Escape rhythm from a partially disconnected pulmonary vein

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We present a 34-year-old patient with recurrent episodes of drug refractory paroxysmal atrial fibrillation referred for pulmonary vein (PV) isolation at our institution. During isolation of the right superior PV, a dissociated escape rhythm was observed on a portion of the PV that was disconnected, while the rest of the PV showed clear left atrium to PV conduction. This report demonstrates the rare possibility of escape PV rhythm from only partially disconnected PV, highlighting that dissociated PV rhythm does not necessarily reflect complete PV isolation.

Introduction
Radiofrequency ablation at the pulmonary veins (PVs) ostium to achieve their electrical isolation has become a common procedure to cure recurrent atrial fibrillation (AF). Escape rhythm from a PV is usually considered as evidence for complete electrical PV isolation. We present a case of a young patient with escape dissociated PV rhythm from a partially disconnected PV.

Case report
A 34-year-old male with recurrent episodes of drug-refractory paroxysmal AF during the last 3 years was referred to our hospital for PV isolation. The medications at study included sotalol 80 mg BID and aspirin 100 mg. Transthoracic echocardiographic study demonstrated a structurally normal heart without evidence of thrombus in the heart cavities. The diameters of the ostia of the PVs were 12 mm for the left superior and right inferior PVs and 13 mm for the right superior PV.

Figure 1 Baseline recordings from the right superior pulmonary vein. ECG surface leads II and V1 and intracardiac recordings from: ablation catheter (ABL d, ABL p), Lasso catheter (Ls 1–10), and coronary sinus catheter (CS). The patient is in sinus rhythm with obvious left atrium to pulmonary vein conduction in all lasso catheter poles.
**Figure 2** Escape rhythm in partially disconnected right superior pulmonary vein. (The figure is arranged as Figure 1). (A) The vein is partially disconnected as demonstrated by disappearance of pulmonary vein potentials in Ls 6–7, 7–8, 8–9, 9–10, and persistence of the pulmonary vein potentials in the remaining Ls poles. A dissociated pulmonary vein rhythm with a cycle length of 1080 ms is shown (arrows) in the disconnected Ls poles 7–8, 8–9. (B) The pulmonary vein escape rhythm is shown (arrows) with slower paper speed recordings.
The procedure was performed after obtaining patient’s informed consent. A decapolar catheter was inserted into the coronary sinus via the right jugular vein. A right femoral vein approach was used to insert a 15 mm Lasso catheter and an ablation catheter to the left atrium (LA) via a patent foramen ovale. Heparin was given intravenously to maintain an activated clotting time above 250 s throughout the procedure.

At the beginning of the procedure the patient was in stable sinus rhythm. However, during introduction of the ablation catheter the patient developed AF which was long lasting, did not respond to intravenous procainamide, and required DC shock for termination.

Pulmonary vein isolation of the left PVs was initially performed during AF and completed after the patient was converted to sinus rhythm. Thereafter, isolation of the right superior PV was started. Baseline recordings are presented in Figure 1. Delivery of several radiofrequency pulses in close proximity to the PV ostium resulted in partial PV disconnection. However, an obvious dissociated bradycardic PV rhythm with a cycle length of 1080 ms was observed in the disconnected area while the remaining PV recordings demonstrated clear LA-PV conduction (Figure 2A and B). This dissociated rhythm lasted 3 min and disappeared after complete PV electrical isolation (Figure 3).

Discussion
This case report demonstrates that a dissociated PV rhythm does not necessarily imply a complete electrical PV isolation. Pulmonary veins are connected electrically to the LA by discrete or wide muscular sleeves. These muscular sleeves are longer in the superior PVs and are composed of bundles of myocyte arranged in a complex three-dimensional architecture with different degree of fibrotic changes that can isolate them electrically.1 Thus an electrically disconnected sleeve may evoke an escape rhythm that is dissociated from the remaining PV and the LA. Another possible explanation of our case findings is functional block inside the PV and a recording of a far field rhythm. As the dissociated rhythm was observed just after we created an entrance block to a PV segment and was confined to that specific segment this explanation seems unlikely.

Similar findings were observed by Oral et al.2 who reported a case of tachycardia and bradycardia coexisting in the same PV. Another case report demonstrated two levels of block within a PV.3 Thus although rare, a dissociated rhythm can exist in part of a PV while the rest of the PV is still electrically connected to the LA.

The mechanism underlying PV firing and dissociated PV rhythm has not been fully determined. Several PV electrophysiological properties like short ERPs and FRPs combined with long conduction times may favour re-entry,4 nevertheless PV firing response to pacing

Figure 3 Complete pulmonary vein isolation (The figure is arranged as Figure 1). The pulmonary vein potential disappeared in all Ls poles. The dissociated pulmonary vein rhythm is no longer present.
The disappearance of the dissociated rhythm after achieving complete PV isolation in our case does not favor any of these two possible mechanisms.

The main endpoints for electrical PV isolation include: (a) disappearance of PV potentials recorded circumferentially at the PV ostium prior to ablation, implying entrance block to the PV, (b) exit block when pacing from multiple sites within the PV, and (c) dissociated PV rhythm (brady/ cardiac or tachy/ cardiac) that does not spread to the LA. As this case demonstrates it seems that the first endpoint is superior to the last, as complete circumferential ablation of the PV potentials reflects total isolation of the PV, while a dissociated PV rhythm may reflect electrical isolation of a discrete PV area, especially when there is evidence of continued LA-PV conduction in other segments of the circumferential PV recording catheter. This finding has clinical implications when trying to avoid extensive LA radiofrequency applications. Indeed, in a study examining adenosine potential to restore PV-LA conduction after apparently successful ostial PV isolation, recurrent PV-LA conduction occurred more frequently in the presence of dissociated PV rhythm. However, in another study, patients with dissociated PV rhythm did not have significantly different clinical recurrence rate, probably reflecting the rarity of our case report findings.

Dissociated PV rhythm is found in 12% of isolated PVs. It is usually slow with a mean cycle length of 2300 ± 1000 ms. It occurs more commonly in the superior PVs and in the RS more than the LS PV as in our report.

In conclusion, although rare, our case demonstrates that dissociated PV rhythm does not necessary reflect a completely isolated PV. It may exist in a partially disconnected PV. This probably reflects that muscular sleeves extending from the LA may be electrically separated, and each can have its own autonomic activity.

Conflict of interest: none declared.

References