Original Article

Comparative Analysis between the NYHA and CCS Classification and Performance in the 6-Minute Walk Test

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Abstract

Background: Functional classification is a critical predictor to establish a prognosis for heart failure (HF) and Coronary Artery Disease (CAD). However, recent research has questioned the reproducibility of the New York Heart Association (NYHA) and Canadian Cardiovascular Society (CCS) classifications, and their ability to discriminate patient prognosis at an individual level.

Objective: To investigate the discordance rate between the NYHA/CCS class assigned by the physician during outpatient consultation and the 6-minute walk test (6MWT) performance to refine the assessment of patients with HF/CAD.

Methods: A retrospective cohort study collected data from medical records of patients referred for cardiovascular rehabilitation. The 6MWT was performed with the aim of evaluating the functional capacity and associated symptoms of patients with HF and CAD. The correlation between variables was assessed using the correlation coefficient and agreement was assessed using the kappa coefficient.

Results: A total of 65 patients were selected, with 50.8% male, and a mean age of 57.3 ± 11 years. The median left ventricular ejection fraction was 45%, with 13.8% of patients presenting ischemic cardiomyopathy. Discordance in functional class was observed in 54% of HF patients by NYHA and 55% of angina patients by CCS.

Conclusion: The present study identified discordance between the functional class assigned by the attending physician and that determined by the 6MWT, indicating that NYHA/CCS functional classification and 6MWT provide complementary information that is more accurate when used in concomitance.

Keywords: Myocardial Ischemia; Walk Test; Heart Failure.

Introduction

Heart failure (HF) is a complex clinical syndrome characterized by the heart's inability to pump blood effectively to meet the metabolic needs of tissues, or to do so only at elevated filling pressures. HF is one of the leading causes of morbidity and mortality worldwide, affecting more than 64 million individuals. In Brazil, the primary cause of HF is ischemic etiology.[1-4]

Patients with Coronary Artery Disease (CAD) can either be completely asymptomatic or experience angina and signs of HF; thus, utilizing both the Canadian Angina Score (CCS) and the New York Heart Association (NYHA) classifications is recommended.[5,6]

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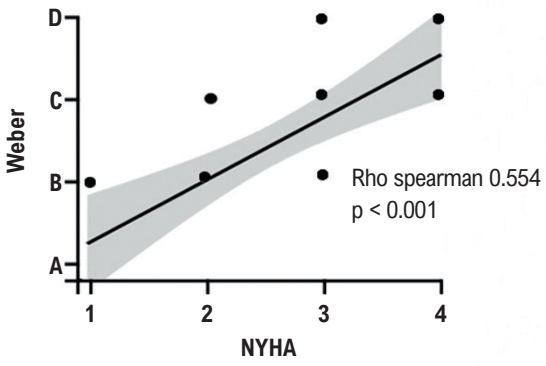
The NYHA classification is a core predictor for establishing HF prognosis at the group level.[7-9] However, recent research has questioned the reproducibility of the NYHA classification and its ability to discriminate the prognosis of patients with HF at the individual level.[10-15]

The subjective nature of the NYHA classification has prompted research aimed at establishing more precise and reproducible parameters for functional capacity in patients with HF. This has evolved from structured questionnaires to objective assessments like the Cardiopulmonary Exercise Test (CPET) and the 6-minute walk test (6MWT).[16,17]

The 6MWT is considered a submaximal assessment test. The 6MWT is a straightforward, easy-to-administer, cost-effective, and well-tolerated tool that reflects daily activities, enabling the evaluation of functional capacity and exercise responses in patients with cardiovascular diseases, particularly those with HF.[17-19]

The assessment of physical performance through the 6MWT objectively establishes the patient's actual functional status in the context of heart disease. A correct prognostic assessment implies the appropriate selection of additional therapies through referral to specialized HF centers, as well as the indication of more advanced treatment strategies.[4,18-20]

Central Illustration: Comparative Analysis between the NYHA and CCS Classification and Performance in the 6-Minute Walk Test



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Correlation between NYHA classification and estimated VO_2.

Therefore, this study aims to explore the level of discordance between the NYHA/CCS classifications assigned by physicians during outpatient consultations and the results of the 6MWT, to enhance the prognostic evaluation of patients with HF/CAD.

Methods

Patients and study design

This is a retrospective cohort study that includes both male and female patients over 18 years old who were referred for Cardiovascular Rehabilitation (CVR) at a public cardiology referral hospital in Bahia, Brazil, with diagnoses of HF and CAD between January 2023 to January 2024. Patients had to be clinically stable and using optimized drug therapy. NYHA/CCS class was determined at the previous outpatient consultation by the attending physician. Left ventricular ejection fraction was measured using the most recent transthoracic echocardiogram with the Simpson's method, performed at the institution of origin. 6MWT was performed on the day of admission. Patients lacking functional class data in their medical records, those with decompensated HF and modified BORG scores greater than 5, untreated acute myocardial infarction (AMI), angina rated above 5 on a visual analogue scale, and those with mobility limitations due to neurological and/or orthopedic issues were excluded from the study. The present study received approval from the Ethics and Research Committee under opinion No. 5,753,770/5,443,600 and is a sub-study of the project titled: Effect of Cardiovascular Rehabilitation on the functional class of patients with heart failure and coronary artery disease.

Definitions and outcomes

The NYHA/CCS classification is a subjective assessment defined by the physician, correlating to the patient's physical limitations related to exertion, due to dyspnea/angina, ranging from minimal exertion (class I) to symptoms occurring at rest (class IV). The Weber class is derived from the maximum oxygen consumption during exercise (VO_2 peak) and can be quantified through CPET. However, when this test is unavailable, the 6-minute walk test (6MWT) is commonly utilized to evaluate exercise capacity, prognosis, and mortality.

The peak VO_2 obtained by the 6MWT was categorized as follows: class A (peak VO_2 > 20 ml/kg/min), B (16 to 20 ml/kg/min), C (10 to 16 ml/kg/min) and D (< 10 ml/kg/min). Classes A, B, C, and D were correlated with CCS/NYHA I, II, III, and IV, respectively. Patients with a functional class assigned by the physician different from that determined by the 6MWT were classified as "discordant".[16]

The 6-minute walk test (6MWT)

The 6MWT aims to assess exercise capacity using the criteria proposed by the American Thoracic Society (ATS). The 6MWT was performed in a flat 30-meter-long corridor. Blood pressure (BP), heart rate (HR), and peripheral oxygen saturation (SpO_2) were measured, in addition to the perception of fatigue using the Borg subjective exertion scale and visual pain scale. The interruption criteria were pre-established as signs and symptoms of hemodynamic instability, such as acute changes in mental status, atypical chest pain, systolic BP (SBP) ≥ 180 mmHg and/or diastolic BP (DBP) ≥ 120 mmHg, signs of pulmonary congestion and shock.[21] Before the test started, the patient was informed about its purpose and given permission to reduce their speed or take breaks as needed, returning to the test when they felt able, all without stopping the timer. Borg, HR, and SpO_2 were assessed every minute and BP was also assessed at the end of the test.

Statistical analysis

The data collected were organized into tables that illustrated the distribution characteristics of the observed values. Categorical variables were expressed as absolute and relative frequencies (percentages) and compared using Fisher's exact test. For numerical variables, measures of central tendency (mean and median) and variability (standard deviation and interquartile range) were calculated, with comparisons made using either the unpaired Student's t-test or the Mann-Whitney test, depending on the data distribution. The correlation between variables was assessed using either the Spearman or Pearson correlation coefficient, while the agreement was evaluated with the kappa coefficient.

Results

Patient characteristics

A total of 65 patients were evaluated (Figure 1), 50.8% of whom were male, with a mean age of 57.3 ± 11 years. The median left ventricular ejection fraction was 45%. Ischemic cardiomyopathy was found in 13.8% of patients. Patients were distributed between functional classes I and IV, as described in Table 1.

Six-minute walk test characteristics

When assessing functional capacity through the distance covered by the 6-minute walk test, a median of 350 (245-394) meters and a median of 14 (11-15) estimated peak VO_2 were observed.

The correlation test between NYHA classes and the assessment of peak VO_2 through the Weber classification was $r = 0.554$, $p < 0.001$ (Central Illustration), but no agreement between the assessments (kappa = 0.03, p = 0.71) were observed.

Assessed according to NYHA classification

Patients diagnosed with heart failure were classified according to the NYHA classification. In the clinical assessment, 4 patients were classified as NYHA I, 15 as NYHA II, 22 as NYHA III, and 4 as NYHA IV. After the 6MWT, patients were reclassified according to the test: 9 patients were NYHA I, 13 patients were NYHA II, 17 patients NYHA III, and 6 patients were classified as NYHA IV (Figure 2).

After the 6MWT, 54% of patients with heart failure had their functional class reclassified (Figure 3).

Assessed according to CCS classification

Patients in the cohort with chronic coronary artery disease were evaluated and classified under the CCS classification. During medical consultation, 1 patient was classified as CCS I, 14 as CCS II, 10 as CCS III, and 6 as CCS IV. There was a reclassification according to the walking test, with 2 patients as CCS I, 13 patients as CCS II, 15 patients as CCS III, and only 1 patient as CCS IV (Figure 4).

In patients with coronary artery disease, 55% of patients with angina pectoris were reclassified in the CCS assessment after the 6MWT (Figure 3).

Discussion

In the present study, there was disagreement between the functional class assigned by the attending physician and that found after assessment of submaximal exercise capacity by the 6MWT. Patients with more advanced functional class (NYHA/CCS) also presented worse results in the 6MWT. Previous studies highlighted the significance of functional class as a prognostic factor, indicating a variation in risk from 7.1% in patients classified as NYHA II to 28% in those with NYHA IV over at least ten years.[7] However, other studies suggest that it is not such a reliable marker and is insufficient at the individual level.[12,14]

Most studies found for prognostic evaluation focused on the NYHA classification or the CPT. In the absence of the CPT, the 6MWT is frequently employed due to its availability, low cost, safety, and ease of implementation in assessing functional capacity, serving as an independent predictor of mortality and readmissions in patients with heart failure.[17] Research examining its relationship with CCS is limited.

Cahalin et al. assessed the reproducibility of the 6MWT and reported an estimated intraclass correlation coefficient of 0.96, along with a linear correlation between peak VO_2 measured during the 6MWT and the CPT in heart failure patients.[19,20]

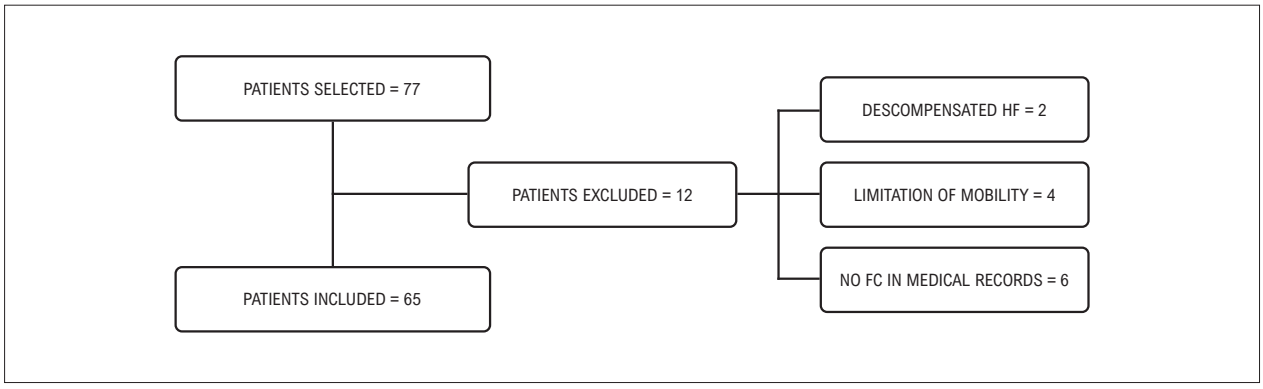

Figure 1 – *Flowchart of eligibility factors. HF: feart failure; FC: functional class.*

Table 1 – Patients' demographic and clinical characteristics

Variables	Patients (n = 65)
Age	57.3 (± 11)
Male, n (%)	33 (50.8)
Heart failure	40 (61.5)
Ischemic etiology	9 (13.89)
Coronary artery disease	31(47.7)
Diabetes, n (%)	32 (49.2)
Hypertension, n (%)	47 (47)
Chronic kidney disease, n (%)	4 (6.2)
Obstructive pulmonary disease, n (%)	3 (4.6)
Atrial fibrillation, n (%)	4 (4.6)
Previous stroke	6 (9.2)
Smoking, n (%)	13 (20)
Obesity, n (%)	14 (21.5)
LVEF, %	45 (31- 65)
LVEF < 40%	29 (44.6)
LVEF 40 to 49.9%	7 (10.8)
LVEF ≥ 50%	29 (44.6)
Distance walked (m)	350 (245-394)
Estimated VO_2 peak ($mL.kg^{-1}.min^{-1}$)	14 (11-15)

LVEF: left ventricular ejection fraction; VO_2: oxygen volume.

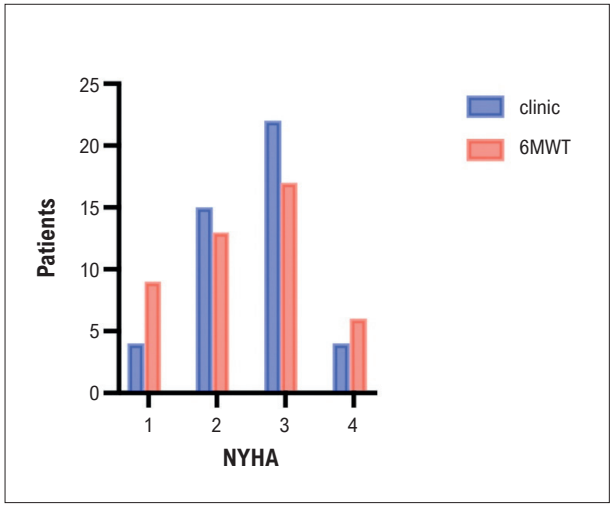

Figure 2 – *Clinical and six-minute walk test (6MWT) assessment of NYHA classification.*

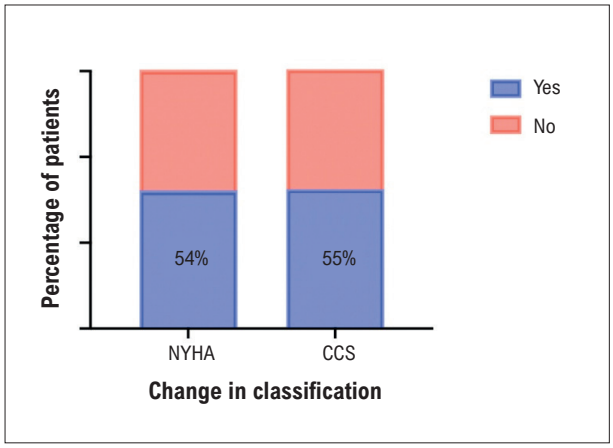

Figure 3 – *Change in classification after the walk test. CCS: Canadian Cardiovascular Society.*

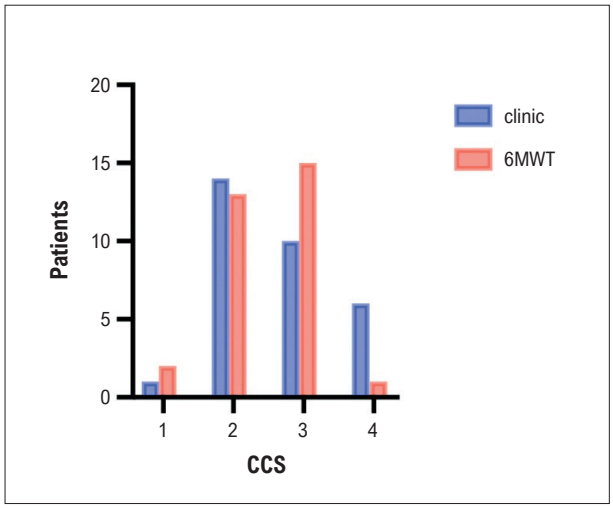

Figure 4 – *Clinical and six-minute walk test (6MWT) assessment of CCS classification. CCS: Canadian Cardiovascular Society.*

A more recent study found that the mean peak VO_2 measured directly during the CPT in patients diagnosed with heart failure was 14.12 ± 4.11 ml/kg/min.[22] A moderate correlation was observed when comparing the indirect mean obtained from the 6MWT (20.49 ± 1.99 ml/kg/min) with the two measures.

In this study, there was low agreement between the functional classification and the 6MWT results, supporting the findings of Ritt et al., which correlated NYHA with CPT.[23] This disagreement can significantly impact therapeutic decision-making, including medication prescriptions, surgical recommendations, or device placements. Therefore, the NYHA/CCS functional classification and the 6MWT performance provide complementary prognostic information that is more accurate than the use of either one alone.

The importance of this study lies in determining the differences between the subjective assessment derived from medical questioning during consultations about functional class and angina score, versus the objective assessment provided by the 6MWT, which influences treatment choices. Different guidelines suggest that myocardial revascularization surgery is an option for patients with symptomatic coronary artery disease that does not respond to drug therapy, as

defined by the CCS score. Similarly, patients with valvular heart disease have definitive surgical treatment options based on symptom presence, with the NYHA classification commonly utilized. Furthermore, drug treatment for heart failure can also be implemented depending on the persistence of symptoms.[24-26]

Our research had some limitations that deserve consideration, namely: it was a single-center study, with a convenience sample, which limits its external validity; it was a retrospective study that included a single assessment of the NYHA/CCS class described in the medical records during the medical evolution, which cannot be extrapolated to the variation in the NYHA/CCS class over time; for the longitudinal analysis, we did not investigate how the 6MWT results were used to guide therapeutic decisions; reduced number of patients due to the lack of functional classification described in the medical records, motor and neurological dysfunctions that prevented the performance of the 6MWT.

Conclusion

This study found a disagreement between the functional class assigned by the attending physician and that determined by the 6MWT, indicating that both the NYHA/CCS classification and the 6MWT offer more precise complementary prognostic information than either one alone. Thus, while cardiopulmonary exercise testing is the gold standard, the 6MWT can serve as a valuable tool for risk stratification in patients with HF/angina across all NYHA/CCS classes when the former is not available.

Further research with a larger sample size and analysis of clinical outcomes is necessary to enhance the understanding of its prognostic value. Additionally. Research investigating the combination of 6MWT with functional classification is important to refine the prognostic assessment of patients with heart failure and angina pectoris.

Author Contributions

Conception and design of the research: Passos LCS, Santos Junior RP; Acquisition of data: Santos Junior RP, Sampaio LFD; Analysis and interpretation of the data: Passos LCS, Santos Junior RP, Sampaio LFD, Figueiredo CS, Cafezeiro CRF; Statistical analysis: Cafezeiro CRF; Writing of the manuscript: Passos LCS, Santos Junior RP, Sampaio LFD, Cafezeiro CRF; Critical revision of the manuscript for content: Passos LCS, Figueiredo CS, Cafezeiro CRF.

Potential conflict of interest

No potential conflict of interest relevant to this article was reported.

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There were no external funding sources for this study.

Study association

This study is not associated with any thesis or dissertation work.

Ethics approval and consent to participate

This study was approved by the Ethics Committee of the Hospital Ana Nery under the protocol number 0165546. All the procedures in this study were in accordance with the 1975 Helsinki Declaration, updated in 2013. Informed consent was obtained from all participants included in the study.

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