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Original article

Gait speed and hospital readmission after coronary artery bypass grafting

Velocidade de marcha e reinternação hospitalar após cirurgia de revascularização do miocárdio

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ABSTRACT

Introduction: Gait speed can be applied, predicting outcomes associated with hospital stay such as length of stay and/or discharge. Despite these studies that correlate gait speed with the aforementioned outcomes, when we deal with cardiac surgery there is a gap. **Objective:** Verify whether gait speed is associated with the risk of hospital readmission in the postoperative period of coronary artery bypass grafting. **Methodology:** This is a prospective cohort study. In the preoperative period, all patients underwent a 10-meter gait speed test and repeated at hospital discharge. After the repetition of the gait speed test, patients were divided into two groups: slow and non-slow. Those who were not discharged walked less than 1.0 m/s occupied the slow group and those who were above 1.0 m/s were classified as not slow. Patients were followed for six months to observe the primary outcome, which was the need for hospital readmission. **Results:** The 6 months rate of readmission was 58%(14/24;95%CI 49% to 80%) among slow walkers and 17% (6/36; 95%CI 13% to 46%) among non-slow walkers (p=0.002).In univariate analysis, gait speed, treated as a continuous variable, was associated with the primary outcome (HR0.6;95%CI 0.2 to 0.9), while age, gender, BMI, MV and CPB time were not. In the multivariate model including age, gender, BMI, MV and CPB time, gait speed remained the only variable associated with readmission (multivariate HR:0.5,95%CI 0.1 to 0.7, p=0.02). **Conclusion:** Our data suggest that gait speed is associated with hospital readmission in patients undergoing to coronary artery bypass grafting.

Keywords: critical care; walk test; exercise; early walking; intensive care units.

RESUMO

Introdução: A velocidade de marcha pode ser aplicada, prevendo resultados associados à estadia hospitalar, tais como tempo de internação e/ou alta. Apesar de estudos que correlacionam a velocidade de marcha com os resultados acima mencionados, quando lidamos com cirurgia cardíaca, há uma lacuna. **Objetivo:** Verificar se a velocidade de marcha está associada ao risco de readmissão hospitalar no período pós-operatório de revascularização do miocárdio. **Metodologia:** Este é um estudo de coorte prospectivo. No período pré-operatório, todos os pacientes foram submetidos a um teste de velocidade de marcha de 10 metros e repetido na alta hospitalar. Após a repetição do teste de velocidade de marcha, os pacientes foram divididos em dois grupos: lentos e não lentos. Aqueles que andaram menos de 1,0 m/s ocuparam o grupo lento e aqueles que estavam acima de 1,0 m/s foram classificados como não lentos. Os pacientes foram acompanhados durante seis meses para observar o resultado primário, que era a necessidade de readmissão hospitalar. **Resultados:** A taxa de readmissão de 6 meses foi de 58%(14/24;95%CI49%a80%) entre os lentos e 17% (6/36;95%CI13%a46%) entre os não lentos(p=0,002). Na análise univariada, a velocidade de marcha, tratada como uma variável contínua, foi associada ao resultado primário (HR0,6;95%CI0,2a0,9), enquanto que idade, sexo, IMC, VM e tempo de CEC não foram. No modelo multivariado incluindo idade, sexo, IMC, VM e tempo de CEC, a velocidade de marcha permaneceu a única variável associada à readmissão (multivariado HR:0,5,95%CI0,1a0,7p=0,02). **Conclusão:** Nossos dados sugerem que a velocidade de marcha está associada à readmissão hospitalar em pacientes submetidos à cirurgia de revascularização do miocárdio.

Palavras-chave: cuidados intensivos; teste de marcha; exercício; deambulação precoce; unidades de terapia intensiva.

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Introduction

Nos últIn recent years, heart disease has increased considerably, causing a large number of surgical procedures that aim to increase patient survival [1]. There are several risks and complications of this form of treatment that can interfere in pulmonary capacity and physical performance, reducing the functionality of patients. The decrease in daily activities of life due to prolonged hospitalization can also lead to several neuromuscular, pulmonary, functional and quality of life problems [2].

Patients after cardiac surgery tend to have muscle weakness due to lack of movement, loss of physical conditioning, inflammation, use of drugs such as corticosteroids, muscle relaxants, neuromuscular blockers, antibiotics and in the presence of associated neuromuscular syndromes [3]. This weakness may be associated with decreased walking speed in the postoperative period, with this variable being associated with worse outcomes such as mortality and hospital readmission in other profiles such as hypercapnic heart and respiratory failure [4,5].

Gait speed can be assessed using the 10-meter test [6]. This test can be applied preoperatively, predicting outcomes associated with hospital stay such as length of stay and/or discharge [7,8]. Changes in the organism with the surgical procedure cause a decline in the patient's functional activities in the postoperative phase, making walking a complex skill, as gait speed tends to decrease due to the physiological changes that occur such as the reduction of muscle strength [9].

Despite these studies that correlate gait speed with the aforementioned outcomes, when we deal with cardiac surgery there is a gap. This answer can be useful for making decisions and directing appropriate intervention to minimize these adverse results. The aim of this study was to verify whether gait speed is associated with the risk of hospital readmission in the postoperative period of coronary artery bypass grafting.

Methods

Study design

This is a prospective cohort study that was conducted between January 2018 and July 2019, in patients undergoing to coronary artery bypass grafting (CABG) at the *Instituto Nobre de Cardiologia / Santa Casa de Misericórdia*, in the city of *Feira de Santana (BA)*. The research was approved by the Research Ethics Committee of *Faculdade Nobre*, under number 796,580 and the patients were included after signing the informed consent form.

Eligibility criteria

Patients aged over 18 years, of both sexes, submitted to coronary artery bypass graft surgery who used cardiopulmonary bypass and median sternotomy were included. Individuals with some physical limitation, such as sequelae of stroke and lower

limb amputation, uncontrolled arrhythmias, changes in blood pressure at the time of the test (SBP < 80 or > 160 mmHg), angina, electrocardiographic changes were excluded.

Study protocol

In the preoperative period, all patients included in the survey underwent a 10-meter walk test. The following day, everyone underwent a surgical procedure, was referred to the Intensive Care Unit (ICU) and, being discharged, was directed to the inpatient unit. In all these moments, they received routine care from the unit without any influence from the researchers. All patients were assisted by the physiotherapist on duty and performed breathing exercises, orthostasis training on the first postoperative day, sitting in the chair and ambulation on the second postoperative day when there was no clinical contraindication (use of vasoactive drugs, uncontrolled pain or infectious changes). On the day of hospital discharge, patients repeated the 10-meter test.

After the repetition of the gait speed test, patients were divided into two groups: slow and non-slow. The cutoff point used was 1.0 m/s based on the study by Odonkor *et al.* [10]. Those who were not discharged walked less than 1.0 m/s occupied the slow group and those who were above 1.0 m/s were classified as not slow. Patients were followed for six months to observe the primary outcome, which was the need for hospital readmission. There was a comparison between the groups of the initial, final butch speed, delta velocity, cardiopulmonary bypass (CPB), mechanical ventilation (MV), Intensive Care Unit (ICU) time and hospital stay. It is worth mentioning that readmission in any hospital was counted for this study, patients were contacted by telephone seeking this type of information.

Measuring instruments

The 10-meter speed test took place in a corridor with no movement of people. A space of 14 meters was used, the first two for acceleration and the last two for deceleration [6]. Therefore, the 10 meters were used to assess speed. The test was performed three times and an average of the three values was calculated. Before and after each repetition, the patients had their vital signs checked.

For the test, a chronometer was also used, evaluating the time the patient needed to walk for 10 meters and expressed in meters/second [7] (Figure 1). All repetitions were performed by a single examiner.

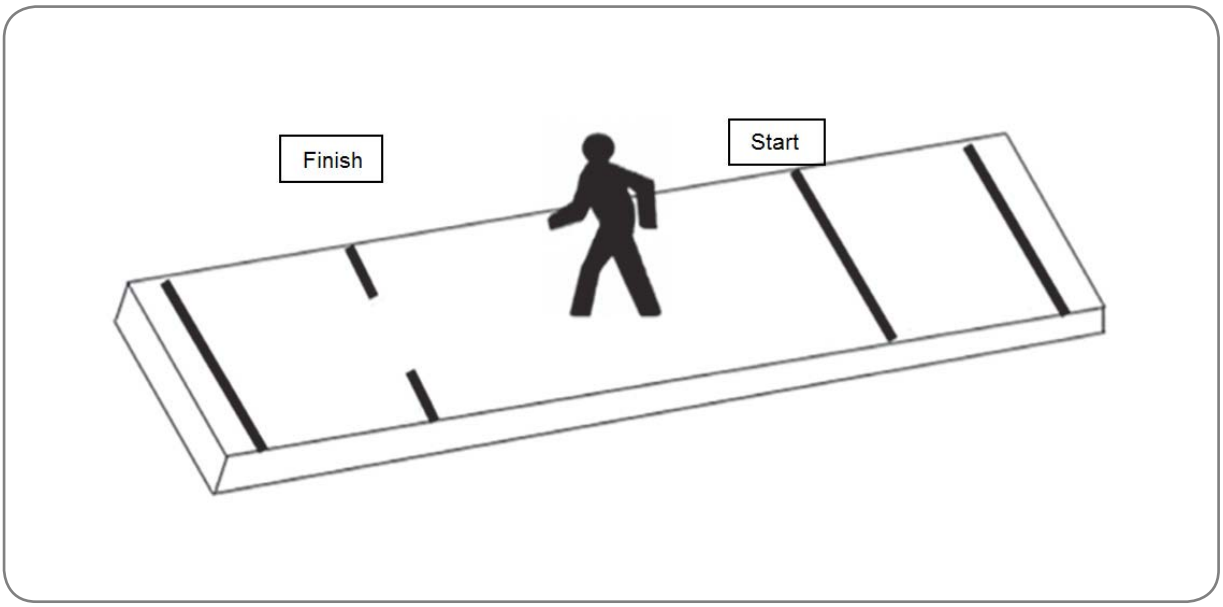

Figure 1 - 10-meter speed test

Statistical analysis

We then adjusted the association of gait speed with the primary outcome by using a multivariable Cox proportional hazards model adjusting for age, BMI and sex, and additionally adjusting for clinically relevant covariates (MV and CPB time). All tests for statistical significance were two-tailed with an alpha level of 0.05. Analyses were conducted using *SPSS version 20.0* and *R version 2.14.113*.

Results

During the research period 71 patients were admitted, and fifteen were excluded due to physical limitations. Thus, 56 patients were evaluated, of these 38 (63%) were male, mean age 61 ± 9 years, with an average BMI of 27 ± 5 km/m², with the most prevalent comorbidity being sedentary with 19 (63%). The other data are shown in Table I.

The average walking speed in the slow group was 0.6 m/s, while in the non-slow group it was 1.2 m/s. Twenty patients (40%) were readmitted to the hospital during the observation period of 6 months. Of those, 14 (70%) were slow walkers, as defined by a gait speed of less than 1.0 m/s, and 6 (30%) were non-slow walkers. The 6 months rate of readmission was 58% (14/24; 95% CI 49% to 80%) among slow walkers and 17% (6/36; 95% CI 13% to 46%) among non-slow walkers (p = 0.002). In univariate analysis, gait speed, treated as a continuous variable, was associated with the primary outcome (HR 0.6; 95% CI 0.2 to 0.9), while age, gender, BMI, MV and CPB time were not (table II). In the multivariate model including age, gender, BMI, MV and CPB time, gait speed remained the only variable associated with readmission (multivariate HR: 0.5, 95% CI 0.1 to 0.7 p = 0.02 (Table II).

Table I - Clinical, surgical and functional data of the studied patients

Variables	Slow walk (n = 20)	Non-slow walk (n = 36)	p
Gender			0,72[a]
Male	12 (60%)	22 (61%)	
Female	8 (33%)	14 (39%)	
Age (years)	60 ± 9	62 ± 10	0.53[b]
BMI (kg/m²)	28 ± 4	26 ± 6	0.32[b]
Comorbidities			
Diabetes	12 (60%)	22 (61%)	0.69[a]
SAH	11 (50%)	15 (42%)	0.43[a]
Dyslipidemia	11 (50%)	20 (56%)	0.51[a]
Sedentary lifestyle	14 (70%)	22 (61%)	0.41[a]
AMI	8 (40%)	14 (39%)	0.76[a]
NYHA			
I	4 (20%)	7 (19%)	0.76 [a]
II	4 (20%)	7 (19%)	0.64 [a]
III	8 (40%)	17 (48%)	0.53 [a]
IV	4 (20%)	5 (14%)	0.32 [a]
CPB Time (min)	88 ± 20	90 ± 22	0.45[b]
MV time (hours)	8 ± 3	6 ± 3	0.58[b]
Ejection fraction (%)	42 ± 7	45 ± 4	0.23[b]
Number of grafts	2.4 ± 0.8	2.6 ± 0.5	0.66[b]

[a]Chi-square; [b]Independent Student's T test; AMI = Acute Myocardial Infarction; BMI = Body Mass Index; CPB = cardiopulmonary bypass; MV = Mechanical ventilation; NYHA = New York Heart Association; SAH = Systemic Arterial Hypertension

Table II - Univariate and multivariate associations between predictive variables and readmission

Predictor	Univariate HR (95% CI)	P value	Multivariate HR (95% CI)	P value
Gait speed	0.6 (0.2 - 0.9)	0.02	0.5 (0.1 - 0.7)	0.02
Age	0.9 (0.6 - 1.3)	0.29	0.8 (0.5 - 1.2)	0.47
Male gender	1.1 (0.7 - 1.6)	0.80	1.0 (0.7 - 1.3)	0.62
BMI	1.0 (0.9 - 1.3)	0.65	0.8 (0.5 - 1.2)	0.12
MV time	1.2 (0.8 - 1.5)	0.21	0.99 (0.9 - 1.1)	0.76
CPB time	0.9 (0.7 - 1.2)	0.71	0.7 (0.5 - 1.2)	0.45

BMI = Body Mass Index; MV = Mechanical Ventilation; CPB = Cardiopulmonary bypass

Discussion

Based on the results of this prospective cohort study, gait speed was associated with hospital readmission of patients undergoing to coronary artery bypass grafting. Walking more slowly (<1 m/s) was associated with hospital readmission, but variables such as age, male gender, BMI, MV and CPB team were not related to the outcome in six months.

Previous studies suggest that gait speed is an independent variable for mortality and hospital readmission in survivors of acute hypercapnic respiratory failure and heart failure [11,12]. Being an extremely simple and feasible test for the application of the practice, we suggest its adoption by hospital services aiming at reducing hospital readmissions, thus minimizing costs, improving the survival and quality of life of these patients.

Afilalo *et al*. [13] demonstrated that patients with low gait speed in the preoperative period have a higher rate of morbidity and mortality during the ICU stay. They also found that factors such as female gender and diabetics made up the slow speed group. In our study, we did not find any difference regarding gender, age or comorbidities, which may be associated with a smaller sample size in the present study. This result only reinforces the need to stratify patients with a higher risk of complications or hospital readmission, and gait speed is a useful tool.

In this rationale, Sawatzky *et al*. [14] found that the application of a program in the preoperative period can increase gait speed, with this effect remaining for up to three months after the procedure. On the other hand, Cerqueira *et al*. [15] did not demonstrate any impact when applied to neuromuscular electrical stimulation in the postoperative period.

A possible explanation for reducing gait speed and increasing the risk of hospital readmission is fragility. It is considered a multidimensional syndrome resulting from the reduction of physiological reserves and an increase in physical and functional decline when exposed to external stressors [16]. After cardiac surgery, factors such as cardiopulmonary bypass, surgical incision, pleurotomy and duration of mechanical ventilation generate pulmonary dysfunction and decrease in physiological reserves [17]. Bed restriction time contributes to physical and functional decline [18,19]. Our group demonstrated that after myocardial revascularization it generates a decrease in functional capacity, observed through the six-minute walk test [20]. We found that performing inspiratory muscle training helps to minimize this decline and improve clinical outcomes such as length of hospital stay [20,21].

Lal *et al*. [22] demonstrated that the frailty assessed using the Edmonton scale is a predictor for the length of hospital stay and risk of readmission up to twelve months in elderly patients undergoing cardiac surgery. The combination of frailty assessment with gait speed will give the therapist fundamental information for the organization of an intervention protocol.

In Castro *et al*. [23], it was evidenced that the greater distance covered in the 6MWT was associated with a shorter hospital stay, as a quick recovery after the surgical procedure allows walking autonomy that allows the transfer of this patient earlier for rehabilitation, and consequently reduce hospitalization time. In the study by Aikawa *et al*. [24], they say that immediate post-surgical rehabilitation can be a means that enables the more agile development and recovery of these patients and found in the 6MWT that there was a significant increase in the distance covered and gait speed of these patients. Thus, comparing the studies presented, it can be unders-

tood that an early rehabilitation of patients after CABG is linked to a shorter hospital stay, consequently generating an improvement in gait speed when evaluated by the 6MWT.

According to Oliveira *et al*. [25], it was evaluated that the CPB time has minimal influence on the patient's ability to walk, the research shows that despite the occurrence of muscle inefficiency, generating a loss of postoperative strength, it does not interfere in the gait of patients themselves. Reinforcing with the results of this study, we analyzed that the CPB time had no correlation with the patients' gait, as it statistically had no influence.

Borges *et al*. [26] showed that patients undergoing cardiac surgery suffer adverse risks during hospitalization in the postoperative period, when they become more fragile due to some physiological changes that occur during the intervention, such as: motor disabilities and physical limitations that can be prolonged, and, consequently, which may lead to future readmissions, the author also identified a vicious cycle of slow gait after surgery. The results of this study were similar to ours, in which it showed that patients undergoing CABG showed a decrease in gait speed due to several associated and already mentioned factors, and that it may possibly be associated with the risk of a hospital readmission.

The limitations of this study include the sample calculation, limiting the extent of its findings, absence of information on pulmonary function, which may have an influence on the performance of the gait speed test and the lack of a spirometric test.

Conclusion

Our data suggest that gait speed is associated with hospital readmission in patients undergoing to coronary artery bypass grafting.

Potential conflict of interest
No conflict of interest for this article have been reported.

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There were no external sources of funding for this study.

Authors' contribution
Conception and research design: Cordeiro ALL, Santos AO, Soares TJ; **Data collection:** Cordeiro ALL, Santos AO, Soares TJ; **Data analysis and interpretation:** Cordeiro ALL, Santos AO, Soares TJ; **Writing of the manuscript:** Cordeiro ALL, Santos AO, Soares TJ; **Critical revision of the manuscript for important intellectual content:** Cordeiro ALL, Guimarães AR.

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