

Original Article

Efficiency of stair-climbing test for the evaluation of cardiorespiratory fitness in aged patients with biliary tract disorder undergoing surgery

Zhongying Chen, Jiangang Chen, Peitu Ren, Mingbo Mao, Xiudi Chen, Chenyan Wu, Qinfeng Qian

Department of Hepatobiliary Surgery, Shaoxing People's Hospital, Shaoxing Hospital of Zhejiang University, Shaoxing 312000, China

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Abstract: Objective: To investigate the efficiency of modified stair climbing test (SCT) for the evaluation of cardiorespiratory fitness in aged population of 80 yrs with biliary tract disorder. Methods: A total of 227 patients (male: 89, female: 138, averaged age: 83.3 yrs) aged more than 80 yrs with biliary tract disease were enrolled in this retrospective analysis. The patients were divided into surgery group (n=126, male: 54, female: 72) and non-surgery group (n=101, male: 41, female: 60) according to their willing. Ejection fraction (EF) was evaluated by qualified staff using the conventional methods. Modified SCT was used to determine the cardiorespiratory fitness. Results: Complete response was noticed in a large majority of 118 (93.65%) patients after surgery. In addition, a mortality rate of 6.35% was noticed. A total of 126 patients received SCT in the surgery group, and all the 101 patients received the questionnaire in the non-surgery group. A majority of patients showed climbing timing of less than 20 seconds, followed by timing of 20-30 seconds and more than 30 seconds. A smaller height in the SCT indicated less satisfactory cardiorespiratory fitness with a higher incidence of postoperative complication. Conclusions: The modified SCT could be considered as an effective predictor for mortality after surgery in aged patients aged of 80 yr or more with biliary tract disorder after surgery.

Keywords: Biliary tract disease, cardiorespiratory fitness, aged population, stair-climbing test

Introduction

With the improvement of life quality and medical equipments, the longevity in Chinese population is commonly increased [1]. Increasing evidences reveal that a higher prevalence of biliary tract disease in patients aged more than 80 years old [2]. In clinical practice, the management of biliary tract disorder is largely depended on surgery in adults. Nevertheless, in aged patients especially those of 80 yrs or more, higher risk and postoperative complications cause great threats to the public health [3, 4]. For example, an incidence rate of 10%-50% was noticed in the pulmonary infection in the aged patients undergoing abdominal surgery. In addition, patients undergoing surgery were apt to develop dysfunction of respiratory and/or circulatory system.

According to the previous description, a prevalence of 40.5% and 5.3% was noticed in the

postoperative complication and mortality in aged patients with biliary tract disorder after surgery, respectively [5]. Among these complications, cardiorespiratory events have been commonly reported, which causes severe damages to the life quality of the victims after surgery. Therefore, it is necessary to determine the cardiorespiratory fitness effectively prior to surgery in these aged patients. Stair-climb test (SCT) has been developed as a simple and self-administrated test to provide a convenient surrogate field performance for predicting the cardiorespiratory fitness [6]. The method has been confirmed to be an excellent mode as the test was not limited by opening hours and outside conditions (e.g. adverse weather). Meanwhile, the test is proved to be effective to track the cardiorespiratory fitness. In this retrospective analysis, we aim to investigate the predicting effects of modified SCT on the postoperative complications in aged population with biliary tract disease.

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Table 1. Type of major concurrent diseases in the patient population

Disease	Surgery Group	Non-surgery Group
Coronary heart disease	23	37
Hypertension	33	45
Diabetes mellitus	25	35
Chronic bronchitis plus emphysema	13	17
Renal insufficiency	2	5
Cerebral infarction plus hemiplegia	1	3
Idiopathic portal hypertension plus hypoproteinemia	2	5
Total	99 (78.6%)	147 (145.0%)

Methods

Patients

A total of 227 patients (male: 89, female: 138, averaged age: 83.3 yrs) aged more than 80 yrs with biliary tract disease were enrolled in this retrospective analysis. The patients were divided into surgery group (n=126, male: 54, female: 72, averaged age: 86.6 yrs) and non-surgery group (n=101, male: 41, female: 60, averaged age: 85.1 yrs) according to their willing. The onset of disease ranged from 2 h to 48 h (mean: 36 h). The written informed consents were obtained from each patient. This study was approved by the Ethic Committee of Shaoxing Hospital of Zhejiang University.

Concurrent diseases

A prevalence of 108.4% (246/227) was noticed in all the patients. A prevalence of 78.6% and 145.5% was noticed in the surgery group and non-surgery group, respectively. The major concurrent diseases were listed in **Table 1**. The other concurrent diseases were mainly consisted of prostatic hypertrophy (n=12), gastric ulcer (n=9), cataract (n=6), anemia (n=8), hypokalaemia (n=4), rectum and colon carcinoma (n=2), lung cancer (n=2), liver cancer (n=2), and carcinoma of pancreas (n=1).

Determination of cardiorespiratory fitness

Ejection fraction (EF) was determined as previously described [7]. ECG was monitored using 12-lead ECG system (Shidi Medical corporation, Nanjing, China) according to the manufacturer's instructions. In addition, common pulmonary test was performed by sophisticated staff.

Stair climbing was performed as previously described with slight modifications [8]. In brief, patients were brought to staircase consisted of 7 flights of stairs with 18 steps in each. In our hospital, each step was 6.3 inches in height and 11.7 inches in width. Before test, the patients were informed to climb as far as possible until no further climbing

could be made. All the patients participated in the stair climbing were well informed that their safety would be guaranteed by qualified medical staff. Upon the stopping of the climbing, the number of flights of stairs was recorded. For the patients with half landings, the landings were rounded down accordingly. For the patients could not move upstairs due to abdominal pain, nausea and vomiting, fatigue or powerless, a self-designed questionnaire was given to each patient to memorize the exact flights of stairs before the onset of diseases. During the test, no patients showed complications. A qualified investigator blinded to this test assessed the records.

Special cares of the patients during the SCT

Aged patients were apt to fall down, especially the patients of 80 yrs aged or more with an incidence of > 50%. For the patients undergoing SCT, Timed Up and Go (TUG) test was performed in advance according to the previous study [9]. Patients were asked to stand up from a standard chair with a seat height of 44-47 cm, and walk a distance of 3 m at an acceptable pace. Meanwhile, patients were allowed to use routine aids except using arms to stand up. The time to complete the task is measured using a stopwatch. The tests were performed in triplicate, based on which the average time was calculated. A time of less than 20 seconds indicated that the patient could walk with no aid, while a time of more than 30 seconds predicted a higher risk of falling down.

Statistical analysis

Data analysis was performed using SPSS 17.0 software. Chi square test was used to analyze the incidence of complications after SCT and

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Table 2. Clinical features of patients

Variable	Surgery group	Non-surgery group
Patient number (male:female)	126 (54:72)	101 (41:60)
Age, yr	85~90	
Height, cm	794.7±71.1*	120.1±12.2
Weight, kg	68.2±6.5	67.1±8.7
EF, %	68.8±10.1*	58.8±10.1
Pulmonary disease, %	9.3±1.4*	11.9±3.2
ICU stay	7.0±1.1	5.1±0.9
Hospitalization	15.7±2.3	10.4±2.8

*P < 0.05, compared with non-surgery group.

Table 3. SCT results and EF of left ventricle in patients

Group	Height (m)	N	EF (%)
Surgery Group	< 4	10	47.3±5.8
	4~5	14	53.2±9.4
	5~6	15	59.7±9.1
	6~7	15	63.6±10.0
	7~8	17	64.2±12.1
	8~9	13	65.1±9.8
	9~10	12	66.6±10.4
	10~11	11	67.8±9.8
Non-surgery Group	11~12	19	71.2±11.2
	< 4	36	38.1±5.6
	4~5	26	45.5±7.3
	5~6	20	52.1±9.5
	6~7	5	59.2±8.3
	7~8	5	63.1±8.9
	8~9	3	65.2±9.7
	9~10	2	67.5±9.4
	10~11	3	68.0±11.0
	11~12	1	69.3±10.5

surgery. Linear analysis was performed to analyze the EF of left ventricle and the flights of stairs. P < 0.05 demonstrated statistical difference.

Results

Patient characteristics

Table 2 summarized the patient characteristics in each group. In total, the admitting diagnosis were acute cholecystitis (n=90), biliary tract disease concurrent with incarcerated gallbladder stone in the gallbladder neck and/or peribiliary hydrops (n=47), calculus in common bile duct plus infection (n=96), biliary tract disease

concurrent with suppurative cholangitis (n=17), biliary pancreatitis (n=16), gallbladder polyps concurrent with pulmonary infection (n=8), carcinoma of gallbladder concurrent with pulmonary infection (n=11), hilar cholangiocarcinoma concurrent with obstruction (n=3), gangrene of gallbladder (n=2), and fistula in common bile duct, gallbladder and duodenum (n=1).

Among the 126 patients undergoing surgery, a total of 48 patients received the surgery in the Emergency department, while 78 received surgery at a selected time point. Laparoscopic cholecystectomy was performed in 47 patients, among which 12 received abdominal drainage. Biliary surgical procedures were performed in 77 patients, among which 1 received dissection of duodenal papilla plus calculus removal, and 2 received implantation of endoscopic retrograde cannulation of the pancreas plus implantation of metal stent.

Determination of cardiorespiratory fitness

A total of 23 patients underwent ECG monitoring, in which a large majority of patients showed sinus arrhythmia (n=10), followed by sinus bradycardia (n=5), premature ventricular or atrial beats (n=3), atrioventricular block (degree I-II) (n=2), atrial fibrillation (n=1), decrease of ST segment (n=1), reversal or lowering of T waves (n=1).

Among the patients received surgery, 10.3% showed pulmonary lesions, while that of non-surgical group was 11.9%. No statistical difference was noticed in the surgery group compared with that of the non-surgery group. The lesions were featured by increased pulmonary markings, and pulmonary emphysema. In addition, part of these patients showed moderate to severe pneumonia. No pneumonia related death was reported.

SCT results

A total of 126 patients received SCT in the surgery group, while all the 101 patients received the questionnaire in the non-surgery group (**Table 3**). In surgery group, most of the patients showed climbing timing of less than 20 seconds, followed by timing of 20-30 seconds and more than 30 seconds. A smaller height in the SCT indicated less satisfactory cardiorespiratory fitness with a higher incidence of postop-

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Table 4. Correlation between climbing heights and incidence of postoperative complications in aged population after surgery

Height (m)	N	Postoperative complications	Death
4~5	10	7	5
6~8	61	12	2
9~10	36	6	1
11~12	19	2	0

erative complication. In addition, a higher mortality was revealed in those with a small height in the SCT. This further indicated that SCT could be considered as an effective predictor for mortality after surgery in aged patients with biliary tract disorder after surgery.

EF

The EF was listed in **Table 3**. Liner regression analysis was performed to investigate the correlation between flights of stairs in the SCT test and the EF of left ventricle. The results indicated that flights of stairs the patients climbed was positively related with EF in left ventricle ($r=0.936$, $P < 0.01$). This indicated that evaluation of EF and SCT showed similar efficiency on the evaluation of cardiorespiratory fitness.

Outcome

Complete response was noticed in a large majority of 118 (93.65%) patients after surgery. In addition, a mortality rate of 6.35% was noticed. Cardiopulmonary complications were considered as the major problems after surgery with an incidence of 21.4%. The major cardiopulmonary complications were arrhythmia ($n=13$), pneumonia ($n=11$), bronchial asthma ($n=2$), and respiratory failure after anesthesia ($n=1$). **Table 4** summarized the correlation between the height and the postoperative complications in patients undergoing SCT in the surgery group. The results revealed that the flights of stairs were positively correlated with the incidence of postoperative complications.

Discussion

Aged population is apt to develop biliary tract disorders compared with the adults. In aged population, the cholesterol metabolism in liver was comparatively lower together with the release of the bile acid, which finally resulted in higher risks of biliary calculi [10]. Besides the

pathological lesions, multiple concurrent diseases are also detected in these patients, especially cardiorespiratory disorders [11, 12]. To date, like adults, surgery is the preferred method for the management of biliary tract disease in aged population of 80 yrs or more. However, higher mortality, morbidity and postoperative complications are reported in those patients [13].

Upper abdominal surgery, sternotomy and thoractomy have been reported to be associated with higher risks for aged patients with biliary tract disorders [14-16]. In the past decades, several methods were used for the determination of postoperative risks, including spirometry, functional residual capacity as well as maximum voluntary ventilation [17, 18]. To date, evaluation of cardiorespiratory fitness has been considered as the major method for the evaluation of the potency of whether surgery could be performed. The determination of maximal oxygen uptake, as the key measure for the assessment of preoperative risk in aged population [19], was determined during symptom-limited stair climbing test. In a previous study, SCT was performed in 31 patients with various degrees of chronic obstructive pulmonary disease (COPD), which revealed a linear correlation between maximal oxygen uptake and the number of flights of stairs the patients climbed [20]. In our study, the number of stairs the patient climbed served as an indicator for cardiorespiratory reserve and the capacity of cardiorespiratory stress tolerance in the aged population. In addition, the number of flights of stairs the patient climbed was positively correlated with the EF in left ventricle. All these confirm that our modified SCT is still valid for the evaluation of the cardiorespiratory fitness in the aged population. Moreover, in our modified SCT test, a questionnaire was designed for the evaluation of aged patients who could not conduct the SCT test due to abdominal pain, nausea and vomiting, fatigue or powerless. Instead, the self-designed questionnaire was given to each patient to memorize the exact flights of stairs before the onset of diseases, which could provide helpful information for the exact evaluation of cardiorespiratory fitness.

Previously, stair climbing was used in prospective study to determine the postoperative risks of patients undergoing lung resection [21]. The results indicated that SCT could be used for the prediction of postoperative mortality and pro-

longed mechanical ventilation. In our study, a larger group of patients with many a type of concurrent disease was included in this study. Our study revealed that the number of flights of stairs was correlated with the postoperative complications in heart and lung. In addition, among the 126 patients performed the SCT, 23 showed aberrant ECG and cardiorespiratory reserve. Moreover, patients with increased stair climbing were not apt to develop cardiorespiratory complications after surgery compared with those with less stair climbing. Further, the incidence of mortality and morbidity was decreased in those population with increased stair climbing. Based on these results, we concluded that SCT could evaluate the cardiorespiratory fitness effectively, which contributed to the selection of surgical indications, date of surgery, as well as surgical methods.

In the past decades, patients showed no tolerance to SCT were evaluated as high risk for postoperative complications [8]. However, on some occasions, some patients only showed no capacity of stair climbing due to immediate causes after hospitalization. The cardiorespiratory fitness of these patients may not be as bad as expected. Therefore, a self-designed questionnaire was designed to help the patients to remember the exact flights of stairs before cardiorespiratory fitness evaluation in our hospital.

In conclusion, SCT could be used for the prediction of postoperative complications in aged patients undergoing treatment of biliary tract disease. Our modified SCT contributed to the selection of surgical indications, date of surgery and surgical methods for the aged patients with multiple concurrent diseases.

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Disclosure of conflict of interest

None.

Address correspondence to: Dr. Jiangang Chen, Department of Hepatobiliary Surgery, Shaoxing People's Hospital, Shaoxing Hospital of Zhejiang University, No. 568 Zhongxing North Road, Shaoxing 312000, China. Tel: +86-575-88229452; Fax: +86-575-85138402; E-mail: chenjq0551@163.com

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