Lead extraction for cardiac implantable electronic device infection

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Lead extraction for cardiac implantable electronic device infection: comparable complication rates with or without abandoned leads

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Aims Abandoned leads are often linked to complications during lead extraction, prompting pre-emptive extraction if leads become non-functional. We examined their influence on complications when extracted for device-related infection.

Methods and results All patients undergoing lead extraction for device-related infection from 2006 to 2017 in our hospital were included. The primary endpoint was major complications. Out of 500 patients, 141 had abandoned leads, of whom 75% had only one abandoned lead. Median cumulative implant times were 24.2 (interquartile range 15.6–38.2) and 11.6 (5.6–17.4), respectively years with or without abandoned leads. All leads were extracted only with a femoral approach in 50.4% of patients. Mechanical rotational tools were introduced in 2014 and used in 22.2% of cases and replacing laser sheaths that were used in 5% of patients. Major complications occurred in 0.7% of patients with abandoned leads compared with 1.7% of patients with only active leads ($P = 0.679$). Failure to completely remove all leads was 14.9% and 6.4%, respectively with or without abandoned leads ($P = 0.003$), and clinical failure was 6.4% and 2.2% ($P = 0.028$), respectively. Procedural failure dropped to 9.2% and 5.7% ($P = 0.37$), respectively after the introduction of mechanical rotational tools. The only independent predictor of procedural and clinical failure in multivariate analysis was the cumulative implant duration.

Conclusion Despite longer implant times, patients with abandoned leads did not have more major complications during lead extraction. Therefore, preventive extraction of non-functional leads to avoid complications at a later stage is not warranted.

Keywords Lead extraction • Cardiac implantable electronic device infection • Abandoned leads • Complications

Introduction

In the recent expert consensus statement on lead management and extraction, non-functional leads are considered a Class IIb indication for extraction, leaving the choice between abandoning and extracting the leads following a shared decision-making process between physician and patient.[1] Even with this restrained indication, 47.3% of extraction procedures in the recent Electra European registry had a non-infectious indication.[2] The motivation to extract non-functional leads is often the evasion of a presumed higher complication rate or worse extraction results in case of an extraction later in life. Longer dwell times and accumulation of multiple abandoned leads over a patient's lifetime are considered to compromise the success of a deferred recent paper in the setting of cardiac implantable electronic device infection that reported increased complication extraction. This is seemingly corroborated by a recent paper describing more complications and more failed extraction attempts in patients possessing abandoned leads compared to patients with only active

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What's new?

- Three-quarter of patients with abandoned leads who develop device-related infection have only one abandoned lead by that time.
- Their active leads have the same (old) dwell time as the abandoned leads in almost two-thirds of these patients.
- Abandoned leads do not necessarily increase the complication rate during lead extraction for device-related infection compared to patients with only active leads.
- There is no indication today that a patient cohort with non-functional leads will have fewer complications or better procedural outcomes in case of preventive extraction when compared with lead extraction limited to the subset of patients who eventually acquire a device-related infection.

leads.[3] As most patients do not need lead extraction over their lifetime, it remains questionable if these differences in complication rate between singular patients with or without abandoned leads justifies subjecting all patients with a non-functional lead to an extraction procedure. We, therefore, examined the impact of abandoned leads in patients with device-related infections referred to our hospital on complications during lead extraction, and also the procedural and clinical outcome of lead extraction.

Methods

Study population

The study population consisted of consecutive patients undergoing lead extraction for any pacemaker and defibrillator related infection referred to the Catharina Hospital Eindhoven from 2006 up to and including 2017. Only patients who had at least one lead implanted for more than a year were included. All data were gathered prospectively. The study was approved by the Medical Research Ethics Committees United of our hospital.

Extraction procedure

All procedures were performed in an operating room during general anaesthesia with the patients prepared for an emergency thoracotomy. This included invasive hemodynamic monitoring, transoesophageal echo surveillance, and internal jugular and femoral vein central venous access. Since late 2017, we prepare patients for the use of a Bridge venous occlusion balloon (Spectranetics, Colorado Springs, CO, USA). A cardiothoracic surgical team was available to provide immediate support, with cardiopulmonary bypass equipment and a cell saver already primed inside the operating room.

Direct traction with either a standard or locking stylet was initially attempted in all leads. The further approach evolved during the study period and according to lead type. Initially, we attempted a femoral approach with a needle's eye retriever for all pacing leads. After evaluation of the results showed higher failure rates especially in older ventricular leads, we started using the newer generation of mechanical rotational extraction tools as a primary extraction tool in 2014 (Evolution RL: Cook Medical, Bloomington, Indiana; TightRail: Spectranetics, Colorado Springs, CO, USA).[4] However, we continued using the femoral approach initially for extraction of atrial and coronary sinus pacing leads, and for ventricular pacing leads with short implant times.

The laser sheath was initially used as bail-out device or as primary extraction tool for defibrillator leads but was abandoned after the mechanical rotational extraction tools became available. If endovascular extraction failed, or continuation of the procedure was considered too risky, we opted for elective surgical extraction. We started with a combined surgical and endovascular extraction procedure in one patient.

Endpoints

The main outcome of the study was major complications that were defined according to published guidelines: a complication was considered major if life-threatening, necessitating surgical intervention or leading to the demise of the patient.[1]

Procedural success was defined according to the 2017 Heart Rhythm Society expert consensus statement on cardiovascular implantable electronic device lead management and extraction as the removal of all the targeted leads and all lead material from the vascular space with endovascular tools, in the absence of any permanently disabling complication or procedure-related death.[1] Clinical endovascular success was defined as removal of all targeted leads and lead material from the vascular space with endovascular tools, with the possible exception of the retention of a small portion of the lead (<4 cm) that did not negatively impact the outcome goals of the procedure and also in the absence of surgery for complications or retained leads. Clinical overall success was defined as the removal of all targeted leads and lead material from the vascular space either endovascularly or surgical, including the retention of only a small portion of the lead (<4 cm) that did not negatively impact the outcome goals of the procedure, and including the absence of any permanently disabling complication or procedure-related death. Complications were defined according to the 2017 HRS consensus paper: major complications are those that pose an immediate threat to life or that result in death. Minor complications are undesired adverse events that require medical intervention, including minor procedural interventions but do not significantly affect the patient's function.[1]

Statistical analysis

Continuous variables were presented as mean ± standard deviation or as median [interquartile range (IQR)], where appropriate. Proportions were presented as numbers with percentages. Comparison of continuous variables was done with the Student's *t*-tests or Mann–Whitney tests, whereas proportions were compared with the χ^2 tests or Fisher's exact tests as appropriate. Multivariate logistic regression analyses were performed including the number of leads, having an abandoned lead, and cumulative implant time together with variables from univariate analyses with a *P*-value <0.1. Analyses were done with SPSS 23.0 (IBM SPSS Statistics).

Results

Study population

There were 500 consecutive patients undergoing lead extraction for pacemaker or defibrillator related infection in our hospital during the study period. One or more abandoned leads were present in 141 patients (Group 1). In the remaining 359 patients, only active leads were present (Group 2). There were significantly more patients with implantable cardioverter-defibrillator (ICD) leads in Group 1 (*Table 1*).

A total of 1175 leads were extracted, including 183 abandoned leads in Group 1 (*Table 2*). The implant time of the oldest lead present in every patient and the cumulative implant times of all leads per

Table 1 Patient characteristics

	Group 1 ($n = 141$)	Group 2 ($n = 359$)	*P*-value
Age (years)[a]	72.0 (66.4–76.9)	70.4 (63.5–78.4)	0.517
Male	78.7%	77.2%	0.353
ICD	35.5%	25.1%	0.019

ICD, implantable cardioverter-defibrillator.
[a]Median (interquartile range).

patient were significantly longer in Group 1 (*Table 2*). There were more leads that needed extraction in Group 1 with a median of 3 (IQR 3–4) vs. 2 (IQR 2–2) in Group 2.

In Group 1, the oldest active lead had an equal or longer dwell time compared to the oldest abandoned lead in 70.2% of patients (median difference 0 years; IQR: 0–5.7). A majority of the patients (75.2%) had only one abandoned lead at the time of lead extraction, and only 4.3% of patients had three or more abandoned leads (*Table 2*). The location of the leads did not differ between both groups.

Extraction procedure

The extraction techniques used in both groups are shown in *Table 3*. In only one patient did, we use a first-generation Evolution device (Cook Medical, Bloomington, IN, USA). In one patient in Group 1, we used a combined surgical—endovascular approach from the start because of dwell time exceeding 25 years for all leads and signs of heavy calcification before the procedure. There were 313 lead extractions before and 187 after the introduction of mechanical rotational tools.

Two patients in each group had additional epicardial leads: they were removed with thoracoscopy in three patients, in one patient the lead was cut at a sterile site away from the infected pocket and the intrathoracic part was left *in situ*. These procedures were not tallied as surgical procedures.

Complications

A major complication occurred in one patient of Group 1 and in six patients of Group 2 (0.7% vs. 1.7%; $P = 0.679$). The patient in Group 1 concerned the only patient in whom we started with a combined surgical—endovascular procedure. During the surgical procedure, the superior vena cava (SVC) was lacerated but successfully repaired.

Two patients in Group 2 had an SVC tear. One occurred during laser extraction of a 9-year-old defibrillator lead, and this patient succumbed despite the presence of the surgeon in the room. The second one occurred with a first-generation Evolution mechanical rotational tool: emergency surgery was successful in this case, and the patient completely recovered. In a third patient in Group 2, we used thoracoscopic surveillance for what we considered a high-risk laser procedure and noticed a developing haematoma at the junction of the left brachiocephalic and SVC.[5] Even though there were no signs of haemodynamic compromise, we preferred to abort the laser and removed the leads surgically. The three other patients with major complications in Group 2 had intrapericardial tamponade: two during a femoral approach and one with an Evolution RL mechanical rotational sheath (Cook). All three recovered completely after acute surgery. One patient in Group 2 had pre-existent severe tricuspid regurgitation after avulsion of chordae and septal myocardium during a previous extraction procedure in the referring centre.

Minor complications occurred in seven patients. A small pericardial effusion without haemodynamic instability occurred in one patient in Group 1 and was treated conservatively. Post-procedure pocket bleedings that did not require intervention occurred in two patients in Group 1 and three patients in Group 2. One patient in Group 1 experienced ventricular fibrillation within 24 h after the procedure.

Table 2 Lead characteristics

	Group 1 ($n = 141$)	Group 2 ($n = 359$)	*P*-value
Total number of leads	471	704	
Number of leads per patient			
All[a]	3 (3–4)	2 (2–2)	<0.001
1	2 (1.4%)	69 (19.2%)	
2	24 (17.0%)	238 (66.3%)	
3	53 (37.6%)	49 (13.6%)	
4	51 (36.2%)	3 (0.8%)	
5	8 (5.7%)	0 (0%)	
6	3 (2.1%)	0 (0%)	
Number of abandoned leads	183	NA	NA
1	106 (75.2%)	NA	
2	29 (20.6%)	NA	
3	5 (3.5%)	NA	
4	1 (0.7%)	NA	
Location of leads			0.092
Right atrium	161 (34.2%)	289 (41.1%)	
Right ventricle	259 (55.0%)	357 (50.7%)	
Coronary sinus	47 (10.0%)	54 (7.7%)	
Epicardial	4 (0.8%)	2 (0.3%)	
Subcutaneous array	0 (0%)	2 (0.3%)	
Implant times			
Cumulative implant time[a]	24.2 (15.6–38.2)	11.6 (5.6–17.4)	<0.001
Implant time oldest lead[a]	10.2 (6.3–16.3)	5.9 (3.3–9.5)	

NA, non applicable.
[a]Median (interquartile range), all implant times in years.

Table 3 Use of extraction tools

	Group 1 (%)	Group 2 (%)
Traction only	10.6	24.5
Needle's eye only	46.8	51.8
Any mechanical rotational sheath	32.6	18.1
Any laser sheath	7.1	4.2[a]
Surgical bail out or primary surgery	5.7	0.8
Surgical rescue for complications	0.7	1.7

[a]Includes one patient in whom a first-generation Evolution extraction device was used.

Table 4 Univariate analysis for all study patients combined

	Major complications			Procedural success			Clinical success		
	No ($n = 493$)	Yes ($n = 7$)	*P*-value	No ($n = 44$)	Yes ($n = 456$)	*P*-value	No ($n = 17$)	Yes ($n = 483$)	*P*-value
Age (years)[a]	69.6 ± 11.8	69.7 ± 15.2	0.97	68.6 ± 13.7	69.7 ± 11.6	0.57	69.1 ± 11.7	69.6 ± 11.8	0.86
Male gender (%)	77.7	71.4	0.656	75.0	77.9	0.665	70.6	77.8	0.553
Number of leads per patient (*n*)			0.37			0.025			0.017
1	70	1		4	67		1	70	
2	257	5		20	242		7	255	
3	102	0		10	92		4	98	
4	53	1		9	45		4	50	
5	8	0		0	8		0	8	
6	3	0		1	2		1	2	
Abandoned leads (%)	28.4	14.3	0.679	52.3	73.7	0.003	47.1	72.7	0.028
ICD (%)	27.4	71.4	0.021	25.0	28.3	0.643	41.2	25.5	0.270
Cumulative implant time (year)[b]	13.9 (7.2–22.4)	18.3 (12.1–23.7)	0.363	24.6 (16.7–42.7)	13.5 (6.7–21.2)	<0.001	29.2 (18.9–59.9)	13.7 (7.1–21.7)	<0.001

ICD, implantable cardioverter-defibrillator; SD, standard deviation.
[a]Average ± SD.
[b]Median (interquartile range).

Univariate analyses for major complications only showed a significant association with the presence of an ICD lead or both groups combined (*Table 4*). In a multivariate analysis, both the presence of an ICD lead and the cumulative implantation time proved independent predictors for major complications (*Table 5*).

Procedural and clinical outcome

The procedural failure rate of endovascular extraction in Group 1 and 2 was 14.9% and 6.4% ($P = 0.003$), respectively, and the clinical failure rate was 6.4% and 2.2% ($P = 0.028$), respectively. In eight patients of Group 1, bail-out surgery was needed after a failed endovascular attempt, compared to seven in Group 2 (5.7% vs. 1.9%; $P = 0.039$). The final overall clinical success, including surgical bail out but excluding patients in whom leads were removed during surgery for complications, was 99.3% and 98.3% in Group 1 and 2, respectively.

The endovascular failure rate in patients of Group 1 improved considerably after the introduction of mechanical rotational tools and became comparable with Group 2 patients with procedural failure rates of 9.2% and 5.7% ($P = 0.37$), respectively , and clinical failure rate was 3.0% and 1.6% ($P = 0.52$), respectively.

The leads that could not be removed endovascularly was an abandoned lead in two patients, both an active and abandoned lead in two patients and an active lead (all abandoned leads already endovascularly removed) in two other patients. The median difference in implant time between the oldest active and the oldest abandoned leads in the patients requiring surgical backup was 5.7 years (IQR 0–11.3).

We observed a linear relationship between endovascular procedural success and implant time in Group 1 ($P = 0.001$), but not in Group 2 ($P = 0.051$) when stratified by periods of 5 years as reflected by a linear-by-linear association. Also, for clinical endovascular failure, we found an association with implant time in Group 1 ($P = 0.003$), but not in Group 2 ($P = 0.366$).

Again for all study patients combined, univariate analyses showed that both procedural and clinical success were influenced by the number of leads, having an abandoned lead, and by cumulative implant time (*Table 4*). The latter factor was the only independent predictor in a multivariate logistic regression analysis for both procedural and clinical success (*Table 5*).

Discussion

Major complications in our single-centre study of consecutive lead extractions for pacemaker or ICD related infections were not negatively influenced by the presence of abandoned leads. Although intuitively, longer implant times and a higher number of extracted leads with abandoned leads are expected to result in higher complication rates, this is not uniformly corroborated in the literature. Hussein *et al.*[3] recently reported more major complications amongst patients with abandoned leads (3.7% vs. 1.4%) in a similar setting of device infection, and with a comparable population regarding implant times and extracted leads. However, the same group previously reported that they observed no relation between the combined age of all extracted leads and major cardiovascular complications, nor a significant increase in major cardiovascular injuries if three or more leads needed to be extracted in their overall extraction experience.[6] In the Lexicon registry of laser lead extractions, major adverse events increased with implant times but not to a significant extent (0.8, 1.67, and 1.8% for implant times of respectively <5, 5–10, and over

Table 5 Multivariate analysis of all study patients combined

	Major complications[a]	Procedural success[a]	Clinical success[a]
Age	–	–	–
Male gender	–	–	–
Number of leads	1.50 (0.15–15.0)	0.82 (0.26–2.57)	1.01 (0.12–8.67)
2	x	0.47 (0.11–2.03)	0.64 (0.05–8.63)
3	0.03 (0.00–14.0)	0.38 (0.07–2.00)	0.39 (0.02–7.36)
4	x	x	x
5	x	0.10 (0.002–6.42)	0.28 (0.002–50.6)
6			
Abandoned leads	0.33 (0.005–21.4)	1.82 (0.68–4.89)	1.32 (0.25–7.00)
ICD	51.6 (4.09–651.6)*	–	–
Cumulative implantation time	1.10 (1.04–1.17)*	1.06 (1.03–10.8)**	1.07 (1.04–1.10)**

ICD, implantable cardioverter-defibrillator; x, odds ratio cannot be calculated.
[a]Odds ratio (95% confidence interval).
*$P = 0.002$.
**$P < 0.001$.

10 years; $P = 0.34$).[7] In contrast, the European Electra registry noticed a significant higher complication rate in patients with leads implanted for more than 10 years [odds ratio (OR) 3.54, risk ratio 1.60–7.83; $P = 0.0018$].[2] A meta-analysis of lead extraction procedures from 1999 until 2013 showed 1.1% major complications in patients with implant times <5 years, compared to 2.0% for longer implant durations.[8]

Another potential influence on complications is the number of leads that are extracted. This was not predictable of major complications in our study, neither in univariate analysis nor in multivariate analysis. This is consistent with the Electra registry and the Cleveland Clinic who both did not show a significant increase in major cardiovascular injuries if three or more leads needed to be extracted.[2,6]

Abandoned leads were not an independent risk factor for extraction related complications in our study. Also, Merchant *et al.*[9] did not find any difference in complications or mortality from lead extraction in 38 patients with compared to 736 patients without abandoned leads. In contrast, the recent published Electra data signalled more major complications, including death, in the presence of abandoned leads (3.3% vs. 1.4%).[10] There were no details provided about the nature of these complications. Major differences between the Electra registry and our study included a smaller fraction of patients with abandoned leads in the Electra registry (12% vs. 28.2% in our study), and a significant different distribution of indications in the Electra study between patients with and without abandoned leads (device infection in respectively 78.8% and 49.8% of the patients). Moreover, 11% of the patients in the abandoned group of the Electra study had undergone a previous failed extraction attempt. Previous ill-fated attempts at extraction may result in damaged or indwelling leads that could jeopardize the outcome of later extraction attempts.[11] Normally, one should not expect a different behaviour from abandoned leads during lead extraction compared to active leads with similar dwell times, on condition that the leads were correctly abandoned.

Little is known about the relative influence of the extraction technique used on the incidence of complications. The only comparative study is the Plexus trial that randomized 301 patients between laser sheath extraction and telescoping polymer sheaths: three life-threatening complications occurred in the laser group vs. none in the conventional extraction group.[12] In a meta-analysis, it was noticed that major complications and death were more often reported with laser sheath extraction than with a femoral approach or mechanical dilators.[13]

We had a divergent approach from many of the mentioned papers to lead extraction as a femoral approach was sufficient to extract all leads in almost half of the patients with abandoned leads, and a laser sheath was only used in a minority of cases. Still, all SVC lacerations in our study were caused by laser extraction or with a first-generation Evolution mechanical rotational sheath that was only used in one patient. This might indicate that a femoral approach is much less prone for this particular complication.

We experienced more procedural failures of endovascular lead extraction in patients with abandoned leads. Merchant *et al.*[9] did not find a significant difference in procedural or clinical outcome between patients with or without abandoned leads, although numbers of extractions in patients with abandoned leads were small. Notwithstanding different approaches, our results are comparable with the report of Hussein *et al.*[3] who mainly used a laser sheath. The femoral approach we used in many patients is more prone to procedural failure as more often small remnants are left *in situ*, especially with longstanding ventricular leads.[4] However, once we introduced mechanical rotational tools, the difference in procedural outcome between patients with or without abandoned leads reduced and became non-significant. There is only one direct comparison between extraction techniques in the literature: the Plexus trial showed a procedural success of the laser sheath of 94% compared to only 64% with telescoping polymer sheaths.[12] However, the 33.5% cross-over from polymer sheaths to laser in this study may indicate to an operator bias, taking into consideration of the excellent results obtained by others with polymer sheaths.[12,14]

In multivariate analysis of our cohort, only the cumulative implant time was related to procedural and clinical outcome of endovascular

extraction attempts. We could only demonstrate a linear correlation with implant time for the incidence of both the procedural and clinical failure in the group with abandoned leads but not in the patients with only active leads. This lack of correlation in the latter group may follow the more limited range of implant times, with a high proportion of cases where traction was sufficient to remove the leads. Also, in the Lexicon study procedural failure rates initially increased only gradually with implant duration: from 0.75% at 5 years, 0.93% at 10 years, 1.2% at 15 years, 2.4% at 20 years, and 10.9% at 25 years. The increase only reached statistical significance with implant times of more than 10 years.[7] The same correlation was observed in the Electra registry where leads implanted more than 10 years had a clinical failure rate of 13.8%, with an OR 4.0 (2.20–7.26) compared to leads implanted for <10 years.[2]

In concordance with higher cumulative implant times in patients with abandoned leads, the failure rate of endocardial extraction in our study is higher when compared one-to-one with patients with only active leads. But although often suggested otherwise, current literature does not give support to the view that patients with abandoned leads have an excessive risk for infection and hence a high future requirement for lead extraction: Suga *et al.*[15,16] reported an 1.8% incidence of infection in the follow-up of their cohort of 433 patients with abandoned leads, comparable to the 1.9% infection rate over 3 years in the control group of the WRAP-IT study. This implicates that, when considered on a population level and intention-to-treat basis, the number of failed extractions in the group of patients with abandoned leads most likely does not significantly exceed that of the patient cohort in whom all non-functional leads are preventively extracted.

The often expressed fear for accumulating multiple abandoned leads over time as motivation for extraction of non-functional leads is contradicted by the observation that most patients possess only a single abandoned lead at the time of lead extraction for infection: 75% of patients in our study, which is comparable with 72.1% reported from the Cleveland Clinic and 79.6% from the Mayo Clinic.[3,15] In most patients there is also no advantage regarding implant times at the time of a future extraction if non-functional leads are preventively extracted: in 70.2% of our patients, the oldest active leads had the same dwell time as the abandoned leads. As a result, there is no substantial advantage from shorter implant times in case of a second extraction attempt for future device infection, and as most extracted non-functional leads will be replaced, the number of leads to be extracted will not change as well.

Limitations

Ideally, one should prospectively compare a group of patients in whom extraction is deferred until necessitated by infection, with a group of patients in whom non-functional leads are removed at the time of abandonment. As of now, there are no randomized trials addressing this subject, and such a trial would run decades before becoming conclusive.

In all current reports, patients without abandoned leads are used as a surrogate for patients with non-functional leads extracted at the time of abandonment. There are several flaws using this substitution. First, comparison at a group level insinuates that all patients with non-functional leads eventually undergo lead extraction. As indicated, a majority of patients with abandoned leads will most likely never need an extraction procedure, and therefore, never be submitted to the risk of extraction. Second, patients in whom non-functional leads are extracted are not exempted from a later necessity for a second extraction procedure. There is no proof that either the incidence of a future device infection or that the risk of the second extraction is attenuated by the previous extraction procedure. Third, in spite of often much shorter implant times, the reported complication rates of extracting recalled leads do not suggest a considerably more favourable outcome than in the patients with abandoned leads in our study.[17,18]

Another limitation is that we conducted a single-centre observational study over a long period, with developing experience and extraction techniques that may have influenced safety and success rates.

Conclusion

In our experience, patients with abandoned leads did not suffer more major complications from lead extraction for device-related infection compared to patients with only active leads. As there is no indication to date that most patients with abandoned leads will ever need lead extraction, and considering that pre-emptive extraction of non-functional leads does not exempt patients from later complications, abandoning non-functional leads, and deferring extraction until it becomes compulsory in case of a future device infection, is a safe and cost-effective option for this population.

Conflict of interest: none declared.

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A visually striking calcific band causing monomorphic ventricular tachycardia as a first presentation of constrictive pericarditis

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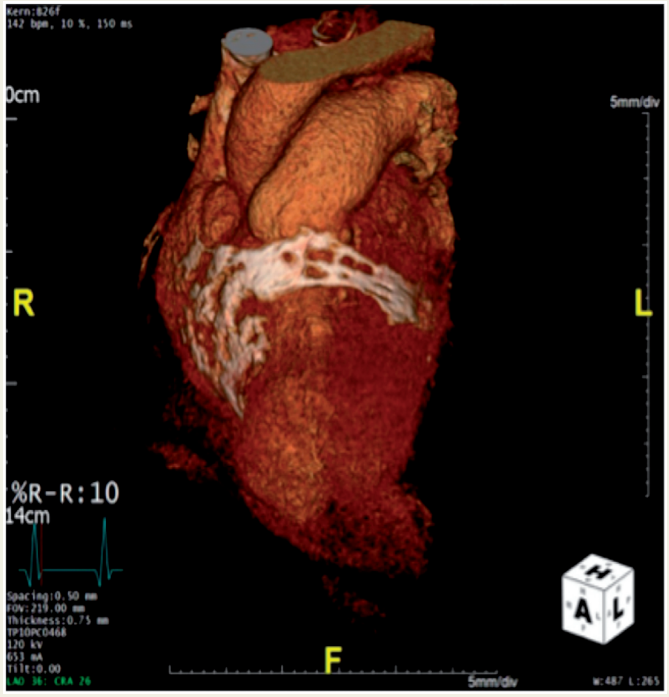
Constrictive pericarditis is a rare condition caused by thickening and stiffening of the pericardium manifesting in diastolic dysfunction and enhanced interventricular dependence.

We report the case of a 49-year-old man who presented with chest discomfort and right sided heart failure. He developed frequent runs of symptomatic non-sustained ventricular tachycardia (NSVT). An echocardiogram showed a dilated, akinetic right ventricle with septal dyskinesis and flattening. Magnetic resonance imaging was not tolerated. Gated cardiac computed tomography with multiple cines demonstrated extensive pericardial calcification and thickening (*Figure*) and impaired biventricular diastolic filling. Despite attempted total pericardiectomy, beta blockade, and amiodarone therapy, he experienced further NSVT and underwent dual-chamber implantable cardioverter-defibrillator implantation. He represented with a significant burden of NSVT and developed symptomatic sustained ventricular tachycardia (VT). Endocardial VT ablation was successfully undertaken corresponding to areas of previous epicardial scarring. He remains well at follow-up at 4 months with no further arrhythmias on device interrogation.

This summary describes the first reported case of symptomatic ventricular arrhythmia as a presentation for constrictive pericarditis and presents a striking visual representation of the disease.



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