Three dimensional modelling in structural heart disease: How can LGE MRI help electrophysiologist?

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Purpose

Left ventricle (LV) structural changes (scar tissue and grey zones (GZ)) are the substrate for development of ventricular arrhythmias (VA). Estimation the spatial relations between the LV structural changes and location of VA s is the aim of the study.

Methods and Materials

Study enrolled 25 patients (pts) with prior myocardial infarction(MI).

Patients underwent

- 24-hour ECG monitoring;

- body surface electroanatomical activation mapping with reconstruction of LV 3D models for location the VA origin. On 3D models of LV electroanatomic isopotentioal and isochrone maps were reconstructed. On theese maps the location of VA origin was detected as a point of earliest electrical activation.

- LGE MRI on 1.5 T clinical scanner using high resolution(1.25x1.25x2.5mm) inversion-recovery pulse sequence (TI 290-340ms, TE 2,4ms, TR 750-950ms). On obtained images LV myocardium epicardial end endocardial surface were segmented manually. Scar tissue threshold was 3.5SD above the mean LV signal intensity(SI), GZ threshold was 2.5-3.5SD above the mean LV SI. Scar and GZ were mapped on reconstructed 3D models of LV structure.

- Both 3D models of LV structure and LV electroanatomical maps were divided into 17 segments manually. Both these 3D models were evaluated simultaneously by two experts (radiologist and electriphysiologist). The ralations between location of VA in comparison with the LV myocardial structure were assessed.

Results

The extent of scar tissue was 7.7 [4; 18.5] %. The extent of GZ was 7.3 [5.5; 10.3] %. The infarct zone had heterogenic structure. The scar zone was mosaic and was surrounded by regions of GZ.

In 73% of patients (18 patients) VA origin was the zone of enhancement. It should be mentioned that in most cases the location of VA was endocardial surface of LV (14 patients). At the sane time some patients had epicardial origin of VA (4 patients). No relations between the depth of LV damage (enhancement transmurality) and the origin of VA was estimated.

However, data regading the structure of LV in the location of VA may be helpful for planning ablation. The thickness and structure of LV myocardium in planed ablatin site may give an opportunity to use optimal energy and decrease the risk of pericardial effusion of hemopericardium.

Images for this section:

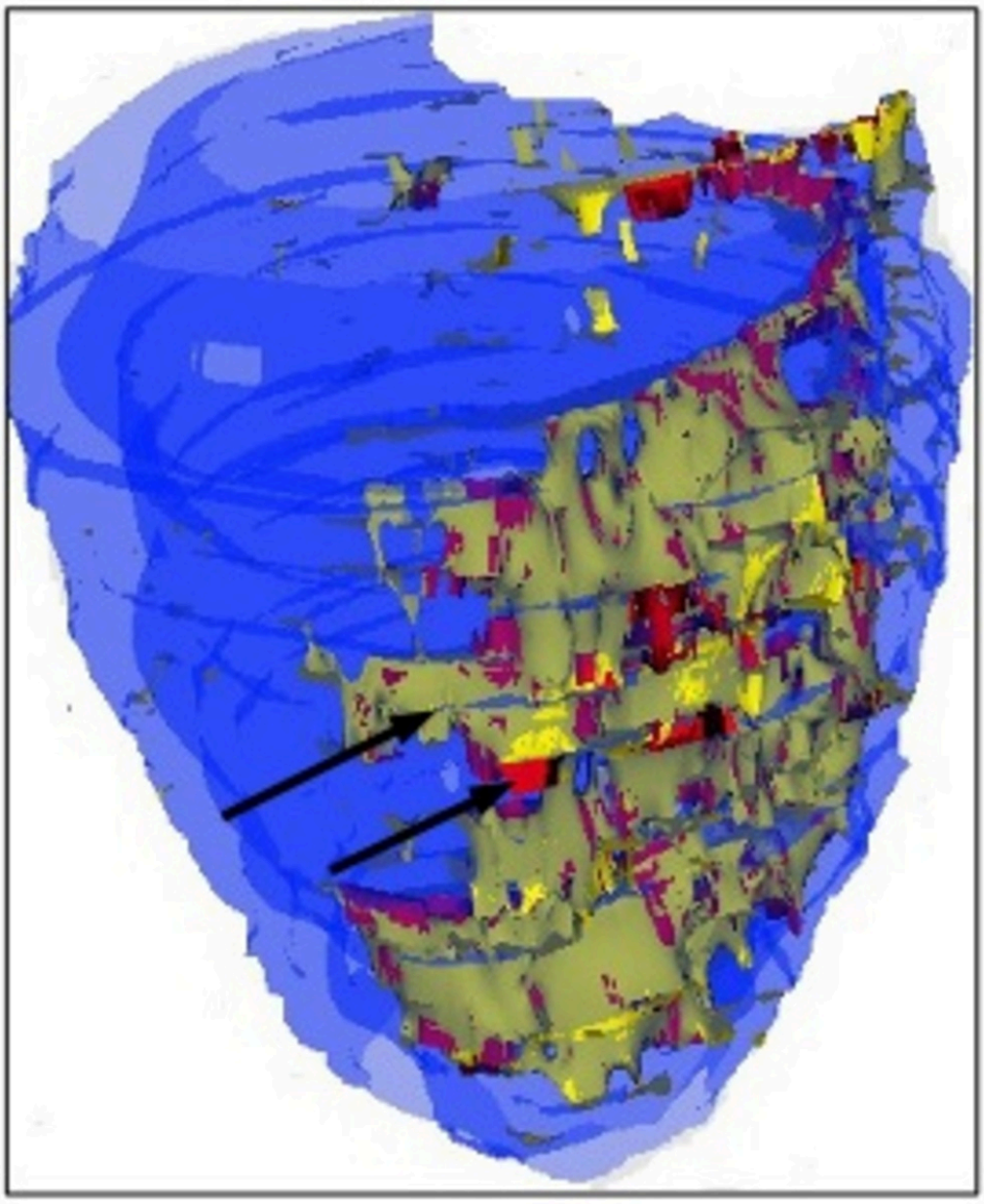

Fig. 1: 3D map of left ventricle. The epicardial amd endocardial suffaces of healthy muocardium are marked blue. The zone of unfarction has a geterogenic structure. The scar tissue ia marked red. It is surrounded by grey zone which is marked yellow

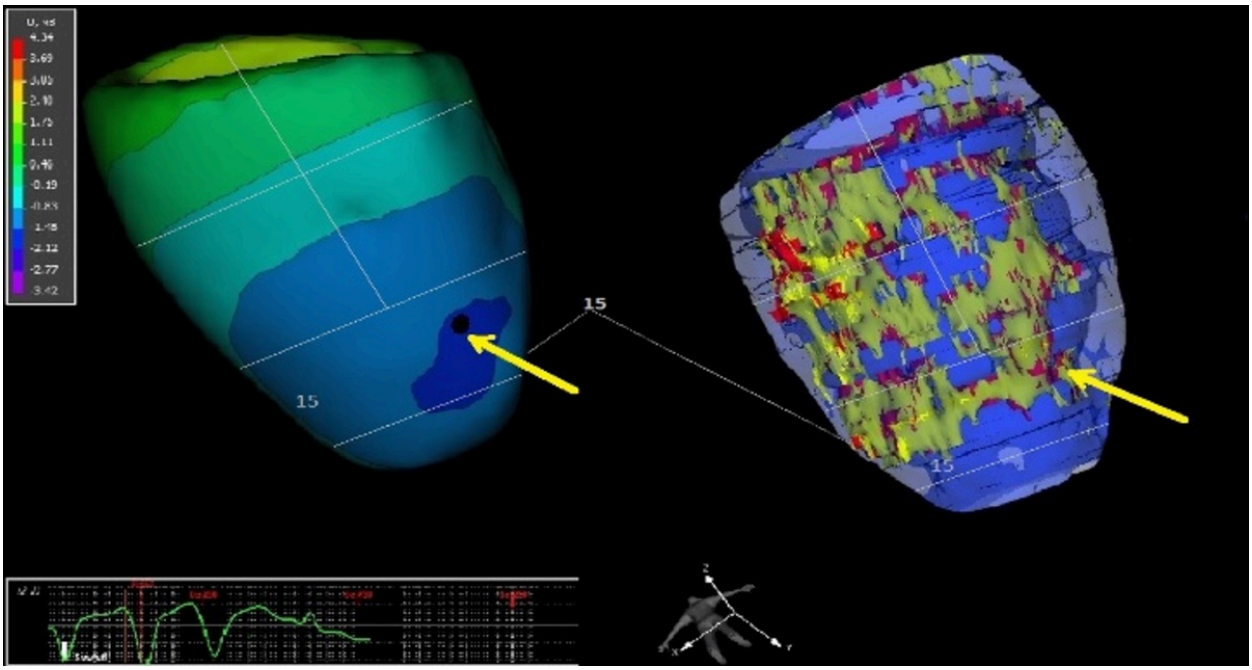

Fig. 2: The 3D elecroanatomic map (left) and 3D structure map of the left ventricle. On both maps the division into 17 segments is performed, origin of ventrucular arrhythmia is pointed by yellow arrow. The origin of ventricular arrhythmia is located in zone where scar tissue, gray zone and healthy myocardium are met together.

Conclusion

A robust approach without need for special software for simultaneous assessment of left ventrical structural and electrophysiological properties is described.

In majority of patients with prior myocardial infarction ventricular arrhuthmias may originate from zones of LGE. The data regarding the structure of the left ventricle in the planned site of ablation may improve the safety of the ablation procedure.