

# Symptomatic pulmonary regurgitation secondary to redundant transvenous lead prolapse

Guillermo Andres Cortes, Rahul N Doshi, Philip M Chang

## ABSTRACT

**Introduction:** The use of cardiac implantable electronic devices (CIEDs) with transvenous leads (TVLs) in young patients continues to increase. Challenges persist, particularly related to TVLs complications. We present a unique case of redundant lead prolapse into the right ventricular outflow tract (RVOT) causing symptomatic pulmonary regurgitation (PR). **Case Report:** A 23-year-old female with congenital heart block underwent initial transvenous (TV) pacemaker implant at age 9 years, followed by new lead implants at age 20 due to lead fracture. The original TVLs were abandoned. She developed progressive exercise intolerance and exertional dyspnea. Catheterization showed normal pulmonary pressures; exercise testing indicated worsening PR and limited LV functional increase. Imaging confirmed significant lead prolapse of the original right ventricular (RV) lead causing PR. Extraction with cardiac resynchronization therapy-pacemaker (CRT-P) upgrade was recommended. A superior/inferior extraction approach was employed for extraction of all TVLs with CRT-P implant using the retained venous access post-extraction. Post-implant imaging revealed appropriately positioned leads, normalization of left ventricular (LV) function, and trace tricuspid regurgitation (TR) and trace-mild PR. **Conclusion:** This case highlights an unusual complication of

excessive TVLs slack. Challenges remain with long-term TVLs management in young patients. Proactive lead management is recommended to ensure CIED benefit while reducing TVLs complications. When extraction is considered, a superior/inferior approach can afford tremendous versatility to maximize success.

**Keywords:** Congenital, Heart block, Pulmonary regurgitation, Slack, Transvenous lead

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## INTRODUCTION

The use of cardiac implantable electronic devices (CIEDs) with transvenous leads (TVLs) in pediatric and congenital heart disease (CHD) patients has substantially increased over the last three decades [1–3]. Despite their benefits, challenges remain that are inherent to TVLs, their implantation and follow-up in growing patients, mainly those with unconventional cardiac structural anatomy [3, 4]. In young patients, it is common practice to introduce additional slack to compensate for anticipated growth; however, redundant lead slack can result in mechanical and hemodynamic complications [1–5].

We present a unique case of a patient with TVLs prolapse into the right ventricular outflow tract (RVOT)/proximal pulmonary artery resulting in significant symptomatic pulmonary regurgitation (PR).

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## CASE REPORT

A 23-year-old female with history of congenital complete heart block underwent dual chamber transvenous pacemaker implant at age 9 years. At age 20, during routine follow-up and device interrogation, evidence of lead fracture was found. New transvenous atrial and ventricular leads were implanted along with pulse generator replacement; the original TVLs were capped and abandoned. Over the next two years, the patient developed progressive exercise intolerance and was referred to our institution for evaluation. Transthoracic echocardiogram (TTE) showed mild left ventricular dilation with mildly reduced systolic function ejection fraction (EF 45%), moderate right ventricular enlargement, moderate tricuspid regurgitation (TR), and moderate-severe PR with prominent lead slack prolapsing into the RVOT and across the pulmonary valve (PV) (Figure 1). Exercise stress echocardiography revealed worsening PR and limited left ventricular (LV) functional augmentation with overall decreased functional capacity for her age and gender.

Diagnostic right heart catheterization with pulmonary angiography was recommended. Fluoroscopy demonstrated a total of four TVLs, two right atrial and two right ventricular, with one ventricular lead prolapsing into the RVOT (Figure 2A and B). Pulmonary artery (PA) and left and right ventricular filling pressures were normal at a baseline heart rate of 60 bpm and with increasing the paced heart rate to 120 bpm. Pulmonary angiography exhibited moderate PR (Figure 2A). Transesophageal echocardiogram (TEE) further confirmed that one of the RV leads was prolapsing into the RVOT with resultant moderate PR.

The findings were extensively reviewed with the patient and her family. Removal of the redundant lead slack was considered the best way to address PR. Given the patient's chronic, high right ventricular pacing burden and left ventricular dysfunction, biventricular pacing was recommended for cardiac resynchronization therapy-pacemaker (CRT-P). The family was in agreement to proceed with TVLs extraction and CRT-P implant. For the procedure, femoral venous and arterial access were obtained. Temporary ventricular pacing, transesophageal echocardiography, and invasive blood pressure monitoring were used during extraction (Figure 2B). A combined superior and inferior approach was integrated for extraction of all four TVLs. Powered sheath-assisted extraction from the left subclavian vein was performed with the GlideLight laser (Spectranetics Corporation, Colorado Springs, CO) while the Byrd Workstation™ Femoral Intravascular Retrieval Set (Cook Medical Inc, Bloomington, IN) via right femoral vein was used to remove the redundant loop from the RVOT (Figure 2C). The two approaches were employed in concert to free the adhered leads and maintain as much coaxial dissection as possible. After successful extraction, a CRT-P device was implanted afterward (Figure 3). A transthoracic

echocardiogram on day 1 post-procedure revealed normalization of LV function, trace TR, and only trace to mild PR (Figure 4). The patient has maintained regular follow-up in cardiology clinic with reported complete resolution of symptoms and normalization of exercise capacity.

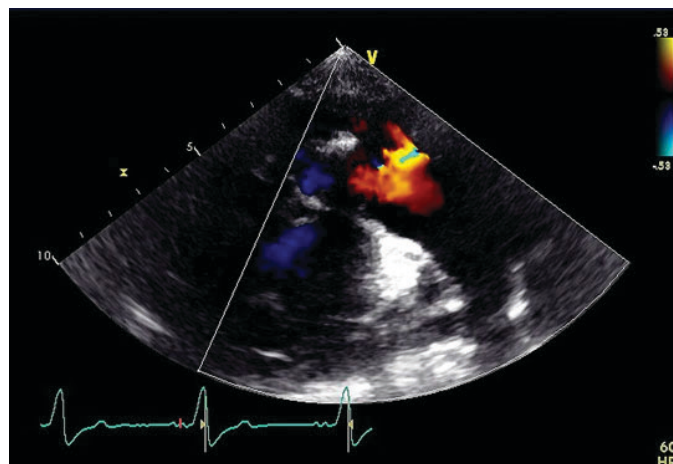


Figure 1: Transthoracic echocardiogram. Short axis view at the base, revealing moderate pulmonary regurgitation.

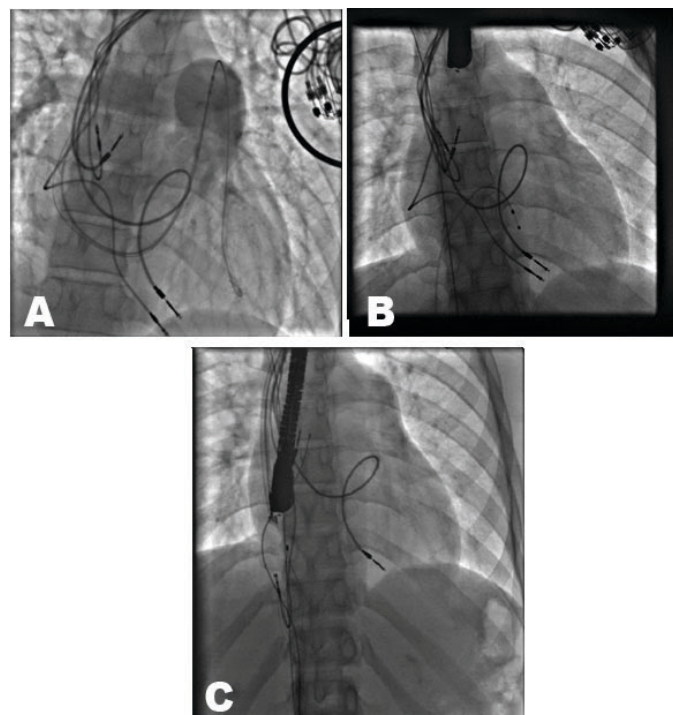


Figure 2: Fluoroscopy. (A) Pulmonary angiography with evidence of mild to moderate pulmonary regurgitation. (B) Prior to extraction, right femoral vein temporary transvenous pacemaker was placed in right ventricle: 2 atrial and 2 ventricular leads can also be visualized. (C) GlideLight laser (Spectranetics Corporation, Colorado Springs, CO) inserted via left subclavian vein and Byrd Workstation™ Femoral Intravascular Retrieval Set (Cook Medical Inc, Bloomington, IN) inserted via right femoral vein.



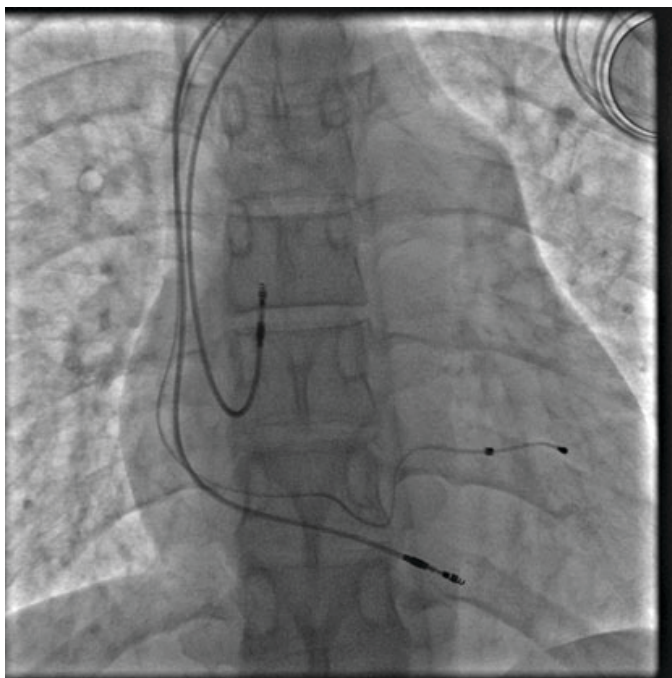


Figure 3: Fluoroscopy. Successful retrieval of 2 atrial and 2 ventricular leads, with placement of new CRT-P device.

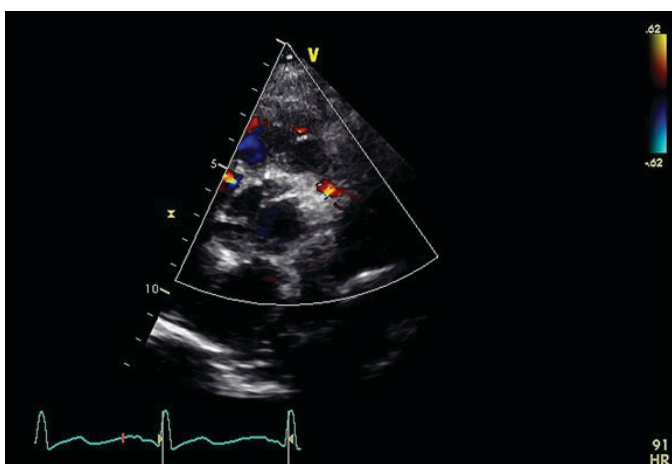


Figure 4: Transthoracic echocardiogram on day 1 post-procedure. Short axis at the base (same level than Figure 1). Trace pulmonary regurgitation.

## DISCUSSION

The number of CHD CIED implants has steadily grown over the last few decades [1]. New techniques and more sophisticated devices have played an important role in the expanded application of these devices in the care of these patient population [4, 6]. Different from adults where infection has a major role; lead malfunction/fracture is the most common indication for TVL extraction in congenital population. Atallah et al., in the PLEASE study, reported independent predictors of lead failure including younger age of implantation <8 years old compared to >18 years old, and Sprint Fidelis® ICD leads [5].

Awareness of long-term complications and risk factors related to CIEDs that are unique to the pediatric and

CHD population is significantly increasing for the adult electrophysiologist [7].

This case represents an uncommon complication of a common practice in the pediatric population. Extra lead slack in anticipation of somatic growth has been described by multiple authors and largely avoids problems related to mechanical lead stretch and resultant lead dysfunction over time [2, 8–11]. However, this technique can have potential complications related to failure of slack to properly release and migration of excessive slack. Furthermore, either lack of serial follow-up or timely interventions to address these complications can lead to irreversible sequelae related to cardiac and adjacent organ dysfunction [7].

This case also highlights the unique challenges of integrating extraction techniques into the long-term care of CIEDs in these patients. Smaller patient and vascular size, prior cardiothoracic surgery, considerably longer TVLs, age since implant, and the psychological challenges for both patients and their families, add significant complexities to extraction procedures in young patients. In our patient's case, multiple atrial and ventricular leads were present, and the original abandoned leads were over 12 years old at the time of extraction. Increased duration following implantation of TVLs is associated with an increased requirement of powered/assisted extraction techniques and increased risk of complications with extraction [6, 10–14]. In addition, the redundant lead slack in the RVOT required unique considerations for the extraction approach given the difficulty in maintaining coaxial sheath dissection [3, 5, 6]. A combined approach including extraction from the femoral vein allowed for better alignment with the lead body in the RVOT.

This patient's symptoms were felt to be largely due to baseline PR that was further accentuated with exercise secondary to the prolapse TVLs slack across the PV. To our knowledge, this is the first published case of this unique complication due to excessive slack and unexpected migration out to the RVOT. Removal of the prolapsed lead eliminated the mechanical disruption across the PV, leading to prompt resolution in both symptoms and valvular dysfunction. It is important to acknowledge that failure to recognize and treat this complication could result in irreversible cardiac dysfunction. This must also be balanced with the risk associated with TVL extraction.

## CONCLUSION

This case emphasizes the importance of close follow-up in this population and the need for an expanded approach to long-term CIED management in order to avoid complications. Serial radiographic imaging should be standard in pediatric patients while somatic growth is occurring. Greater consideration should be given to proactive lead management strategies in order to address potential or active complications with TVLs. An integrated and experienced approach to lead extraction

in these patients affords the best results while minimizing complications. When extraction is considered, a combined superior and inferior approach can afford tremendous versatility to maximize success.

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## Author Contributions

Guillermo Andres Cortes – Conception of the work, Design of the work, Acquisition of data, Analysis of data, Interpretation of data, Drafting the work, Revising the work critically for important intellectual content, Final approval of the version to be published, Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

Rahul N Doshi – Conception of the work, Design of the work, Analysis of data, Interpretation of data, Revising the work critically for important intellectual content, Final approval of the version to be published, Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

Philip M Chang – Conception of the work, Design of the work, Analysis of data, Interpretation of data, Revising the work critically for important intellectual content, Final approval of the version to be published, Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

## Guarantor of Submission

The corresponding author is the guarantor of submission.

## Source of Support

None.

## Consent Statement

Written informed consent was obtained from the patient for publication of this article.

## Conflict of Interest

Authors declare no conflict of interest.

## Data Availability

All relevant data are within the paper and its Supporting Information files.

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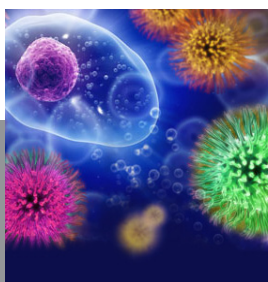
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