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Research article

PERCEIVED EXERTION AS AN EXERCISE INTENSITY INDICATOR IN CHRONIC HEART FAILURE PATIENTS ON BETA-BLOCKERS

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ABSTRACT

The Rating of Perceived Exertion (RPE) has been used as a supplementary tool for prescription of exercise training intensity for healthy and special populations. Despite the wide use of the RPE scale, there is an inconsistency regarding the accuracy of that scale for chronic heart failure (CHF) patients treated with beta-blockers. The study examined the correlation between RPE and heart rate (HR), percentage of maximal HR (%MHR), ventilation (VE) and oxygen consumption (VO_2) during graded treadmill testing and examined the RPE scale as a guideline for training intensity for CHF patients treated with beta-blockers. Fourteen men age 57.7 ±10.2yrs diagnosed with CHF and treated with beta-blockers participated in the study. During a Balke treadmill test the subjects RPE, HR, VE and VO_2 $ml \cdot kg^{-1} \cdot min^{-1}$ were monitored. Low to moderate significant correlations were found between RPE and HR, %MHR, VE and VO_2 $ml \cdot kg^{-1} \cdot min^{-1}$ ($r = 0.44$, 0.43, 0.55 and 0.69 respectively, all $p < 0.001$). Some subjects exhibited clinical symptoms (e.g. fall of systolic blood pressure, ST depression/elevation) despite relatively low RPE. The RPE may be used to indicate the level of exercise intensity; however it may not represent the HR responses in CHF patients on beta-blocker medication. Therefore, it is recommended to monitor the HR in combination with RPE when prescribing exercise intensity for CHF patients on beta blocker medication.

KEY WORDS: Chronic heart failure, rating of perceived exertion, beta-blockers.

INTRODUCTION

The Rating of Perceived Exertion (RPE) has been used as an indicator for work intensity and as an essential tool in the prescription of exercise training intensity for healthy and special populations (Borg, 1982; Pollock et al., 1990). The RPE score has been shown to be reliable and valid, and it has a moderate to high correlation (r range, 0.57-0.89) with respiratory variables, heart rate (HR) and blood lactate in healthy men (Chen et al., 2002; Dunbar et al., 1992; Wilmore et al., 1985). However, despite the wide use of RPE as an intensity indicator, there is an inconsistency in the literature regarding the accuracy of that scale for patients on beta-blocker including chronic heart failure (CHF) patients (Connolly, 1996; Ekblom et al., 1971; Whaley et al., 1997).

Sympathetic nervous system inhibitors, such as beta –blockers, are common therapy for cardiac populations (Gersh, 2000). Beta-blocker treatment reduces HR and blood pressure (Australia- New Zealand Heart Failure Research Collaborative Group, 1995; Krum et al., 1995). It may also change

heart oxygen consumption and pressure afterload (Gersh, 2000; Way, 2002). These hemodynamic and metabolic changes may interfere with and alter the correlation with the RPE score. Moreover, general well being may change after beta-blocker treatment (Fowler, 1998) which may alter the subjective perception of the level of intensity during exercise testing and training.

The purpose of this study was to examine the correlation between RPE and HR, percentage of maximal HR (%MHR) ventilation (VE) and oxygen consumption (VO_2) during graded testing and to examine the RPE scale as a guideline for exercise intensity for CHF patients treated with beta-blockers.

METHODS

Subjects

Fourteen men, age 57.7 ±10.2 yrs, weight 91.5 ± 12.5 kg and height 1.78 ± 0.08 m, diagnosed with left ventricular systolic dysfunction (ejection fraction, 34.5 ± 7.5% and peak VO_2 14.5 ± 2.3 $ml \cdot kg^{-1} \cdot min^{-1}$) and treated at John Flynn Private Hospital (Gold Coast, QLD, Australia) volunteered to participate in the study. Medication profile across the group is shown in Table 1. All patients had stable CHF and had been using beta-blocker medication for at least 3 months prior to the commencement of the study. Patients had no change in their clinical status for at least 8 weeks before the study. The protocol was approved by the Human Research Ethics Committees at Southern Cross University (Lismore, NSW Australia) and John Flynn Private Hospital (Gold coast, QLD, Australia). Potential subjects were informed of the study via the hospital staff. Each subject received an explanation about the nature of the study, and those who chose to participate in the trial signed an informed consent document.

Subjects with the following contraindications were excluded from the study: smokers, those with locomotor disability, severe ventricular arrhythmias, unstable angina or who had a resting diastolic pressure above 95mmHg, a resting systolic pressure above 160 mmHg or uncontrolled congestive heart failure, acute myocarditis, severe valvular stenosis and persons who were unable to consent for themselves.

Study protocol

The subjects performed a Balke incremental test (Tracmaster, JAS Fitness System 210AC/R, USA) where walking speed remained constant ($3 km \cdot h^{-1}$) and the grade was increased by 2.5 percent every two minutes (Hanson, 1984). Two to three days prior to the incremental test, subjects performed a familiarization session with the test procedures (walking on treadmill and breathing through a mask) and including the use of Borg scale (Borg scale of 6-20) during walking exercise (Borg, 1982). Subjects were asked not consume caffeine or alcohol for a minimum of two hours before the treadmill test.

Table 1. Medical profile across the group (n =14).

Medication	N*
Carvedilol	10
Bicor	2
Atenolol	1
Inderal	1
Diuretics	5
ACE inhibitors	12
Ant cholesterol	9
Digoxin	3
Anti arrhythmic	4
Pain reliefs	6
Diabetes medications	3

* N (number of subjects on each medication, some subjects on multiple medications).
Abbreviation: ACE = angiotensin-converting enzymes.

During the test, HR was monitored by a 12 lead electrocardiograph (ECG) and brachial blood pressure was measured by auscultation every 2 minutes. RPE was evaluated in the last 10-15 seconds of each workload. Expired respiratory gases were collected through pneumotach mouth piece connected to gas analyzer (Medgraphics, cardio2 and CPX/D System Operators Manual – Utilizing Breezeex Software, 142090-001, Revia, MN, providing data every 15 seconds). Calibration against three standard alpha gases was conducted prior to each test. Criteria to terminate the test followed the recommendations of the American College of Sport Medicine (ACSM, 2000).

Data analysis

A repeated measured ANOVA was used to examine if a linear relationship existed over the different stages (workloads) of the incremental test for each of the variables (RPE, HR, %MHR, VE and VO_2 $ml \cdot kg^{-1} \cdot min^{-1}$). Spearman rank order correlations were used to determine the relationship between RPE, HR, %MHR, VE and VO_2 $ml \cdot kg^{-1} \cdot min^{-1}$. The interpretation of the correlation was based on Domholdt (1993). A 0.05 level of significance was used and variables reported as mean ± standard deviation.

RESULTS

All variables showed linear changes with increased exercise workload ($p < 0.001$). There were

significant low to moderate correlations ($p < 0.001$) between RPE and HR, %MHR, VE and VO_2 $ml \cdot kg^{-1} \cdot min^{-1}$ ($r = 0.44$, 0.43, 0.55 and 0.69 respectively). Additionally, low to moderate correlations ($p < 0.001$) were found between HR and VE and VO_2 $ml \cdot kg^{-1} \cdot min^{-1}$ ($r = 0.62$ and 0.45 respectively). High correlation was found between VE and VO_2 $ml \cdot kg^{-1} \cdot min^{-1}$ ($r = 0.82$, $p < 0.001$).

Mean RPE at termination of the tests was 13.1±1.4 (range 11-15). Four subjects (29%) had their test terminated at RPE of 15 as this was the upper most criterion which was approved by the Ethic Committees. Other terminating criteria were a fall of systolic blood pressure ≥10 mmHg (N=3), ST depression/elevation (N=4) and no increase in VO_2 despite an increase of workload (N=4). Some tests were terminated due to appearance of several terminating criteria simultaneously.

DISCUSSION

The study found significant correlation between RPE and HR, %MHR, VE and VO_2 $ml \cdot kg^{-1} \cdot min^{-1}$ in CHF patients on beta-blocker therapy during a graded treadmill test. Additionally, the wide range of the RPE score at test termination may indicate large inter-individual variability between the patients during exercise. Therefore the RPE scale can be used as a method of determining training intensity for CHF patients on beta-blockers, however, it must be taken with caution.

The results indicated a linear relationship between workload and the cardiorespiratory variables, high correlation between VE and VO_2 $ml \cdot kg^{-1} \cdot min^{-1}$ and moderate correlation between HR, and VE and VO_2 $ml \cdot kg^{-1} \cdot min^{-1}$. The moderate correlation between the RPE, and VE and VO_2 $ml \cdot kg^{-1} \cdot min^{-1}$ also suggests that CHF patients on beta-blocker medication may have a similar respiratory responses to exercise to that reported by Wasserman et al (1987) for healthy people. The RPE scale therefore can be used as an indicator for respiratory responses during exercise for CHF patients on beta-blocker therapy.

Despite the common use of the RPE as an assistant tool for determining exercise intensity in healthy populations, it may be different for cardiac patients who are on beta blocker medications. Beta-blocker therapy is followed by physiological changes such as a reduction of HR, cardiac output, and systolic and diastolic blood pressure (Australia-New Zealand Heart Failure Research Collaborative Group, 1995; Krum et al., 1995). Additionally, beta-blocker treatment is followed by emotional changes, an improved of quality of life and well being (Fowler, 1998). These changes may alter the relationship between the perceived exertion and physiological variables (Ekblom and Goldbarg, 1971). Low correlation was found between RPE and HR, suggesting that the use of RPE as an indicator for HR in patients on beta-blocker therapy may be problematic. It has been reported that use of a beta-blocker did not change the RPE scores at any given workload, although a reduction in HR was observed (Squires et al., 1982; Van Herwaarden et al., 1979). Sjoberg and Frankenhaeuser (1979) reported that the RPE score of healthy subjects did not alter after beta-blocker treatment, although the HR decreased by 16-19% at any given workload. They suggested that HR may not be a crucial factor in determining perceived exertion. As such, RPE may indicate the level of exercise intensity, but not necessarily represent the HR responses in CHF patients on beta-blocker. Therefore RPE should be accompanied by HR monitoring during exercise in these population. Nevertheless, due to the relatively small sample size caution must be taken when interpreting the study results. The study also may not be generalized to the entire CHF population, as some CHF patients are not treated with beta-blockers.

Although the sample size in the current study was relatively small, we found a large inter-individual variability in RPE at submaximal and maximal exercise levels. This finding is similar to Whaley et al. (1997) who reported large inter-individual variability in RPE scores of both healthy and cardiac populations at intensities of 60% and 80% of maximal HR. The large inter-individual variability at submaximal and maximal effort and the fact that almost 30% of their subjects reported both lower and higher RPE scores compared to the recommended RPE guidelines set by Pollock and Wilmore (1990) , challenged the accuracy of the use of RPE scale as a determinant of exercise intensity of healthy and cardiac individuals when HR monitoring is not available (Whaley et al., 1997).

It is important to note that overall perceived exertion is a subjective response to an effort and it encompasses two contributors. Firstly, local factors, such as sensations from the exerting muscles, and secondly, central factors, such as sensations from the cardiopulmonary system (Pandolf, 1986). In the current study, separate measures of muscular and cardiopulmonary RPE were not assessed. However, our finding that some patients exhibited clinical changes (such as ST elevation/depression or fall of systolic blood pressure) before a substantial increase in perceived exertion may indicate that these subjects were mainly focused on local effort, such as concentrating on walking on the treadmill and pain from the joints. In some patients it was possible that the body was also unable to translate the stress on the cardiopulmonary system to a parallel increase in RPE score since they were mostly aware of local

sensations rather than central sensations (Hartzell et al., 1986). This finding is disturbing since it may suggest that patients can "push" themselves post symptoms appearance (ST changes or fall in systolic blood pressure) which may expose them to an increased risk during exercise.

CONCLUSIONS

The main findings of the current study were: (a) there was low to moderate correlation between RPE score and HR, %MHR, VE and VO_2 $ml \cdot kg^{-1} \cdot min^{-1}$ in CHF patients on beta blocker medication, (b) it seems that there was a large RPE inter-individual variability during graded treadmill tests, and (c) some subjects may exhibit clinical symptoms despite a relatively low RPE. The RPE may be used to indicate the level of exercise intensity, however, it may not represent the HR response in CHF patients on beta-blocker. Therefore, it is recommended to monitor the HR in combination with RPE when prescribing exercise intensity for CHF patients on beta blocker medication. However, when a RPE scale is the sole method to indicate work intensity, caution in prescription of training intensity for these patients must be taken. As such, the use of the RPE score and understanding of its limitation are important for cardiac rehabilitation staff in order to determine a safe exercise intensity for these patients in the exercise rehabilitation programs.

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KEY POINTS

- RPE correlated with HR, VE and VO_2 in CHF patients on beta blockers.
- There was a large RPE inter-individual variability during graded treadmill tests.
- RPE can be used as an exercise intensity indicator for patients on beta-blockers, however, it must be taken with caution.

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