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The effect of magnetization transfer contrast on muscle image and tissue contrast in foot MRI: A qualitative study

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ABSTRACT

Background

Magnetization Transfer Contrast (MTC) is a technique with different methods that can provide such a good contrast for tissue characterization. MTC is based on very clear biophysical and biochemical properties, because different tissues have different macromolecular compositions, the degree of interaction can be very different which can produce very high tissue contrast. Muscle becomes the second tissue with the largest percentage after skin (60-80%) experiencing signal attenuation when the MTC is applied. At Premier Bintaro Hospital reported that related MRI images have not produced good tissue contrast, therefore a combination technique that can be used in the sequences is urgently needed.

Methods

A qualitative study with experimental approach was done to confirm the availability and probability of applying the MTC technique to related sequences as well as qualitatively assessing the effect of using MTC on the generated muscle image signal. One patient with pedis MRI examination used as sample to assessing the effect of MTC in form of on-resonance MTC and off-resonance MTC.

Results

Qualitatively MTC has an impact on signal reduction in muscle image by 13-15% using both on-resonance and off resonance methods. Respondents also gave an assessment by increasing subjective contrast (visually on contrast, detail, and sharpness) on the use of both MTC methods. The muscle signal is suppressed due to the composition of macromolecules in muscle tissue including the bound pool category. Increased tissue contrast occurs both objectively and subjectively due to a decrease in muscle image signals without a decrease in the signal image of the surrounding tissue.

Conclusion

There is a change in the intensity of the muscle image signal and an increase in tissue contrast both objectively and subjectively on the pedis MRI with application of Magnetization Contrast Techniques (MTC).

Keywords: MTC, Muscle, Tissue Contrast, Pedis, Foot MRI.

INTRODUCTION

Magnetization Transfer Contrast (MTC) is the magnetization transfer with a new technique to enhance contrast in MRI images based on the application of radio-frequency pulses. The use of MTC can show changes in the MRI image of the difference in signal intensity with and without the application of pulses (magnetization displacement ratio). Transfer magnetization is a technique with different methods that can provide tissue contrast in such a way as to characterize the tissue (differentiate between one tissue with another). Transfer magnetization can be used to detect changes in the structural status of the brain parenchyma that may not be seen with routine MRI protocols. The use of MTC in MRI is the result of selective observation of proton interactions in a group of water with protons contained in macromolecules in a tissue. MTC is based on very clear biophysical and biochemical properties, because different tissues have different macromolecular compositions, the degree of interaction can be very different which can produce very high tissue contrast [1].

Pathology assessment of an organ becomes very vital in MRI imaging. Utilization of MTC for clinical imaging, usually used in sequence gradient echo and MRA (Magnetic Resonance Angiography). Previously MRA and gradient echo have also used TR which is short to increase image contrast and to detect other areas that contain short T1 elements, for example: methemoglobin, and lipids. MTC can also be used to reduce signal intensity in tissues, especially in fatty tissue, water, and contrast media found in the brain and muscles.

MRI can properly describe a muscle if it can be distinguished from other tissues with the right technique. R.W. de Boer [1] states that muscle becomes the second largest percentage of tissue after skin (60-80%) [2, 3] which experiences signal attenuation when MTC is applied. In several cases of MR arthrography performed at Premier Bintaro Hospital it was reported that the associated MRI picture did not produce good tissue contrast. This is caused when the application of the sequence with the technique of fat suppression (to see fluid and tendon tears) muscle signals are mostly drastically suppressed. Therefore, we need a combination technique that can be used in the sequence so that it can produce good tissue contrast [2, 4].

The initial study was conducted by researchers to see the availability and possibility of applying the MTC technique to the relevant sequences as well as to assess qualitatively the effect of using MTC on the resulting muscle image signal.

METHOD

Type of research in this mini research is a qualitative research with an experimental approach aimed at the availability and possibility of applying the MTC Technique to the relevant sequences while evaluating qualitatively the effect of using MTC on the generated muscle image signal. 1 patient with an MRI examination pedis at the Radiology Unit of Premier Bintaro Hospital as a sample of related studies. The procedure in this study is as follows:

1. Patients underwent MRI with routine sequences applied at the Bintaro premiere hospital (without the application of MTC).
2. Supplementary sequence (axial PDW)[5][6] with two additional treatments, on-resonance and off-resonance MTC.
3. Quantitative assessment to detect changes made in the form of measuring signal quality and contrast by using the system ROI.
4. Qualitatively, two radiology specialists who are experienced in the field of MRI 1.5 Tesla are requested to examine the image of each image. Qualitative assessment is carried out in the form of assessing subjective image contrast and related anatomical information.

Data were processed and tested descriptively to assess the effect of applying magnetization contrast techniques to muscle images and tissue contrast on the associated Foot MRI, as well as seeing MTC techniques that are well applied to MRI with muscle images as tissue of interest.

RESULT

The images generated in one routine PDW sequence as a control and 2 PDW sequences with treatment show the following results:

Table 1. Signal intensity values on Foot MRI Anatomies

	ROI	Without MTC	MTC	
			on-resonance	off resonance
Signal	1	687.47	596.68	599.96
	2	737.75	633.13	629.08
	3	737.63	634.35	630.23
	4	1500.11	1514.64	1542.01
	5	0	0	0

The table shows the change in signal intensity on the MTC technique used both on-resonance and off-resonance (figure 1-5) with the intensity distribution profile as shown on the histogram (figure 6). The percentage change in the value of signal intensity in each tissue can be seen in table 2.

Figure 1.

Figure 2.

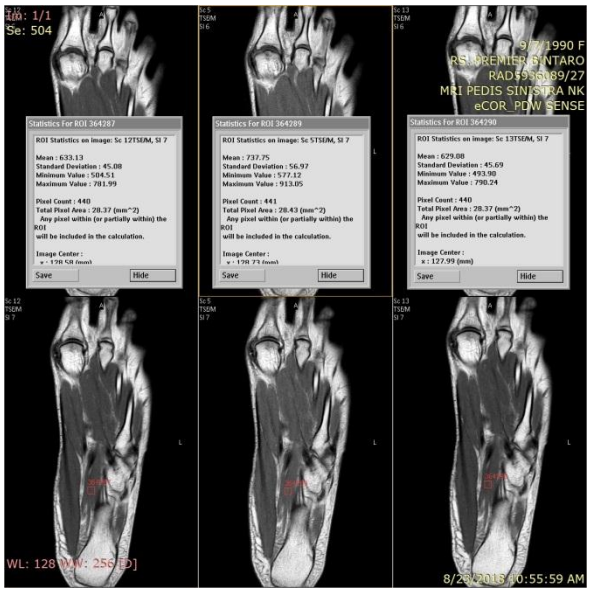

Figure 3.

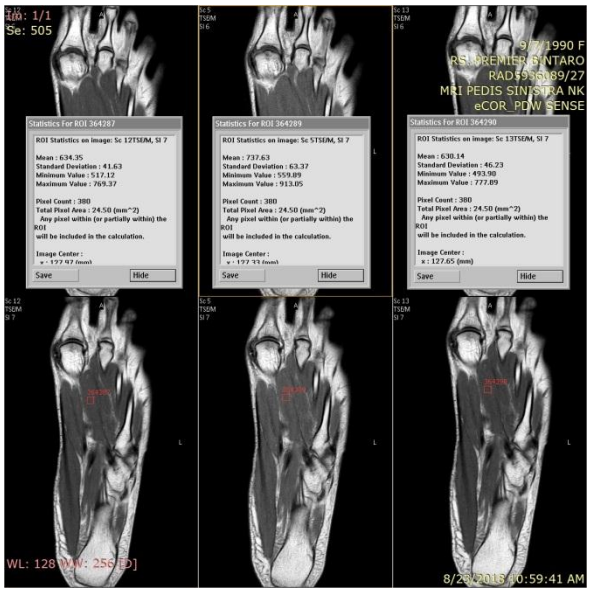

Figure 4.

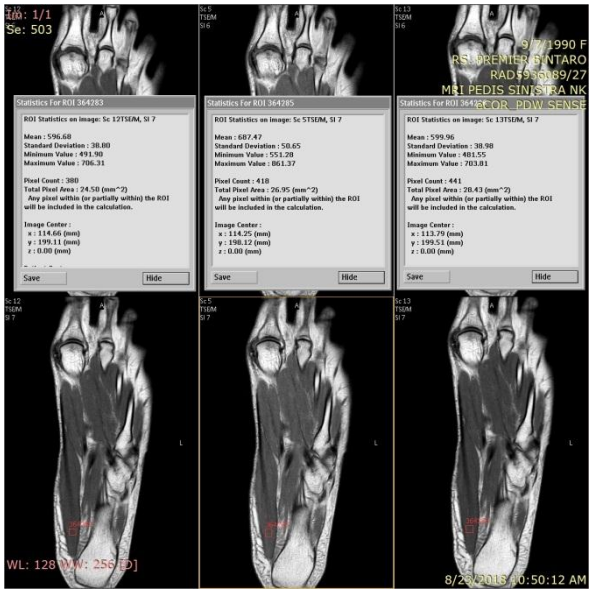

Figure 5.

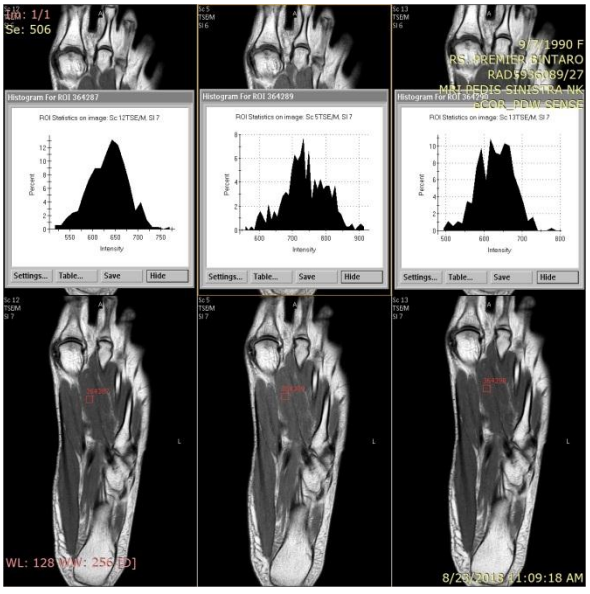

Figure 6.

Figure 1-6. Pedis MRI images with signal intensity assessment using ROI in certain tissues, muscles (1-3), fat (4), background signals (5), and the distribution of signal intensity values in the form of histograms (6).

There are differences in the signal intensity profile shown in PDW sequences without MTC when compared to MTC applications (both on and off resonance). The distribution shows a different range of signal values where sequences with MTC applications show lower and upper limits compared to sequences without MTC applications.

Table 2 shows a decrease in the value of signal intensity in the muscle tissue around Pedis with varying percentages. Objectively the resulting tissue contrast can be seen in table 3 with an increase in tissue contrast in the application of both MTC techniques.

Table 2. Percentage change in the signal intensity of tissues on Foot MRI

ROI	Changes in Signal Intensity (%)	
	Without MTC vs on resonance	**Without MTC vs off resonance**
1	-13.2*	-12.7*
2	-14.1*	-14.7*
3	-14.0*	-14.5*
4	0.96	2.79
5	0	0

** minus sign (-) indicates a decrease in intensity*

Table 3. Changes in Tissue's Contrast Value on Foot MRI

Tissue Contrast	Without MTC	MTC			
		on-resonance		off -resonance	
1 & 4	812.6	903.4	11.1%	900.2	10.8%
2 & 4	762.3	866.9	13.7%	871	14.3%
3 & 4	762.4	865.7	13.5%	869.9	14.1%

Subjectively, an assessment of image quality was assessed by two experienced radiologists with the following results:

Table 4. Image quality with subjective assessments from foot MRI

	Without MTC	On resonance	Off resonance
Contrast	6.5	9	8
Detail	7	9	8.5
Sharpness	8	8.5	8

In a subjective assessment, the radiologist assigns values to each criterion with a range of values 1-10, and is shown in table 4, contrast and detail values in the sequence with the application MTC is superior to routine sequences. Whereas the sharpness of MTC on resonance is considered better in visualizing the sharpness of the image.

DISCUSSIONS

The use of MTC can reveal changes in the MRI image of differences in signal intensity with and without the application of pulses (magnetization displacement ratio). From the studies conducted, MTC qualitatively gave a signal reduction effect on the muscle image of 13-15% using both the on-resonance and off resonance methods. This is consistent with the characteristics of muscle tissue which incidentally is the second tissue that has the highest percentage in the effect of MTC application.

As we know, MTC can be used to increase contrast in a tissue which in the future will help characterize the tissue and increase the specificity of the diagnosis [2]. The use of MTC will help increase silent tissue suppression and signal repairs such as blood flow image signals thus increasing visualization of blood vessels especially those of small size [7, 8].

MTC is best applied to multiple sclerosis (MS) abnormalities, where MTC can help to specify and subcategorize MS lesions, whether lesions demyelinating oedematous or, which this cannot be done with standard MRI protocols [9, 10].

For musculoskeletal, MTC can also be applied to the examination to increase tissue contrast where the use of MTC can increase the contrast between active and less active muscles. use of both MTC methods. By increasing contrast between tissues, it can be easier for radiologists to analyses the anatomy and pathology that is visualized in the associated MRI image [1, 11].

With the limited time and sample in this study, it can be continued to become a complete quantitative study so that other generalizations can be made to improve the quality of MRI images as a diagnostic support.

CONCLUSION

There is a change in the intensity of the muscle image signal and an increase in tissue contrast on Foot MRI. Muscle signals are suppressed due to the formation of macromolecules in muscle tissue including bound pool categories. Increased tissue contrast occurs both objectively and subjectively due to a decrease in muscle image signal without a decrease in the surrounding tissue image signal.

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