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Guide-point modeling for the assessment of left ventricular function: comparison with the standard summation of slices method

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Introduction

Left ventricular (LV) function parameters play an important role in diagnosis, therapy monitoring and risk stratification in a variety of cardiovascular diseases; therefore, their analysis is part of daily clinical practice. The standard SoS-approach, however, is relatively time-consuming, thus, faster alternatives are desirable.

Purpose

We aimed to prospectively evaluate the accuracy of a new guide-point modeling post-processing technique (GPM-approach) in the assessment of LV function with both the standard steady-state free-precession (SSFP)-sequence and a highly accelerated cine MRI in multi-orientations compared to the standard summation of slices-method based on a stack of short-axis views (SoS-approach).

Methods

52 consecutive patients were examined on a 1.5 T scanner with the standard SSFP- ("trueFISP", TR, 3.0 ms; TE, 1.5 ms; temporal resolution, 36 ms) and a highly accelerated, single breath-hold temporal parallel acquisition SSFP-sequence (TR, 4.6 ms; TE, 1.1 ms; temporal resolution, 40 ms). The standard SSFP-sequence was post-processed both with the standard SoS-approach and the new GPM-approach, which relies on a 4-dimensional model of the LV and requires long- and short-axis views for analysis. The highly accelerated sequence was solely evaluated with the GPM-approach. Thus, in each patient ejection fraction (EF), end-diastolic volume (EDV), and end-systolic volume (ESV) was calculated using three different approaches and results were compared by applying various statistical tests.

Results

Post-processing was considerably faster with the two GPM-approaches when compared to the SoS-approach (standard SSFP-sequence/SoS-approach, 6 ± 3 min; standard SSFP-sequence/GPM-approach, 4 ± 1.5 min; accelerated SSFP sequence/GPM-approach, 3 ± 1.5 min).

EF: The approaches did not significantly vary in calculations of EF and in their variances ($p > 0.539$), mirrored by high Pearson's ($r > 0.977$) and intraclass correlation coefficients ($ICC > 0.977$).

EDV: Post-processing with the GPM-approaches yielded higher volumes compared to the SoS-approach (Table 1) due to an improved definition of the mitral valve by including long-axis views in the analysis. Consequently, Bland-Altman-Plots showed higher degrees of statistical spread (Figure 1) and significant differences in the variances ($p < 0.00$) when the SoS-approach was compared with either of the GPM-approaches. Pearson's and intraclass coefficients demonstrated high correlation between the two GPM-approaches ($r = 0.968$; $ICC = 0.967$).

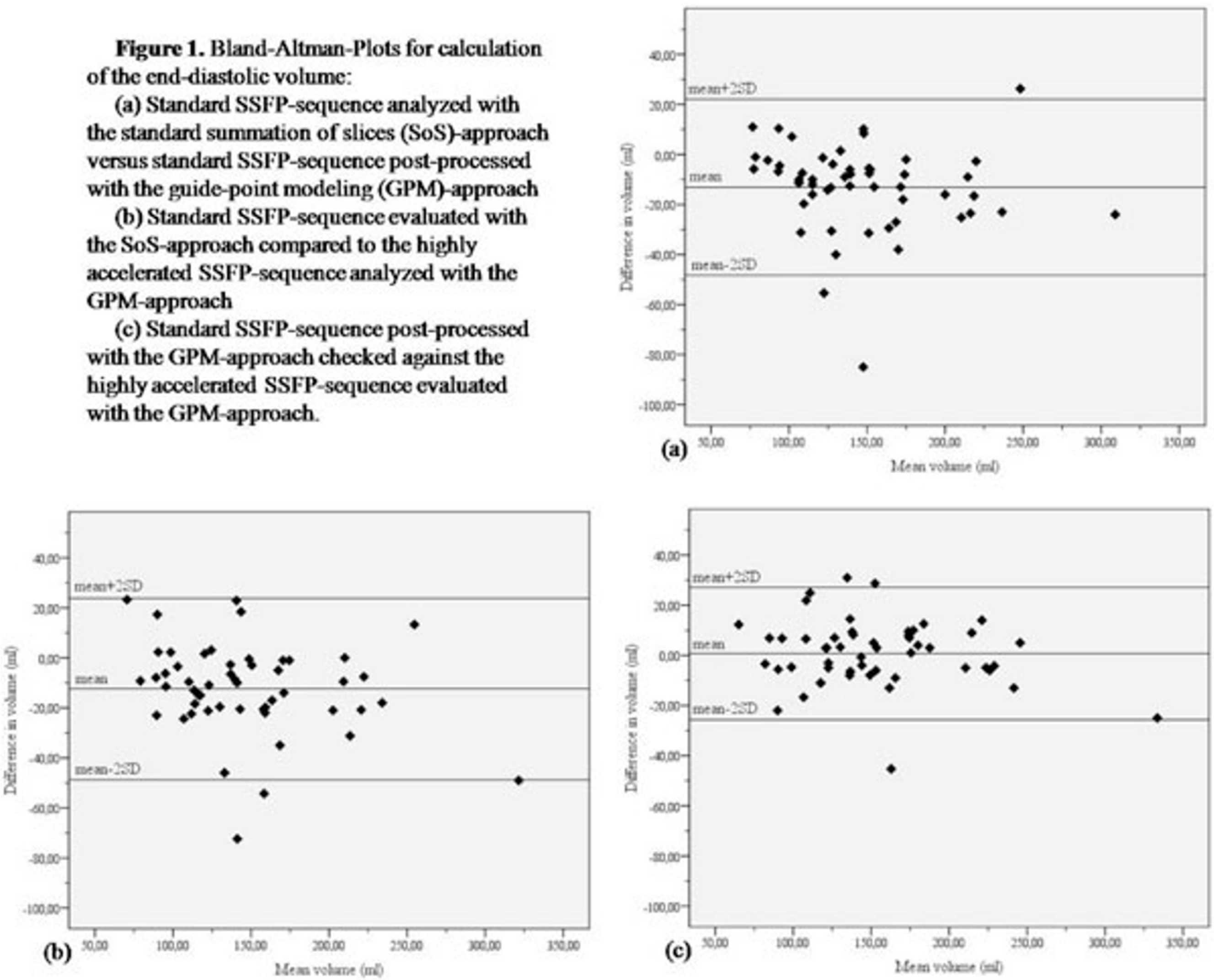

Figure 1
Bland-Altman-Plots for calculation of the end-diastolic volume.

ESV: As with EDV, ESV measurements were higher when the GPM-approaches were used. The SoS-approach and GPM-approaches had significant differences in their variances and showed considerably more statistical spread in the Bland-Altman-Plots when compared than was evident between the two GPM-approaches, which demonstrated high correlation (r = 0.992; ICC = 0.990).

Table 1: LV function parameters as measured with the three different approaches

	Ejection Fraction (%)	End-Diastolic Volume (ml)	End-Systolic Volume (ml)
Standard SSFP-sequence with SoS-approach	54.86 ± 12.97 (range, 16-73)	140.06 ± 47.92 (range, 75-297)	68.50 ± 44.88 (range, 20-250)
Standard SSFP-sequence with GPM-approach	54.99 ± 12.55 (range, 17-74)	153.16 ± 50.10 (range, 71-321)	73.34 ± 45.55 (range, 22-266)
Highly accelerated SSFP-sequence with GPM-approach	55.07 ± 13.15 (range, 15-75)	152.43 ± 52.34 (range, 59-346)	73.19 ± 48.77 (range, 22-294)

Conclusion

The GPM-approach can be fast and reliably used with standard and highly accelerated SSFP-sequences and is well-suited for assessment of LV parameters in daily clinical practice.