Unavoidable multiple inappropriate shocks of a subcutaneous implantable cardioverter-defibrillator system in a patient of Brugada syndrome; a limitation and a pitfall of the Smart pass algorithm

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**Introduction**: Inappropriate shocks (IAS) due to T wave over-sensing (TWOS) remains to be one of the major safety issues of the subcutaneous implantable cardioverter-defibrillator (S-ICD) system. It has limitations for discriminating R wave from other cardiac signals because detectable cardiac signals are limited to 3 selectable sensing vectors of subcutaneous ECG. To reduce IAS, the smart PASS (SP) algorithm of a high-pass filter of 9Hz was developed and incorporated with current S-ICD system to minimize TWOS. However, the validity and limitation of SP algorithm is not well-determined. We demonstrate a case of multiple IAS with a S-ICD system due to unexpected deactivation of SP algorithm as a limitation and a pitfall of S-ICD management.

**Methods**: A 35-year old male of survived Brugada syndrome patient was found suitable for S-ICD system based on the pre-implantation ECG screening. A S-ICD was uneventfully implanted and the primary sensing vector was incorporated because both of primary and secondary sensing vectors were considered to be optimal based on the verification of the surface ECG recorded on the S-ICD system.

**Result**: He complained of multiple shocks without loss of consciousness on the next day of the operation. Device interrogation revealed multiple IAS due to TWOS In order to avoid IAS, the primary sensing vector was switched to the secondary vector, and the SP algorithm was activated. However, he complained of multiple shocks again after three months. We found that multiple IAS were resulted from double or triple counts of cardiac signals owing to TWOS. According to the device interrogation, we found that the SP algorithm was automatically deactivated because of further attenuation of R wave amplitude below the threshold (<0.25mV) for more than 1.4seconds. Even after the manual re-activation of the SP and the change of unconditional zone up to 240ppm, subsequent recurrence of IAS could not be avoided because of multiple over-sensing of cardiac signals owing to repeatedly deactivated SP algorithm. Screening ECG of right precordial side found to be also ineffective to discriminate T wave. Since we concluded diurnal variation of R wave in this patient was the limitation for utilization of the SP algorithm, the S-ICD was retrieved and a conventional TV-ICD was implanted. No more IAS was recorded during 1-year observation via the remote monitoring system.

**Conclusion**: The SP algorithm could be turned off automatically if sensed R wave amplitude was too low (<0.25mV). Although recent studies regarding SP demonstrated favorable results for reducing IAS, it still has limitations to avoid IAS especially in patients with variable and/or reduced R wave amplitude such as Brugada syndrome or progressive myocardial diseases.