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S-ICD oversensing detected by remote monitoring using a new atrial fibrillation diagnostic algorithm

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ABSTRACT

A 64-year-old male with a high body mass index, and subcutaneous implantable cardioverter defibrillator, (S-ICD) presented with a remote transmission of inappropriately diagnosed AF episodes, due to oversensing of P and T waves. The AF monitor can be an early warning for inappropriate sensing. Oversensing, due to small amplitude signals, can be caused by the lead position not being adequately opposed to the sternum.

1. Case history

A 64-year-old male with a high body mass index (BMI 37), and severe left ventricular systolic dysfunction due to ischaemic heart disease, was implanted with a primary prevention subcutaneous implantable cardioverter defibrillator (S-ICD), Boston Emblem MRI A219. Pre-implant ECG screening had been successful in all three vectors. Implant was conducted using the 2-incision technique; however, implantation was challenging due to the depth of the dissection required to position and secure the lead to the sternum, and the device in a posterolateral submuscular pocket. Ventricular fibrillation (VF) induction was successful with defibrillation of VF at 65J with an impedance of 100Ω. The secondary vector had been selected as oversensing was seen in the primary and alternate vectors. The SMART Pass filter had not been programmed on due to small amplitude signals. Device parameters were stable at the follow-up one-month post implant and the patient was set up with home monitoring (Latitude ™).

Two months followed before the patient sent his first transmission; this was a yellow alert for aborted charge and atrial fibrillation (AF) episodes. He had a 5% diagnosed AF burden and multiple electrograms (EGM) for AF episodes (Fig. 1) demonstrated low amplitude R waves with intermittent P wave, T wave and noise oversensing. In addition, there were inappropriately diagnosed ventricular tachycardia episodes with aborted charge due to the same intermittent oversensing pattern (Fig. 2). The EGMs and X-rays (Fig. 3) were sent to the manufacturer who concluded that the lead, and or the device, was not positioned close enough to the sternum and fascia, respectively. Therefore, initially, the lead was re-tunnelled closer to the sternum and secured with a superior suture using the 3-incision technique, without re-positioning the generator, to minimise the extent of the dissection required. This resulted in stable sensing with optimal QRS-T wave amplitudes in alternate and secondary vectors and a shock impedance of 90Ω. Post-operatively, the patient has not had any inappropriate detections of AF or VT.

This case highlights the importance of optimal lead placement, especially in high BMI cases. A 3-incision technique to fully secure the lead to the sternal fascia will help prevent electrode migration in adipose tissue and will optimise sensing long-term.

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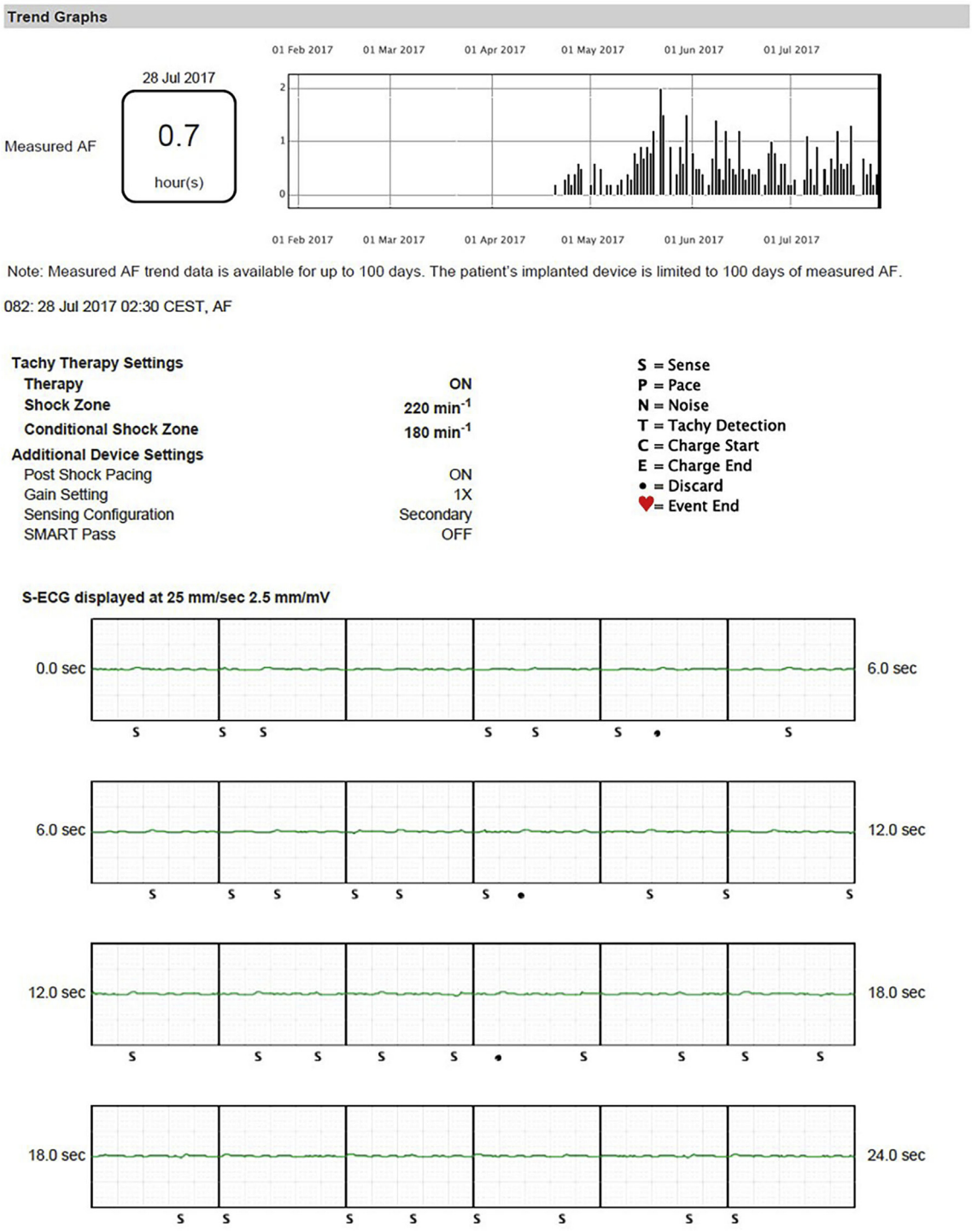

Fig. 1. AF trend graphs show the start of 'AF' episodes occurring a week after the previous interrogation and becoming more frequent over time. AF EGM shows intermittent oversensing of P and T waves due to low amplitude signals.

2. Discussion

The Emblem MRI S-ICD (Model A219) has recently received a new feature to detect AF, the AF Monitor. This applies a 192-beat rolling window, in combination with ventricular scatter and the heart rate density index (HRDI) algorithms to classify a rhythm as AF. These algorithms assess the regularity of the RR intervals and the heart rate distribution. Both algorithm criteria must be met with more than 80% of the beats qualifying as AF for the device to declare an episode. The AF Monitor has been demonstrated to have a sensitivity of 87% and a positive predictive value of 90% [1].

The physician is notified when there are more than 6 min of AF in a day as a yellow alert on the remote monitoring system (Latitude™). The device allows for the storage of up to one episode per day, keeping the most recent seven (44 seconds

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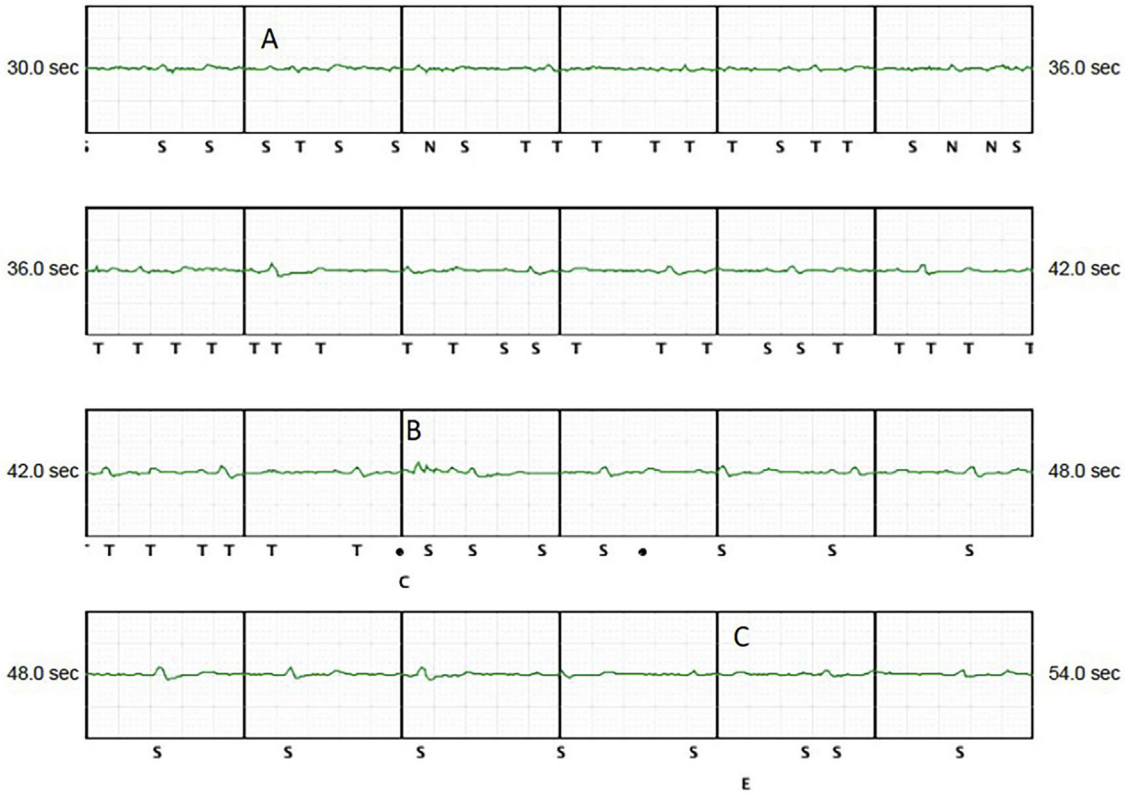

Fig. 2. Aborted charge episode shows low amplitude QRS morphology, followed by intermittent oversensing of P waves and T waves. At point A, the device begins to triple count these complexes and at point B the device fulfils its criteria for VT detection. The charge is aborted at point C as the oversensing has not sustained.

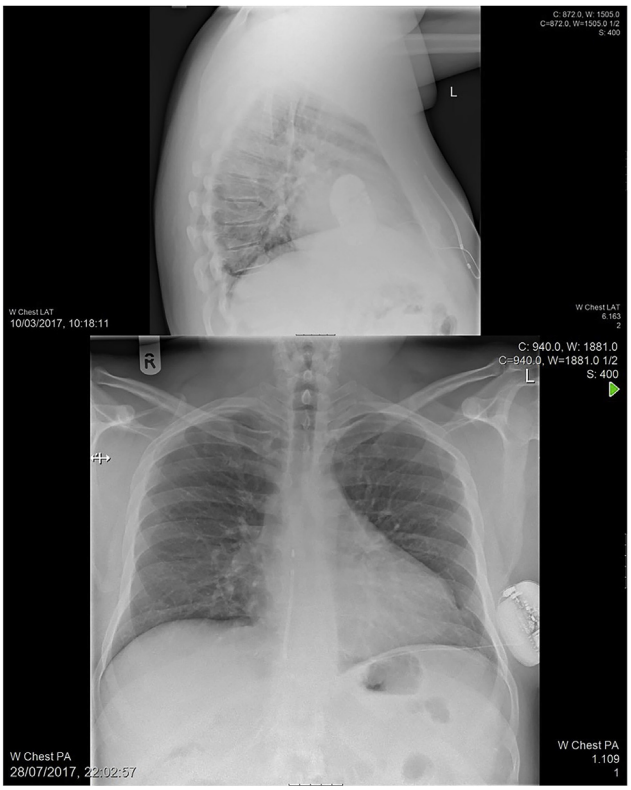

Fig. 3. Chest radiographs showing the position of the generator and the lead. There is a significant amount of subcutaneous fat separating the lead from the sternum.

duration) in memory [1]. There are also two further diagnostics: days with measured AF and estimate of measured AF, over a 90 days' window. This information is also made available via Latitude™.

The X-ray clearly demonstrates the device and lead are not optimally aligned. The generator is moderately anterior and, importantly, the ICD lead is separated from the sternum by a significant amount of subcutaneous fat. This can cause a reduction in R wave amplitude. Small R wave sizes (<0.5 mV) and periods of asystole (≥3 sec) can cause the S-ICD to automatically disable the SMART Pass filter, which has shown to be useful at reducing inappropriate therapies [2,3]. The dampened R waves led to a low signal-to-noise ratio, resulting in oversensing of P and T waves, some episodes being sustained enough to meet both AF and VT/VF detection criteria.

Our case displays how the AF episodes can be inappropriately recorded for P and T wave oversensing and not just AF, especially if there is a large reduction in signal amplitude with variability in signal size. Therefore, it can act as an early warning sign of suboptimal lead or device positioning before the patient receives inappropriate therapies. It also highlights the importance of implanting the device as close to the fascia as possible and the lead close to the sternum, with significant attention being paid to achieve this in patients with elevated BMIs. In such patients it is prudent to employ a 3-incision technique to ensure that the lead is deployed and permanently secured as close to the sternum as possible, with the device in a sub-muscular pocket to ensure low shock impedances and successful cardioversion [4]. If low amplitude R waves are detected at implant, lateral X-ray screening views of the lead and generator to assess their position

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could help guide re-positioning the lead. This can help prevent lead migration, oversensing or inappropriate shocks.

3. Conclusion

This case highlights that in patients with high BMI, increased care should be taken to ensure the lead is adequately opposed to the sternum at implant. The new AF monitor can provide an early warning for patients who may be at risk of inappropriate therapies that would not have been seen before.

Conflicts of interest

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