Relationship of shuttle walk test and lung cancer surgical outcome

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Abstract

Objective: Surgery remains the treatment of choice in patients with potentially resectable lung carcinoma. Both the British Thoracic Society and American Chest Physician guidelines for the selection of patients with lung cancer surgery suggest the use of a shuttle walk test to predict outcome in patients with borderline lung function. The guidelines suggest that if the patient is unable to walk 250 m during a shuttle walk test, they are high risk for surgery. However, there is no published evidence to support this recommendation. Therefore, we undertook a prospective study to examine the relationship between shuttle walk test and surgical outcome in 139 patients undergoing assessment for possible lung cancer surgery. Methods: The shuttle walk test was performed in 139 potentially resectable patients, recruited over a 2 year period, prior to surgery. Outcome of surgery, including duration of hospital stay, complication and mortality rates was recorded. Student’s t-test was used to compare the shuttle walk distance in patients with good and poor outcome from surgery. Results: Mean age of patients undergoing surgery was 69 years (42–85). Mean shuttle walk distance was 395 m (145–780), with a mean oxygen desaturation of 4% (0–14) during the test. Sixty nine patients had a good surgical outcome and 34 had a poor outcome. The shuttle walk distance was not statistically different in the two outcome groups. Conclusion: Shuttle walk distance should not be used to predict poor surgical outcome in lung cancer patients, contrary to current recommendations. It is therefore advisable to perform a formal cardiopulmonary exercise test if at all possible. The usefulness of a shuttle walk test might be improved. It could be compared to a predicted value, as for a formal cardiopulmonary exercise test.

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1. Introduction

Surgery remains the treatment of choice for resectable lung carcinoma. However, a significant number of surgical patients have a poor post-operative outcome, usually due to the presence of coexisting disease, especially chronic obstructive pulmonary disease. In order to assist the prediction of surgical outcome, a number of exercise tests have been used. These include maximal cardiopulmonary exercise tests and walk tests.

There are a number of studies [1–3] suggesting that cardiopulmonary exercise testing is one of the most valuable parameters for the evaluation of risk assessment in lung cancer surgery. It is a sophisticated physiological test from which maximal oxygen consumption (VO\textsubscript{2} max) can be calculated. It provides the best index of functional capacity and global O2 transport (VO\textsubscript{2}) as well as estimating both cardiac and pulmonary reserve not available from other modalities. Many studies [1,4–8] have found that VO\textsubscript{2} max is a good predictor of increased surgical risk.

However, there remains the practical difficulty as to when to recommend this test, as it is not widely available. As a result, other type of exercise tests have been considered [9]. Compared to the formal cardiopulmonary exercise test, walk tests require less technical expertise and equipment, making them inexpensive and easy to administer [10]. More importantly, they employ an activity that individuals perform on a daily basis (i.e. walking) [11].
Although the stair-climbing test has been used as a surrogate for cardiopulmonary exercise test historically, it is difficult to perform in a standardized manner. The duration of the test, speed of ascent, number of steps per flight, height of each step, and reason for stopping the test have not been well defined.

Other walk tests include the shuttle walk test, the 6-min walk and the 12-min walk tests. Amongst them, the 6-min walk test has been investigated most thoroughly regarding its relationship to VO2 max [12–15]. It has also been reported as being a good predictor of surgical risk in patients undergoing lung cancer surgery [16]. However, again, interpretation of the distance walked in 6 min is currently not well standardized [17]. Several studies have correlated distance walked in a 12 min walk test with VO2 max [15,18,19]. However, the 12-min walk test was found to be poorly discriminative in predicting lung cancer surgical risk [20].

In 1992, Singh and colleagues [11] developed the incremental 10-m shuttle walk test. It is a reproducible measure of functional capacity in patients with chronic airflow limitation [21]. The shuttle walk test involves many of the same principles as formal cardiopulmonary exercise testing. Both types of tests are standardized, externally paced, incremental and are maximal exercise tests (unlike the time-based tests). However, the shuttle walk test has been correlated to VO2 max in only one relatively small study of chronic obstructive pulmonary disease patients [22].

Both the British Thoracic Society [23] and American Chest Physician [9] guidelines on the selection of patients for lung cancer surgery suggest that a shuttle walk test should be used to further assess surgical risk in patients with borderline lung function (FEV1 < 1.5 l for lobectomy, <2.01 for pneumonectomy, and with a predicted postoperative FEV1 and/or TLCO of <40%). The guidelines suggest that patients who cannot reach 250 m on shuttle walk testing or who desaturate more than 4% from baseline oxygen saturation are at increased risk from surgery. This suggestion was based on the fact that the shuttle walk test could be used to predict VO2 max as measured by a formal cardiopulmonary exercise test, using the regression equation developed by Singh et al. [22] and used in an algorithm for selection of patients with borderline lung function for lung cancer surgery. However, this recommendation is not backed up by published evidence.

For this reason we prospectively examined the relationship between the shuttle walk test and surgical outcome in patients undergoing assessment for possible lung cancer surgery.

2. Methods

Patients with resectable lung cancer (stages I, II and IIIA) were recruited from the Thoracic Oncology multidisciplinary clinic at our institution. Exclusion criteria included unstable angina, recent myocardial infarction (within 6 weeks), and any disorder that might influence exercise performance physically, e.g. severe back pain. One hundred and thirty-nine potentially operable patients were recruited over 2 years and each performed the shuttle walk test preoperatively. The patients were familiarized with the test.

Additionally they all had full pulmonary function tests according to the Association of Respiratory Technology and Physiology practical handbook guidelines. Cardiac function was assessed by history taking, regarding cardiac symptoms and drugs, a full cardiac physical examination and an electrocardiogram. If the patient was over 70 years of age and/or had any cardiac signs and/or symptoms in history and physical examination suggestive of valve disease or cardiac dysfunction, they also underwent echocardiography. If there was any significant abnormality in these tests, they were referred for a cardiologist opinion regarding further investigation such as coronary angiogram. The operability was assessed by review of the pulmonary function test results and all other clinical information at the multidisciplinary team meeting, however, the surgeon made the final decision concerning operability.

2.1. Shuttle walking test

The shuttle walking test was performed using the method established by Singh et al. [21]. The patients walked between 2 cones 10 m apart at an incrementally increasing pace. Each increment was signaled by a fully calibrated audiocassette. To assist, the operator accompanied the patient throughout the test. The end point was reached when the patient could no longer maintain the required speed or become too breathless to proceed further. Using a pulse oximeter (Minolta Pulsox 3i), oxygen saturation and heart rate were recorded every 30 s throughout the test. The Borg score [24] was also recorded at the beginning and end of the test. A note of the recovery time, and the reason for terminating the shuttle walk was also documented.

2.2. Surgery

Three dedicated cardio-thoracic surgeons performed surgery on lung cancer patients via standard posterolateral thoracotomy. The routine surgical and anaesthetic procedure included single lung ventilation using a double lumen endobronchial tube during the operation. Standard post-operative physiotherapy was performed by use of breathing exercises and early ambulation. Outcome of surgery, including length of stay, complication and mortality rates, were recorded. Length of stay was divided into time spent in either the intensive care unit or in a surgical ward. Complications were classified as major and/or minor. The poor surgical outcome group was defined as any of the following: post-operative death and major complication (myocardial infarction, heart failure,
respiratory failure, septicemia, pneumonia and significant cardiac arrhythmia).

Unpaired Student’s t-test was used to compare shuttle walk distance in the good and poor outcome groups.

The Local Ethics Committee approved the study and all patients gave informed written consent.

3. Results

One hundred and eleven patients underwent surgery of which, 8 (7%) were open and closed procedures, 57 were lobectomy, 37 pneumonectomy, 6 bilobectomy and 3 wedge resection. Mean age was 69 years (42–85). Male to female ratio was 1:1.8. The mean preoperative FEV1 was 1.95 l (1.0–4.65). Fifty patients had borderline lung function as judged by spirometry (FEV1 <1.5 l for lobectomy, <2.0 l for pneumonectomy). The histology of resected tumours consisted of 49 squamous cell carcinomas, 37 adenocarcinomas, 16 non-small cell carcinomas, 5 large cell carcinomas and 4 miscellaneous.

The mean preoperative shuttle walk distance in all operated patients was 395 m (145–780). The mean oxygen desaturation was 4% (0–14), and mean change in Borg score at the end of exercise was 3 (0–7). There was no significant correlation between the shuttle walk distance and FEV1 (r = 0.46).

Sixty nine patients had a good surgical outcome, and 34 had a poor outcome (4 patients with 40-day mortality, and 30 patients with a major complication). Major complications included respiratory failure (7.3%), septicemia (14%), arrhythmia (14.5%), cardiac failure (2%), myocardial infarction (2%). Most of these patients had more than one complication. Mean duration of hospital stay was 13 days (range 1–56; SD = 8). The mean FEV1 for the good outcome group was 2.0 l and for the poor outcome group was 1.9 l. There was no statistically significant difference in FEV1 (P = 0.7) between the two groups.

The relationship between preoperative shuttle walk distance and surgical outcome for the whole group is shown in Table 1. The mean shuttle walk distance for the good outcome group was 419 m and for the poor outcome group was 388 m. There was no statistically significant difference in shuttle walk distance (P = 0.6) between the two groups. There was also no statistically significant difference in preoperative shuttle walk distance between the patients who died and those who survived (P = 0.5), or between those who had a short or prolonged hospital stay (P = 0.5).

If preoperative shuttle walk distance was <250 m, 50% of female and 83% of male patients experienced a subsequent poor surgical outcome. However, if preoperative shuttle walk distance was <400 m, only 27% of female and 43% of male patients experienced a poor outcome. If oxygen saturation fell by >4% during the shuttle walk test, only 33% of patients had a poor outcome (no different to those who did not have a fall in oxygen saturation). However, 50% of patients with a change in Borg score >3 at the end of a shuttle walk test had a poor outcome, compared to only 28% of patients who had a change in Borg score of <3.

4. Discussion

Our study found no significant difference in the preoperative shuttle walk test between patients in a poor surgical outcome group and those in a satisfactory outcome group. As such, the shuttle walk test is not a useful test to predict poor surgical outcome in patients undergoing lung cancer surgery. It could, however, be hypothesized that the poor predictive value is due to the way the shuttle walk distance is reported rather than to a flaw in the test per se.

For instance, since the test is reported as an absolute value, i.e. distance walked, there is no compensation made for the age, sex or physique of the patient. Since modern day lung cancer surgical populations have a wide mix of sex and aged patients, the use of absolute values have been found to be less useful than values that take into account important patient variables. For instance, recent studies [1,6,25] have shown that for VO2 max, the percentage of predicted values are better than the corresponding absolute values in predicting poor surgical outcome.

We suspect therefore that the shuttle walk distance might be more predictive if there was a range of normal values for a given age and sex. Thus, for example, if a 70-year-old lady walked 83% of her predicted distance, a surgical risk may then be extrapolated.

Although the shuttle walk distance as a continuous measure was not predictive of surgical outcome, we found it useful, when analysed by categorical groups. For instance, if a patient walked less than 250 m on shuttle walk testing, the overall chance of having a poor outcome was 66%, which was reduced to 44% when the walk distance was less than 300 m. As the average risk of poor surgical outcome was 33%, this percentage could be modified depending on whether the patient could walk 400 m in the shuttle walk or not (>400 m = 29% risk, <400 m = 37% risk).

At shuttle walk distances of less than 250 m, there was 88% risk of poor surgical outcome in male patients undergoing pneumonectomy. Therefore, shuttle walk testing was a better predictor of poor surgical outcome in male and/or pneumonectomy patients. The risk was only average
for females and patients undergoing lobectomy. Contrary to current BTS and ACP guidelines, oxygen desaturation > 4% after exercise was not shown to predict outcome, although an increase in Borg score > 3 was more useful.

5. Conclusion

We conclude that the absolute distance achieved on a shuttle walk test should not be used to predict poor surgical outcome in lung cancer patients with borderline lung function, contrary to current recommendations. It is advisable to perform a formal cardiopulmonary exercise test in the assessment of such patients if at all possible, since it can be expressed as a predicted value and has been shown to be a better predictor of poor outcome. As such, the shuttle walk test should be used with caution, only when the former is not available. However, if a normal range of shuttle walk distances corrected for age and sex becomes available, then the role of the shuttle walk test should be re-evaluated.

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