Bioelectrical phase angle in individuals after transcatheter aortic valve implantation

Maciej Stąpór[1], Agnieszka Stąpór[2], Elżbieta Ostrowska-Kaim[3], Jarosław Trębacz[1], Robert Sobczyński[4], Paweł Kleczyński[5], Janusz Konstanty-Kalandyk[6], Andrzej Gackowski[7], Krzysztof Żmudka[5], Bogusław Kapelak[6], Jacek Legutko[5]

[1]Clinical Department of Interventional Cardiology, St. John Paul II Hospital, Kraków, Poland
[2]Department of Clinical Oncology, Maria Sklodowska-Curie National Research Institute of Oncology, Kraków, Poland
[3]Noninvasive Cardiovascular Laboratory, St. John Paul II Hospital, Kraków, Poland
[4]Department of Cardiovascular Surgery and Transplantology, St. John Paul II Hospital, Kraków, Poland
[5]Department of Interventional Cardiology, Institute of Cardiology, St. John Paul II Hospital, Jagiellonian University Medical College, Kraków, Poland
[6]Department of Cardiovascular Surgery and Transplantology, Institute of Cardiology, St. John Paul II Hospital, Jagiellonian University Medical College, Kraków, Poland
[7]Department of Coronary Disease and Heart Failure, Institute of Cardiology, St. John Paul II Hospital, Jagiellonian University Medical College, Kraków, Poland

Correspondence to:
Prof. Jacek Legutko, MD, PhD, FESC,
Department of Interventional Cardiology, Institute of Cardiology,
Jagiellonian University Medical College, St. John Paul II Hospital,
Prądnicka 80, 31–202 Kraków, Poland,
phone: +48 12 614 35 01,
e-mail: jacek.legutko@uj.edu.pl

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INTRODUCTION

Bioelectrical impedance analysis (BIA) is frequently employed to estimate body composition and fluid status. BIA devices deliver electrical currents through surface electrodes, providing measurements of raw parameters like resistance, reactance, and phase angle (PA). Resistance represents the opposition to electrical current flow through tissues, while reactance gauges the conduction delay attributed to cell membranes and other tissue interfaces. PA results from the interaction between resistance and reactance and is considered to indicate cellular health and integrity [1]. These parameters are commonly used to indirectly assess body fluids or composition [2].

According to current literature, a low PA at 50 kHz is associated with various age-related conditions, including malnutrition, sarcopenia, and frailty, and it predicts disability and mortality in older adults [3, 4]. Additionally, PA may be an important prognostic factor in critically ill patients, as well as in patients with pulmonary and oncological conditions, as well as transplants and heart failure [5–9]. Generally, a high PA suggests good health.

Despite the association of sarcopenia with increased long-term mortality following transcatheter aortic valve implantation (TAVI), the role of PA in aortic stenosis and the TAVI population remains unexplored [10]. There is only one report on body composition analysis in patients undergoing TAVI using BIA [11]. Thus, this study primarily aimed to describe alterations in PA in patients undergoing TAVI at mid-term follow-up. The secondary objective was to assess the dynamics of the remaining BIA parameters.

METHODS

This was a prospective single-center study of subjects undergoing routine TAVI implantation, during which BIA was conducted. The study protocol was approved by the local Institutional Review Board (1072.6120.155.2018, dated October 25, 2018) and was in full compliance with the Declaration of Helsinki. Patients provided written informed consent to participate in the study.

Consecutive patients aged 75 years or older, scheduled for TAVI due to symptomatic severe aortic stenosis and without musculoskeletal disorders or a pacemaker were prospectively enrolled from November 2019 to September 2022. BIA was analyzed at the time of qualification, on the day of the procedure, and during the 6-month follow-up visit using a Bodystat 1500 analyzer (Bodystat Ltd., Douglas, Isle of Man, United Kingdom), capable of measuring PA at 50 kHz. The device estimated body composition parameters based on direct bioelectrical measurements and anthropometric data [1, 8].

Table 1. Bioimpedance analysis

	Baseline	Implantation	Follow-up	ANOVA/Friedman *P*-value
BMI, mean, kg/m^2	29.05 (4.9)	27.93 (5.8)	22.82 (6.13)	0.41
WHR, median (IQR)	0.94 (0.87–0.96)	0.91 (0.83–0.96)	0.81 (0.06)	0.42
Fat mass, median (IQR), kg	30 (25.7–37)	28.7 (23.20–40.2)	26 (16.7–27.4)	0.78
BFMI, median (IQR), kg/m^2	11.4 (8.50–15.3)	11.2 (8.4–17)	10.4 (5–11.3)	0.17
Fat-free mass, mean, kg	47.7 (10.74)	43.84 (6.39)	37.06 (4.15)	0.53
FFMI, mean, kg/m^2	17.23 (2.47)	16.14 (2.12)	13.32 (1.47–1.8)	0.3
Lean body mass, mean, kg	8.2 (3.71)	7.16 (2.03)	3.84 (1.99)	0.44
Water, mean, kg	39.51(7.38)	36.68 (4.48)	33.18 (3.58)	0.72
ECW, median (IQR), l	17.2 (16.2–19.3)	17.8 (15.9–19)	15.4 (14.7–15.9)	0.26
ICW median (IQR), l	21.6 (17.8–24.1)	19.2 (15.5–21.3)	17.2 (16.3–20.6)	0.42
Impedance 5 kHz, median (IQR), ohm	561 (496–650)	541 (502–699)	684 (682–703)	0.17
Impedance 50 kHz, median (IQR), ohm	509 (440–581)	524 (465–640)	625 (619–629)	0.47
Resistance 50 kHz, median (IQR), ohm	508 (438–579)	523 (464–638)	623 (617–626)	0.47
Reactance 50 kHz, mean, ohm	43.62 (9.89)	43.45 (7.78)	50.28 (5.09)	0.5
Phase angle 50 kHz, mean, °	4.86 (1.08)	4.49 (0.31)	4.62 (0.29)	0.46

Abbreviations: BFMI, body fat mass index; BMI, body mass index; ECW, extracellular water; FFMI, fat-free mass index; ICW, intracellular water; WHR, waist-hip ratio

Statistical analysis

Based on the results of the pilot study, the standard deviation (SD) of the difference in PA before and after the procedure was found to be 0.45°, with an expected difference in means of 0.6°. Considering a 50% variation in the assumed SD, a minimum of 21 patients were required to achieve a 0.9 probability of detecting the assumed difference at a significance level of 0.05 (two-sided).

Normality was assessed using the Shapiro–Wilk test. Descriptive statistics were presented as means (SDs) for continuous variables with a normal distribution, medians (interquartile ranges [IQR]) for non-normally distributed variables, and numbers (percentages) for categorical variables. Changes in BIA parameters were analyzed using repeated measures ANOVA for normally distributed variables, and the Friedman test was used for non-normally distributed data. A two-sided *P*-value <0.05 was considered to be statistically significant. Statistical analyses were conducted using Statistica 14.1 (Tibco Software, Inc., Palo Alto, CA, US).

RESULTS AND DISCUSSION

Seventy-one subjects were assessed for eligibility. Among them, 40 patients were excluded: 30 due to musculoskeletal disorders and 10 due to having a pacemaker or cardioverter-defibrillator. Ultimately, 31 patients with increased surgical risk (European System for Cardiac Operative Risk Evaluation [EuroSCORE] II: 3.54% [2.2%–8.23%]; Society of Thoracic Surgeons Score [STS]: 4% [2.2%–7.92%]) were included. To ensure an uninterrupted analysis of the impact of aortic stenosis on BIA parameters, patients with musculoskeletal disorders (osteoarthritis, joint replacements, myopathies, etc.) were excluded [12] Additionally, while BIA measurement appears to be safe in patients with implantable cardiac electronic devices, current medical practice guidelines advise against performing BIA in these subjects to avoid potential electromagnetic interference [13]. These restrictive inclusion criteria significantly reduced the group size.

The median age was 83 years (81–86), with 16 patients (51.61%) being women. Most of them were overweight or obese, with a mean body mass index of 29.05 kg/m^2 (4.9). Nineteen subjects (61.29%) reported symptoms in New York Heart Association class III or higher. The most common comorbidities were hypertension (27, 87.1%), coronary artery disease (15, 48.39%), type 2 diabetes (12, 38.71%), and atrial fibrillation (10, 32.26%). The median valve area was 0.8 cm^2 (0.7–0.9), and the mean gradients (peak and mean) were 74.17 mm Hg (22.1) and 46.46 mm Hg (14.35), respectively. Left ventricular systolic function was preserved with median ejection fraction (EF) of 60% (50–61). Mitral regurgitation (moderate or severe) was present in 7 patients (22.58%), and tricuspid regurgitation in 4 (12.9%). The mean N-terminal pro B-type natriuretic peptide was 2389.37 pg/ml (1949.7).

Only 21 subjects underwent implantation, with the remaining excluded due to death (4, 12.9%), consent withdrawal (2, 6.45%), opting out of TAVI (1, 3.23%), or urgent aortic valve replacement (1, 3.23%). A further reduction of the study group resulted from healthcare reorganization and patients' reluctance to engage with healthcare providers due to Severe Acute Respiratory Syndrome CoronaVirus 2 (SARS-CoV-2) pandemic.

Nineteen subjects (90.48%) underwent complete percutaneous access. Self-expandable valves were most commonly implanted (14, 66.66%). The median hospitalization time was 4 days (3–8). No in-hospital mortality was observed, and only one major vascular complication was recorded (4.76%). The mean prosthetic gradients (peak and mean) were 16.65 mm Hg (7.96) and 10.47 mm Hg (4.54), respectively. A moderate perivalvular leak was registered in 2 patients (9.52%). All patients were followed up and underwent analysis.

The PA and other bioimpedance indices remained unchanged during the follow-up (Table 1). So far, results of a similar analysis have not been published. Only Nitsche et al. [11] assessed BIA once, before TAVI, to evaluate the potential prognostic value of the method. Other authors assessed body composition and frailty using different methods, typically preoperatively [10, 14, 15].

Our study's limitations include a small sample size, as mentioned before, and a single-center design. These factors may have influenced the study's negative outcome.

In conclusion, phase angle and other bioimpedance indices do not appear to change at mid-term follow-up after TAVI. Further expanding the study group to enhance statistical power appears beneficial for a better understanding of this previously unexplored topic in the population of elderly individuals at risk of sarcopenia and frailty.

Article information

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