

# Control of water in the organism of elderly patients with severe chronic heart failure based on bioelectrical impedance analysis

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## Abstract

**Introduction.** Heart failure (HF) is defined as an abnormality of the cardiac structure and/or function resulting in clinical symptoms (dyspnoea) and signs (edema), poor quality of life and shortened survival [1]. Currently, the correlations between heart failure with reduced ejection fraction (EF) (HFrEF) and Bioelectrical impedance analysis (BIA) have been only scantily investigated.

**Aim.** The aim of this study is the evaluation of the possible role of Bioelectrical impedance analysis in patients with severe chronic heart failure.

**Materials and Methods.** We evaluated 30 elderly patients: 22 were males (mean age  $77 \pm 8$  years) and 8 females (mean age  $60 \pm 10$  years) with HFrEF at baseline electrocardiograph evaluation. All patients were classified as New York Heart Association (NYHA) class III at baseline and provided an informed consent.

The treatment with angiotensin-converting enzyme — inhibitors or angiotensin receptor blockers was interrupted and all patients were switched to sacubitril/valsartan 24/26 mg bid.

**Results.** At the end of the observation period, therapy with sacubitril/valsartan was associated with improved redistribution of body water and extracellular mass ( $19,4 \pm 3,0$  at baseline vs  $18,4 \pm 2,6$  Kg/m at 1 month;  $p=0,001$ ) and body weight reduction ( $81 \pm 8$  vs  $78 \pm 8$  Kg;  $p=0,002$ ). Overall, this therapy resulted in a prompt (1 month) amelioration in the distribution of body water and decreased body weight, as well as improved clinical outcomes (dyspnoea) at physical examination.

**Conclusion.** In this small case series, we investigated the correlation between sacubitril/valsartan and body water modification in elderly patients with HFrEF. Our preliminary data show that Bioelectrical impedance analysis could be a new effective approach in the evaluation and follow-up of elderly patients with chronic heart failure and reduced ejection fraction.

*Key words:* Chronic Heart Failure; Bioelectrical impedance analysis (BIA); water body composition, Impedance; Reactance.

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References (7)

## Introduction

Electrical properties of tissues have been described since 1872. These properties were further described for a wider range of frequencies on a larger range of tissues, including those that were damaged or undergoing change after death.

Thomasset A. (1962) [5] conducted the original studies using electrical impedance measurements as an index of total body water (TBW), using two subcutaneously inserted needles.

Nyboer J. (1959) and Hoffer E.C. et al. (1969) [6, 7] first introduced the four-surface electrode BIA technique.

A disadvantage of surface electrodes is that a high current (800  $\mu$ A) and high voltage must be utilized to decrease the instability of injected current related to cutaneous impedance (10 000  $\Omega/\text{cm}^2$ ).

A variety of single frequency BIA analyzers then became commercially available, and by the 1990s, the market included several multi-frequency analyzers. The use of BIA as a bedside method has increased because the equipment is portable and

safe, the procedure is simple and non-invasive, and the results are reproducible and rapidly obtained. More recently, segmental BIA has been developed to overcome inconsistencies between resistance (R) and body mass of the trunk.

The impedance of cellular tissue can be modeled as a resistor (representing the extracellular path) in parallel with a resistor and capacitor in series (representing the intracellular path). This results in a change in impedance versus the frequency used in the measurement. The impedance measurement is generally measured from the wrist to the contralateral ankle and uses either two or four electrodes. A small current on the order of 1–10  $\mu$ A is passed between two electrodes, and the voltage is measured between the same (for a two electrode configuration) or between the other two electrodes.

Heart failure (HF) is defined as an abnormality of the cardiac structure and/or function resulting in clinical symptoms (dyspnoea) and signs (edema), poor quality of life and shortened survival [1].

Currently, the correlations between heart failure with reduced ejection fraction (EF) (HFrEF) and bioelectrical impedance analysis

(BIA) have been only scantily investigated. Importantly, there are no trials evaluating HFrEF patients by bioelectrical impedance analysis. Bioelectrical impedance analysis is an instrumental method to evaluate the body composition about water and fat mass.

**Aim.** The aim of the present study was to evaluate the role of sacubitril/valsartan on heart failure. We believe that this information can provide insight to an evolution of HF management in elderly patients.

## Materials and Methods

We evaluated 30 elderly patients: 22 were males (mean age  $77 \pm 8$  years) and 8 – females (mean age  $60 \pm 10$  years) with HFrEF at baseline electrocardiograph evaluation. All patients were classified as New York Heart Association (NYHA) class III at baseline and provided an informed consent to the use of their data for research purposes. All patients were recruited in our Internal Medicine Department.

The treatment with angiotensin-converting enzyme (ACE)-inhibitors or angiotensin receptor blockers (ARBs) was interrupted and all patients were switched to sacubitril/valsartan 24/26 mg bid.

Patients were followed by monthly clinical and laboratory examinations. In line with our standard practice, we evaluated bioelectrical impedance analysis. Bioelectrical impedance analysis is a technique that allows evaluating the resistance of the body to the passage of low intensity electric currents. With this method it is possible to calculate the percentage of body water and fat mass. [1].

All the above-mentioned parameters were assessed at baseline and after 1 month of therapy; explorative comparisons between

these time points were performed by the Student t test or the Wilcoxon signed rank test, as appropriate and variables are expressed as mean  $\pm$  SD.

A 2-sided p-value  $< 0,05$  was considered significant. All analyses were performed using Sigmasat v. 3.5 Systat Software Inc.

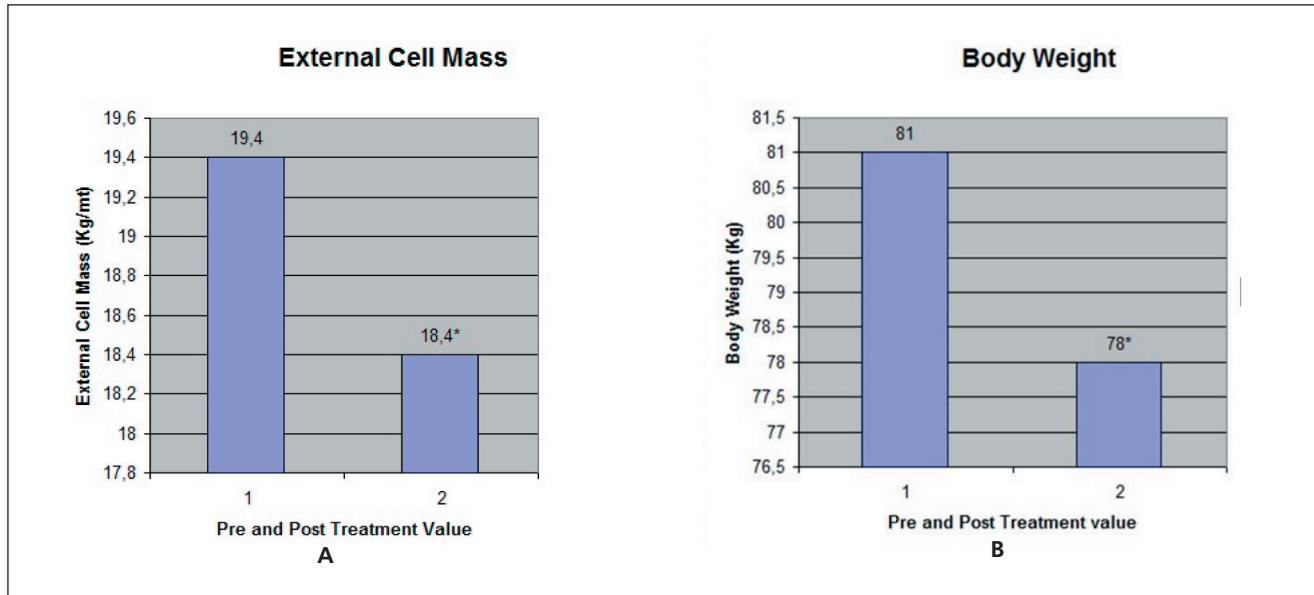
At baseline, 4 patients had laboratory test compatible with moderate kidney dysfunction and 4 patients had glucose value compatible with type II diabetes. All patients had mild hypertension and normal electrolyte levels (due to adapted doses of different diuretic treatments). In all cases, patients continued treatment with diuretics (furosemide 25 mg twice daily and spironolactone 100 mg/day) and beta-blockers (bisoprolol 2,5 mg/day).

One patient did not complete the 1-month period of observation due to the onset of orthostatic hypotension.

## Results

At the end of the observation period, therapy with sacubitril/valsartan was associated with improved redistribution of body water and extracellular mass ( $19,4 \pm 3,0$  at baseline vs  $18,4 \pm 2,6$  Kg/m at 1 month;  $p=0,001$ ) and body weight reduction ( $81 \pm 8$  vs  $78 \pm 8$  Kg;  $p=0,002$ ). (Pic. 1 A, B; tab. 1).

The patients received the same medication because during the treatment there are only low variation of the blood pressure and there are not side effects. Moreover, all patients reported improved clinical outcomes (i.e. reduction of dyspnoea, mean duration of symptoms and improvement of walking test). All patients do not have experienced any severe side effects.



**Pic. 1. (A) Redistribution of body water and extracellular mass; (B) Body weight reduction.**

**Tab. 1. Descriptive Statistics of BMC (body cell mass), ECM (external cell mass), and Body weight.**

	Value (pre)	Value (post)	p Value
BMC (Kg/m)	14,6 + 3,6	14,8 + 3,4	$p=0,758$
EMC (kg/m)	19,4 + 3	18,4 + 2,6	$p=0,001$
Weight (Kg)	81 + 8	78 + 8	$p=0,002$

## Conclusions

In this small case series, we investigated the correlation between sacubitril/valsartan and body water modification in elderly patients with HFrEF. Overall, this therapy resulted in a prompt (1 month) amelioration in the distribution of body water and decreased body weight, as well as improved clinical outcomes (dyspnoea) at physical examination. Of note, we initiated sacubitril/valsartan treatment at the lowest possible dose for HFrEF therapy [3–4].

Overall, these findings, if also confirmed by further larger trials, support the use of sacubitril/valsartan in elderly patients with HFrEF since this therapy has been shown not to influence the examined parameters and renal function, in particular in patients with chronic kidney disease.

### Transparency

Declaration of financial/other relationships: None.

Author contributions: none.

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