Assessment of lesion characteristics post RF ablation procedure in a chronic canine model of atrial fibrillation

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Purpose

Radiofrequency (RF) ablation of the left ventricle (LV) and left atrium (LA) are clinically acceptable therapies for ventricular tachycardia (VT) and atrial fibrillation (AF) [1,2]. However, to the best of our knowledge, there is still a lack of good understanding of acute cardiac lesion physiology and its appearance in MRI at different time points after ablation. It has been shown earlier that serial late gadolinium enhancement (LGE) imaging of immediately post-ablation atrial lesions can help differentiate between transient and permanent injuries based on time course of lesion enhancement [3]. However, this observation has not been evaluated in a longitudinal survival study. **In this work, we have studied lesion characteristics like contrast enhancement over time in a canine model of chronic atrial fibrillation (AF).**

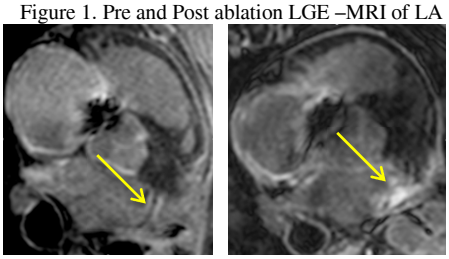
Methods

Two mongrel dogs (weight ~27 kg) that were induced with AF by rapid atrial pacing for over a year were ablated in the electrophysiology (EP) suite. The electrophysiologist performed RF ablations in all the four chambers of the animal's heart according to protocols approved by the local IACUC. Catheter access was by means of a 12F introducer sheath placed in the right femoral vein to enable the introduction of a conventional EP catheter (Biosense Webster, Diamond Bar, CA). All MRI studies were performed using the body and spine array coils at 3-Tesla MAGNETOM Verio scanner (Siemens Healthcare, Erlangen, Germany).

RF ablations in the right and left atrium (RA & LA) and right and left ventricle (RV & LV) were performed in the EP suite to create distinct lesions in the myocardial wall. The animals were then transported to the MRI suite. The MRI study began with localizers, followed by contrast injection (contrast dose of 0.15 mmol/kg, Multihance(Bracco Diagnostic Inc., Princeton, NJ)). 3D LGE imaging of the whole heart was performed to identify the regions of the myocardium ablated in the EP-suite (Figure 1 shows a comparative image of the LA of one animal before and immediately after ablation). The parameters for the LGE scan were as follows: respiratory navigated, ECG gated, inversion recovery prepared GRE sequence with resolution=1.25x1.25x2.5 mm, TR/TE=2.9/1.4 ms, flip angle=15°; parallel imaging with R=2. The ablation lesions were imaged for almost 2.5 hours every week after the initial ablation. This is a longitudinal study of chronic AF and hence the lesions after ablation have been imaged with the same protocol once a week for a month so far. Figure 2 shows a series of images of 2 characteristic lesions in the RV and LV respectively over time (immediately post RF ablation procedure, 1, and 3 weeks after the ablation procedure).

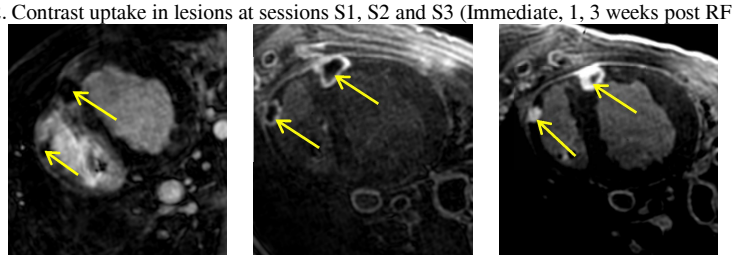
No-reflow detected by LGE-MRI was used to characterize contrast dynamics in ablation lesions. It was previously shown in [3] that lesion volume is highly correlated with no-reflow volume from early LGE-MRI (< 5 minutes after contrast injection). The volume of no-reflow was measured in the post ablation LGE images at different time points after contrast injection for each imaging session. Normalized volume of no-reflow was calculated as volume of no-reflow at given time point divided by volume of no-reflow from the earliest LGE scan (typically as early as a minute after contrast injection). Figure 3 shows dependence of the normalized volume of no-reflow on time post contrast injection.

Figure 1. Pre and Post ablation LGE –MRI of LA



Pre-ablation LA Immediately post-ablation LA

Figure 2. Contrast uptake in lesions at sessions S1, S2 and S3 (Immediate, 1, 3 weeks post RF ablation)

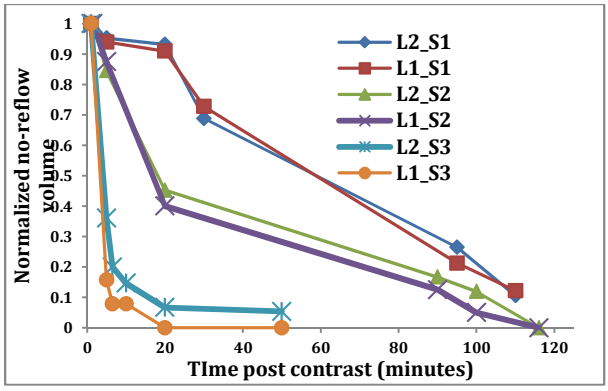


S1 (20 mins post) S2 (20 mins post) S3 (20 mins post)

Results

It can be seen in Figures 2 and 3 that contrast kinetics varies with time after RF ablation. In S1 (immediately post ablation), at about 20 minutes post contrast injection, there was absolutely no contrast uptake in the lesions (normalized volume of no-reflow = 1). In S2 (a week after ablation), some enhancement is seen on lesion boundaries (normalized volume of no-reflow < 1) whereas in session S3 (3 weeks after ablation), by 20 minutes post contrast injection, one lesion is completely bright (normalized volume of no-reflow = 0), while the other one is almost completely bright with contrast (normalized volume of no-reflow << 1). This clearly shows that contrast kinetics of lesions change with time after RF ablation procedure.

Figure 3. Plot of contrast uptake in lesion volume as a function of time after RF ablation procedure



Conclusion/Discussion

In this work, we have shown that lesion characteristics change with time after RF ablation. These changes are visualized as a change in enhancement of lesions in LGE-MRI, over time post ablation and post contrast injection. These animals are still alive and future work will involve imaging them over time and following up with histology, to understand lesion physiology better and improve procedure outcome.

References

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