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Original article

Whole-body strength training with Huber Motion Lab and traditional strength training in cardiac rehabilitation: A randomized controlled study

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ABSTRACT

Background: Isometric strengthening has been rarely studied in patients with coronary heart disease (CHD), mainly because of possible potential side effects and lack of appropriate and reliable devices.
Objective: We aimed to compare 2 different modes of resistance training, an isometric mode with the Huber Motion Lab (HML) and traditional strength training (TST), in CHD patients undergoing a cardiac rehabilitation program.
Design: We randomly assigned 50 patients to HML or TST. Patients underwent complete blinded evaluation before and after the rehabilitation program, including testing for cardiopulmonary exercise, maximal isometric voluntary contraction, endothelial function and body composition.
Results: After 4 weeks of training (16 sessions), the groups did not differ in body composition, anthropometric characteristics, or endothelial function. With HML, peak power output ($P = 0.035$), maximal heart rate ($P < 0.01$) and gain of force measured in the chest press position ($P < 0.02$) were greater after versus before training.
Conclusion: Both protocols appeared to be well tolerated, safe and feasible for these CHD patients. A training protocol involving 6 s phases of isometric contractions with 10 s of passive recovery on an HML device could be safely implemented in rehabilitation programs for patients with CHD and improve functional outcomes.

1. Introduction

Physical activity is considered an effective non-pharmacological intervention for both primary and secondary prevention of coronary heart disease (CHD) [1]. For the last 30 years, resistance training combined with aerobic endurance exercises has been an integral part of international recommendations for prevention and rehabilitation in patients with CHD [2–5] and is now considered by the medical community as an essential part of exercise programs. Muscle mass and muscle strength decrease by about 30% between the third and sixth decades of life [6]. With aging, the total number of muscle fibres decreases, especially fast-twitch muscle fibres, which are recruited during the development of force. In CHD patients, increasing muscle strength and function can help improve health features such as insulin resistance, endothelial function, and quality of life [7]. As well, resistance exercise positively affects proprioceptive abilities, thereby leading to a

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gradual improvement in coordination and gait control, which reduces the risk of falls [7–9].

Unfortunately, the range of techniques or devices available to increase the efficacy of cardiac rehabilitation (CR) remains limited [10]. Among new devices, the Huber Motion Lab (HML), a motorised rotating platform, seems to feature the qualities needed in such programs because it allows patients to perform exercises that simultaneously involve balance, coordination and strength training. In 2015, our team showed that exercise sessions with the HML, based on very short periods of exercise (6 s) at 70% of the maximal isometric voluntary contraction (MVC), interspersed with short periods of passive recovery were safe and well tolerated for selected patients with stable coronary disease [11]. Moreover, a recent study showed that 8 weeks of training on the HML had a positive impact on body composition (especially decreased body fat), anthropometric data (reduced waist circumference), muscle performance (strength) and walking economy in healthy people [12].

HML training and traditional strength training (TST) have never been compared for efficacy in patients with CHD. We aimed to compare a conventional rehabilitation program associating global aerobic reconditioning with dynamic/segmental aerobic muscle strengthening and a program combining aerobic training and isometric exercises predominantly based on the HML in such patients.

2. Materials and methods

2.1. Patients

We recruited 50 patients with CHD from the cardiovascular rehabilitation centre of Saint Orens (France). Inclusion criteria were $\geq$ 70% arterial diameter narrowing of at least one major coronary artery and/or documented previous myocardial infarction. Exclusion criteria were recent acute coronary syndrome ($\leq$ 1 month), significant resting electrocardiography (ECG) abnormality, severe arrhythmia, history of congestive heart failure, uncontrolled hypertension, bypass surgery $\leq$ 3 months, percutaneous coronary intervention $\leq$ 1 month, left ventricular ejection fraction $\leq$ 45%, pacemaker installation, modification of medication $<$ 2 weeks, and musculoskeletal conditions making exercise on a cycle ergometer difficult or contraindicated. Patients provided written informed consent. The research protocol was approved by the Committee for the Protection of Human Subjects (Toulouse, France).

2.2. Study design

All patients were enrolled in an outpatient CR program (CRP). On the first and last visit, patients underwent a complete medical evaluation that included measurement of height, weight, body composition, resting ECG variables, endothelial function, muscular function, quality of life, quality of sleep, and fitness based on a maximal cardiopulmonary exercise test (CPET) performed on a cycle ergometer. After the first visit, patients were randomly assigned to the HML or TST group. The sole difference between groups was the strength training activity (HML or resistance training machines). The CRP focused on optimizing the medical treatment, controlling cardiovascular risk factors, diet monitoring, therapeutic education sessions and psychological support when needed.

The exercise program lasted 3 hr/day, 4 days/week. The daily activity training included 1) a 45-min strength training activity using machines (TST) or HML (HML group) and 2) a 45-min walking session outside or 45-min of cycling at the target heart rate determined during the stress test (i.e., 60–80% of the heart rate reserve) [13,14]. Furthermore, the patients participated in relaxation sessions or aquatic relaxation sessions (45 min). Each session was monitored by a physiotherapist and was supervised by a cardiologist. In addition to the exercise protocol, patients were involved in therapeutic education sessions conducted by a multidisciplinary team with workshops and conferences on cardiovascular risk factors and treatment knowledge (~3–4 hr/week).

2.3. Exercise sessions

2.3.1. Whole-body strength training with HML and assessment of MVC

The Huber Motion Lab (LPG Systems, France) is an oscillating platform with 2 large handles mounted on a movable column. Several feet and hand positions are marked on the platform and handles, respectively (Fig. 1). HML exercises consist of adopting specific positions, defined as a combination of various foot and hand positions, and developing low-high force levels against the handles. These actions require the synergistic activation of various

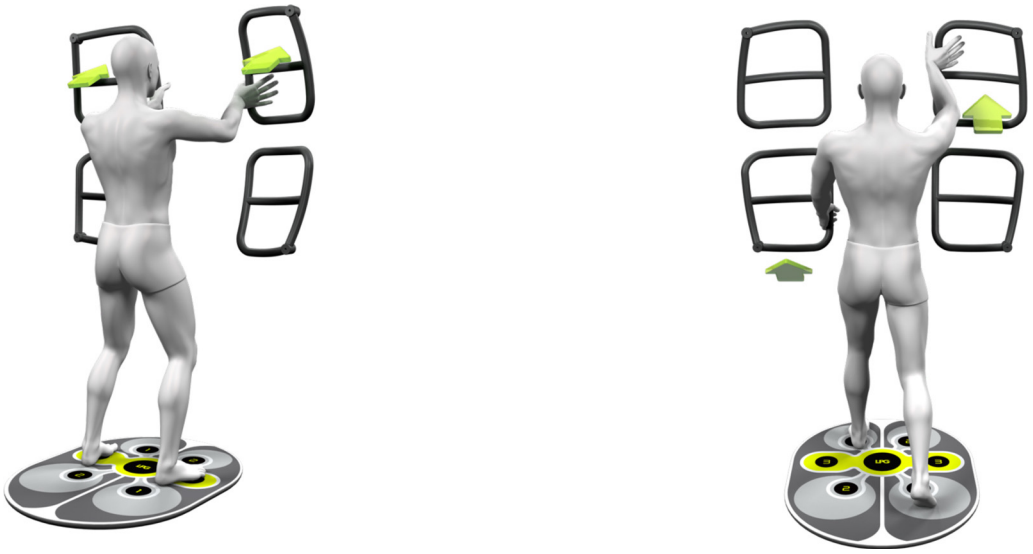

Fig. 1. The Huber Motion Lab, an oscillating platform with 2 large handles mounted on a movable column. Several feet and hand positions are marked on the platform and handles, respectively.

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