

Brief report

Evaluation of myocardial contraction fraction in transcatheter aortic valve replacement

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Abstract

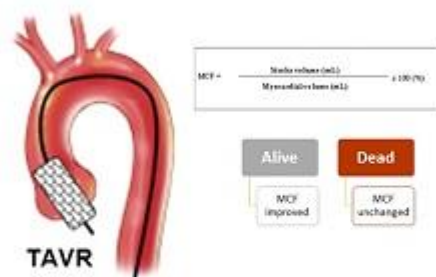
Objective: Myocardial contraction fraction (MCF), a costless, easy-to-perform echocardiographic measure, which estimates cardiac function through the volumetric measurement of myocardial shortening, may be a useful prognostic indicator in patients undergoing transcatheter aortic valve replacement (TAVR). This study aimed to evaluate MCF in patients who underwent TAVR at a public hospital in Rio de Janeiro, Brazil.

Methods: This was a retrospective cohort study. Clinical and echocardiographic data were obtained from medical records. MCF was calculated as $\text{FDV in mL} / \text{FSV in mL} \times 100$, where FDV= final diastolic volume and FSV= final systolic volume. These were derived from the dimensions of the left ventricle. The FDV was estimated as $4.5 \times$ (final diastolic diameter of the left ventricle) and the FSV was estimated as $3.72 \times$ (final systolic diameter of the left ventricle). Patients were followed for 66 months, and all-cause mortality was registered.

Results: Overall, 78 patients were studied. Median age was 78 years. Mortality was 56.4% over 9 years, with 29% of deaths in the first year. Pre-TAVR median MCF (45.9%) was low, while mean left ventricular ejection fraction (LVEF) was normal (57.0%). In patients who survived after the procedure, MCF increased post-TAVR, but in those who died, it decreased (49.3% vs 45.1%).

Conclusions: MCF may demonstrate left ventricular dysfunction unrecognized by LVEF measurement in patients undergoing TAVR, and may be a prognostic marker in this patient population.

Graphical abstract



Key words: transcatheter aortic valve replacement, aortic stenosis, myocardial contraction fraction, ventricular function

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Left ventricular ejection fraction (LVEF), assessed by echocardiography, is a key parameter for planning transcatheter aortic valve replacement (TAVR) (1). However, myocardial dysfunction may be unrecognized by LVEF assessment, especially without the aid of myocardial strain assessment; however, the

latter requires specific software, as well as operator expertise (2). A different measure of myocardial shortening, myocardial contraction fraction (MCF)- the ratio between systolic volume and myocardial volume- is considered analogous to myocardial strain (3).

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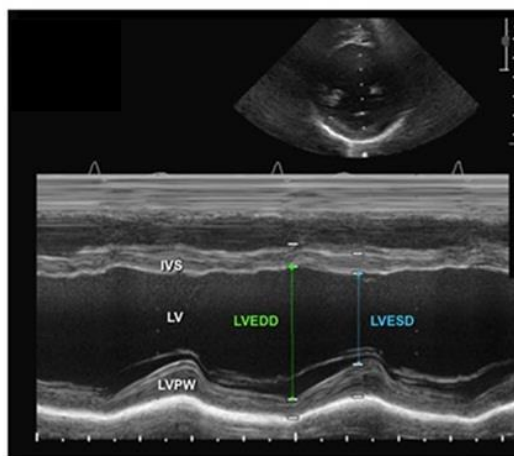
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MCF has been recently shown to be a prognostic marker in patients with aortic stenosis, including those undergoing TAVR (4-6); however, studies are still limited. Therefore, this study sought to evaluate MCF and its association with mortality in patients with severe aortic stenosis undergoing TAVR.

This was a retrospective study of consecutive patients aged ≥ 18 years who underwent TAVR at a public hospital in Rio de Janeiro from October 2011 to June 2020. The study was approved by the institutional Ethics Committee (# 4.580.337). Clinical and echocardiographic variables were obtained from medical records. All-cause death was identified from

medical records or death certificates provided by the state's Health Secretariat.

Data from echocardiograms performed immediately before TAVR, 1 week after TAVR, and at late follow-up were registered. LVEF was calculated by the Teicholz method. For the calculation of MCF, the following formula was employed (3): $MCF = (FDV \text{ in mL} / FSV \text{ in mL}) \times 100$, where FDV= final diastolic volume and FSV= final systolic volume. The FDV was estimated as $4.5 \times$ (final diastolic diameter of the left ventricle [LV]) and the FSV was estimated as $3.72 \times$ (final systolic diameter of the LV) (Fig. 1).



$$MCF = \frac{\text{Stroke volume (mL)}}{\text{Myocardial volume (mL)}} \times 100 (\%)$$

Stroke volume = End-diastolic volume – end-diastolic volume

Myocardial volume = LV mass $[1.04 \times (\text{end-diastolic diameter} + \text{thickness of the interventricular septum} + \text{thickness of the posterior wall})^2 - (\text{end-diastolic diameter})^2]$ divided by the mean myocardial density (1.04 g/mL)

IVS, interventricular septum; LV, left ventricle; LVEDD, left ventricular end diastolic diameter; LVESD, left ventricular end systolic diameter; LVPW, left ventricular posterior wall

Figure 1. Myocardial contraction fraction (MCF) determination

Continuous variables are expressed as mean (SD) or median (IQR) and were compared using Mann-Whitney's test. Categorical variables are expressed as frequencies. A $p < 0.05$ was considered statistically significant. Survival was evaluated using Kaplan-Meier survival analysis.

Seventy-eight patients were studied. Baseline characteristics are shown in Table 1. Mean aortic valve area was 0.62 ($0.42 - 0.8$) cm^2 , LVEF was 57.3 (16.3)% and MCF, 45.9 ($34.8 - 54.1$)%. In the 1-week evaluation, mean LVEF was 57.7 (16.6)% and median MCF was 47 ($37.7 - 45.9$)%. Moderate to severe aortic regurgitation was present in 26.9 %, severe aortic regurgitation in 7.7 %, and severe mitral regurgitation in 2.6 % of patients. Regarding diastolic function, 30.7 % of the patients had grade I diastolic dysfunction, and 14.1 %, grade 2 diastolic dysfunction. In 14.1 % of the patients, the evaluation of diastolic

function was compromised due to arrhythmias or other issues, and in 7 %, diastolic function was not reported. The median pre-TAVR pulmonary artery systolic pressure was 41.1 ($31.5-48.5$) mmHg. Right ventricular function was not evaluated.

Patients were followed for a mean of 66 months. All-cause death occurred in 56.4 %. A Kaplan-Meier curve is shown in Figure 2, depicting patient survival during follow-up. Of the 78 patients, 57 completed 30 months of follow-up and 33 completed five years of follow-up.

In surviving patients, the median MCF was 43 % before TAVR, raised to 49 % after 1 week, and persisted at 49 % at late follow-up ($p < 0.01$). In those who died, median MCF was 48 % before TAVR, 45 % after 1 week, and 47 % in the last echocardiogram ($p > 0.05$) (Fig. 3).

Table 1. Baseline characteristics	
Variables	Study population (n=78)
Age, years	78.6 (75.2 – 83.0)
Female, n(%)	41 (52.5)
Functional class I/III (NYHA) , n(%)	16 (20.5)
Functional class III/IV (NYHA) , n(%)	62 (79.5)
Syncope, n(%)	24 (30.8)
Angina, n(%)	32 (41.0)
Known coronary artery disease, n(%)	43 (55.1)
Systemic hypertension, n(%)	71 (91.0)
Diabetes, n(%)	21 (26.9)
Dyslipidemia, n(%)	52 (66.7)
Cerebrovascular disease, n(%)	7 (9.0)
Carotid artery disease, n(%)	17 (21.8)
Peripheral artery disease, n(%)	15 (19.2)
Chronic obstructive pulmonary disease, n(%)	14 (17.9)
Chronic renal failure, n(%)	52 (66.7)
Prior coronary artery bypass, n(%)	15 (19.2)
Prior valve replacement, n(%)	8 (10.3)

Variables are expressed as number and percentage or median and interquartile range.
NYHA - New York Heart Association

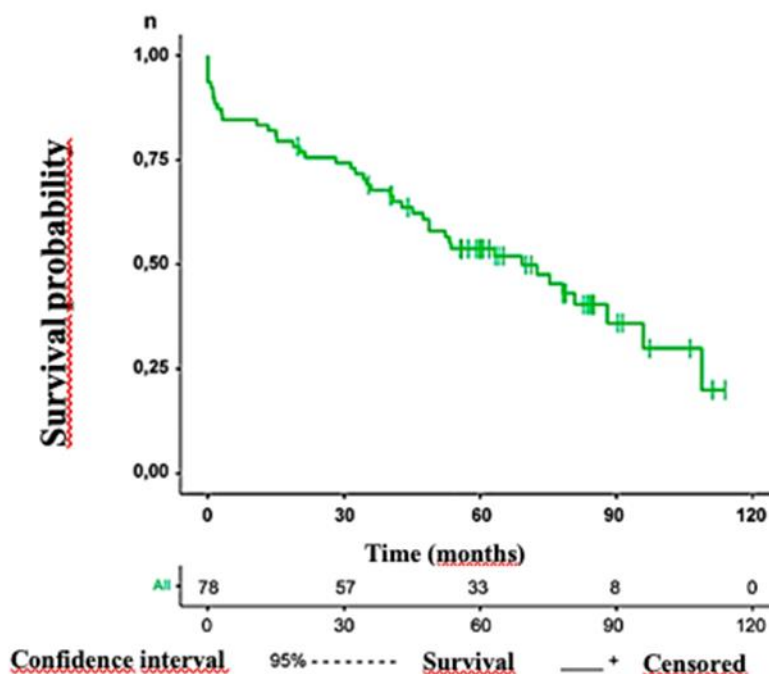


Figure 2. Kaplan-Meier curve depicting survival of the transcatheter aortic valve replacement (TAVR) patient population

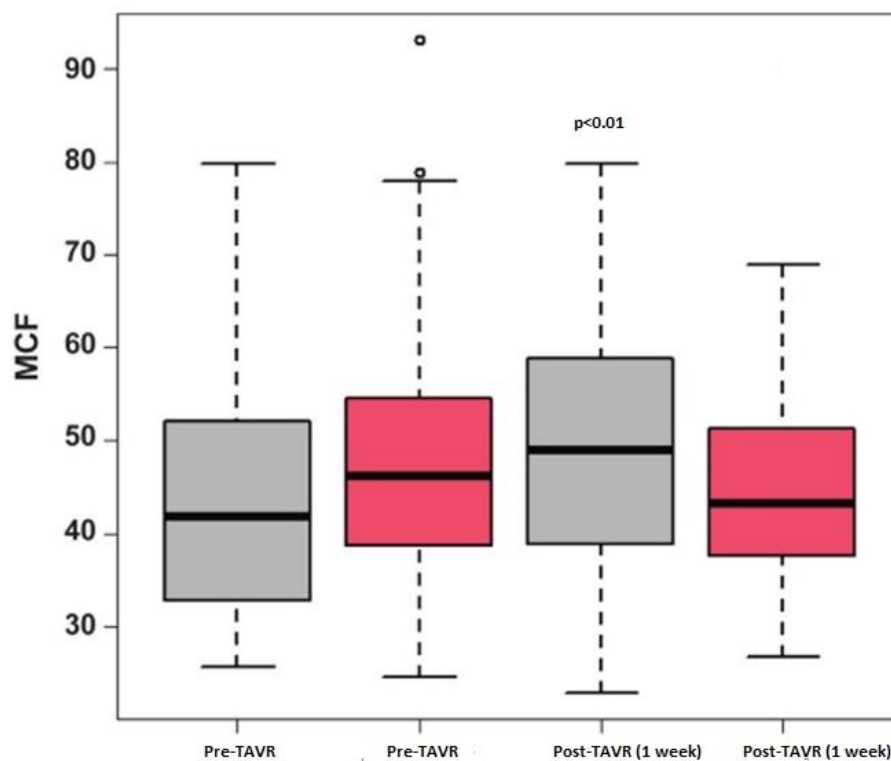


Figure 3. Myocardial contraction fraction (MCF) in patients who survived (gray boxes) or died (pink boxes) after transcatheter aortic valve replacement (TAVR). Surviving patients had increased MCF post-TAVR, while deceased patients did not show MCF improvement.

Study Limitations

This is a retrospective study from a single hospital, and therefore its results may not be extrapolated to other patient populations. Additionally, echocardiographic data were obtained from previously recorded exams, and further analyses (eg, of strain or right ventricular function) were not possible. It was also not possible to evaluate intra- or inter-observer variability of echocardiographic measures.

Conclusions

In this population of patients with severe aortic stenosis undergoing TAVR, MCF was reduced while LVEF was preserved, what may indicate unrecognized myocardial dysfunction. After TAVR, there was an increase in MCF in patients who survived and absence of increase in those who died. Therefore, MCF may be an easy, no-cost measure with prognostic value, which may merit incorporation into routine

echocardiographic evaluation of patients undergoing TAVR.

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Conflict of interest: None to declare

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