4 V, we prolapsed an Attain 4194 lead into the CS resulting in stable lead position and a threshold of 1.6 V. We subsequently developed a method for quickly delivering the prolapsed double-canted bipolar lead to the CS.

Methods

Prior to the procedure, patients gave informed consent and were enrolled in an Institutional Review Board-approved clinical trial evaluating the effect of simultaneous pacing of the RA and mid to distal CS in CRT. Prior to implanting the LA lead, the RA, right ventricular, and left ventricular (LV) leads are placed. Before removing the CS access catheter used to implant the lead, a soft curved stylet is advanced to the tip of the LV lead and left in place until LA placement is complete. A 0.035 inch J tip extra support wire [Amplatz Extra Stiff Wire Guide (order # THSCF-35-145-3-AES), Cook Incorporated, Bloomington, IN, USA] is advanced into the CS through the sheath. The left ventricular lead placed at the beginning of the procedure with stylet in place beside the LV lead. Holding the LV lead in place with the stylet, the initial CS access catheter is advanced to the proximal bend (tip of the sheath) then used to advance the lead as far as possible into the CS (Figure 1A). The tip of the lead is oriented towards the LA by advancing and withdrawing the sheath and lead simultaneously. After the CS access catheter is removed the stylets in the LA and LV leads are removed. The final position of the lead is shown in Figure 3B. Next day post-implant chest X-rays confirmed the prolapsed lead retained its LA orientation. The LA and RA leads were connected via a bipolar adapter (2872 lead adapter kit Medtronic, Inc.) and the IS-1 connector of the adapter inserted in the atrial output of the implantable cardioverter defibrillator (ICD; InSync Sentry 7297 and 7299 Medtronic, Inc.). Left atrial pacing threshold at 0.5 ms were determined by watching for a change in P-wave morphology in the electrocardiogram lead with the most apparent paced P-wave (typical lead II). Because the LA pacing thresholds were higher than RA, the LA threshold was determined by a change in P-wave morphology and loss of RA capture when there was no atrial pacing.

Results

After the initial case, the prolapsed Attain 4194 lead was successfully placed in 10 additional patients using the methods described above. In all 11 patients the lead was placed in the CS in <5 min. None of the leads dislodged. Pacing thresholds at 6–10 months are displayed in Table 1, there were no lead fractures.

The prolapsed lead tends to spontaneously assume the position shown in Figure 3B with the tip oriented towards the LA. In three cases where the tip electrode initially oriented towards the LV, the atrial thresholds were >5 V, with pacing of the LV on two occasions. As mentioned above the tip of the lead is oriented medially by advancing and withdrawing the sheath and lead. The final orientation of all leads is shown in Figure 3B.
There were no complications from prolapsing the Attain 4184 lead into the CS. There were no clinically apparent problems with the CS blood flow or with the function of the LV leads. Venous obstruction was not clinically apparent in any of the patients.

**Discussion**

When passive leads are placed in the CS in the traditional fashion they have high thresholds and are unstable, dislodging in up to 42% of implants. Prolapsing the lead into the CS eliminates dislodgement. We did not systematically compare pacing thresholds with the lead tip first vs. prolapsed, but in the first case we only achieved acceptable thresholds after lead prolapse. In the one case where the prolapsed lead would not pace the CS it did not pace when placed tip first as well. Although we were successful in placing the lead in all patients, it is likely that the technique will not work in a CS that is difficult to cannulate. As mentioned in the Methods, the CS access used for LV lead placement can be preserved by inserting an extra support wire beside the LV lead prior to removal. The CS access catheter used for placement of the LA lead is then advanced over the wire retained in the CS. The figures are from a patient who was upgraded from a pacemaker to a biventricular ICD. The RV pacemaker lead was not extracted; as a result, there are five endocardial leads including two apical RV leads, one

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**Figure 2** How to prolapse the lead into coronary sinus for left atrium pacing part 2. (A) The sheath is advanced back into the coronary sinus os over the extra support wire. The tip of the sheath is at the coronary sinus os. The proximal bend of the double-canted lead is at the tip of the sheath. The extra support provides the rail to advance the sheath into the coronary sinus. (B) The tip of the sheath is in the proximal coronary sinus. The tip of the sheath is at the proximal bend of the lead. The lead is prolapsed on the sheath.

**Figure 3** How to prolapse the lead into coronary sinus for left atrium pacing part 3. (A) With the sheath providing support, the stiff stylet at the proximal bend is used to advance the prolapsed lead further into the coronary sinus. The tip of the prolapsed lead is oriented towards the left atrium (medial) by advancing and withdrawing the stylet and sheath. (B) The prolapsed lead is held in place with the stylet at the proximal cant as the sheath is removed. Once the sheath is removed the stylet of the prolapsed lead is removed followed by the stylet of the left ventricular lead.
of which is a regular pacemaker lead as well as the LV lead and the RA lead. It is important to note that the internal diameter of the current device company CS access catheters (≤7 Fr.) is insufficient to allow a 0.035 inch wire and a 6.2 Fr. pacing lead side by side. Despite 4–5 leads implanted from the same access site, neither early nor late venous obstruction was clinically apparent; however, silent venous obstruction is common with two leads and more likely with multiple leads, thus we must assume that some patients did develop venous obstruction.

**Conclusion**

The success of prolapse to reduce thresholds and eliminate dislodgment suggests the principles on which an LA pacing lead can be designed. Production of a lead based on the principles demonstrated here might allow RA–LA bi-atrial pacing to be studied more comprehensively.

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