

Usefulness of Right Ventricular Trabeculae and Papillary Muscles on Volumes and Function Assessed by Cardiovascular Magnetic Resonance with a Semi-automatic Threshold-based Segmentation Algorithm

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Introduction

- The objective of this study was to assess the usefulness of right ventricular (RV) trabeculae and papillary muscles on measured volumes and function assessed by cardiovascular magnetic resonance (CMR) with a novel semi-automatic segmentation algorithm.
- The new algorithm excludes trabeculae and papillary muscles from the blood pool, while the manual approach includes these objects in the blood pool.

Methods

- The subject included patients with right heart lesion of the congenital heart diseases.
- We measured RV end-diastolic volume (RVEDV), end-systolic volume (RVESV), stroke volume (RVSV) and ejection fraction (RVEF) using standard method of manual contour tracing and semi-automatic method.
- Also, we measured pulmonary artery flow volume (PAFV) as RSV using phase contrast (PC) MR.
- The MRI imaging was obtained using the Siemens MAGNETOM Sonata 1.5T system.
- The analyses were performed using a workstation. (Medis QMass Enterprise Solution & QFlow)

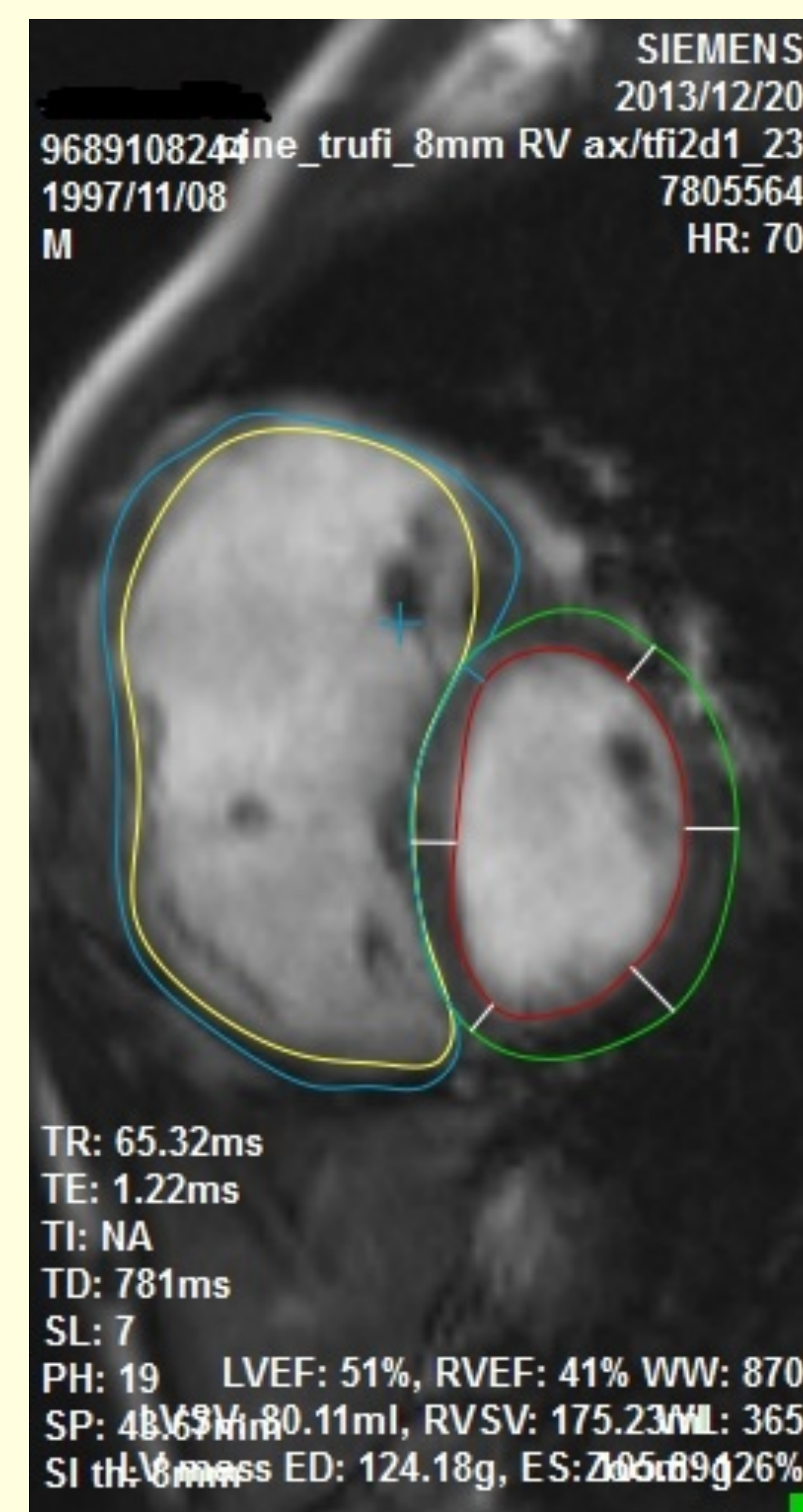


Figure 1: Manual contour tracing

Table 1: Measurements for RV volume and function

	manual tracing	semi-automatic	T-test
RVEDVI(ml/m ²)	178 +/- 65	122 +/- 65	p < 0.005
RVESVI(ml/m ²)	112 +/- 65	74 +/- 44	p < 0.005
RVSVI(ml/m ²)	61 +/- 27	47 +/- 26	p < 0.005
RVEF(%)	41 +/- 14	44 +/- 17	p = 0.01

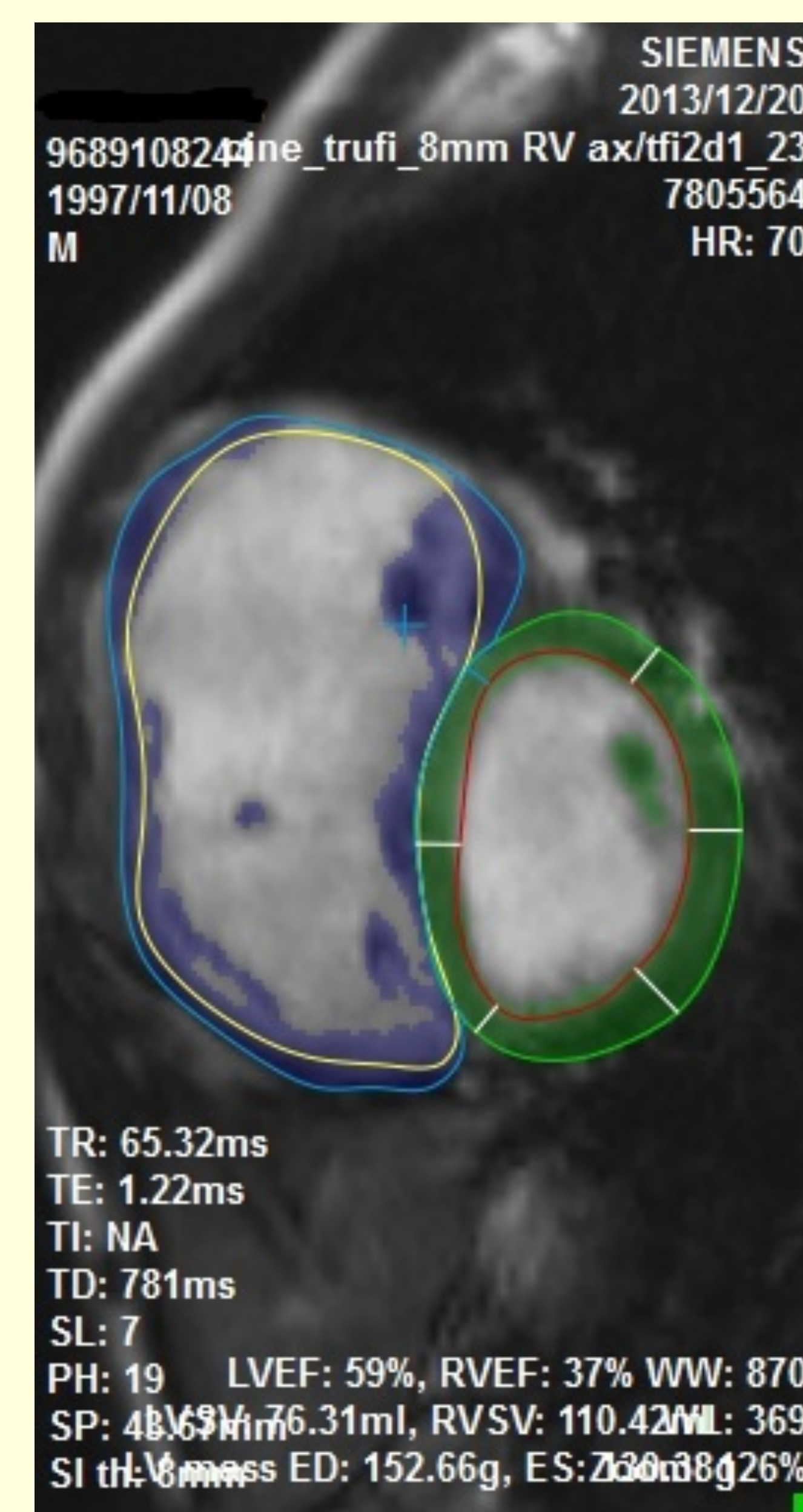


Figure 2: Semi-automatic segmentation algorithm

Table 2: Measurements for RSVI (ml/m²)

phase contrast	manual tracing	semi-automatic
43 +/- 22	61 +/- 27	47 +/- 26
compared to PC	p < 0.005	p = 0.27

Results

- There was a total of 30 cases (26 tetralogy of Fallow, 2 atrial septal defect with partial anomalous pulmonary venous return, 1 truncus arteriosus and one transposition of the great arteries), with the mean age of 24 +/- 16 years old.
- Exclusion of trabeculae and papillary muscle in the RV blood volume decreased measured RVEDV by 31 % (from 178 +/- 58 to 122 +/- 65 ml/m², p < 0.01) compared to inclusion, RVESV by 34 % (from 112 +/- 65 to 74 +/- 44 ml/m², p < 0.01), RVSV by 23 % (from 61 +/- 27 to 47 +/- 26 ml/m², p < 0.01) and relatively increased RVEF by 7 % (from 41 +/- 14 to 44 +/- 17 %, p = 0.01).
- RVSV by PAFV (43 +/- 22 ml/m²) had strong approximation with value measured by semi-automatic method (mean difference = 4.86 ml/m², p = 0.27) rather than standard method (mean difference = 18.7 ml/m², p < 0.01).
- In 22 cases, RVEDV, RVESV and RVSV including trabeculae and papillary muscles on ventriculographies had strong approximation with those measured by standard method rather than semi-automatic method on MRI.

Conclusions

- Excluding trabeculae and papillary muscle significantly affect measured RV volumes and function.
- Semi-automatic threshold-based segmentation software can reliably exclude trabeculae and papillary muscles from the RV blood volume.
- We highly recommended this novel method for measurement of true right ventricular volumes and function in congenital and acquired heart diseases.