The association between aerobic capacity and spinal deformity in patients with adolescent idiopathic scoliosis – A systematic review.

Arnold Wong[1], PT, PhD, Fabio Zaina[5], MD, Matthew Chung[1], BSc, Henry Pang[2], MBBS, MRes, Stefano Negrini[4], MD, Jason Cheung[3], MBBS,FHKCOS, Sabrina Donzelli[5], MD, and Francesca Di Felice[5], MD, Dino Samartzis[6], DSc

1. Rehabilitation Sciences, The Hong Kong Polytechnic University, Hong Kong
2. Orthopaedics and Traumatology, Prince of Wales Hospital, Hong Kong
3. Orthopaedics and Traumatology, The University of Hong Kong, Hong Kong
4. Physical and Rehabilitation Medicine, University of Brescia, Italy
5. Italian Scientific Spine Institute, Italy
6. Department of Orthopaedic Surgery, RUSH University Medical Center, USA

INTRODUCTION

While patients with severe adolescent idiopathic scoliosis (AIS) are known to have poor aerobic capacity, there is no consensus regarding whether some components of the spinal deformities are the determinants of aerobic capacity in patients with different severity of AIS. Unfortunately, no systematic reviews have summarized and compared the relations between these components and aerobic capacity in AIS patients, which may inform clinical practice. Therefore, the objective of the current systematic review was to summarize the associations between various structural characteristics and aerobic capacity of patients with AIS during exercise tolerance tests.

METHODS

Eight electronic databases were searched for relevant publications, from inception to November 2016. Two reviewers independently screened the titles, abstracts, and full-text of potential articles according to the selection criteria. Two other independent reviewers extracted data and appraised the methodological quality of the included studies using relevant risk of bias evaluation tools. Associations between various spinal parameters and aerobic capacity were summarized qualitatively because the heterogeneous data did not allow the conduction of a meta-analysis.

RESULTS

Of 1,045 identified citations, eight studies (377 participants) met the inclusion criteria. The overall methodological quality was low to moderate. Many included studies did not justify the sample size or adjust for confounders. Interestingly, aerobic capacity of AIS patients (expressed as maximum oxygen intake (VO_2max)) as estimated by treadmill exercise tolerance tests differed from that deduced from cycloergometer exercise tolerance tests. Using treadmill tests, three studies found that the average body weight normalized VO_2max in patients with mild to moderate curves (Cobb angles between 20° and 45°) was significantly lower than the normative values. Likewise, two studies revealed that patients with mild curves had significantly poorer ventilatory efficiency (as indicated by higher ventilation volume per VO_2max) than healthy individuals during a treadmill test. One study found that increased thoracic Cobb angles were associated with decreased VO_2max ($r = -0.71$; $p < 0.01$). Another study showed that patients with mild to moderate curves had significantly poorer exercise tolerance, lower anaerobic threshold and a higher breathing frequency than healthy controls during treadmill exercise tolerance tests. Conversely, using cycloergometer exercise tolerance tests, three studies found that the curve angle or number of scoliotic vertebrae was unrelated to body weight normalized VO_2max or maximum tidal volume/inspiratory capacity ratio. Interestingly, one study showed that patients with Cobb angles > 40° displayed slightly decreased VO_{2max} and mild hyperventilation during a cycloergometer exercise tolerance test.

DISCUSSION

While existing results suggested that suboptimal aerobic capacity might start to occur in patients with mild thoracic curves, these findings might be confounded by various factors (e.g., physical fitness levels or muscularity). Future cohort studies should determine if suboptimal aerobic capacity in patients with AIS is related to poor fitness level and/or spinal deformities. However, given the beneficial effects of aerobic exercises on aerobic capacity, clinicians can recommend AIS patients to perform regular aerobic training in order to optimize their aerobic capacity.