Post-processing measurement of left ventricular ejection fraction compared to direct measurement in patients with heart failure with reduced ejection fraction

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Introduction: Left ventricular ejection fraction (LVEF) derived from transthoracic echocardiography (TTE) is routinely used to guide therapeutic decisions in patients with heart failure with reduced ejection fraction (HFrEF). However, TTE-based quantification of LVEF is limited by low diagnostic accuracy and poor agreement with gold-standard methods which may be improved by application of post-processing (pp) analysis tools. In our study, we aimed to compare different methods of LVEF quantification, using direct and pp techniques, and their correlations to NT-proBNP plasma concentrations in patients with a previous diagnosis of HFrEF.

Methods: A total of 205 clinically stable patients with HFrEF were enrolled in a prospective cohort study. They underwent a standardized TTE examination performed by two experienced investigators. Biplane LVEF according to Simpson's method was evaluated directly during the examination. Pp evaluation of biplane and triplane LVEF (pp LVEF) using a vendor-independent software on digitally saved echo loops was performed by a blinded investigator who underwent comprehensive training in pp analysis but was otherwise unexperienced in TTE. For correlation analyses patients were subdivided according to the underlying etiology into ischemic and non-ischemic HF.

Results: Pp analysis was feasible in 164 patients. Mean direct biplane LVEF was 36.0±9.1%, mean pp biplane LVEF was 35.8±8.2%, mean pp triplane LVEF was 34.2±8.8%, and median NT-proBNP was 978 [IQR 332–2279] pg/mL. All LVEF parameters had strong and comparable correlations to NT-proBNP (direct biplane r=–0.352; pp biplane r=–0.412; pp triplane r=–0.426; $p<0.01$ for each). Bland Altman Plot revealed a high variability between direct and pp biplane LVEF, with a mean difference of 0.15±6.2%. Linear regression analysis indicated proportional bias across all LVEF ranges (β=0.154, p=0.049). Among 83 patients with direct biplane LVEF >35%, 16 had a pp biplane LVEF ≤35% (mean pp biplane 43.3±4.5 vs 32.0±2.3%, $p<0.001$; median NT-proBNP 511 [179–1421] vs 1205 [457–3706] pg/mL, p=0.055). On the other hand, out of 81 patients with direct biplane LVEF ≤35%, 16 patients had pp biplane LVEF >35% (mean pp biplane 28.2±4.8 vs 39.2±3.4%, $p<0.001$; median NT-proBNP 1644 [711–3113] vs 543 [297–3015] pg/mL, p=0.1). Furthermore, the correlation between biplane LVEF and NT-proBNP was more pronounced in patients with ischemic HF (n=65) using pp than direct measurement (pp r=–0.443, $p<0.001$; direct r=–0.314, p=0.01). We did not observe such a signal in patients with non-ischemic HF (n=99).

Conclusion: Direct biplane LVEF shows low agreement with pp biplane LVEF in patients with HFrEF. Moreover, application of pp analyses leads to a reclassification from LVEF >35 to ≤35% in one out of five patients. In conclusion, pp biplane LVEF analysis appears to provide more accurate values and should be preferred in examinations with therapeutic implication, particularly in patients with HFrEF of ischemic origin.

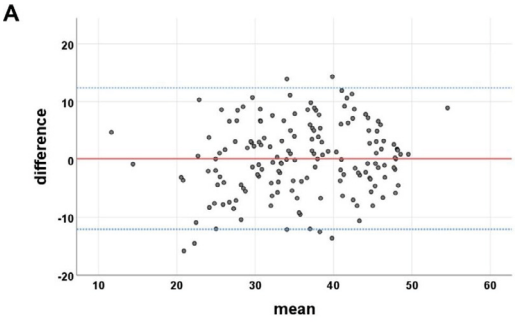

*Figure A: Bland Altman plot; *difference: direct – post-processing biplane EF measurement.*

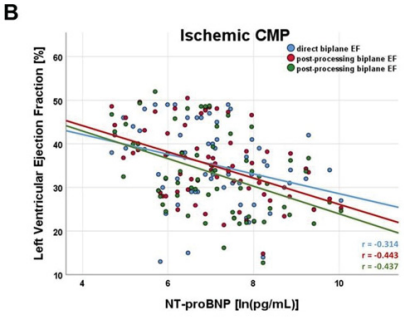

Figure B: Scatterplot; significant correlations between NT-proBNP and direct biplane EF (r=-0.314, p=0.01), pp biplane EF (r=-0.443, p<0.01), and pp triplane EF (r=-0.437, p<0.001) in patients with ischemic CMP.

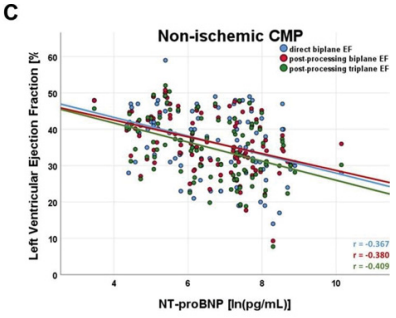

Figure C: Scatterplot; significant correlations between NT-proBNP and direct biplane EF (r=-0.367), pp biplane EF (r=-0.380), and pp triplane EF (r=-0.409, p<0.001 for each) in patients with non-ischemic origin of CMP.