# Dynamic contrast-enhanced MRI: a valuable non-invasive tool to evaluate tissue perfusion of free flaps?

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## INTRODUCTION:

The coverage of tissue defects after trauma, tumor resection, congenital anomalies, burns and wound healing disturbances is an important and challenging field in plastic, reconstructive and microsurgery. Due to the rapid progress in the area of plastic surgery a considerable increase of the number of free flaps (composed of different tissues like skin, muscle, bone and combinations of these tissues) was seen during the last 30 years. The early detection of flap failure caused by blood flow irregularities and an immediate reoperation to restore blood flow may prevent a certain percentage of free flap failures. Therefore, a suitable monitoring method should not only evaluate the patency of microvascular anastomoses but also the perfusion and microcirculation of the whole flap in all tissue layers. Therefore, the aim of our study was to examine the potential use of dynamic contrast-enhanced (DCE) magnetic resonance imaging (MRI) to evaluate the vascularization and perfusion of free tissue transplants.

## METHODS:

11 patients (17-79 years, mean: 44 years) with free flap transplantation underwent DCE MRI between the 7$^{th}$ and the 14$^{th}$ postoperative day. For tissue transplantation fasciocutaneous parascapular skin flaps (n=5), musculo-fasciocutaneous latissimus dorsi flaps (n=2), a gracilis muscle flap (n=1), a musculo-fasciocutaneous trapezius flap (n=1), a fasciocutaneous radialis skin flap (n=1) and an adipocutanoeus deep inferior epigastric perforator flap (n=1) was used. Based on preceeding clinical and ultrasound examinations, normal perfusion was assumed in 9 patients, compromised perfusion in 2 patients. These results were confirmed by clinical follow-up and/or reoperation.
MRI was performed on a 1.5 T system (Magnetom Symphony, Siemens) after intravenous bolus injection of 0.1 mmol/kg bodyweight Gd-DTPA with a flow rate of 2.0-4.0 mL/s. Contrast enhancement was assessed over a time period of 2 min 20 s using a transverse 3D volumetric interpolated breathhold examination (VIBE) sequence with fat saturation. Choosing a voxel size of 1.5 mm x 1.2 mm x 4.4 mm the perfusion of the complete free flap was detected with a temporal resolution of 6.7 s.
Mean signal increase over time was evaluated in the free flap and in a reference tissue of comparable soft tissue composition. This kind of evaluation was performed in 3 different slice positions corresponding to 3 different regions of the free flap – anastomosis, central and distal region. In two patients with a musculo-fasciocutaneous latissmus dorsi flap (patients 5 and 6, see below) the free flap contained larger parts of fat and muscle which were assessed separately. Therefore, two reference tissues – fat and muscle – were evaluated in both patients, respectively. Furthermore, normalized signal increase was calculated as the ratio of percentage signal increase of the free flap to the percentage signal increase of the corresponding reference tissue. Results for the different anatomical positions within the flaps were compared using the Wilcoxon test. Normally perfused flaps vs. flaps with compromised perfusion were analyzed using the Mann-Whitney test. Throughout all results, a P-value below 0.05 was regarded statistically significant.

## RESULTS:

For the normally perfused flaps, the mean signal increase ranged from 7.8 to 51.1%. No statistically significant differences were found between the normally perfused flap and the reference tissues; furthermore, there were no significant differences between the different positions within the free flap. Mean signal increase in flaps with compromised perfusion (patient 6 and patient 9, see Fig. 1) ranged between 0.2% and 10.8%. In one patient (patient 9), tissue perfusion was compromised in the central and distal region, but remained excellent in the region of the anastomosis (therefore, the perfusion in the anastomosis region was excluded for the evaluation of flaps with compromised perfusion). The differences between free flap and reference tissue were statistically significant for the central and the distal position, but not for the anastomosis (p=0.061).
Normalized signal increase (see Fig. 1) ranged from 0.51 to 2.58 in normally perfused flaps and from 0.01 to 0.54 in free flaps with compromised perfusion. The difference between both types of flaps was statistically significant – for all positions within the flap.

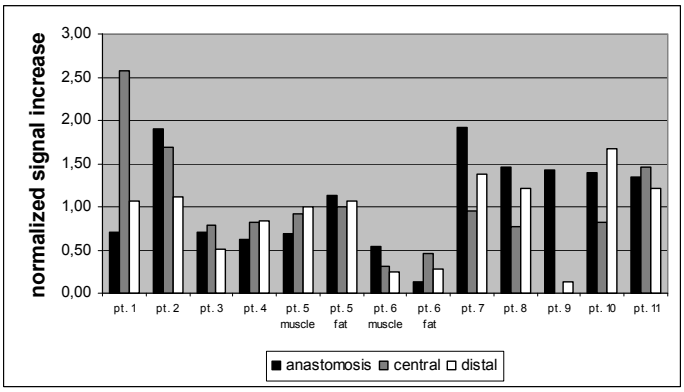


**Fig. 1**: Normalized signal increase (free flap / reference tissue) in 11 patients at 3 different regions within the flap: region of anastomis, central and distal region.

## CONCLUSION:

DCE MRI may become a valuable non-invasive tool for the evaluation of free flap circulation within the complete flap in all tissue layers. However, further studies with a higher number of patients are necessary to confirm the clinical effectiveness of these promising results.