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### **MRI-BASED THERMAL DOSIMETRY DURING FOCUSED ULTRASOUND SURGERY OF UTERINE FIBROIDS**

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#### **PURPOSE**

To compare the spatial extent of MRI-derived thermal dose acquired during MRI-guided focused ultrasound (MRgFUS) treatments of uterine fibroids with the resulting non-perfused area. A growing number of animal studies are showing that MRI-based temperature information gathered during thermal ablation can be used to accurately predict extent of the ablated volume. However, to this date no large set of clinical data has been available to test this method in human trials.

#### **METHOD AND MATERIALS**

A time series of MR temperature maps (chemical shift method) was acquired during each ultrasound exposure in 32 fibroid treatments in 24 women. The treatments used the Exablate 2000 MRgFUS system (InSightec, Haifa Israel). The maps were acquired in a single imaging plane, and they were used to estimate a thermal dose map. The area in a central coronal image that received dose values of 240 and 18 equivalent min at 43°C (DA240, DA18) were compared to the non-perfused area (NPA) in a contrast-enhanced T1-weighted image in the same plane immediately after the treatment. These two dose values represent a conservative threshold for thermal damage and the value found in animal studies that produces damage 50% of the time.

#### **RESULTS**

The thermal dose was predictive of the NPA ( $R=0.88$  for both DA18 and DA240 vs. NPA), but the NPA was larger on average. The NPA was 0.9-5.2 times DA240 and 0.4-2.7 times DA18. On average, NPA was  $2.6 \pm 1.0$  and  $1.4 \pm 0.5$  times larger than DA240 and DA18 respectively. In most cases, while the dose area was spotty, the NPA was contiguous. In extreme cases, areas completely outside of the targeted area were non-perfused, indicating in those cases that perhaps a large portion of NPA was induced by vascular occlusion.

#### **CONCLUSIONS**

This analysis indicates that either that the temperature distribution was underestimated or that the ultrasound was inducing secondary effects such as vascular occlusion in addition to thermal coagulation. In extreme cases at least, it is clear that contrast-enhanced imaging shows more than the area that was directly targeted for thermal ablation in uterine fibroid MRgFUS treatments.