Rev Port Pneumol. 2015;21(3):138–143

revista portuguesa de PNEUMOLOGIA portuguese journal of pulmonology

www.revportpneumol.org

ORIGINAL ARTICLE

Long-term impact of pre-operative physical rehabilitation protocol on the 6-min walk test of patients with adolescent idiopathic scoliosis: A randomized clinical trial

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Received 11 September 2013; accepted 27 August 2014
Available online 24 February 2015

KEYWORDS
Scoliosis;
Exercise;
Exercise movement techniques;
Exercise therapy;
Exercise test

Abstract
Background: Monitored physical activities in patients with adolescent idiopathic scoliosis (AIS) have been shown to improve physical performance, endurance and cardiopulmonary function and may be assessed by the 6-min walk test (6MWT). We aimed to evaluate the long-term results of the 6MWT after a rehabilitation protocol employed before surgical correction for AIS.
Methods: This prospective randomized clinical trial studied the impact of a 4-month pre-operative physical rehabilitation protocol on post-operative cardiopulmonary function and physical endurance, by using the 6MWT, in patients with AIS submitted to surgical correction, comparing them to matched controls without physical rehabilitation. Studied variables were heart and respiratory rate, systolic and diastolic blood pressure, peripheral blood oxygen saturation, Borg score, and distance walked. Patients were assessed at baseline, after 4 months of rehabilitation, and 3, 6 and 12 months post-operatively.
Results: A total of 50 patients with AIS were included in the study and allocated blindly, by simple randomization, into either one of the two groups, with 25 patients each: study group (pre-operative physical rehabilitation) and control group. The physical rehabilitation protocol promoted significant progressive improvement in heart and respiratory rate, peripheral blood oxygen saturation, distance walked, and level of effort assessed by the Borg scale after surgery.
Conclusions: Post-surgical recovery, evaluated by 6MWT, was significantly better in patients who underwent a 4-month pre-operative physical rehabilitation protocol.

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http://dx.doi.org/10.1016/j.rppnen.2014.08.006

Introduction

Adolescent idiopathic scoliosis (AIS) is a lateral deviation of the spine. It is defined as a lateral curvature greater than 10 degrees of unknown cause that progressively distorts the anatomy of the thorax, and with vertebral rotation.[1–6] It affects 2–4% of children between 10 and 16 years of age.[6] The prevalence of curves greater than 30 degrees is approximately 0.2%, and of curves greater than 40 degrees is approximately 1% of the children between 10 and 16 years of age.[1–6] It corresponds to about 80% of the scoliotic deformities of the spine in the adolescent population, and over 50% of the patients present a thoracic curve.[1–5] A number of different factors, isolated or combined, have been associated to AIS, such as a deviation in the growth pattern of the spine, neuromuscular or connective tissue abnormalities, asymmetrical growth or lateralization of the sagittal configuration of the spine, as well as hereditary factors.[1–5] It is thought to be a multigene dominant condition, with variable phenotypic expression.[6]

Distortion of the three thoracic dimensions in patients with AIS results in a syndrome with pulmonary function abnormalities, pain and physical deformity.[2–4] Pulmonary function testing (PFT) in these patients shows a reduced vital capacity, combining a drop in total pulmonary capacity, reduced arterial oxygenation, and alveolar hypoventilation.[2] The pulmonary abnormalities may cause ventilatory restrictions and lead to exercise intolerance, mostly due to a decreased capacity to offer oxygen to the muscles undergoing greater demand.[7–9]

There are a number of tests designed to assess the inability to perform physical activities. The 6-min walk test (6MWT) has been used to assess physical and cardiorespiratory status of patients presenting with moderate to severe pulmonary and cardiac abnormalities submitted to medical procedures, allowing correlations with morbidity and mortality of specific diseases.[7–9] Assessment of the distance walked is an expressive measurement of physiological function and an important component of overall quality of life, since walking is directly related to daily life activities.[9] The 6MWT presents a stronger correlation with heart rate (HR), peripheral blood saturation (SpO_2), and dyspnea than other physical exertion tests, such as the stationary bicycle and treadmill, both in healthy individuals and in patients with functional respiratory and pulmonary abnormalities.[10]

The 6MWT significantly correlated to forced expiratory volume in the first second (FEV1) in a study of healthy adolescents aged 12–16 years,[11] and in children aged 3–16 years it successfully determined submaximal functional capacity.[12] Patients with AIS usually present with reduced aerobic capacity that is possibly related to the ventilatory restriction observed in the reduced forced volume of these patients.[13,14] In the first phase of the current study the authors used the 6MWT to evaluate the results of a physical therapy protocol on the pre-operative cardiopulmonary performance of a group of surgical candidates with AIS comparing them to matched controls that did not receive physical rehabilitation, finding that patients submitted to the protocol presented significant reduction in all vital signs and a significant increase in the distance walked when compared to baseline parameters and to controls.[7]

Considering the improved performance in the 6MWT of patients with AIS submitted to the abovementioned pre-operative rehabilitation protocol,[7] the current study was designed to evaluate the long-term results of this regimen following surgical correction of the spinal deformity.

Methods and materials

Study design and ethics

This prospective randomized clinical trial was carried out at a tertiary teaching hospital from January 2008 to January 2009. All participants diagnosed with AIS at the Orthopedics Department of the Institution who consented to participate in the study after careful clarification of the objectives and techniques involved, and those who met the inclusion and exclusion criteria were included. The Institutional Review Board for Ethics in Clinical Studies approved this study (protocol # 235/09).

Inclusion criteria were: a diagnosis of AIS with a thoracic curve greater than 45 degrees; being a candidate for surgery; aged between 10 and 18 years; able to complete the 6MWT. Exclusion criteria were: present or past history of pulmonary, cardiac, myo-articular or neurological diseases.

Participants were randomized by opaque, sealed envelopes, into one of the two groups: Group I – patients with AIS who were submitted to the physical rehabilitation protocol, and Group II – patients with AIS who were not submitted to the rehabilitation protocol (controls). A total of 50 patients were included, 25 in each group.

The sample size was calculated for simple random sampling, using a confidence interval of 95 (95%) and 5% error for infinite sample.

Exercising protocol

Patients in Group I underwent a 4-month pre-operative physical rehabilitation program, modified from Bouchard and Shepard[15] and Covey et al.[16] Sessions were three times a week (every other day) and 60-min long, consisting of a 10-min warm-up (stretching and low grade aerobic exercises, such as, slow and progressive walks); 40-min aerobic workout on the treadmill or stationary bicycle working at 60–80% of the maximum heart rate; and a final 10-min cool-down with relaxation (stretching and low energy aerobic exercises followed by relaxation techniques).[7] This protocol was chosen because it had been found to be effective in patients with pulmonary diseases before,[17] and it was already tested by our team.[14] The participants were closely supervised by the same physical therapist, who was not present during the 6MWT evaluation.

Surgery

All AIS participants in this study, in both groups, had indication for and underwent surgical correction of the spine. Vertebral arthrodesis was performed with the same instrumentation techniques for all of them, with a posterior longitudinal approach and iliac autologous graft.