Histological Characterization of Reversible and Irreversible Ventricular Lesion Boundaries Produced by Pulsed Field Ablation

BACKGROUND

During pulsed field ablation (PFA), electric pulses induce reversible (R) or irreversible (IR) injury on cardiac myocytes.

OBJECTIVE

To perform histological examination of acute ventricular lesions produced by PFA, determining R and IR injury boundaries in a swine heart model.

METHODS

A 7F catheter with a 3.5mm ablation electrode (TactiCath, Abbott) was connected to a pulsed electric field (PEF) generator (CENTAURI, Galaxy Medical) and positioned in RV and LV under EnSite guidance in 2 closed chest pigs. Biphasic PEF current was delivered between the ablation electrode and a skin patch at 13 RV sites (28Amp, total pulse width of 1.4ms, 4 pulses) and 19 LV sites (35Amp, 1.6ms, 7 pulses). Two hours after ablation, triphenyl tetrazolium chloride (TTC) was administered. Pigs were sacrificed and hearts were excised and fixed in formalin. Hearts were sectioned and stained with hematoxylin and eosin (H&E) and Masson trichrome. Cytochrome c oxidase (COX) staining was also performed to examine mitochondrial activity to delineate R and IR lesion boundaries.

RESULTS

Fig. Ablation lesions were well demarcated with TTC staining, showing a dark central zone surrounded by pale boundaries (PB). Histology showed destruction of myocyte architecture within the PB. A hyperstained (dark red) rim beyond the PB indicates R zone. COX staining showed no or low mitochondrial activity within the PB, consistent with IR ablated region. Enhanced activity of COX staining extended to unaffected normal myocardium, consistent with R zone.

CONCLUSION

Acute ventricular lesions produced by PEF ablation show clear demarcation by TTC staining. COX staining suggests that IR lesions are surrounded by R zone.

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