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S-ICD: RECOMMENDED FOR USE IN THE MAJORITY OF ICD-INDICATED PATIENTS

This clinical update focuses on recent guidelines recommending the use of the S-ICD. Also discussed are studies reporting that the S-ICD is associated with low inappropriate shock rate and no evidence of cardiac damage, a meta-analysis concluding superiority of the S-ICD over the TV-ICD with respect to lead-related complications and real-world data reporting good outcomes for the S-ICD.

1. AMERICAN GUIDELINES INCLUDE A CLASS I AND A CLASS IIA RECOMMENDATION FOR S-ICD

The American Heart Association (AHA), American College of Cardiology (ACC) and Heart Rhythm Society (HRS) use scientific evidence to formulate joint clinical practice guidelines, with recommendations to improve cardiovascular health. Although the guidelines focus on medical practice in the US, they are widely used outside the US to guide clinical practice.

A wealth of evidence now shows that the S-ICD is a feasible choice of therapy for both primary and secondary prevention of sudden cardiac death in a wide range of patients. The AHA, ACC and HRS have, for the first time, specifically recommended the S-ICD in their most recent guidelines.[1]

CLASS I RECOMMENDATION FOR S-ICD

The S-ICD received a **Class I** recommendation (should be performed) for patients who meet the criteria for an ICD, have inadequate vascular access or are at a high risk for infection and in whom pacing is neither required nor anticipated.[1]

The authors comment that the risk of infection appears to be lower with S-ICDs than with TV-ICDs. Therefore, an S-ICD may be preferred in patients who are at high risk of infection, such as those with a prior device infection, end-stage renal disease or diabetes mellitus, or those who are chronically immunosuppressed.[1] Recent National Cardiovascular Data Registry data show that more than 35 % of ICD-indicated patients have diabetes.[2]

Furthermore, the S-ICD was given a **Class IIa** recommendation (should be considered) for **all** patients who meet the indication for an ICD, if pacing is not required or anticipated.[1]

In support of this recommendation, the authors commented that there were no lead failures, endocarditis or bacteraemia, tamponade, cardiac perforation, pneumothorax or haemothorax associated with the S-ICD, in the studies referenced.[1]

Multiple studies demonstrated that the clinical need for bradycardia or antitachycardia pacing in low in ICD patients; therefore, the S-ICD is recommended for most ICD-indicated patients.[3-7]

These recommendations support the widespread use of the S-ICD in the majority of ICD-indicated patients, but particularly in patients with more complex symptoms.[1]

Joint US clinical practice guidelines recommend the use of the S-ICD in all ICD-indicated patients without a pacing need.[1]

2. LOW INCIDENCE OF INAPPROPRIATE SHOCKS WITH S-ICD

The reduction in long-term lead-related complications with the S-ICD makes it an attractive therapy for the majority of ICD patients, particularly patients with longer life expectancy, such as those with inherited channelopathies. These patients have a near normal life expectancy, and therefore a longer-than-usual requirement for an ICD.[8]

Rudic *et al.* analysed data from 62 consecutive patients with primary hereditary arrhythmia syndromes, without an indication for pacing, who received an S-ICD between November 2010 and August 2016. Of the 62 patients, 22 (35 %) had previously received a TV-ICD and had an indication for device removal/system change.[8]

PATIENTS WERE YOUNGER WITH AN INCREASED RISK OF INAPPROPRIATE SHOCK

Rudic and Kuschyk *et al.* noted that, in this study, patients were younger (age: 38 ± 3 years) with a more preserved ejection fraction (left ventricular ejection fraction: 58 ± 6 %) than patients in previous studies, and more commonly had rapid, unstable ventricular tachycardia/ventricular fibrillation (VT/VF), rather than monomorphic VT.[8]

Multiple studies report high rates of complications and inappropriate shocks in patients with inherited arrhythmia syndromes.[9]

LOW INAPPROPRIATE SHOCK RATE EVEN IN HIGH-RISK PATIENTS

Over a mean follow-up of 31.0 ± 14.2 months, 20 discrete episodes of VT/VF were recorded in 10 patients. All episodes were effectively converted within the first shock at 80 J.[8]

The rate of complications was very low, with no pocket site infections or device revisions, and only two incidences of inappropriate shock.

Of the two patients (3.2 %) who experienced inappropriate shocks, one patient experienced two inappropriate shocks due to post-procedural air entrapment that resolved spontaneously. Another patient experienced an inappropriate shock due to oversensing of myopotentials, which was managed by manual reprogramming of the sensing vector.[8]

These data show that S-ICD had a low incidence of inappropriate shock, and complications in patients with arrhythmia syndromes.

3. DATA SUGGESTS THAT S-ICD SHOCKS ARE NOT ASSOCIATED WITH MYOCARDIAL DAMAGE

While ICD devices have consistently been shown to be superior to drug therapy alone at preventing sudden death, appropriate and inappropriate ICD shocks are associated with a 2- to 10-fold increased risk of death.[10]

Garcia *et al.* demonstrated in a preclinical porcine model that S-ICD shocks were less cardiotoxic than TV-ICD shocks; however, at that time, no data were available on the effect in humans.[11]

Now, D'Onofrio *et al.* have analysed biomarkers in 30 consecutive patients who received an S-ICD and underwent defibrillation testing (DFT) with a single 65 J shock. Results show that markers of cardiac injury and haemodynamic stress neither increased after S-ICD implantation, nor at 6 or 24 hours post-shock, suggesting that S-ICD shock does not cause cardiac injury. Copeptin levels were elevated at 1 hour post-shock, but had returned to normal by 6 hours and remained stable for the rest of the observation period.[10]

These data are the first to suggest that S-ICD shock does not cause cardiac damage in humans.

4. S-ICD *VERSUS* TV-ICD META-ANALYSIS

Basu *et al.* systematically reviewed the PubMed and Embase databases. The inclusion criteria for review were:[12]

- Studies that directly compared clinical outcomes of the S-ICD and TV-ICD in adult patients.
- Articles that contained data on ICD lead-related complications, non-lead complications, inappropriate and appropriate therapies.

Following this process, five studies were selected for inclusion. The meta-analysis compared baseline characteristics, and outcome data for the TV-ICD versus the S-ICD, and included over 6,400 patients.[12]

LEAD-RELATED COMPLICATIONS WERE SIGNIFICANTLY LOWER FOR S-ICD THAN FOR TV-ICD, AND S-ICD AVOIDED THE SYSTEMIC/ INTRAVASCULAR INFECTIONS CAUSED BY TV LEADS

The meta-analysis revealed that lead complications were 7.3 times more common in the TV-ICD group compared with the S-ICD group (1.02 % vs 0.14 %, p=0.0001).[12]

Similar rates of infection were seen in both groups (0.34% for S-ICD vs 0.31 for TV-ICD). The authors noted that although the infection rates were similar, the type of infections differed, with no intravascular infections seen in the S-ICD group.[12]

The systemic/intravascular infections associated with the TV lead have an impact on morbidity and mortality:

- A previous study reported a difference in the prognosis of patients with pocket infection versus endovascular infection, and demonstrated that 1-year survival was significantly reduced in patients with endovascular infection compared with patients with pocket infection.[13]
- One-year follow-up data from the ELECTRa (European Lead Extraction ConTRolled) Registry observational study, looking at long-term outcomes of TV lead extraction was presented in 2006. The data showed that the 1-year mortality rate for patients with systemic infections was 15.1 % versus 6.9 % for patients with pocket infections.[14]

The inappropriate shock rate was 9.4 % in TV-ICD patients, compared with 8.3 % in S-ICD patients. Although these rates are similar, the nature of the inappropriate shocks differed: the main cause was supraventricular tachycardia for the TV-ICD, and T-wave oversensing for the S-ICD.128 The data included in this meta-analysis were from the first generation S-ICD, which did not have SMART Pass technology (9 Hz digital filter). Computer modelling of real episodes from the EFFORTLESS cohort with the SMART Pass algorithm estimated that SMART Pass would have reduced the inappropriate shock rate to 3.8 %.[15]

Only two of the five studies analysed reported appropriate shock rates. Based on these limited data, the rates of appropriate therapy were similar between the S-ICD and TV-ICD, despite the lack of antitachycardia pacing in the S-ICD.[12]

Lead-related complications are almost eight times more likely with the TV-ICD than with the S-ICD.

5. CLINICAL OUTCOMES IN PATIENTS WITH AN S-ICD

Sponder *et al.* analysed the clinical outcomes for 231 patients who received an S-ICD from December 2012 to May 2017, in 12 centres in Austria. The mean follow-up was 1.7 ± 1.1 years. S-ICD indications included sudden cardiac death and various hereditary arrhythmias. Overall, 58 % of S-ICDs were implanted for primary prevention.[16]

Appropriate shocks were documented in 16 patients (6.9 %), with a first shock efficiency of 96 %. Inappropriate shock occurred in 12 patients (5.2%). Of these 12 incidents, five (42%) were caused by T-wave oversensing. Six of the 12 patients (50%) had a first-generation S-ICD without SMART Pass technology. In this registry analysis, only two (0.8%) patients required a change to TV-ICD for bradycardia pacing.[16]

The S-ICD is indicated for a wide range of patients, including patients with more complex conditions.

SUMMARY

- Joint US clinical practice guidelines now recommend the use of the S-ICD in all patients indicated for ICD implantation, in whom pacing is not required, or expected.
- The S-ICD now has recommendations in both the US and EU[17] guidelines, with the S-ICD receiving Class I guidance for patients at high risk of infection.
- Meta-analysis data showed that the S-ICD was superior to the TV-ICD in terms of lead-related complications, and that S-ICD shocks may not be associated with the same cardiac injury as TV-ICD shocks.
- The inappropriate shock rate of the S-ICD was similar to that of the TV-ICD, even in patients with an increased risk of inappropriate therapy.

References

1. Al-Khatib SM, Stevenson WG, Ackerman MJ *et al.* 2017 AHA/ACC/HRS Guideline for Management of Patients With Ventricular Arrhythmias and the Prevention of Sudden Cardiac Death: Executive Summary: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines and the *Heart Rhythm* Society. Heart Rhythm. 2017; pii: S1547-5271(17)31249-3
2. Friedman DJ, Parzynski CS, Varosy PD *et al.* Trends and In-Hospital Outcomes Associated With Adoption of the Subcutaneous Implantable Cardioverter Defibrillator in the United States. *JAMA Cardiol.* 2016; **1**: 900–11
3. de Bie MK, *et al.* Suitability for subcutaneous defibrillator implantation: results based on data from routine clinical practice. Heart 2013;99:1018–1023.
4. Kutiyfa, V. *et al.* The Need for Pacing in patients who qualify for and ICD: Clinical Implications. ESC abstract 2014
5. Boriani, G. *et al.* Battery drain in daily practice and medium-term projections on longevity of cardioverter-defibrillators: an analysis from a remote monitoring database. Europace, http://dx.doi.org/10.1093/europace/euv436
6. Poole, *et al.* Who Should Receive the Subcutaneous Implanted Defibrillator? The Subcutaneous Implantable Cardioverter Defibrillator (ICD) Should Be Considered in all ICD Patients Who Do Not Require Pacing. Circulation: Arrhythmia and Electrophysciology 2013; 6: 1236-1245.
7. Botto GL, Forleo GB, Capucci A *et al.* The Italian subcutaneous implantable cardioverter-defibrillator survey: S-ICD, why not? Europace. 2017; **19**: 1826–32
8. Rudic B, Kuschyk, J. *et al.* Low Prevalence of Inappropriate Shocks in Patients With Inherited Arrhythmia Syndromes With the Subcutaneous Implantable Defibrillator Single Center Experience and Long-Term Follow-Up. *J Am Heart Assoc.* 2017; **6**: pii: e006265
9. Olde Nordkamp LR, Postema PG, Knops RE *et al.* Implantable cardioverter-defibrillator harm in young patients with inherited arrhythmia syndromes: A systematic review and meta-analysis of inappropriate shocks and complications. *Heart Rhythm.* 2016; **13**: 443–54
10. D'Onofrio A, Russo V, Bianchi V *et al.* Effects of defibrillation shock in patients implanted with a subcutaneous defibrillator: a biomarker study. Europace 2017
11. Garcia R, Inal S, Favreau F *et al.* Subcutaneous cardioverter defibrillator has longer time to therapy but is less cardiotoxic than transvenous cardioverter defibrillator. Study carried out in a preclinical porcine model. *Europace.* 2017; doi: 10.1093/europace/eux330
12. Basu-Ray JL, Jia X, Gold M *et al.* Subcutaneous Versus Transvenous Implantable Defibrillator Therapy. *J Am Coll Cardiol* EP. 2017; https://doi.org/10.1016/j.jacep.2017.07.017
13. Tarakji KG, Wazni OM, Harb S *et al.* Risk factors for 1-year mortality among patients with cardiac implantable electronic device infection undergoing transvenous lead extraction: the impact of the infection type and the presence of vegetation on survival. Eurospace. 2014; **16**: 1490–5
14. Bongiorni MG. ELECTRa (European Lead Extraction ConTRolled) Registry: Long-term Outcomes on Transvenous Lead Extraction in Europe. Heart Rhythm 2016, 4–7 May 2016, San Francisco, USA
15. Theuns DA, Burke MC, Allavatam V *et al.* Evaluation of a Novel Algorithm Designed to Reduce Oversensing in the S-ICD. Heart Rhythm 2016, 4–7 May 2016, San Francisco, USA
16. Sponder M, Khazen C, Dichtl W *et al.* Specific indications and clinical outcome in patients with subcutaneous ICD - A nationwide multicentre registry. Eur J Intern Med. 2017; pii: S0953-6205(17)30404-1
17. Priori SG, Blomstrom-Lundqvist C, Mazzanti A *et al.* 2015 ESC Guidelines for the management of patients with ventricular arrhythmias and the prevention of sudden cardiac death: The Task Force for the Management of Patients with Ventricular Arrhythmias and the Prevention of Sudden Cardiac Death of the European Society of Cardiology (ESC). Endorsed by: Association for European Paediatric and Congenital Cardiology (AEPC). Eur Heart J 2015; 36: 2793–867.

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