

The Diagnostic Value of 3D Wall Motion Tracking in the Assessment of Complex Wall Motion Abnormalities – A Case Study

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Introduction

Speckle Tracking is a new technique that allows the reliable analysis of myocardial movement and deformation. Unlike Tissue Doppler, Speckle Tracking is independent of cardiac translation and insonation angle, as it is based on B-mode images. 3D Speckle Tracking evaluates strain, twist and rotation of the entire left-ventricular myocardium using a three-dimensional dataset. Before, the analysis relied on the sequential analysis of different two-dimensional views. With 3D Speckle Tracking the assessment of the total left-ventricular myocardium can be done with one capture. To evaluate the feasibility and accuracy of this new method we conducted a pilot study.

In this study we examined a population of healthy volunteers and patients with different heart diseases. We would like to present a case of a young heart transplant patient. The patient presented with repeated cardiac decompensations accompanied by progressive weight gain and progressive dyspnoea. In 2001, the patient suffering from dilated cardiomyopathy underwent a heart transplant. Due to a CMV myocarditis and recurring, histologically confirmed rejection reactions, left-ventricular ejection fraction determined by echocardiography had been reduced but stable at approximately 30% for the past eight years. During the current hospital stay a conventional echocardiography showed global reduced systolic left-ventricular function and severe

hypokinesia – septal, anteroseptal and anterior. Ejection fraction was estimated by eyeballing to be 30% (Fig. 1).

As transversal or radial strain reflects myocardial contractility we assessed transversal strain of this patient. The two-dimensional analysis of transversal strain in four-chamber view confirmed reduced contractility of the septum as represented by the red coloured myocardium. The lateral wall showed a preserved transversal strain (Fig. 2). In the three-chamber view strain imaging showed reduced anteroseptal contractility with maximum strain values of 6% (Fig. 3) illustrating the reduced contractility. Based on the two-dimensional images a left-



Fig. 1: Apical four-chamber view of a patient suffering from cardiac decompensation after heart transplant.

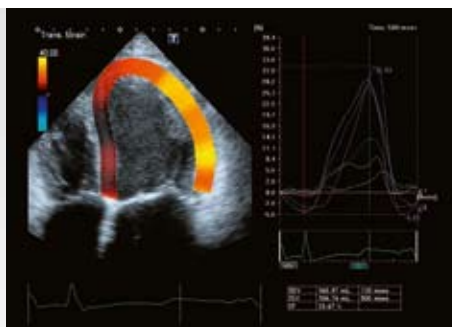


Fig. 2: The automatic strain analysis in apical four-chamber view shows colour-coded transversal strain on the left. Strain curves for the 6 segments are displayed on the right. Yellow indicates preserved strain. Dark red indicates areas with reduced strain.

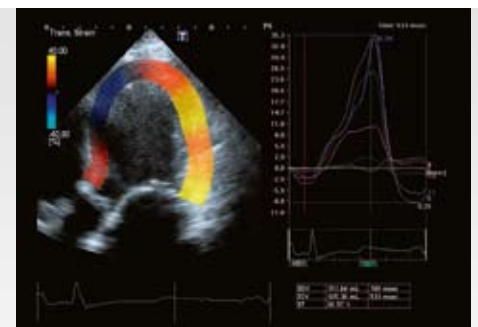


Fig. 3: The automatic strain analysis in apical three-chamber view shows colour-coded transversal strain on the left. Strain curves for the 6 segments are displayed on the right. Yellow indicates preserved strain. Dark red indicates areas with reduced strain. Blue indicates local dyskinesia.

ventricular ejection fraction of approximately 32 percent was calculated. As an example for good left-ventricular contractility figure 4 shows the four-chamber view of a healthy volunteer. Obviously contractility is preserved in all segments, as the homogenous colour-coding shows.

To quantify the complex wall motion abnormalities a 3D Speckle Tracking strain analysis was performed for this patient. Figure 5 shows the preserved radial strain from the apical lateral/inferior segments to the basal lateral segment whereas the rest of the left-ventricular myocardium shows reduced contractility. The left-ventricular ejection fraction based on the three-dimensional analysis was calculated with 34.93 %.

According to the reduced left-ventricular ejection fraction the maximal global radial strain (averaged radial strain of all segments) of the left ventricle was 11 %. In healthy volunteers we found maximal global radial strain values to be around 30 %. We compared the echocardiographic data with MRI examination. With both methods the reduced global radial strain was obvious (Fig. 6).

As an example for the assessment of regional strain figure 7 shows the radial strain of the posterior and septal segments. The red curves show echocardiographic, the blue curves show MRI measurements. Contractility in the extreme posterior segments of the myocardium was preserved, while septal contractility was visibly reduced.

Moreover, maximum septal strain was reached earlier than maximum posterior strain. MRI showed generally lower radial strain rates. Both techniques showed a good correlation ($r > 0.9$).

Summary and conclusion

3D Speckle Tracking is well suited to capture, objectify and quantify wall movement abnormalities. Left-ventricular ejection fraction and global radial strain determined with 3D Speckle Tracking correlate strongly with MRI. 3D Speckle Tracking is a simple and fast bedside procedure. Radial strain provides good insights into myocardial contractility. The case presented here shows that this method provides a reliable and fast analysis also for patients with complex wall motion abnormalities.

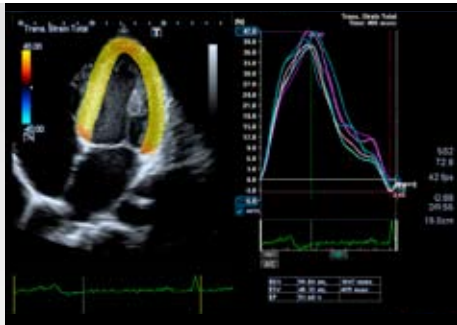


Fig. 4: Apical four-chamber view of a healthy volunteer. Colour-coding from yellow to blue indicates strain from +40% to -40%.

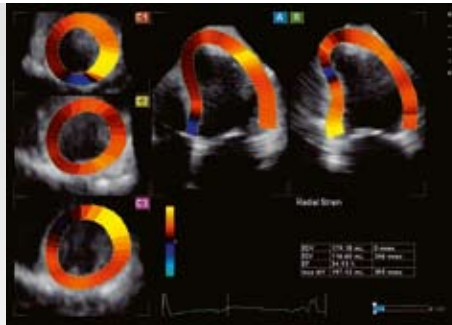


Fig. 5: Automatic strain analysis of the left ventricle. A short axis view from apex to basal segments (up to down) is shown on the left, four- and two-chamber views on the right. Bright yellow indicates preserved strain. Dark red indicates areas with reduced strain.

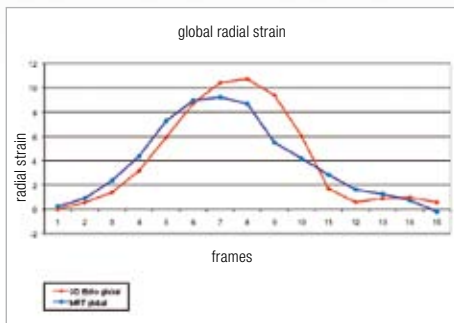


Fig. 6: Global radial strain measured with three-dimensional echocardiography and MRI. Red curve represents echocardiographic measurements, blue curve MRI measurements.

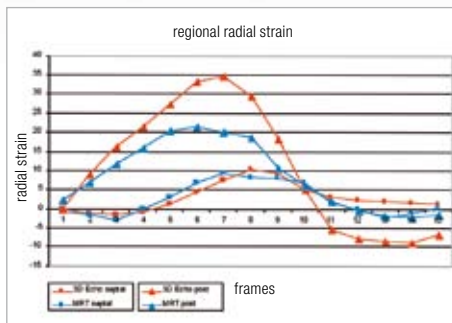


Fig. 7: Regional radial strain for septal and posterior segments. Red curves represent echocardiographic measurements, the blue curves MRI measurements. The triangle indicates posterior segments, whereas the square indicates septal segments.

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