

# Breakage of extracted leads: another management option

Złamanie usuwanych elektrod: inna możliwość postępowania

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## Abstract

Extracted lead breakage is a well-known technical complication of lead extraction. If the remaining fragment is longer than a few cm, it should be removed. The femoral or jugular approach, with different tools, is used. We describe the utility of the extracted lead venous entry approach as the optional solution in six patients. The role of the shape of the utilised sheath and the presence of venous entry valve and favourable specific properties of basket catheters are discussed, and also the utility of a repeated Byrd dilator.

**Key words:** extracted lead breakage, basket catheter usability, subclavian approach

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## INTRODUCTION

Extracted lead breakage is a well-known technical complication of transvenous lead extraction (TLE) [1, 2]. The age of the lead, its construction, its condition, and the method of extraction all play important roles, but extractor experience seems to be important too [3, 4]. Using locking stylets reduces the risk only of the lead tearing [3, 4]. A remaining lead fragment may be left behind if the invasiveness of the procedure of extraction exceeds the anticipated benefits; attempts are usually made to extract longer lead fragments [5]. The femoral [6, 7] or right jugular approach [8] are used most frequently. In our opinion, the venous lead entry subclavian approach seems to offer an interesting alternative.

The goal of our study is the presentation of a single centre experience in the management of lead breakage caused by extraction procedure, with a detailed description of our proposed alternative approach.

## METHODS

Source of information: computer database of reference centre, containing information about performed procedures of TLE since March 2006.

**All patients/procedures.** Over the last five years, we have extracted 1,184 ingrown (PM > 12, ICD > 6 months) leads in 681 patients (62.3% males), mean age 64.5 years, with PM, ICD and CRT-D/P systems. Mean lead longevity was  $80.9 \pm 60.3$  months. The commonest (51.8%) indications for lead extraction were non-infective; local pocket infection and endocarditis were less frequent (29.2% and 18.9%, respectively). Full radiological success was reached in 642 (94.3%) patients, a remaining tip of a lead in 17 (2.5%) patients; a lead fragment (< 4 cm) was left in 19 (2.7%) cases; and in only three cases were three leads left for the cardiac surgeon due to a high risk of accidental tricuspid valve damage. Clinical success was reached in 670 (98.4%) patients. Major complications appeared in eight (1.2%) cases but minor ones were slightly more frequent (13 cases, 1.9%). Two procedure-related deaths were noted.

**Lead extraction — standard procedures.** The procedures of TLE were performed transvenously with the use of cutting-rotation forces (mechanical) of telescopic polypropylene Byrd dilators (all sizes and lengths) manufactured by the Cook company and usually using a subclavian approach. Laser energy or radiofrequency waves were not used. The re-

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removal of screw-in leads which had been in place for less than two years was attempted using simple extortion and gentle traction only. Broken leads with a proximal ending in the cardio-vascular system were extracted using the femoral (and in a few cases the jugular) approach. Mechanical systems (various stylets and Byrd-Cook dilators) were used for most (84.6%) of the leads extracted by a superior approach (at the insertion site through the subclavian vein); a femoral approach (FWS with basket, snare or lasso catheters and sometimes Byrd dilators) were used for free floating leads with proximal ending in lumen of vein. A combined approach (including the jugular approach) for extraction of leads torn during extraction was used in 3.1% and 1.2%, respectively. The technique of simple extortion and gentle traction was used in 10.8% for the removal of active fixation (screw-in), straight, isodiametric leads.

**Lead breakage patients.** Extracted lead breakage happened in 33 (4.8%) patients (72.7% males), aged 8–80, average  $56.3 \pm 21.9$  years. Indications for LE in this subgroup of patients were: infective in 26 (78.9%) patients (LDIE 39.4%, pocket infection 21.2%), non-infective in 13 (39.4%) patients, consisting of superfluous functional or nonfunctional lead extraction due to different reasons and recapture of venous approach. Age (longevity of staying in) of all extracted leads in this patient group was 12–384 months, average  $124.4 \pm 69.3$  months. Mean age (longevity of staying in) of extracted leads in patients was 15–253 months, average  $115.6 \pm 49.9$  months. There were no major or minor complications in this patient subgroup.

**Lead breakage management.** Due to different clinical and technical conditions, there were five options:

1. Open-chest cardiac surgery. One patient was sent to cardiac surgery (3.0%) due to the impossibility of obtaining full success (LDIE).
2. Acceptance of abandoned lead remnant — in 16 (18.2%) patients. Broken tip only (three patients, 9.2%) or the lead fragment with tip left behind in another ten (30.3%) patients. In three of these patients, we left behind a lead remnant of 5–6 cm due to the complete impossibility of grasping the end with different tools (broken end covered by connecting tissue scar).
3. Removal with lasso catheter or basket catheter freed (liberated) lead fragment (two from the right atrium and two from the pulmonary artery). This rare complication occurs when the distal part with its tip of lead already liberated from the endocardium is ruptured and is free in the cardiovascular system (four patients, 12.1%).
4. Successful extraction of broken lead part using a femoral approach (three patients), a jugular approach (two patients), or a combined approach (one patient) using lasso or basket catheters and different sheaths (total of six patients, 18.2%).
5. Successful extraction of a broken lead fragment using recaptured subclavian lead venous entry approach (six patients).

Eventually, full radiological success after following various transvenous procedures of lead remnant removal was obtained in 16 of the 33 patients (48.5%).

The use of the femoral approach for lead extraction, including spontaneously fractured leads with proximal ending which have migrated into the venous system, has been described in numerous papers [1, 2]. Similarly, the advantages of the jugular approach have been proved [8]. The utility of recaptured venous access by even incomplete lead extraction (guidewire introduced by empty lead liberating catheter) has, to the best of our knowledge, not previously been described.

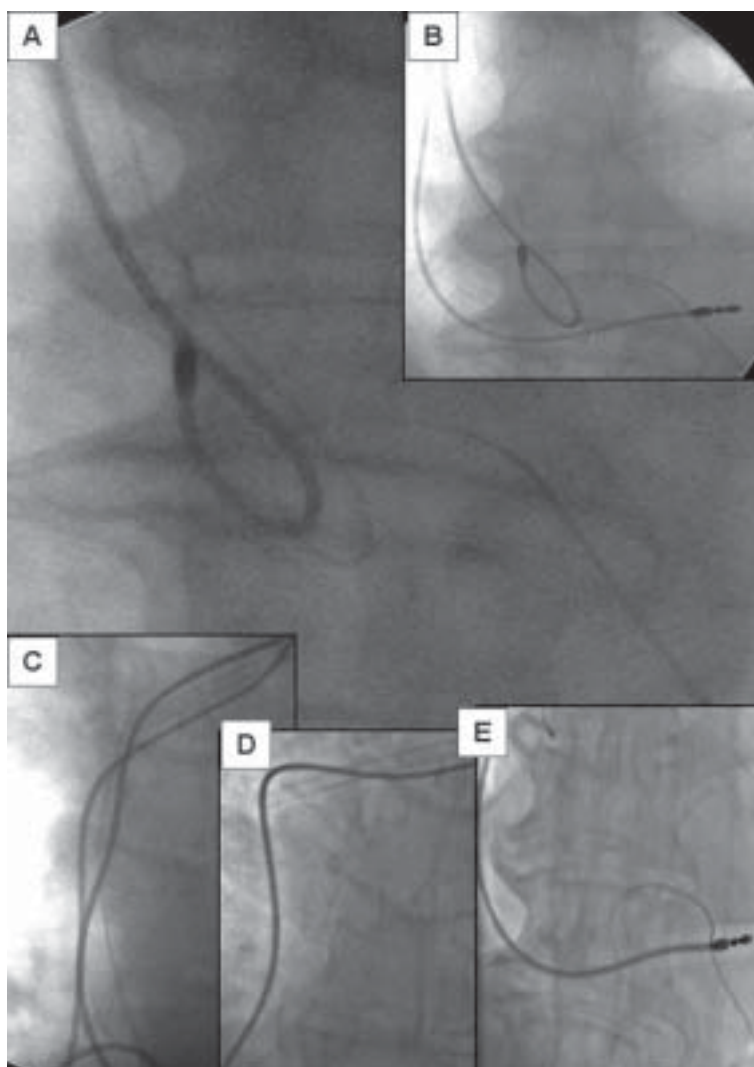
**Proposed procedure description.** In a case of extracted transvenous lead breakage, the broken proximal part of the lead can be removed easily from a Byrd dilator. As the first step, a standard angiographic guidewire (preferably two) should be introduced into the inferior cava vein. Our experience has shown that for precise manipulation, a curved sheath is more useful, and soft atraumatic distal ending and haemostatic valve presence make it an ideal accessory tool. The set dedicated primary to coronary sinus lead implantation fulfils all criteria. Distal ending of this catheter (Attain Medtronic®) permits for safe manipulation in the tricuspid valve region or right ventricle as well. Via this tool, a lasso catheter, or even better a basket catheter, can be introduced. When the lead fragment is grasped and retracted into the lumen of the Attain catheter, only slight tension is enough to keep the lead. It permits the cutting of the proximal catheter ending with a haemostatic valve and the introduction of an external green Byrd dilator over the cut Attain sheath containing basket catheter and lead fragment. The last idea is to introduce the Byrd dilator over the Attain sheath, which permits the lead extraction procedure to continue. The described procedure seems to be shorter than the conventionally-used jugular or femoral approach.

We illustrate the utility of the proposed technique below.

## PATIENT 1

Patient 1 had a DDD pacing system implanted 11 years ago (Figs. 1, 2) and chronic pocket infection since unit replacement four years ago, complicated by LDIE. Both leads created unnecessary loops in the tricuspid valve region (Fig. 1A). A screw-in lead for prolonged temporary pacing was implanted due to pacemaker-dependence (Fig. 1B). Stylets can be introduced onto loops only. As the first one, the unipolar ventricular lead was attempted to be extracted, but unfortunately it was broken in its loop region (Figs. 1C, D, E). The atrial lead was extracted bodily.

Having recaptured venous approach, the Attain sheath, designed for CS lead implantation, was introduced into the end region of the broken lead (Fig. 2A). At first, the basket catheter permitted the liberation of the sharp lead ending from the tricuspid valve. Later rotation of the basket catheter ena-



**Figure 1.** DDD pacing system implanted chronically, LDIE and the new screw-in lead introduced via jugular vein due to pacemaker-dependence (A, B). Unipolar ventricular lead was attempted to be extracted (C) but it was broken (D, E)

bled it to be caught cleanly (Fig. 2B). As the next step, the proximal part of the Attain sheath was cut off, continuing gentle traction for the basket catheter. We used lead blockade in its distal part and introduced an internal green Byrd catheter over the Attain sheath, containing a basket catheter with the lead ending inside (Figs. 2C, D). The distal part with the tip of the broken lead was liberated and extracted (Fig. 2E).

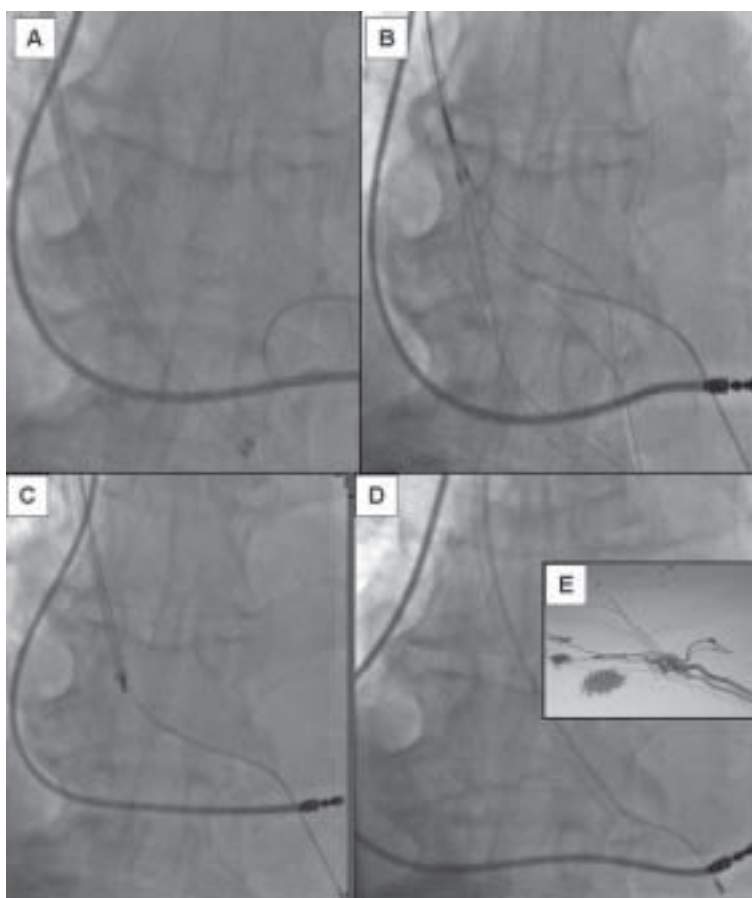
#### PATIENT 2

Patient 2 had a DDD pacing system with a 23 year-old ventricular lead and an eight year-old atrial lead. The old ventricular lead had dysfunction (Figs. 3, 4). Conventional lead extraction (Fig. 3A) was complicated by lead fracture (Figs. 3B, C). An empty Byrd dilator made it possible to recapture venous approach in spite of venous occlusion (Fig. 3D).

Attain sheath, designed for CS lead implantation, was introduced in the broken lead ending region (Fig. 4A). The gentle, soft nitinol basket catheter was used (Fig. 4B) and the lead fragment was cleanly grasped inside the Attain sheath (Fig. 4C). Over the Attain sheath, the Byrd dilator was introduced (Fig. 4D), and finally the lead fragment was extracted (Fig. 4F). Due to venous occlusion, the next Attain sheath was used for the new ventricular lead implantation.

#### PATIENT 3

Patient 3 had long QT-syndrome, with a long history of overdrive pacing, which had reached indications for DDD-ICD implantation. There was a functional DDD pacing system (right side of the chest) with a 26 year-old atrial lead and a five year old ventricular lead. On the left chest



**Figure 2.** Recaptured venous approach enabled the introduction of the Attain (A). Basket catheter was used to grasp the lead fragment (B, C). As the next step, a green Byrd catheter was inserted over the Attain sheath (D). The distal part with the tip of the broken lead was liberated and extracted (E)

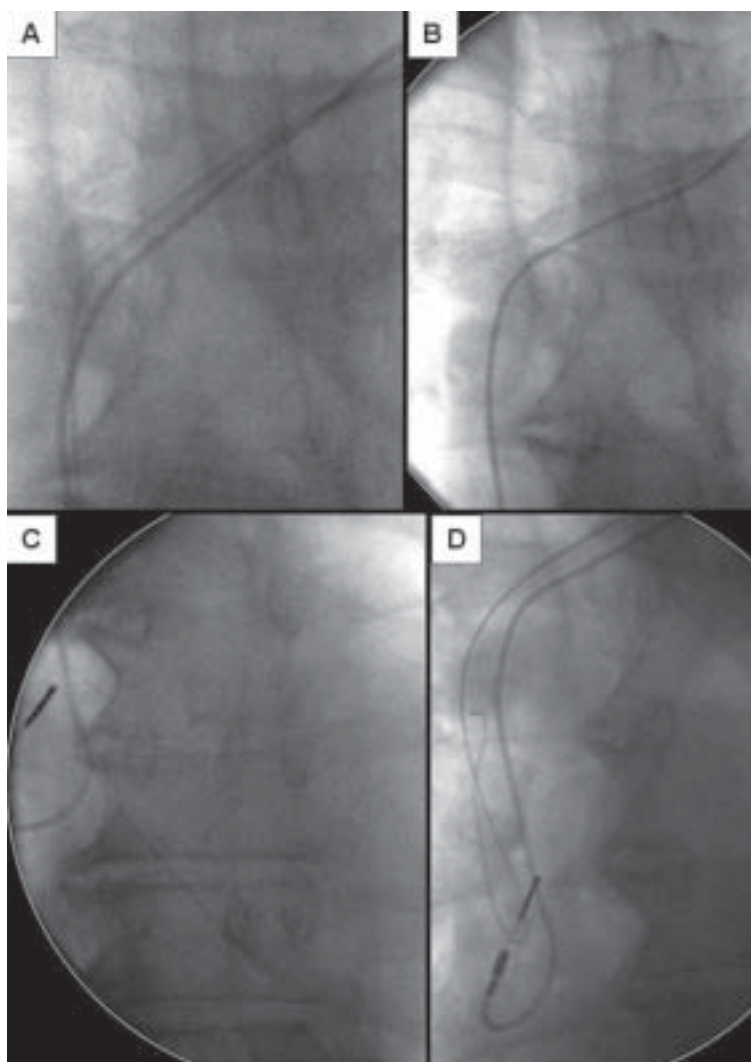
side, she had an abandoned 32 year-old ventricular lead inserted via the left cephalic vein, and another very old lead fragment in the jugular vein (Fig. 3A). Extraction of all leads was planned, with subsequent left side ICD-DDD system implantation. The screw-in ventricular lead was extracted easily. The extraction of the 26 year-old atrial lead was not so easy, and the tip of the lead with < 1 cm conductor was left in the right atrial appendage intramurally. Finally, extraction of the 32 year-old left-side ventricular lead was begun, but the stylet reached to mid atrium level only. The lead was liberated up to the mid atrium, but problems consisted of very strong calcified connecting tissue scar surrounding the lead and fixing the lead within the atrial wall. Finally, the lead was broken in the low right atrium. We finished the first stage of procedure having four guide-wires in the superior cava vein. Given our previous experience, we used once again an Attain sheath and basket catheter successfully. The distal part of the broken lead was caught with the basket catheter. And once again, as in the previous patient, we repeated all steps to introduce an internal green Byrd di-

lator over the Attain sheath containing the basket catheter and lead. The lead remnant was extracted unbroken, and new atrial and ICD leads were implanted.

#### PATIENT 4

Patient 4 had a one year-old right side DDD pacing system and two four-year old abandoned leads in the left side of the chest with infective endocarditis (Fig. 4A). The abandoned ventricular lead had been destroyed and its internal part (a conductor with a silicone tube) was floating in the right pulmonary artery (Fig. 4A). The extraction of all leads was planned (LDIE). Both functional screw-in leads were removed easily (Figs. 4C, D). Severe venous occlusion posed an additional problem (Fig. 4B).

The extraction of the abandoned atrial and external parts of the ventricular leads was simple (Fig. 4F). And despite complete venous occlusion, venous approach was recaptured by insertion of two guidewires via Byrd dilator. One served as back-up only, and using the second one, the Attain sheath with soft nitinol basket catheter was inserted. Precise manipulation with angulated catheter permitted the tip of the lead



**Figure 3.** DDD pacing system with a 23 year-old unfunctional ventricular lead, venous occlusion. Conventional lead extraction (A) complicated by lead fracture (B, C). Recapture of venous approach (D) was obtained

fragment to be grasped and the lead remnant to be removed successfully.

### DISCUSSION

The transvenous extraction of endocardial leads can cause complications connected with complete lead rupture [8, 9].

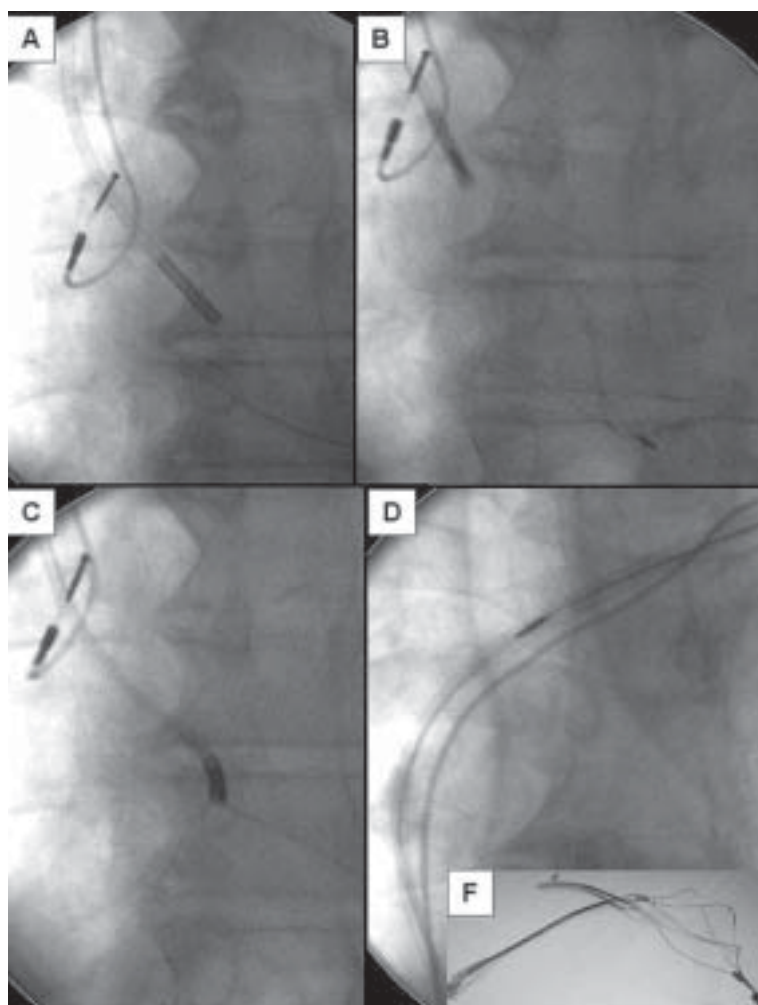
In our experience, this took place in 33/681 lead extraction procedures (4.8%). In most of the patients, the lead remnant is short (2–3 cm) and may be abandoned [5]. However, longer lead fragments should be extracted. The jugular approach is more useful for short ventricular lead remnants [8] but the femoral approach seems to be better for short atrial lead fragment extraction and the removal of lead fragments from a pulmonary vascular bed [1, 2, 6, 7]. Both approaches have their advantages and disadvantages. The lead recaptu-

red venous entry approach seems to be equally as useful as the jugular approach, provided that a curved sheath is used. Haemostatic valve consist additional advantage of CS lead implantation designed system. We want to underline the utility and universality of the Dotter basket catheter; after steadily gripping the lead, continuous gentle tension makes it possible to use it alone as a 'guidewire' and to introduce and replace over them necessary tools (any sheaths and introducers) from the proximal ending.

### CONCLUSIONS

Lead breakage is a rare but troublesome complication of lead extraction. For extraction of lead fragments longer than 3–4 cm, the jugular and femoral approach can be used. The recaptured venous approach may be an interesting alternative.

*Conflict of interest:* none declared



**Figure 4.** Recapture of venous approach made it possible to locate the Attain sheath precisely in broken lead ending region (A). Basket catheter grasped the lead fragment (B, C) and dragged it into the Attain sheath (C, D). The Byrd dilator introduced over both of them (D) permitted the successful extraction of the lead fragment (F). Using the next Attain sheath, the new ventricular lead was implanted despite venous occlusion

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