Extraction of chronic pacemaker and defibrillator leads from the coronary sinus: laser infrequently used but required

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Aims
Cardiac resynchronization therapy is an accepted treatment for heart failure but it may be necessary to explant these systems along with their leads. The evidence base for coronary sinus (CS) lead extractions is limited. We aimed to evaluate the percutaneous removal of these leads and the utility of laser extraction when necessary.

Methods and results
Of 265 patients referred for lead extraction between January 2004 and June 2008, 32 (12.1%) involved CS leads (30 males, mean age 67 years). Mean implantation time was 26.5 ± 28.7 months (range 1–116 months). Indications for extraction were pocket infection (34.4%), lead malfunction (43.8%), skin erosion (15.6%), and endocarditis (6.2%). Twenty-eight (87.5%) CS leads were removed with manual traction, with laser utilized in four cases (12.5%). No major complications of CS laceration, pericardial effusion, emergency surgery, or death occurred.

Conclusion
Our experience supports the percutaneous extraction of CS leads as a safe and effective procedure including the utility of laser when necessary.

Keywords
Cardiac resynchronization therapy • Lead extraction • Pacing complications

Introduction
Cardiac device therapy is being used increasingly to treat heart rhythm disorders. Subsequent removal of these systems with their leads may be necessary for various reasons. There is accumulating evidence in the literature to support the safe and successful percutaneous extraction of leads for pacemaker implanted for bradycardia indications and for implantable defibrillators.1 Cardiac resynchronization therapy (CRT) is now a widely accepted treatment modality for heart failure.2 This has led to a need for coronary sinus (CS) lead explantations. This is potentially a high-risk procedure due to the placement of leads in often tortuous and fragile veins, and experience in this is limited.

Aims
The aim of this study was to examine the feasibility and safety of percutaneous extraction of leads in the CS, including the use of laser when appropriate.

Methods
We are a quaternary referral centre for pacemaker and defibrillator extraction and report our experience of CS lead extractions from January 2004 to June 2008. All our patients were entered into a prospective registry with data entered regarding patient demographics, indication for extraction, procedural information, type of device and leads, co-morbidities, and procedural outcome. Renal dysfunction was defined as glomerular filtration rate below 90 ml/min/1.73 m².

All but one case was performed in the cardiac catheter laboratory with onsite cardiothoracic cover. The procedures were carried out by three operators, all of whom had been performing extractions for a minimum of 8 years. One case, where a CS shocking lead had been in situ for 116 months, was performed in cardiothoracic theatres with a surgeon on stand-by.

The target lead(s) was identified and dissection performed to expose it. A stepwise approach was taken, with manual traction with the aid of a locking stylet (Liberator Universal Locking Stylet, Cook Medical, Leechburg, PA, USA) utilized in the first instance. If the indication was for removal of all the leads then the non-CS leads were...
extracted first. If manual traction was not successful then eximer laser, a system utilizing a sheath positioned over the lead to vaporize adherent fibrotic tissue, was used (Spectranetics Model CVX-300, Colorado Springs, Colorado, CO, USA) with fluoroscopic guidance. All patients underwent transthoracic echocardiography post-procedure and the day after to look for pericardial effusion and valvular damage.

Procedural success and complications were defined according to the criteria outlined by the North American Society of Pacing and Electrophysiology policy statement on extraction of chronically implanted transvenous pacing and implantable cardioverter defibrillator leads. Therefore, complete extraction was defined as removal of all lead material from the vascular space. The extraction was considered partial if a residual lead fragment of 4 cm or less was left in the vascular space. Failure was defined by the remaining lead fragment of more than 4 cm in the vascular space.

Procedural complications were classified as major or minor. Major complications were defined as those resulting in death or serious harm to the patient requiring a procedural intervention or transfusion to prevent death or threat to life. All other complications deemed related to the extraction procedure were considered minor.

Statistics
Continuous variables are expressed as mean ± standard deviation with the range shown as appropriate. Discrete variables are shown as percentages.

With continuous variables, group means were compared with the unpaired Student’s t-test or Mann–Whitney U test if the variable did not fulfil the normality assumption. A value of $P < 0.05$ was considered statistically significant.

Results
Between January 2004 and June 2008, 265 consecutive cases were admitted to hospital for lead extraction. Of these, 32 (12.1%) cases involved CS leads. Thirteen were CRT-pacemakers, 18 CRT-defibrillators, and 1 was an atrial defibrillator consisting of 3 shock leads to the right atrium and ventricle as well as 1 deep in the CS. Patient demographics and co-morbidities are outlined in Table 1. Mean implantation time was 26.5 ± 28.7 months (range 1–116 months). Indications for extraction are outlined in Table 2. The total number of leads extracted were 97; atrial 23 (23.7%), right ventricular lead 25 (25.8%), defibrillator lead in right ventricle 17 (17.5%) and CS 32 (33%).

The explants were performed from a superior approach in all cases and average procedure time was 85 min (range 35–127 min).

Twenty-eight (87.5%) CS leads were removed with manual traction, with laser utilized in four cases (12.5%). These were the CS leads that had been in situ the longest (62–116 months). In these cases, the laser was required to free adhesions in the superior vena cava and the sheath was introduced into the proximal third of the CS, and in one case (the CS defibrillation lead) it was necessary to lase within the CS. The following CS leads were extracted, all utilizing passive fixation: Medtronic (Minneapolis, MN, USA): 2187 (1), 2188 (2), Attain 4193 (5), and 4194 (12); Guidant (Minneapolis, MN, USA): Easytrak 1 (1), Easytrak 2 (4) and Easytrak 3 (2); St Jude Medical (Minneapolis, MN, USA): Aescula 1055K (1) and QUICKsite (2); Sorin (Milano, Italy) Isoline 2CR (1); Ela Medical (Montrouge, France): Situs LV UC28D (1).

Laser extraction was necessary in eight cases (25%) to mobilize non-CS leads. Complete removal of all CS leads was achieved in all cases and in 99.6% of the non-CS leads with partial removal of one lead. No erosion of any of the CS leads was observed. The use of laser for the CS lead was only associated with a longer median implant length ($P < 0.001$).

No major complications of CS laceration, haemothorax, emergency surgery, or death occurred. Post-procedural transthoracic echocardiography did not demonstrate any evidence of pericardial effusion. One patient had a small pocket haematoma who was treated without the need for re-opening the wound. New CRT systems were re-implemented in 13 (40.6%) at the time of extraction and in 16 (50%) at a later date, all successfully implanted with a new CS lead.

Discussion
There is a considerable evidence base for percutaneous lead extraction of pacemaker and defibrillator leads. Cardiac resynchronization therapy is now an accepted form of treatment for heart failure and the increasing number of devices being implanted will also lead to an increasing requirement for CS lead extraction.

Previous series of coronary sinus lead extraction (CS-LE) have been published. Tyers et al. reported a series of 14 CS-LE, 8 of which had been placed in the CS inadvertently. All CS leads were successfully removed with the use of locking stylets and powered sheaths. Kasravi et al. reported a case series of 14, which were specifically CRT cases, the longest having been in situ for 43 months. The three leads which had been in the longest (≥ 27 months) required removal via a femoral vein approach. No major complications were reported and all CS leads were removed.
De Martino et al. described their experience of 12-lead extractions, the longest in place for just under 26 months, all with manual traction. Burke et al. removed 10 CS leads, 4 of them utilizing excimer laser without any procedural complications. In three of the cases, the laser was deployed within the CS without any adverse effects. The longest lead had been in place for 59 months.

The largest study to date by Bongiorni et al., reported on 37 patients, the longest CS lead which had been in situ for 84 months. They were able to remove 73% with manual traction and the remaining 27% were successfully removed using mechanical dilation with polypropylene sheaths. No major complications were reported and their analysis did not identify pre-operative markers that predicted the failure of manual traction.

Our experience adds to the data accumulating with regards to CS-LE. The majority were removed with manual traction directly or after mobilization of the non-CS leads in a quarter of cases. Four CS leads required utilization of excimer laser. All of these had been in situ for the longest periods, between 62 and 116 months. No major peri- or post-operative complications were observed.

It might be expected that removing leads from fragile and tortuous CS vein tributaries would lend itself to a higher risk of complications with vein avulsion or tamponade. The published data so far suggest that CS leads can be safely and successfully removed percutaneously. Leads that have been in situ for ≤2 years appear amenable to manual traction. There is limited experience with the use of laser with CS leads but where its use has been reported, it appears to have been successful without any adverse events.

The commonest reason for extraction in our patients with CRT devices was for increased CS lead threshold or displacement. This is in contrast to series published predominantly for single-/dual-chamber pacemakers and defibrillators, where infection was the predominant reason for extraction.1,2,3,4 The advent of CRT therapy is reflected in the practice of lead extraction as previously published data from our institution in 2002.5 This study was the predominant reason for extraction.1,3,12,13 The majority were removed with manual traction directly or after mobilization of the non-CS leads in a quarter of cases. Four CS leads required utilization of excimer laser. All of these had been in situ for the longest periods, between 62 and 116 months. No major peri- or post-operative complications were observed.

Coronary sinus lead extraction is likely to become more common as increasing numbers of CRT devices are implanted and its indications are expanded. In addition, it may become more challenging as leads are in situ longer and with the use of coronary stents and active fixation to stabilize the lead against branches of the CS vessel wall.5,6 Research is on going regarding multiple leads in the CS and in cases where there are issues with high-defibrillation thresholds, defibrillator coils are being placed in the CS.7

**Summary**

Percutaneous extraction of CS leads is a practical and viable option when CRT systems need to be explanted. The majority can be removed safely by manual traction and in the minority necessitating laser, no complications occurred. The procedure should be performed by an experienced operator and cardiothoracic backup should be available on-site. As more CRT devices are implanted, more CS leads will need to be extracted and as they are in situ longer, it is likely that removal with laser extraction will be increasingly necessary.

**Conflict of interest:** none declared.

**References**