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RESISTED EXERCISE IN CARDIAC REHABILITATION AFTER CARDIAC SURGERY (A REVIEW ARTICLE)

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ABSTRACT

Coronary artery disease (CAD) was defined as the pathological process characterized by atherosclerotic plaque accumulation in the cardiac arteries. Coronary syndromes are a range of clinical presentations or syndromes that arise due to structural and/or functional alterations related to chronic diseases of the coronary arteries and/or microcirculation. Coronary artery bypass grafting (CABG) is the main treatment for CAD when medicines or percutaneous procedures are not enough to revert symptoms. Over the past 10 years, the use of more durable grafts, aiming to minimize injuries to the patients, brought a progressive improvement to this surgical procedure.

Following cardiac surgery there are variable changes in important indicators of musculoskeletal and cardiorespiratory function (handgrip strength, lung function) due to inflammatory deconditioning which may lead to a concomitant decrease in health-related quality of life (HRQoL).

Cardiac rehabilitation (CR) has been established as an effective, multidisciplinary approach to enhance physical and psychosocial recovery following cardiac surgery. Phase I CR initiated during hospitalization, focuses on early mobilization, respiratory exercises. Resistance training (RT) has emerged as an essential component of CR, offering benefits that extend beyond those of aerobic exercise alone. Early postoperative resistance exercise is both safe and feasible and contributes to the prevention and reversal of sarcopenia, improved muscle adaptation, and enhanced circulatory efficiency. Furthermore, it has been shown to reduce inflammation, improve psychological well-being, and enhance quality of life (QOL) in post-CABG patients

Key Words: Coronary artery disease, Coronary artery bypass grafting, Cardiac rehabilitation, Resisted exercise

Coronary artery disease

Prevalent cases of total cardiovascular disease (CVD) almost doubled from 271 million in 1990 to 523 million in 2019 **(Roth *et al.*, 2020)**. According to the World Health Organization (WHO),

approximately 17.9 million deaths, representing 31% of all global deaths, were attributed solely to CVD in 2016 **(WHO, 2021)**.

Coronary artery disease (CAD) develops due to the narrowing or blockage of the coronary arteries caused by atherosclerotic plaque formation, resulting in an imbalance between myocardial oxygen demand and supply and inadequate oxygenation of the heart muscle **(Bauersachs *et al.*, 2019).**

Coronary artery disease is a multifactorial condition. The etiological factors are divided into non-modifiable and modifiable categories. Non-modifiable factors include age, gender, family history, and genetic predisposition, while modifiable factors consist of hypertension, smoking, obesity, abnormal lipid levels, and psychosocial influences **(Bauersachs *et al.*, 2019).**

Cardiac surgery

Coronary artery bypass grafting (CABG) remains the gold-standard treatment for multivessel coronary artery disease, particularly in patients with three-vessel or left main CAD. It continues to be the most frequently performed cardiac surgical procedure worldwide, with approximately 200,000 cases conducted annually **(Melly *et al.*, 2018).**

This procedure involves grafting a blood vessel from the aorta to a coronary artery, bypassing the blocked segment to improve myocardial blood flow. It is performed in patients with ischemic heart disease to restore the balance between oxygen demand and supply to the myocardium **(Ghandakly *et al.*, 2024).** CABG can be carried out either on-pump, with cardiopulmonary bypass (CPB) and a stopped heart, or off-pump on a beating heart. The surgical approach may be performed endoscopically or through thoracotomy **(Gaudino *et al.*, 2018).**

Bypassing a diseased coronary artery improves perfusion to the ischemic myocardium supplied by the affected vessel and protects distal myocardial tissue from future ischemic damage resulting from plaque progression or rupture **(Lawton *et al.*, 2022).**

Cardiac surgery using cardiopulmonary bypass is associated with several complications, including atrial fibrillation, cardiac tamponade, cardiac arrest, and the need for a permanent pacemaker or implantable cardioverter-defibrillator. Additional complications may involve pulmonary, gastrointestinal, renal, and neurological events, as well as superficial or deep wound infections and anticoagulation-related disorders **(Juwhyreeyeh *et al.*, 2023).**

Functional capacity (FC) and muscle strength reduction are common postoperative outcomes in patients following CABG **(Cordeiro *et al.*, 2020**). Prolonged bed rest after surgery may contribute to multi-organ dysfunction. Immobilization negatively affects oxygen transport, increases the risk of deep venous thrombosis in the lower limbs, and leads to muscle atrophy and weakness, all of which contribute to a decline in functional capacity **(Bourdin *et al.*, 2010).**

Cardiac rehabilitation (CR)

Cardiac rehabilitation is defined as a structured process in which patients with cardiac disease or those recovering from cardiac surgery work with a multidisciplinary team to achieve and maintain optimal physical and psychosocial health. It is widely recognized as an effective method for reducing disability and extending life expectancy in post-CABG patients **(Maddocks and Cobbing, 2017).**

Cardiac rehabilitation aims to improve cardiovascular health in patients with CVD and is strongly recommended by international clinical guidelines (Class IA). Regular physical activity is one of the most effective interventions for patients recovering from cardiac surgery, as it helps reduce the risk of future cardiac events. Participation in cardiac rehabilitation has been shown to lower two-year mortality following cardiac surgery **(Kourek and Dimopoulos, 2024).**

Phase I CR is implemented during hospitalization and continues until the patient is discharged. It focuses on mobility training, physical and respiratory exercises, as well as education regarding cardiac risk factors, stress reduction, and anxiety management **(Galih *et al.*, 2022).**

Post-cardiac surgery rehabilitation protocols are designed to help patients resume daily activities by integrating physical exercises and educational sessions aimed at long-term lifestyle modification. Recent advances in rehabilitation approaches have enabled earlier hospital discharge with minimal decline in functional capacity **(Siddiqui *et al.*, 2023).**

Resistance training (RT) aims at enhancing muscular strength is an essential component of the exercise program within CR protocols for patients following open-heart surgery. Although initiating RT in the early postoperative period has been proven safe and feasible, its implementation is often postponed for up to four weeks. Evidence suggests that such delays may considerably reduce the effectiveness of CR outcomes **(Atef *et al.*, 2023).**

Resistance Exercise is an important aspect of an exercise program for CR population, offering unique benefits that are not provided by aerobic exercise training. Specifically, resistance exercise can prevent or reverse the loss of muscle mass (sarcopenia) that occurs after CABG with older age **(Verdicchio *et al.*, 2023).**

Resistance exercise enhances maximal workload tolerance through peripheral muscle adaptations like increased cross-sectional area, capillarization, and oxidative capacity, reduces resting and submaximal exercise plasma norepinephrine levels, promoting increased blood flow during activities like the six-minute walk test (6-MWT). **(Dwiputra *et al.*, 2023).**

Resistance exercise not only augments improvements in cardiovascular fitness and muscle strength, but recent evidence also suggests that it may play a role in the reduction of inflammation, cognitive dysfunction and sarcopenia **(Koster *et al.*, 2009)** which can persist for several months after surgery; improve QOL, psychological wellbeing, morbidity, and ability to perform household activities. **(Pollmann *et al.*, 2016).**

Resistance exercises include whole body, single- or multi-joint exercises, performed bilaterally, may include a range of modalities including body weight training, free weights with a maximum of 2 kg to 3 kg for upper limb (UL) and lower limb (LL) which considered safe weights within the exercise protocol proposed, machine weights and elastic resistance bands. **(Verdicchio *et al.*, 2023).**

CONCLUSION

Cardiac rehabilitation is a cornerstone of postoperative recovery for patients undergoing CABG, facilitating functional improvement, risk reduction, and enhanced quality of life. Incorporating resistance training into CR programs provides distinct and complementary physiological and psychological benefits compared to aerobic exercise alone. By preventing muscle atrophy, improving muscular and cardiovascular performance, and supporting psychosocial well-being, resistance training accelerates recovery and enhances overall rehabilitation outcomes. Therefore, early, individualized, and safely monitored resistance exercise should be considered a vital component of comprehensive cardiac rehabilitation strategies for post-CABG patients.

Conflict of interest

The authors have declared no conflict of interest.

Compliance with Ethics Requirements

Ethical Committee Approval of the Faculty of Physical Therapy, Cairo University was obtained before preceding the procedures of the study. In addition, a written consent form was obtained from patient before starting the study procedure

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تمارين المقاومه في اعاده تاهيل القلب بعد جراحه القلب (مقال مرجعي)

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مرض الشريان التاجي يعرف بانه عملية مرضية تتميز بتراكم لويحات تصلب الشرايين في الشرايين القلبية ؛ اما المتلازمات التاجية فهي مجموعة من الاعراض التي تنشا نتيجة تغيرات وظيفية و/ او تكوينية مرتبطة بالامراض المزمنة في الشرايين التاجية و/ او الدورة الدموية الدقيقة.

تعد جراحة تحويل الشريان التاجي العلاج الرئيسي لمرض الشريان التاجي عندما لا تكون الادوية او الاجراءات التداخلية عبر الجلد كافية لعكس الاعراض ، وخلال السنوات العشرة الماضية ادي استخدام رقع جراحية اكثر تحملا و متانة تهدف الي تقليل الاثار الجانبية علي المرضي الي تحسينات متواصلة في فاعلية و جودة هذا الاجراء الجراحي .

بعد جراحة القلب تحدث تغييرات متفاوتة في مؤشرات متفاوتة في مؤشرات هامة تتعلق بوظائف الجهاز العضلي الهيكلي و الجهاز التنفسي (مثل قوة قبضة اليد ووظائف الرئة) ، نتيجة لحالة الضعف الجسدي الناتجة من الالتهابات و التي تؤدي الي تراجع متزامن في جودة الحياة المرتبطة بالصحة.

يُعَدّ التأهيل القلبي تدخلاً متعدد التخصصات وفعّالاً يهدف إلى تعزيز التعافي البدني والنفسي الاجتماعي بعد جراحة القلب. ويُنفَّذ البرنامج في مرحلته الأولى (المرحلة الأولى من التأهيل القلبي) خلال فترة الإقامة في المستشفى، حيث يركّز على بدء الحركة المبكرة وتمارين الجهاز التنفسي لاستعادة الكفاءة الوظيفية والوقاية من المضاعفات بعد الجراحة

قد برزت تمرينات المقاومه كعنصر أساسي في برنامج التأهيل القلبي، لما يقدّمه من فوائد إضافية تتجاوز ما تحققه تمارين اللياقة الهوائية وحدها. إذ تُعَدّ تمرينات المقاومه المبكره بعد الجراحة آمناً وقابلاً للتطبيق، ويسهم في الوقاية من ضمور العضلات المرتبط بالتقدم في العمر وعكسه، كما يعزز من قوة العضلات وتكيّفها، ويحسن كفاءة الدورة الدموية. إضافةً إلى ذلك، أظهرت الدراسات أنّ تمرينات المقاومه تساهم في خفض مستويات الالتهاب، وتحسين الحالة النفسية، ورفع جودة الحياة لدى المرضى بعد جراحة تحويل مسار الشريان التاجي.