

# THE OXYGENATION IN DIFFERENT FUNAKI TYPES OF UTERINE FIBROIDS AND THEIR CHANGE AFTER MR-HIFU TREATMENT: EVALUATION WITH T2\*

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**Target Audience** radiologists and gynecologists

**Introduction** Funaki [1] previously presented the relationship between the signal intensity on T2-weighted MRIs of fibroids and the therapeutic effect of ultrasound energy and concluded that type 1 and type 2 fibroids were found to be suitable candidates for MR guided high intensity focused ultrasound (MR-HIFU), whereas type 3 fibroids were not based on the treated area ratio and post-treatment volume change. However, mismatches during the treatment always happen since Funaki classification purely depend on visual image contrast. On the other hand, The T2\* value was associated with the oxygenation of the tissues [2], which may help to do more accurate classification and efficiently evaluate the treatment efficacy. In our limited clinical study, we extracted T2\* values from T2\* map to investigate the oxygenation of the fibroids for the classification and the efficacy of sonication before and after MR-HIFU treatment.

**Methods** 15 patients with uterine fibroids underwent MR screening before and after treatment. Informed consents were signed by all the patients. All data were acquired on a 3T MRI scanner (Achieva 3.0T TX, Philips Medical Systems, Best, The Netherlands), utilizing a 32-channel phased array coil. Fast gradient echo sequence was used with parameters as follows: flip angle 24°, thickness/gap 5mm/2mm, TR 478.32ms/TE 4.96–49.50ms (8 echoes), FOV 24cm, matrix 960×960, NSA 1. T2\* values with maps of the fibroids were processed by using the post processing software in a proprietary programming environment (PRIDE; Philips Medical Systems). The T2\* values of the gluteus muscles were also measured to check the stability of the images. Funaki classification was used to classify all fibroids into three types on T2WI as low SI (type1), intermediate SI (type2), and high SI (type3). The one-way ANOVA test was used to calculate the overall statistical differences of these parameters among different types. The follow up screening was done one month after the treatment.

**Results** T2\* maps were acquired from eighteen fibroids in fifteen patients. Twelve of them were type1, three fibroids were type2, and three fibroids were classified into type 3. The mean T2\* values of types 1, 2 and 3 fibroids were (30.33±4.49)ms, (31.78±1.65)ms and (45.68±2.52)ms, respectively. As shown in figure 1, Bonferroni post-test revealed that the mean T2\* value of type3 was significantly higher than both that of type2 ( $P=0.002$ ) and type1 ( $P<0.001$ ), although there was no significant difference between type1 and type2 ( $P=1.00$ ). T2\* values of the gluteus muscles had no significant difference among three types ( $F=3.112$ ,  $P=0.074$ ).

Up-to-date, among 15 patients, there were only four fibroids (three type1 and one type2) in four patients were followed up in one month. The mean T2\* values of the enhanced area, non-enhanced area and the whole fibroid for each fibroids after treatments were showed in table 1. T2\* values of the enhancement area (non-necrotic area) of the fibroid increased in three of them, implying the elevated oxygenation. One remained the same (fig. 2). However, the change had no statistical significance ( $t=-2.60$ ,  $P=0.08$ ). T2\* values of the non-enhancement area (necrotic area) showed different variations, and no statistical significance either ( $t=.67$ ,  $P=0.55$ ).

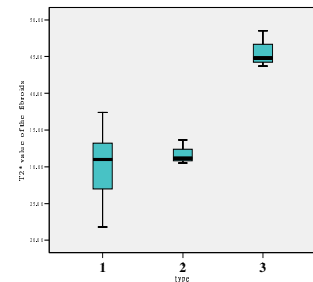
**Discussion** Tumor oxygenation was dependent on the net results of the cellular O2 consumption and O2 supply to the cells. Higher T2\* values in type three fibroids may reflect the higher regional blood flow and more vascularization in these degenerative fibroids. Congestion and inflammation were temporarily present at the marginal tissues of the coagulation necrosis in a short term after treatment which had been identified in other solid tumors' studies, such as RFA of liver tumors[3]. Increase in T2\* values was seen in these residual fibroids one month after treatment. It may be associated with similar changes of the microenvironment of the residual tissues. The change of oxygenation of the fibroids and its contribution to the volume reduction and NPV needs a long term observation, and we will follow up these patients at least six months.

**Conclusion** Although the number of treated fibroids was small, our study showed the tendency that the T2\* value of type3 fibroids were obviously higher than type1 and type2. This may implied that the higher oxygenation of type3 fibroids may be associated with the mechanism that poor effect of the MR-HIFU in type3 fibroids. The oxygenation may increase in the residual non-necrotic area of the fibroids in the short-term after MR-HIFU.

## Reference

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Fig1 the T2\* values of the fibroids in three types



case	type	Pre-HIFU (ms)	post-HIFU(ms)		
			enhancement	non enhancement	whole
1	1	27.57	27.25	17.23	22.01
2	1	31.37	42.31	39.09	37.63
3	1	31.89	46.79	35.3	36.11
4	2	28.8	36.83	13	31.13

Table 1 the T2\* value of the fibroid before and after MR-HIFU

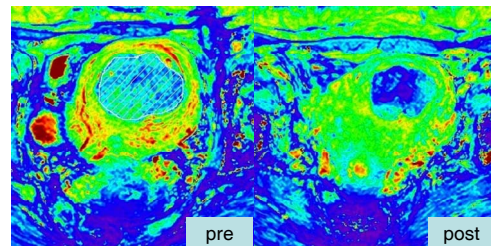


Fig 2 T2\*map of pre- and post MR-HIFU in case 1