Accuracy of electroanatomical mapping guided cardiac radiotherapy for ventricular arrhythmias: pitfalls and solutions

Abdel-Kafi S.[1]; Sramko M.[2]; Omara S.[1]; De Riva M.[1]; Cvek IJ.[3]; Peichl P.[2]; Kautzner J.[2]; Zeppenfeld K.[1]

[1]Leiden University Medical Centre, Leiden, Netherlands (The)
[2]Institute for Clinical and Experimental Medicine (IKEM), Prague, Czechia
[3]University Hospital Ostrava, Department of Oncology, Ostrava, Czechia

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Background: One of the main limitations of Radiofrequency catheter ablation (RFCA) is the difficulty in targeting specific VT substrate locations when they are deep intramural, covered by epicardial fat or in the proximity of a coronary artery. Stereotactic body radiotherapy (SBRT) has emerged as an alternative treatment for VT after RFCA failure. However, the accuracy of substrate volume delineation, the gross target volume (GTV), based on electroanatomical mapping (EAM) and interobserver agreement are still unknown.

Aim: To analyze and optimize the interobserver agreement for GTV delineation on cardiac CT (CCT) based on EAM data acquired to guide radiotherapy for ventricular arrhythmias.

Method: Available EAM data was exported and merged with the segmented CCT using manual registration by two observers. A GTV was created by the observers for predefined left ventricular (LV) areas based on preselected endocardial EAM points, indicating the 2D-surface area of interest. The interobserver (non)overlapping GTV volumes were analyzed. The influence of (interobserver) registration accuracy and availability of EAM data on the final GTV and 2D-surface location within each LV area was evaluated.

Results: The median distance between the CCT and EAM after registration was 2.7 mm, 95%th percentile 6.2 mm for observer #1 and 3.0 mm, 95%th percentile 7.6 mm for observer #2 (p = 0.9). Created GTVs were significantly different (8 vs 19 ml) with lowest GTV overlap (35%) for lateral wall target areas. Similar, the highest shift between 2D-surfaces was observed for the lateral LV (6.4mm (3.0-9.9)). The same trend is seen in the (non) overlapping volume for lateral area (P = 0.004). The optimal surface registration accuracy (2.6 mm) and interobserver agreement (Δ interobserver EAM surface registration accuracy 1.32 mm) on final GTVs could be achieved if at least three cardiac chambers were mapped, including high-density LV EAM.

Conclusion: Detailed EAM of at least three chambers allows for accurate co-registration of EAM data with CCT and high interobserver agreement on GTVs to guide radiotherapy of ventricular arrythmias. However, the substrate location should be taken in consideration when creating a treatment volume margin.

Gross target volume (GTV) and Interobser

	GTV volume Observer #1 (cc)	GTV volume Observer #2 (cc)	Surface shift (mm)
Basal anterior, (IQR)	7.6 (6.2-11.5)	9.3 (5.3-10)	3.8 (2.2-4.5)
Lateral, (IQR)	8.0 (6.9-12.7)	19.1 (15.7-21.4)	6.2 (5.3-6.4)
Septal, (IQR)	10.1 (6.2-12.8)	13.9 (7.7-14.6)	6.4 (3.0-9.9)

Abstract Figure. Graphical abstract