



2020

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Recommended Citation

Osailan, Ahmad and Abdelbasset, Walid K. (2020) "Exercise-based cardiac rehabilitation for post coronary artery bypass grafting: its effect on hemodynamics response and functional capacity using Incremental Shuttle walking test: a retrospective pilot analysis," *Journal of the Saudi Heart Association*: Vol. 32 : Iss. 1 , Article 6.

Available at: <https://doi.org/10.37616/2212-5043.1005>

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Exercise-based cardiac rehabilitation for postcoronary artery bypass grafting and its effect on hemodynamic responses and functional capacity evaluated using the Incremental Shuttle Walking Test: A retrospective pilot analysis

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Abstract

Background: Coronary artery bypass grafting (CABG) is a common surgical procedure for the restoration of blood flow into stenotic or blocked coronary arteries. Cardiac rehabilitation has been implemented to some extent worldwide for the management of postoperative CABG. However, studies about the effect of exercise training on hemodynamic responses of the heart using the Incremental Shuttle Walking (ISWT) test are limited in Saudi Arabia.

Objectives: To investigate the effect of exercise-based cardiac rehabilitation (Phase 3, hospital-based) on some hemodynamic responses including blood pressure, heart rate (HR) and heart rate recovery (HRR), and rate pressure product (RPP) using ISWT on post-CABG patients.

Methods: Fifteen CABG (51.4 ± 6.4 years, 14 male, 1 female) patients without altering their medication were enrolled in a hospital-based cardiac rehabilitation program (Phase 3) between 2011 and 2012 for supervised individual exercise training sessions (three times per week for 8 weeks; 60-minute session at a moderate intensity). Patients performed two tests (ISWT1 and ISWT2) and one before exercise training program and one after, during which resting systolic blood pressure (SBP) and diastolic blood pressure (DBP), post-ISWT SBP and DBP, resting HR, peak HR, HRR (which was defined as the absolute change from peak HR to 1-minute post peak HR), and RPP at rest and at the end of the ISWT were measured. Exercise training sessions included both aerobic and resistance exercises, which were preceded by a cooling down period and followed by a recovery period.

Results: Paired *t*-test showed a significant reduction in both resting SBP ($p = 0.04$) and DBP ($p = 0.03$), and a significant increase in post-ISWT2 SBP ($p = 0.004$), peak HR ($p = 0.003$), HRR ($p = 0.03$), and RPP at maximum ($p = 0.002$) after 8 weeks of supervised exercise training. In addition, there was a significant increase in the speed and distance achieved on ISWT2 ($p < 0.001$) after the training program.

Conclusion: Supervised exercise training (cardiac rehabilitation) for 8 weeks was effective in improving hemodynamic responses and functional exercise capacity in CABG patients. Cardiac rehabilitation should be implemented more frequently and health-care providers should be aware of its importance. Further research is needed in this area to confirm these findings in the region.

Keywords: Cardiac rehabilitation, Heart rate, Incremental Shuttle Walking Test, Rate pressure product

Received 31 October 2019; revised 5 December 2019; accepted 7 December 2019.
Available online 17 April 2020

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1. Introduction

Cardiovascular diseases (CVDs) include a wide range of disorders that affect the heart and blood vessels. Coronary artery disease (CAD), also known as coronary heart disease, is one of the CVDs that affects the coronary arteries, which is responsible for 85% of CVD-related mortality worldwide [1]. Coronary artery bypass grafting (CABG) has been widely and increasingly used since the 1960s as a common surgical procedure to restore blood flow into the stenotic coronary arteries [2].

Although CABG has become less likely to be life-threatening, patients who have undergone the procedure may still have a risk of subsequent ischemic events which can extend to atherosclerosis in the grafted vein [3,4]. Furthermore, such patients may experience difficulties in returning back to normal activities of daily living because of (1) misconception that activity should be limited, (2) generalized muscle weakness after surgery owing to the lack of use. These reasons may eventually have a negative impact on the psychological status and quality of life of the patient [5–7].

Cardiac rehabilitation has shown great benefits to post-CABG patients. These benefits include more than 30% reduction in mortality [8], reduction in readmission rate [9,10], a reduced manifestation of major cardiovascular risk factors, including high blood pressure (BP), dyslipidemia, hyperglycemia, smoking [11], and adverse psychological outcomes [12,13]. Thus, implementation of cardiac rehabilitation is substantial for maintaining positive outcomes and sustaining a healthy life after the surgery in the long run.

Cardiac rehabilitation typically includes multiple interventions such as regular exercise, a healthy diet, medical therapy (e.g., medicine), risk factors management with education, and coping with stress [13,14]. Exercise training is one of the key components of cardiac rehabilitation, as it is known to improve vascular circulation and enhance the oxidative capacity of the muscles in addition to offering many other benefits [15]. Besides, there are various benefits that come from other components of cardiac rehabilitation which include the benefits gained from education and coping with stress, which aid the recovery process of the patients.

Cardiac rehabilitation for post-CABG patients is a well-known management option implemented in the USA, UK, Canada, and Australia [16]. However, in developing countries in the Middle East, this area of

Abbreviations

CABG	Coronary artery bypass grafting
CVD	Cardiovascular diseases
CAD	Coronary Artery diseases
ISWT	Incremental Shuttle walking test
SBP	Systolic Blood Pressure
DBP	Diastolic Blood Pressure
HR	Heart Rate
RPE	Rate of Perceived Exertion
HRR	Heart rate recovery
BP	Blood Pressure
RPP	Rate Pressure Product
6MWT	Six-minutes walking test
CR	Cardiac Rehabilitation
MI	Myocardial infarction
PTCA	percutaneous transluminal coronary angioplasty

rehabilitation has not attracted full attention, despite the high burden and the increased incidence of CAD in the Arabian countries [17]. Saudi Arabia is one of the countries in which cardiac rehabilitation is still under progress in terms of implementation. Moreover, little is known about the effectiveness of cardiac rehabilitation in post-CABG patients in Saudi Arabia, as investigations in this area are limited. To the best of our knowledge, only one study reported the results of a comparison between home-based exercise and hospital-based cardiac rehabilitation [18]. Because of the lack of studies about the effect of cardiac rehabilitation on post-CABG patients in Saudi Arabia, this study was aimed at investigating the effect of an 8-week, individualized, exercise-based cardiac rehabilitation program (hospital-based; Phase 3) on some hemodynamic responses including BP, heart rate (HR), rate pressure product (RPP), and functional capacity, as assessed by Incremental Shuttle Walking Test (ISWT), in post-CABG patients. It was hypothesized that 8 weeks of individualized, exercise-based cardiac rehabilitation will improve hemodynamic responses and functional capacity of post-CABG patients.

2. Methods

2.1. Study population

Data for this study were retrieved from a record file of the attendees of the cardiac rehabilitation program at King Faisal Specialist Hospital and Research Centre-Jeddah with full consideration for the data to be anonymous. The data were recorded manually by the author who was working at the hospital as a physiotherapist specialized in cardiac rehabilitation. Only the author has access to these data. All the data included were coded using

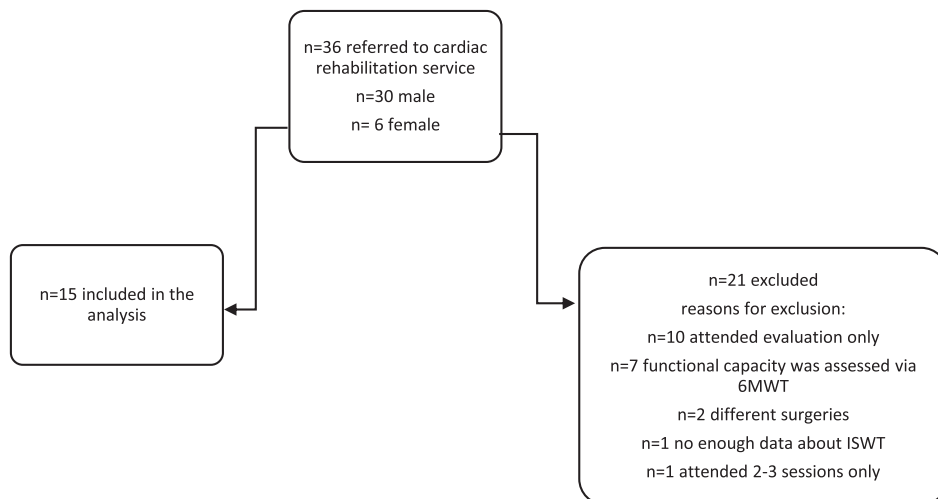


Fig. 1. A flow diagram showing the number of coronary artery bypass grafting patients referred to the cardiac rehabilitation service. 6MWT = 6-Minute Walking Test; ISWT = Incremental Shuttle Walking.

numeric concealment. Because this is a retrospective pilot analysis of an intervention that was provided as rehabilitation management after CABG, there was no informed consent to be filled, as this was part of the postsurgical management. The main author kept a record of patients referred to cardiac rehabilitation services from March 2011 to February 2012. A total of 36 patients were referred during this period (Fig. 1). Only 15 patients met the inclusion criteria which included the following: diagnosis of CABG with physical therapy referral, functional capacity assessed by ISWT, and the patient has to be cleared by the caring physician for his/her ability to exercise. Exclusion criteria were patients with different diagnoses referred to exercise training with other CVDs or other cardiac surgeries. Eventually, this study included data from 15 CABG patients referred to Phase 3 outpatient cardiac rehabilitation program. According to the sample analysis performed using G*Power software, *a priori* test showed that the sample required to achieve the power of $(1-\beta \text{ error probability}) = 0.82$ was 15 with effect size (d) of 0.7. Ethical approval was obtained from the Ethical Committee at Prince Sattam bin Abdulaziz University (RHPT/018/077).

Upon discharge from the hospital after surgery (during inpatient stay), all CABG patients were given an outpatient appointment to start their outpatient exercise training program after 4–6 weeks. All appointments were given in the afternoon (appointment slots for cardiac patients were from 1:00 to 4:00 PM). Patients were also given educational materials about controlling their diets and increasing physical activity at home. Once the

patient attended the first appointment, the physical assessment was performed by the attending physiotherapist with cardiac rehabilitation specialty. The regular assessment was performed including the ISWT as a test to measure the functional exercise capacity and to risk stratify the patients. ISWT was also used to assess the effectiveness of the exercise training program in improving the functional capacity of the patients.

2.2. Functional capacity assessment

Each patient was assessed for any exclusion criteria before the commencement of ISWT. These were unstable angina, unstable or acute heart failure, unstable diabetes, new or uncontrolled arrhythmias, resting or uncontrolled tachycardia (resting HR >100 bpm), resting systolic blood pressure (SBP) >180 mmHg, diastolic blood pressure (DBP) >100 mmHg, symptomatic hypotension, and febrile illness [19]. BP was measured using an automated BP monitor, and HR was monitored during ISWT via a polar HR monitor (polar H7). All the tests were standardized to be conducted in the afternoon at the corridor of the physical therapy department at the hospital. The testing mainly took place in the afternoon between 1:00 and 3:00 PM. The testing area and the rehabilitation area were the same.

The cones were set out on a nonslippery flat surface exactly 9 m apart. This allows for the course to be 10 m, including the distances around each cone at the ends of each shuttle. Patients followed the instructions on the CD and gave verbal confirmation that they understood the protocol. Patients then

walked around the course, aiming to turn at the first marker cone when the first beep sounded and at the second cone when the second beep sounded. During the first levels (three shuttles), patients were accompanied by the investigator to help them pace themselves at the same pace as the beeps from the CD. After the first level, the test operator stood at the halfway point of the circuit and offered advice on when levels were completed. Progression to the next level was given by a triple beep, which indicated an increase in walking speed. The full test has 15 levels, each is a minute long, of incrementally increasing speeds. HR, rate of perceived exertion (RPE), and arising symptoms were recorded at the end of each level. The test was stopped on completion, or if any of the termination criteria were met, which included any angina symptoms or severe shortness of breath; feeling dizzy or faint; leg pain (e.g., severe cramping or “burning”); RPE = 15 on the Borg scale; achieved 85% predicted HR reserve; or failure to walk at the same rate as the speed requirements of the test (i.e., more than 0.5 m from the cone when the beep sounds on two consecutive cones). Careful monitoring of the patient was necessary during the immediate post-test period. The limiting symptoms, total distance walked, peak HR, heart rate recovery (HRR; recorded HR after 1 minute from the peak HR), and reason for terminating the test were recorded. ISWT was repeated before the patient was discharged from the outpatient care of the hospital. None of the patients experienced an adverse event during ISWT or during exercise training.

2.3. Exercise training program

Following the ISWT assessment, the patient was given appointments for supervised individual exercise training sessions (three times per week for 2 months) which were scheduled to be performed in the afternoon. All exercise sessions took place at the gym located at the physical therapy department of the hospital. The rehabilitation program included basic nutritional consultation, basic psychological consultation if necessary, and CVD risk factors education. Before exercise training, vital signs were assessed and medication was reviewed for any change in doses throughout the rehabilitation program. The exercise training program consisted of 10 minutes of warming up on a treadmill or a stationary bike followed by 5 minutes of stretching, then 30–35 minutes of aerobic and resistance exercise in the form of aerobic-resistance circuit training, and 10 minutes of cooling down (active recovery) on a

treadmill or a stationary bike. The intensity of aerobic exercise training was set to 70–80% of maximum HR achieved during ISWT at the start, which was then gradually increased periodically depending on the hemodynamic response of the patient during exercise up to 85%. Before, during, and after the exercise session, HR and BP were continuously monitored. The number of sessions attended was also recorded. RPP was calculated at rest and at maximum value after the end of the test.

$$\begin{aligned} \text{RPP at rest} &= \text{Resting HR} \\ &\times \text{resting SBP, RPP at maximum} \\ &= \text{Peak HR} \times \text{post-ISWT SBP} \end{aligned}$$

2.4. Statistical analysis

Data were analyzed using SPSS version 25 (IBM, Chicago, IL, USA). The normality of the variables was tested using the Kolmogorov–Smirnov test. All variables were normally distributed and were presented as mean and standard deviation. Paired *t*-test was used to assess the effect of the exercise training program on the following factors at baseline and after the exercise training program: post-ISWT SBP and DBP, resting HR, peak HR, HRR, RPP, maximum distance walked, and speed achieved.

3. Results

3.1. Patient characteristics

A flow diagram demonstrating the number of patients referred to cardiac rehabilitation is presented in Fig. 1. A large number of referred patients were excluded due to multiple reasons, with many only attending the first evaluation as the common reason for exclusion. Besides, it can be noticed in the

Table 1. Demographic characteristics.

Variable	N = 15 (mean ± SD)
Age (yr)	51.4 ± 6.4
Weight (kg)	81.2 ± 16.8
Height (m)	1.7 ± 0.1
Body mass index	27.6 ± 4.9
Resting HR (bpm)	71 ± 7.6
Resting SBP (bpm)	121 ± 15
Resting DBP (bpm)	73 ± 10
Resting O ₂ saturation %	98.9 ± 1.2
Risk factors	
Hypertension	8/15
Diabetes mellitus	8/15

DBP = diastolic blood pressure; HR = heart rate; SBP = systolic blood pressure.

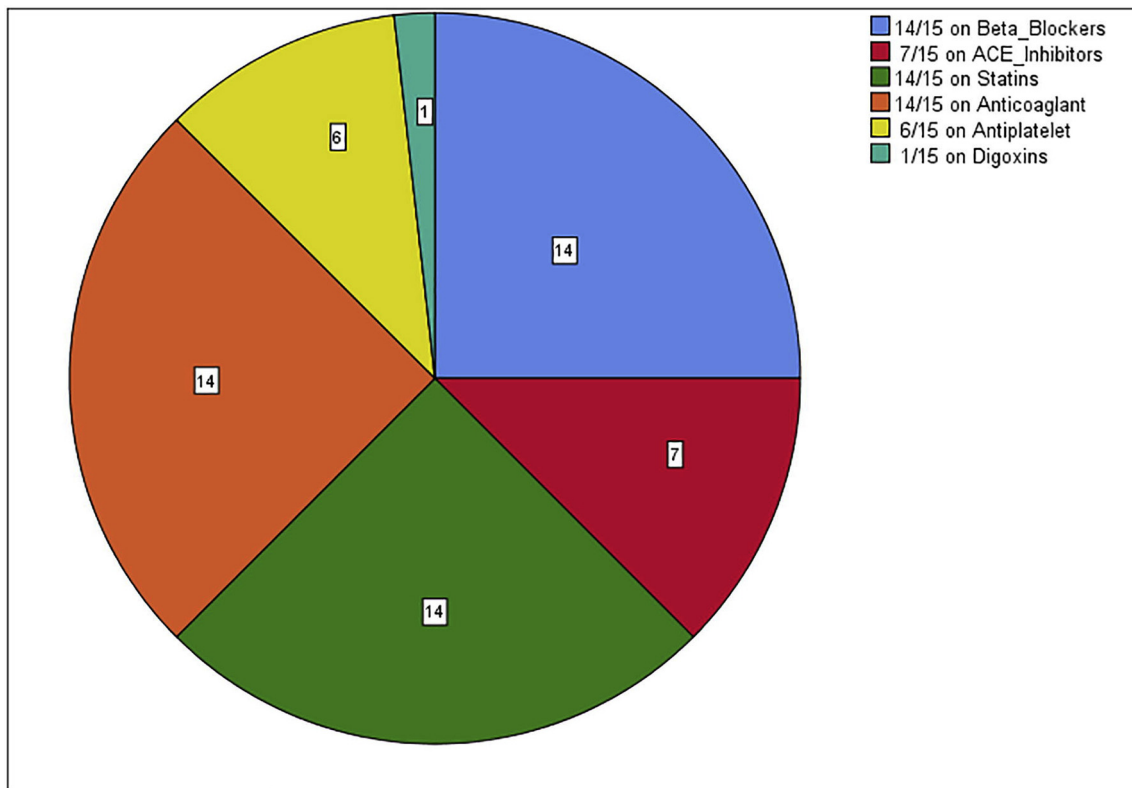


Fig. 2. The type of medication prescribed for the 15 coronary artery bypass grafting patients. ACE = angiotensin-converting enzyme.

flow diagram that most referred patients were male (83.3%). Demographic characteristics of the 15 CABG patients included (14 male and one female; mean age of 51.4 ± 6.4 years) are presented in Table 1. The most common comorbidities were diabetes mellitus and hypertension. All the patients during the exercise training were nonsmokers. The type of medications used are presented in Fig. 2. Patients were continuing their medications during the program. The hemodynamic response of patients in comparison with their baseline readings is presented in Table 2. The attendance was 16 ± 5.3

sessions with adherence to the number of sessions on average of 66.6%.

3.2. The difference in hemodynamic responses before and after exercise training program

A paired *t*-test was conducted to compare the response to ISWT pre- and post-exercise training program. Results of the test (Table 2) showed there was a significant reduction in resting SBP ($t_{14} = 1.9$, $p = 0.04$) and DBP ($t_{14} = 2.0$, $p = 0.03$). There was also a significant increase in post-ISWT SBP

Table 2. Hemodynamic responses to ISWT before and after exercise training.

Variable	Pre-exercise program (ISWT1)	Post-exercise program (ISWT2)	<i>p</i>
Resting HR (bpm)	70 ± 7.6	70 ± 10.2	0.4
Resting SBP (mmHg)	121 ± 15	113 ± 9	0.04
Resting DBP (mmHg)	73 ± 9.5	67 ± 6.2	0.03
Post-ISWT SBP (mmHg)	147 ± 19.1	174 ± 29.1	0.004
Post-ISWT DBP (mmHg)	74 ± 22.7	79 ± 11.6	0.24
Peak HR during the test (bpm)	119 ± 18.1	131 ± 13.6	0.003
HRR	27 ± 13	33 ± 11.6	0.03
RPP at rest	8621.3 ± 1924.2	7990.9 ± 1644.7	0.12
RPP at max	$17,660.9 \pm 3607.5$	$22,746.1 \pm 4574.4$	0.002
Maximum speed achieved (km)	5.51 ± 1.0	6.6 ± 0.7	<0.001
Maximum distance achieved (m)	470.6 ± 151.6	597.3 ± 199.7	<0.001

DBP = diastolic blood pressure; HR = heart rate; HRR = heart rate recovery; ISWT = Incremental Shuttle Walking Test; RPP = rate pressure product; SBP = systolic blood pressure. P value in bold indicate significantly different $p < .05$.

($t_{12} = -3.1, p = 0.004$), peak HR during the test ($t_{14} = -3.3, p = 0.003$), HRR ($t_{14} = -2.1, p = 0.03$), and RPP ($t_{12} = -3.6, p = 0.002$) before and after the exercise program. In addition, there was a significant improvement in the maximum speed ($t_{14} = -6.1, p = <0.001$) and distance achieved ($t_{14} = -3.5, p < 0.001$) after the exercise training program.

4. Discussion

The current pilot study explored the effects of cardiac rehabilitation exercise training program on hemodynamic responses and functional capacity (assessed by ISWT) of patients who have undergone CABG (Table 3). As expected, most hemodynamic responses were better after 8 weeks of the individualized exercise training program including resting SBP and DBP, peak HR, HRR, and RPP. Patients were also able to walk further and achieve better speed on the second ISWT after the exercise training program. The results indicate that 8 weeks of supervised individual exercise training program was beneficial for CABG patients. Therefore, such programs should be included in the management of these patients.

The control and maintenance of BP are highly recommended for CABG patients as they are more likely to be diagnosed with hypertension before surgery, which also needs to be aggressively managed after CABG as a secondary prevention. The present study showed a significant reduction in resting SBP and DBP. Ghashghaei et al. [20], examined the effect of exercise training on multiple hemodynamic responses, and likewise, found a significant improvement in resting BP within the rehabilitation group and a better resting BP when compared with the reference group (a group

without exercise). Similarly, improvement in resting BP after cardiac rehabilitation has been demonstrated in multiple cardiac rehabilitation programs from different centers worldwide [21]. However, it must be noted that medications were not restricted or modified in the current study or in other studies. Therefore, the improvement in resting BP must be interpreted with caution, as most of our patients were prescribed with β blockers, a medication used to reduce BP (93.3%). Although β blockers are widely used because of its beneficial effect in reducing BP, exercise training is also recommended as a core management in hypertensive patients due to its additional effect on reducing BP [22]. Thus, we believe that exercise may have added some additional benefit to these patients. Indeed, the resting SBP was within normal value before the exercise training program, and reduced further after the exercise training program (Table 2).

The exercise training program improved patients' effort tolerance (tolerance to higher level of intensities during ISWT), as the SBP post-ISWT2 after exercise training showed an increase, indicating a better ability to tolerate further increment of exercise intensity. This increase of maximum attainable SBP during an incremental test is consistent with the findings reported by Sharma and McLeod [23]. However, this is not the case with Ghashghaei et al. [20], in which the authors found a decrease in maximum SBP after the 6-Minute Walking Test (6MWT). This difference in findings can be explained by the variation in the methodology used for assessment of functional capacity. Both the present study and the former study used an incremental test, whereas the later one used a simpler nonincremental test which did not provoke more hemodynamic responses from the heart or blood vessels.

Similar to the increase in SBP post-ISWT2, there was an increase in peak HR during ISWT2. This again may indicate further improvement in exercise tolerance after cardiac rehabilitation. Achieving higher peak HR after cardiac rehabilitation was found in some [24], but not all studies [20,23]. The contrast between the findings of the studies in comparison with the current one may be due to the different methodologies employed, as the use of different protocols of functional capacity exercise testing may impose some variation in the response of the patients to exercise test intensities. Our results are parallel to the findings of Daida et al. [24], who compared the effect of cardiac rehabilitation on exercise tolerance between CABG patients and heart failure patients. The results showed that improvement in peak HR was only achieved in CABG patients. Although in the study by Sharma

Table 3. CABG details about the number of grafted vessels and ejection fraction after surgery.

Patient	Number of graft in CABG	Ejection fraction % after surgery
1	One vessel graft	50
2	One vessel graft	55
3	One vessel graft	55
4	One vessel graft	45
5	One vessel graft off-pump	50
6	Three vessels graft	NA
7	Three vessels graft	35
8	One vessel graft	55
9	Four vessels graft	NA
10	Four vessels graft	50
11	One vessel graft	45
12	Three vessels graft	NA
13	Three vessels graft	55
14	Three vessels graft	55
15	One vessel graft	NA

CABG = coronary artery bypass grafting; NA = not available.

and McLeod [23] cardiac surgery patients were involved, the authors did not provide any information about the type of cardiac patients included in their study. Therefore, we may speculate that the effect of exercise training can be more evident in some type of cardiac patients (i.e., CABG) but less evident in other types.

HRR is one of the simple methods to assess the function of the autonomic nervous system (sympathetic nervous system and parasympathetic nervous system). HRR is mainly assessed during recovery immediately at the end of the exercise test, in which it assesses the ability of the parasympathetic nervous system to take over at the end of exercise session [25]. In the present study, HRR increased after the cardiac rehabilitation program. This is consistent with the findings from multiple studies on CABG patients [26–28]. Most of these studies have concluded that HRR improvement is associated with exercise training. However, It should be noted that interpretation of the improvement in HRR should be done with caution, as HRR can be influenced by the medications (i.e., β blockers), which could reduce HRR without exercise training. This warrants further research that should focus on having a control group with their medication and an experimental group with exercise training (with their medication as well) to elucidate the effect of these type of medications.

To further examine the effect of cardiac rehabilitation on hemodynamic responses, we measured RPP, which is a reflection of myocardial oxygen consumption, that can be measured at rest or during exercise [29,30]. Changes in HR and BP were used to obtain RPP during exercise by multiplying the maximum HR with maximum attained SBP ($HR \times SBP$). In the current study, because there was an increase in HR_{max} as well as an increase in maximum attainable SBP, it was not surprising to see an increase in RPP. This significant increase in RPP indicates that the heart after exercise training was able to work more, thus tolerating higher workloads than before [31]. It has been also suggested that reaching a high RPP during exercise without signs of severe ischemia is an indication of a better left ventricular function [31]. It is noteworthy that there was an increase in maximum speed and distance achieved as well, which means an increase in workload; however, there were no reported signs of severe discomfort during ISWT. This increase in workload was met by an increase in RPP, which indicates adequate myocardial oxygen consumption and adequate left ventricular function in our patients.

To our knowledge, this is one of the few studies that utilized ISWT as a measure of functional

capacity for CABG patients. The majority of previous studies investigating the effect of exercise training programs on cardiac patients used a simpler field test (i.e., 6MWT) [32]. The use of ISWT has been found to be superior to 6MWT in reflecting functional exercise capacity [33,34]. ISWT is an incremental test in which the speed is dictated by audible beeps, whereas 6MWT is a self-paced and the patient is allowed to walk as much as he/she tolerates without inducing too much hemodynamic load on the cardiovascular system.

In a systematic review by Traversolo et al. [32], only one single study utilized ISWT as a measure of functional capacity but it investigated the effect of cardiac rehabilitation on refractory angina [35]. In a specific population such as post-CABG patients, very few studies utilized ISWT as a measure of functional capacity before and after a cardiac rehabilitation program [36,37]. A comparison of these studies with the current one is presented in Table 4. Overall, the aim of the two studies was different from the current one. One of the two studies was investigating the effect of cardiac rehabilitation on multiple populations with CABG which was included along with post-myocardial infarction and post-percutaneous transluminal coronary angioplasty patients [37]. This may indicate that there is a shortage of studies that utilize ISWT as an outcome measure which was demonstrated to be a good measure of cardiorespiratory fitness [36].

As mentioned earlier, the application of cardiac rehabilitation in Saudi Arabia is limited. Therefore, this study adds to the available published scientific literature about the importance of cardiac rehabilitation following CABG. In general, access to cardiac rehabilitation in Saudi Arabia should be available as well as in other Arab countries [17]. Readmission to the hospital following open heart surgeries is one of the issues that some hospitals may encounter following this kind of surgeries. Implementation of the cardiac rehabilitation program would be helpful in reducing the burden and the costs of readmissions.

There are some limitations of this study that are worth mentioning. The small sample size is one of the major limitations in this pilot study, partly due to the lack of awareness of the importance of cardiac rehabilitation by the community as well as by some health professionals. Another limitation is that there might be a learning effect from the first ISWT which could have influenced the second test. This learning effect could be more evident in the maximum speed and distance achieved, however, we also measured other factors that cannot be changed even if a trial was provided.

Table 4. A comparison between the current study and other similar studies utilizing the Incremental Shuttle Walking Test as a measurement of functional capacity.

Authors and year	Aim of the study	Control or grouping	Duration of the CR program	Type of patients	Intensity	Number of patients	Main results
Fowler et al. [36] (2005)	Test the sensitivity and reliability of ISWT in CABG patients	No control, just a single group	6 wk	Post-CABG	No information	<i>n</i> = 11	There was a significant increase in ISWT performance. ISWT can detect changes in cardiorespiratory fitness and relates strongly with conventional graded exercise testing.
Jolly et al. [37] (2009)	Compare the effectiveness of home-based versus multiple-center-based CR	Centre-based group and home-based group	Centre-based group: 12 session for 8 wk or 24 sessions over 12 wk. Home-based group: Three visits at 10 d, 6 wk, and 12 wk) and telephone contact at 3 wk	Post-MI, post-PTCA, post-CABG	Center-based 65–75 of estimated maximum heart rate	<i>n</i> = 22 from center-based CR <i>n</i> = 33 from home-based CR	There was an increase in resting systolic blood pressure and resting diastolic blood pressure for both groups. There was no difference between the two groups in the main outcomes of the study.
Current study	Investigate the outcomes of exercise-based CR	Hospital-based group Without control	8 wk for 24 sessions	Post-CABG	65–85% of maximum heart rate achieved during ISWT	<i>n</i> = 15	Similar to Fowler et al.'s study regarding increase in ISWT performance, and contrary to Jolly et al.'s study with reduction in both resting systolic and diastolic blood pressure

CABG = coronary artery bypass grafting; CR = cardiac rehabilitation; ISWT = Incremental Shuttle Walking Test; MI = myocardial infarction; PTCA = percutaneous transluminal coronary angioplasty.

In conclusion, this study demonstrated that a supervised exercise training (cardiac rehabilitation) for 8 weeks was effective in improving hemodynamic responses and functional exercise capacity. However, more research is needed with control groups and on a larger sample to compare the effect of medications alone without enrollment into cardiac rehabilitation.

Acknowledgments

We thank King Faisal Specialist Hospital and Research center for providing the tools at the hospital to conduct the cardiac rehabilitation program. We also would like to thank the Deanship of Scientific research at Prince Sattam Bin Abdulaziz

University for providing the statistical tools to conduct the study.

Conflicts of interest

The authors declare no conflicts of interest.

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