

# Correlations between hand grip strength and NYHA class II-III heart failure

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## ABSTRACT

*The physical rehabilitation of patients with cardiovascular pathology is poorly studied and developed in our country, especially in patients with heart failure. There are studies in the literature that confirm that a decrease in the grasping force of the hand is associated with an increase in morbidity and mortality. The physical deconditioning of patients with heart failure can be assessed with the help of the Amadeo robot, which is a device capable of measuring the flexion and extension force of the hand in kilograms.*

**Material and methods.** *We prospectively analyzed a group of 44 patients diagnosed with heart failure class II-III NYHA who were hospitalized between June 17 and July 15, 2019 in the Cardiology Department of Elias Hospital. We evaluated the grasping force of the hand of patients with heart failure using the Amadeo robot. The Amadeo robot is a device used in the rehabilitation of stroke patients, which can measure the flexion and extension force of the hand using sensors attached to the hand and fingers.*

**Results.** *By evaluating patients with heart failure using the Amadeo robot, the average value of the hand extension force was 2.364 kg at admission and 2.264 kg at discharge. The flex-ion force of the hand was 6.78 kg at admission and 7.361 kg at discharge.*

*Patients enrolled in the study who had valvulopathies, atrial fibrillation and diabetes had a lower value of the extension force of the hand compared to patients with heart failure who did not have these pathologies.*

*Patients with valvulopathies, high blood pressure, and ischemic heart disease also had a lower flexion strength than those without these diseases.*

**Conclusions.** *It is known that the grasping force of the hand is an important indicator in assessing the fragility status of patients. Patients with heart failure are frail patients with multiple comorbidities in which physical deconditioning acts as a negative prognostic factor on morbidity, mortality, and increased hospitalization rates. Thus, the physical rehabilitation of patients with heart failure is essential for increasing the quality of life and also for decreasing morbidity and mortality and the rate of hospitalization.*

**Keywords:** physical deconditioning, heart failure, robot Amadeo

## INTRODUCTION

Heart failure is a public health problem, associated with high morbidity and mortality, with high hospital costs, affecting especially adults over 60 years. Despite the effective drug and interventional treatments meant to reduce mortality from this condition, the rate of hospitalization of patients with heart failure remains high [1].

The incidence of heart failure increases with age and is higher in men than in women. High blood pressure, ischemic heart disease, diabetes, dyslipidemia are risk factors that precede heart failure [2].

Heart failure is a syndrome characterized by a decreased ability of the heart to pump blood to the organs, leading to symptoms such as dyspnea, fatigue and peripheral edema [3].

The aging process associated with heart failure syndrome leads to a decrease in the patient's functional capacity and implicitly to a decrease in the quality of life [4].

Physical rehabilitation improves the quality of life of the patients with heart failure, increasing survival rates and being associated with a decrease in the rate of re-hospitalization [5].

Improving functional capacity should be the main goal of rehabilitation programs for patients with heart failure. Physical rehabilitation of patients with heart failure should be a multidisciplinary activity that includes a continuous exercise program, initiated immediately after the acute phase of the disease. We need to keep in mind that patients with heart failure are generally elderly, with multiple comorbidities [6].

A first step in establishing a plan for the physical rehabilitation of a patient with heart failure should be the correct assessment of the patient.

The hand grip strength may be correlated with mortality and rehospitalization rates in patients with heart failure [7].

The Amadeo robot is a device that combines sensors attached to the hand and fingers, used especially in physical rehabilitation programs for patients with stroke [8]. With the help of sensors attached to the fingers, this robot is able to measure the flexion and extension force of the hand. This force is expressed in kilograms and thus evaluates the gripping force of the hand. The Amadeo robot uses tyro S software and offers a wide range of hand and finger therapies.

## METHODS

We conducted a prospective study that included 44 patients with NYHA class II-III heart failure. The study was conducted between June 15 and July 17, 2019 and included patients admitted to the cardiology department of Elias University Hospital. The study methodol-

ogy was explained to each patient and a handwritten signature was obtained for the study participation agreement. Patients included in the study were patients who were admitted with decompensated acute heart failure and were evaluated immediately after administration of the acute phase treatment. The drug treatment was established by the attending physician, unrelated to the study.

Patients were evaluated using the Amadeo robot, both immediately after the acute phase of heart failure and on the day before discharge. Using the Amadeo robot I measured the flexion and extension capacity of the hand, capacity expressed in kilograms. The assessment was performed using the patient's dominant hand.

Inclusion criteria: NYHA class II-III heart failure patients, patients without psychiatric pathology, age over 18 years, informed consent signed.

Exclusion criteria: immobilized patients, patients with decompensated acute heart failure, infections, acute myocardial infarction, pulmonary thromboembolism, acute pulmonary edema, acute stroke or sequelae, the presence of neoplasms.

The agreement to participate in the study was obtained from both patients and the attending physician.

The treatment of the patients was determined by the attending physician.

The initial stage of the study consisted of collecting data on medical history, risk factors, drug treatment at home, clinical examination, information obtained from both the patient and the clinical observation sheet.

Data on paraclinical investigations performed were also collected: electrocardiogram, echocardiography, blood tests.

The parameters followed were: flexion force of the hand expressed in kilograms after the treatment of the acute phase of heart failure and on the day before discharge, force of extension of the hand expressed in kilograms after the treatment of the acute phase of heart failure and on the day before discharge, age, sex patient, weight, height, smoker/non-smoker status, presence of hypertension, dyslipidemia, atrial fibrillation, diabetes, ischemic heart disease, echocardiographic data, electrocardiographic changes, biological parameters (oxygen saturation, hemoglobin, glycemia, creatinine).

The evaluation of the flexion and extension of the hand was performed using the Amadeo Robot, which is an adjustable device for each patient. Data on echocardiography, electrocardiogram and biological samples were collected from the patient's observation sheet and investigations requested by the attending physician.

## STATISTICAL ANALYSIS

The data analysis was performed in the R programming language, version 3.6.2, and some tables and

graphs in the Excel application of the Microsoft 365 for Enterprise package.

To evaluate the type of distribution i.e. whether the data in a batch were normally distributed or not, the Shapiro-Wilk test was used, with a significance threshold of 0.05.

The Pearson index was used to make correlations. Chi-square test was used for the categorical variables. The McNemar test was used for the categorical-pair variables.

## RESULTS

Our study included 44 patients with NYHA class II-III heart failure, with a mean age of 69.18 years. Of the 44 patients studied, 57% were male and 43% were female.

Regarding the risk factors, we observed the following: out of 44 patients, 35 (representing a percentage of 80%) were hypertensive, 26 (59%) patients had ischemic heart disease, 10 (23%) patients had diabetes, 13 (30%) were smokers, 38 (86%) patients had dyslipidemia.

Regarding the personal pathological antecedents, we observed the presence of valvulopathies in 80% of patients, 57% having a history of paroxysmal or permanent atrial fibrillation.

We analyzed the cardiovascular risk factors and the presence of personal pathological history according to the sex of the patients, observing the following: out of the total number of women, 73% had valvulopathies, 78.9% were hypertensive, 57.89% had ischemic heart disease, 31.57% they were diabetic, 21.05% smokers and 78.95% had dyslipidemia. Regarding male patients, 64% had valvulopathies, 80% had hypertension, 56% had atrial fibrillation, 60% had ischemic heart disease, 16% were diabetic, 36% smokers and 92% dyslipidemic.

The mean value of the extension force of the hand of patients with heart failure was 2.364 kg at admission and 2.264 kg at discharge with a p-value = 0.4507.

In male patients the average value of the extension force was 2.5 kg and in female patients the average value was 2.3 kg, with a p-value = 0.1877

Patients with valvulopathies had an average extension force value of 2.250 kg while those without valvulopathies had an average extension force of 2.6 kg with a p-value = 0.03396, a significant value in our analysis.

Patients with hypertension had an average value of the extension force of 2.4 kg, and those without hypertension, the average extension force was 1.8 kg, with a p-value = 0.05256.

Patients with paroxysmal/permanent atrial fibrillation had an average extension force of 2.3 kg, while those without atrial fibrillation had an average of 2.5 kg, with a p-value = 0.7667.

Diabetics had an average extension force value of 2.550 kg, while patients without diabetes had an average value of 2.3 kg with a p-value = 0.2017.

The mean flexion strength of the hand of patients with heart failure was 6.78 kg at admission, while at discharge was 7.361 kg, with a p-value = 0.02216.

Patients with valvulopathies had an average flexion force value of 6.350 kg and those without valvulopathies had an average value of 6.550 kg, with a p-value = 0.236.

Hypertensive patients had an average flexion strength of 6.3 kg while those without hypertension had an average value of 8 kg, having a p-value = 0.6836.

Patients with ischemic heart disease had an average flexion strength of 6.250 kg, while those without ischemic heart disease had an average value of 6.6 kg, p-value = 0.4376.

The mean value of flexion strength was identical in diabetic and non-diabetic patients, 6.350 kg with a p-value = 0.6948.

In patients with dyslipidemia the average value of the flexion force was 6.450 kg, and in those without dyslipidemia it was 5.050, p-value = 0.3555

Smokers had an average flexion strength value of 7 kg, while non-smokers had an average flexion strength value of 6.1 kg with a p-value = 0.09687

It was observed that the age of the patients was a significant factor correlating with the flexion force of the hand, the older the patients, the lower the flexion force of the hand, p-value = 0.04157.

No adverse events were reported during the use of the Amadeo robot to measure flexion and extension force in patients with heart failure.

**TABLE 1.** Correlation between flexion strength and risk factors

RISK FACTORS	W (Wilcoxon Mann-Whitney)	p-value
Sex	118.5	<b>0.0050</b>
ICC	209	<b>0.0495</b>
Valvulopathies	257.5	0.2360
HTA	172	0.6836
FIA	250	0.7760
BCI	267	0.4376
DZ_tip_II	184.5	0.6948
Smoker	136.5	<b>0.0969</b>
High_cholesterol	86.5	0.3555

**TABLE 2.** Correlation between extension strength and risk factors

RISK FACTORS	W (Wilcoxon Mann-Whitney)	p-value
Sex	181.5	0.1877
ICC	189.5	0.1701
Valvulopathies	294.5	<b>0.0340</b>
HTA	90.5	<b>0.0526</b>
FIA	250.5	0.7667
BCI	201	0.4370
DZ_tip_II	124	0.2017
Smoker	184	0.6613
High_cholesterol	58	<b>0.0572</b>

## DISCUSSION

The use of the Amadeo robot in patients with heart failure is a safe and effective method of assessing the flexion and extension force of the hand. The aim of this study was to assess the strength of the hand grip in patients with heart failure and especially to establish the role that risk factors and associated pathology have on the patient's physical condition. In our study, risk factors such as hypertension, diabetes, smoking, dyslipidemia are associated with decreased flexion and extension of the hand, but without significant statistical significance. The statistical weakness can be explained by the small number of patients studied.

The Amadeo robot is used especially in stroke patients. There are studies that show that using the Amadeo robot in stroke patients improves both hand motor function and cognitive function [9].

In the early stages, after the onset of a stroke, the intensive use of the Amadeo robot in the recovery of hand function showed favorable results, with an improvement in motor deficit in these patients. In both flexor and extensor muscles, an increase in strength was observed after 20 sessions of robotic treatment along with the classic treatment [10].

Data from the literature show a broader reshaping of the sensorimotor plasticity of patients who underwent rehabilitation using the Amadeo robot, with an improvement in both the clinical condition and the neurophysiological condition of these patients [11].

A meta-analysis showed that hand force can be used as a predictor of mortality from both cardiac and other causes and hospitalization rates in patients with heart failure. Sarcopenia and muscle strength are the main elements of the fragility syndrome, also found in patients with heart disease, with the main effect on the quality of life. It is well known that patients with heart

failure are fragile patients with cachexia and sarcopenia [7].

The hand grip strength is associated with fragility, comorbidities and increased risk of cardiovascular events. Measuring hand strength may be useful in identifying fragility in patients with cardio-vascular pathology. The fragile status of these patients, assessed by measuring hand muscle strength, may be associated with comorbidities, sarcopenia, and an increased risk of cardiovascular events. These findings suggest that hand strength measurement can be used as a simple and safe screening tool in patients with cardiovascular disease [12].

Studies have also been shown that a low value of the hand grip force among the healthy population is associated in the long term with an increased risk of developing cardiovascular disease [13].

## CONCLUSIONS

Following the study of 44 patients with NYHA class II-III heart failure, using the Amadeo robot to assess the flexion and extension force of the hand, we can say that risk factors such as hypertension, type II diabetes, dyslipidemia and age may be a significant influence on hand mobility. The patient with heart failure is a fragile patient with multiple comorbidities. Physical deconditioning in patients with heart failure is the effect of the underlying disease, but it is also the cause of comorbidities. Low mobility is associated with an increased risk of cardiovascular disease.

The main purpose of physical rehabilitation is to increase the patient's quality of life, increase mobility and thus decrease the cardiovascular risk and implicitly decrease long-term mortality and morbidity.

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