

MAGNETIC RESONANCE IMAGING OF ARTERIAL THROMBI AND ITS POSSIBLE CORRELATION TO FIBRINOLYTIC TREATMENT

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Abstract: For 13 patients with subacute and 4 patients with chronic occlusion, magnetic resonance imaging (MRI) of occlusive arterial thrombi in the superficial femoral artery were performed *in vivo*. The patients with subacute occlusion were treated with catheter-directed thrombolysis. The frequency of MR signal intensity and its distribution in thrombi were studied for 11 successfully and 2 unsuccessfully treated patients and patients with chronic occlusion. Intra-arterial thrombi were MRI inhomogenous in all of the patients, but the MR signals from lysable and chronic thrombi were significantly different than those from nonlysable ones. The MRI of occlusive arterial thrombi is probably usable to predict the therapeutic outcome of thrombolytic treatment.

Key Words: Thrombolytic Treatment, Arterial Thrombi, Magnetic Resonance Imaging

INTRODUCTION

Thrombotic occlusion of a superficial femoral artery can be successfully treated by catheter-directed thrombolysis within about 6 months of the occlusion [1], but thrombus lysability decreases with age. Therefore, the time window for such treatment was recently shortened to roughly a month [2]. Because the magnetic resonance (MR) properties of thrombi are sensitive to thrombus age [3], MR imaging (MRI) might have the potential to improve patient selection for thrombolytic treatment.

The aim of our study was to analyze occlusive arterial thrombi *in vivo* by MRI, and to correlate the MRI results with the therapeutic outcome for patients with an occlusive atherosclerotic disease of the superficial femoral artery being treated with catheter-directed local thrombolysis. We wanted to find out if MRI of the thrombus can predict the therapeutic outcome of catheter-directed local thrombolytic treatment.

PATIENTS AND METHODS

Seventeen patients (3 women, 14 men), from 43 to 79 (mean 64) years old, with angiographically documented occlusive disease of a superficial femoral artery were studied after they had given their informed consent. In 13 patients (the subacute group), symptoms lasted from two weeks to three months, and in 4

patients (the chronic group), they lasted more than 6 months. In all of the patients, magnetic resonance imaging (MRI) of the occluded artery was performed, and MR pictures of thrombi were analyzed. The acute group was treated with catheter-directed local thrombolysis started one day after MRI. This study was approved by the local ethical committee.

MR imaging

Gradient echo axial MR images (relaxation time – (TR) 300 milliseconds, excitation time – (TE) 12 milliseconds, field of view 170, matrix 256 x 256) were obtained using a whole body 1.5 T MR scanner (Magnetom, Siemens) with a surface coil for the thigh. From 7 to 11 consecutive 4 mm thick axial slices of the thrombosed artery (thrombus) from the proximal end of the occlusion were analysed.

Catheter-directed thrombolysis

Catheter-directed thrombolysis was performed with streptokinase (5000 IU/h). At the same time, heparin (450 U/h) was given to all of the patients through the second coaxial channel of the same catheter. The effect of the treatment was monitored angiographically by the intra-arterial catheter every 12 to 24 hours. If partial lysis was confirmed, the tip of the catheter was repositioned close to or in the rest of the thrombus. Treatment lasted 48 hours, or less if full lysis was achieved before this point. The lysis was estimated as successful when the MR scanned part of the occluded artery was recanalised on X-ray angiography.

Image analysis

On each image the thrombus was identified, and the distribution of pixel signal intensities was measured on a gray scale running from 0 (black) to 256 (white) by the software ImageTools (UTHSCA, USA). The same program calculated the means and standard deviations of the signal intensities for each slice. All of the images were then “normalized”, which means that the signal intensities were expressed relative to the signal intensity of subcutaneous fat in the corresponding slice. In addition to that, inhomogeneity in the spatial distribution of MR signal intensities was studied. This was quantified by calculating the distance between the geometrical and the signal intensity weighted center of gravity (shift in the center of gravity) of a thrombus region in each slice.

Statistical analysis

The t-test for independent samples was used to compare the normalized means of signal intensities and to compare the distances between calculated and corrected centers of gravity between slices for successfully and unsuccessfully treated patients, as well as for comparisons between the acute and chronic group of patients.

RESULTS

For eleven patients from the acute group, the treatment was successful. The mean and standard deviations of the normalised means of frequencies of signal intensities from the MR images of thrombi are shown in Table 1.

Tab. 1. Fat corrected relative frequencies of MRI signal intensities in thrombus slices for all groups of patients.

Parameter	Successfully treated (N=83)	Unsuccessfully treated (N=15)	Chronic group (N=45)	Acute group (N=98)
Frequency of signal intensities (mean±SD/mean f)	0.72±0.17	1.10±0.08	0.75±0.16	0.80±0.22

N - number of slices, mean - related to thrombus, mean f - related to subcutaneous fat

Comparisons of the normalized mean values of thrombus slices are shown in Figure 1.

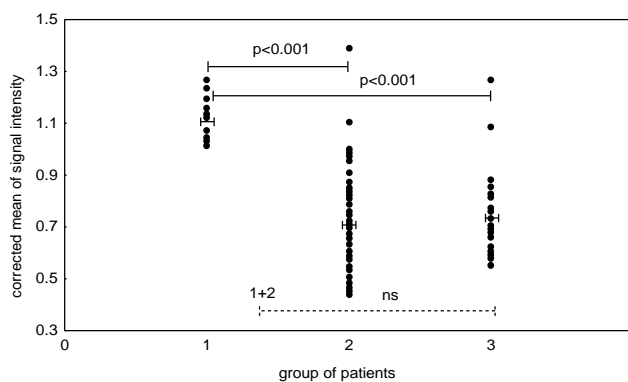


Fig. 1. Fat corrected (divided by the mean of frequencies of subcutaneous fat) means of frequencies of signal intensities in thrombus slices for patients with successful (group 2 - 89 slices) or unsuccessful thrombolysis (group 1 - 15 slices), and for the chronic group of patients (group 3 - 45 slices). The dotted line marks the comparison between the acute (successfully and unsuccessfully treated patients) and chronic groups; ns - not significant.

The results showing the shift in the center of gravity are shown in Figure 2. The smaller shift in the center of gravity in chronic patients suggests that the thrombi in chronic patients are more homogenous than in the acute ones. However, the overlap is too big for this to be treated as certain.

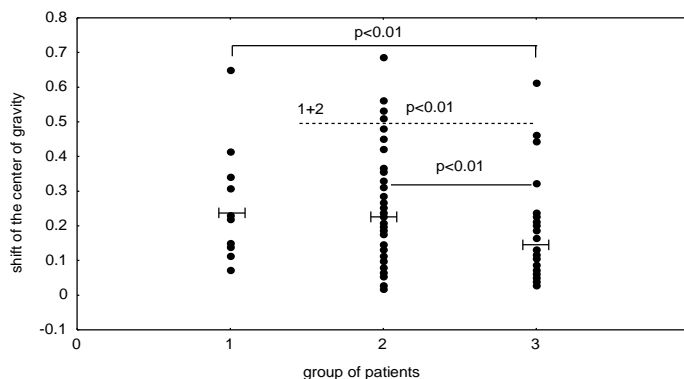


Fig. 2. Shift in the center of gravity slices for patients with successful (group 2 - 89 slices) or unsuccessful thrombolysis (group 1 - 15 slices), and for the chronic group of patients (group 3 - 45 slices). The dotted line marks the comparison between the acute (successfully and unsuccessfully treated patients – group 1+2) and chronic groups. I-I – mark for mean.

DISCUSSION

We analysed occlusive arterial thrombi *in vivo* by MRI in two groups of patients. In the first group, there were patients with fresh occlusive thrombi in their superficial femoral artery, supposed to be prone to thrombolytic treatment, while in the second, there were patients with older occlusions of the same artery, supposed to be unsuitable for thrombolytic treatment according to accepted criteria [2]. In both groups, arterial thrombi were found to be inhomogenous by MRI investigation, meaning that their structure was also inhomogenous [4]. When we correlated the MRI results to the lysability of the thrombi during catheter-directed local thrombolytic treatment, we found that fresh lysable thrombi were different (MR darker) to fresh nonlysable ones, while old thrombi were similar to fresh lysable ones. Other investigators found a correlation between the MRI characteristics of thrombi and their lysability also exists in the venous system [5]. We could speculate that the fibrin network - the target for thrombolytic agents - of the brighter thrombi is not as dense, and permits a higher inflow of the agent to the thrombus; this inflow is important for the therapeutic effect of thrombolytic agent [6]. It is also possible that with MRI, the structural characteristics of fibrin fibers are detected. It is already known that some fibrin networks are more prone to thrombolysis than others [7].

In conclusion, our study showed that occlusive intra-arterial thrombi are MRI inhomogenous. It seems that lysable thrombi are MR darker than nonlysable ones, but further studies with more patients are necessary to find out if it is possible to predict the outcome of local catheter-directed thrombolysis with MRI.

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