A Comparison of the 6-Minute Walk Test and Symptom Limited Graded Exercise Test for Phase II Cardiac Rehabilitation of Older Adults

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ABSTRACT

Background and Purpose: Older adults often find it difficult to bicycle or walk on a treadmill. Therefore we prospectively evaluated whether the 6-minute walk test (6MWT) could be used as a valid substitute for symptom limited graded exercise testing (SLGXT) to determine exercise capacity in a group of cardiovascularly stable older adults after cardiac surgery. **Subjects**: Ten older adults who had undergone cardiac surgery participated in the study. **Methods**: The pedaling speed of the SLGXT was 55-60 rpm, beginning at 20 watts and increasing incrementally until exhaustion. Perceived exertion was rated using the Borg rating scale. Four 6MWTs were performed during the same day with a rest periods of 15-60 minutes. The best distance achieved in the four 6MWTs was used in subsequent analysis. Descriptive statistics and Pearson's correlation coefficients were calculated. **Results**: Performance at the 6MWT and the SLGXT were highly and significantly correlated ($r = .93$, $p < .001$). The maximum heart rate achieved during the best 6MWT and the SLGXT were moderately and significantly correlated ($r = .64$, $p < .009$). The correlation between maximum systolic blood pressure during the 6MWT and SLGXT was somewhat lower ($r = .52$, $p < .038$). **Conclusions**: The 6MWT can be used as a valid substitute for 'the golden standard' SLGXT to evaluate exercise capacity after phase II rehabilitation of cardiovascularly stable older adults who have undergone cardiac surgery.

Key Words: older adults, cardiac surgery, 6-minute walking test, symptom limited graded exercise testing, exercise capacity

INTRODUCTION

Heart disease is a major cause of mortality and morbidity among people 65 years and older; one-third of cardiac operations on adults in the United States are performed on persons in this age group.[1,2] At the age of 70, coronary atherosclerosis occurs in about 15% of men and 9% of women; at the age of 80 years, it rises to 20% in both sexes.[3] The average age of individuals undergoing coronary artery bypass grafting has increased from around 50 years in 1967 to approximately 66 years in 1998. Nearly 30% of patients receiving the procedure are above age 70.[3] The reason for the rise in average age of cardiac surgery patients is most likely due to positive results of preventive measures resulting in later onset of cardiac disease and improvements in surgical techniques making surgery on older subjects more feasible.[3]

Participation rates in phase II cardiac rehabilitation programs among the older adults are low, primarily because of less aggressive referral.[4] Older adults are most frequently excluded,[5] in spite of their potential to benefit most from cardiac rehabilitation because of their lower functional capacity and higher rate of depression and social isolation.[5-12] Furthermore, as Thompson has pointed out, exercise-based cardiac rehabilitation is an underused treatment.[13] It is therefore important to find ways to make cardiac rehabilitation more accessible and user-friendly for this patient group and try to influence health care professionals to foster patient participation.

One step to accomplish this could be to find ways to make exercise testing more suitable for older adults and in that way increasing the likelihood of rehabilitation centers becoming more engaged in that population and health care professionals referring them to cardiac rehabilitation as a routine rather than an exception.

The traditional outcome test in phase II cardiac rehabilitation has been the symptom limited graded exercise test (SLGXT) on a bicycle ergometer or a treadmill. These tests, however, might not be suitable for many older adults as they tend to have poor balance, poor neuromuscular coordination, impaired vision, and abnormal gait patterns. Moreover, they might experience fear of exercising on the treadmill.[14] Walking, on the other hand, has been claimed to be an excellent mode of exercise for many older adults.[14] Therefore, SLGXT will most likely not reflect their true cardiovascular capacity, as more motor units are recruited during unfamiliar physical activity and a fearful state of mind. In particular, frail, elderly patients with severe cardiac or pulmonary diseases become exhausted after only a few minutes of testing.[15] The 6MWT, on the other hand, originally used by physicians to assess patients with lung disease, involves an activity of daily life and requires only minimal equipment.[16-18] If it could be used as a substitute for the SLGXT for quantifying exercise capacity (defined by maximal oxygen uptake; anaerobic threshold, submaximal exercise endurance, muscular strength, and the ability to perform combined dynamic and static activity)[19] among the stable older cardiac patients, rehabilitation centers might become more engaged with that population. An example of the use of the 6MWT in cardiac rehabilitation is a study from North Carolina, where it was used to assess improvement after short-term cardiac rehabilitation of adults age 40 to 89 years and compare with quality of life outcomes.[20] The purpose of this study was to prospectively evaluate whether the 6MWT could be used

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as a valid substitute for SLGXT to evaluate rehabilitation outcome of cardiovascularly stable cardiac surgery patients 70 years and older.

METHODS

The Ethics Committee of the National and University Hospital and the Data Protection Authority approved this study. All participants signed an informed consent prior to entering the study.

Subjects

The study group included 10 elderly patients, 6 men and 5 women, mean age 76 years (SD 5.8) who underwent cardiac surgery 3 months earlier. All had been participating in a Phase II Cardiac Rehabilitation Program prior to entering the study.

SLGXT

All patients underwent a SLGXT (Monark 818 E Ergomedic, Monark-Cresent AB, Varberg Sweden) before and after the rehabilitation program. The testing protocol consisted of constant pedaling at a speed 55-60 rpm. They began pedaling at 20 watts with 10 or 15 watts increment according to fitness every minute and were encouraged to exercise until they were not able to continue. The exercise test was stopped at the patient's request. The heart rate was continuously monitored. Blood pressure was measured manually at one-minute intervals in the right arm. The patients rated their perceived exertion on the Borg Relative Perceived Exertion (RPE) rating scale (6-20)[19] every other minute. Maximum power (watt/kg) were then calculated and used as a measure of exercise capacity.

6MWT

The 6MWTs were performed on a 35 m long hospital hallway. The minimum time between the SLGXT and the 6MWT was 4 hours and maximum time not more than 1 week. A physical therapist blinded to the results of the SLGXT informed the patients of the test procedure and administered the 6MWT according to the method of Guyatt et al.[21-23] The patients were instructed to cover as much ground as possible in 6 minutes and were told to walk continuously if possible. If necessary, they could slow down or stop, but were instructed to resume walking as soon as they felt able to do so. Guyatt et al found out that encouragement had a substantial impact on walking test scores;[23] therefore, no encouragement was given but the time was called out every minute. The reason for not encouraging patients during the test was to avoid over exertion in ambitious patients and the difficulty in giving standardized encouragement. After 6 minutes had elapsed, patients were instructed to stop walking and the total distance walked was measured in meters. For the purpose of ensuring maximal exertion, the patients were told to exert themselves to the degree that, at the end of the test they felt they could not have walked any further. The heart rate and blood pressure were measured before and right after testing and the patients rated themselves on a Borg RPE scale (6-20), also immediately after testing.

As studies have shown that a learning effect occurs up to the third consecutive 6MWT[21,22] and other researchers have used 4 to 5 trials before the baseline test,[24,25] we decided to have all patients perform 4 tests during the same day with a rest period of 15 minutes between trial 1 and 2, 30 minutes between trial 2 and 3, and 60 minutes lying on a couch between trial 3 and 4. Total distance in meters was calculated for each walk and the best distances achieved in the four 6MWTs were used to assess correlation against maximum power (watt/kg) from the SLGXT. When the patients had finished the SLGXT and the 6MWTs, they were asked which test they preferred, found easier, and thought more closely related to daily physical activity.

Statistical Analysis

Alpha level was set at $p \leq .05$. Descriptive statistics were first calculated. Thereafter, Pearson correlation coefficients were used to assess the relationship between performance at the 6MWT and the SLGXT and between both maximum HR and systolic blood pressure reached during the 6MWT and SLGXT.

RESULTS

Mean, standard deviation, and range of the distance walked during the 6MWT, the maximum power reached during the SLGXT, and the maximal systolic blood pressure and heart rate during each test are presented in Table 1. There was a strong and significant correlation between best distance achieved in the 6MWT and the maximum power (watt/kg) from the SLGXT ($r = .932$, $p < .0001$). The relationship between the measures is essentially linear (Figure 1).

The correlation between the maximum heart rate achieved during the best 6MWT and the maximum heart rate achieved during the SLGXT was moderate and significant ($r = .64$, $p < .009$). The correlation between the maximum systolic blood pressure achieved during the best 6MWT and the SLGXT was also moderate and significant ($r = .52$, $p < .038$).

Table 1. Mean, Standard Deviation (SD), and Range (Min-Max) of Pertinent Variables for 2 Exercise Tests

Variable	Mean (SD)	Min - Max
6 Minute Walk Test		
Distance (meters)	541.0 (141.1)	315.0 - 762.0
Maximal systolic blood pressure (mmHG)	178.0 (28.2)	135.0 - 220.0
Maximum heart rate (beats / minute)	115.0 (22.8)	85.0 - 157.0
Symptom Limited Exercise Test		
Power (watts / kg)	1.3 (0.6)	0.6 - 2.3
Maximal systolic blood pressure (mmHG)	187.0 (34.8)	140.0 - 240.0
Maximum heart rate (beats/minute)	121.0 (23.4)	88.0 - 160.0

The fourth 6MWT was the best by all patients. All patients completed the tests and did not have to stop or rest during testing. All of our patients preferred the 6MWT to the SLGXT, finding it easier and more closely related to daily physical activity.

DISCUSSION

The results from this study suggest that the 6MWT may be used as a valid substitute for SLGXT to determine exercise capacity in a group of cardiovascularly stable older patients after cardiac surgery. This can be of value for the health care professionals and for the patients. What makes this type of

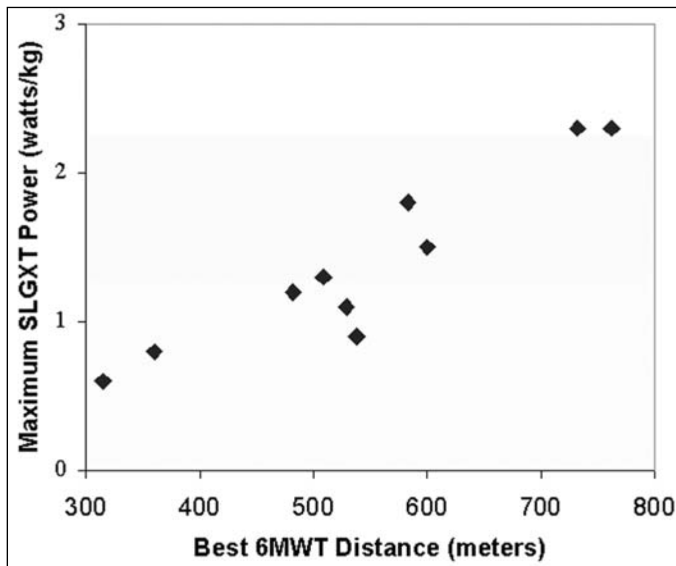

Figure 1. Scatter plot of relationship between performance at a 6 minute walk test (6MWT) and symptom limited graded exercise test (SLGXT). The correlation is high and significant (r = .932 p< .0001).

test more attractive to the older patients is that it involves a familiar activity at which they choose and adjusted their own pace throughout the whole test. Furthermore, the test is a part of their daily activities whereas bicycling and treadmill walking are most likely not.[26] The fact that the 6MWT needs no expensive apparatus, is easy to administer, and does not expose the patients to any additional risk such as falling off the bicycle ergometer or treadmill, can make it more feasible for smaller rehabilitation centers to serve this patient group. It is a safe[27] and well-tolerated test.

The correlation between the longest distance walked in meters during the 6MWT and the maximum power (watt/kg) achieved during the SLGXT (r = .932, p< .0001) was comparable and even better than findings of earlier studies from other groups of patients. Hamilton et al found that the 6MWT was linearly related to maximum METs in a group of younger cardiac rehabilitation patients (r = .687, p< .001).[16] Guyatt described a significant correlation (r = .579, p< .001) between the results of a walking test and a bicycle ergometer test in a group of patients with chronic lung disease and chronic heart failure.[22] Peeters et al found a significant correlation (r = .688, p< .001) between the distance walked in the 6MWT and the distance walked in the treadmill test, in a group of elderly patients with chronic heart failure.[28] Both Faggiano et al and Zugck et al have reported a correlation between 6MWT performance and peak oxygen uptake in a group.[29,30] Zugck et al concluded that the 6MWT provides a prognostic value very similar to peak oxygen uptake in patients with congestive heart failure and dilated cardiomyopathy.[30]

Although of only moderate magnitude, we believe the between test correlations found for maximum heart rate and systolic blood pressure in our study are remarkable. After all, the 6MWT is submaximal and the SLGXT is considered maximal. The fact that patients control their speed in the former and the duration of the latter may be one explanation. This provides further support for use of the 6MWT as a valid substitute for SLGXT to determine exercise capacity in a group of cardiovascular stable older patients following cardiac surgery.

There are several limitations to our study. Foremost is the small sample size. Another is the fact that the SLGXT was not repeated to assess inherent variability or learning effect.

CONCLUSIONS

It is concluded that the 6MWT can be used as a valid substitute for 'the golden standard' SLGXT to evaluate exercise capacity after phase II rehabilitation of cardiovascularly stable older adults who have undergone cardiac surgery. The 6MWT is relatively safe and well tolerated, is simple to administer, and is preferred over the SLGXT by patients.

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(continued from page 64)

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