Posture Alignment of Adolescent Idiopathic Scoliosis: Photogrammetry in Scoliosis School Screening

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Abstract

Objective: The objective of this study was to describe the posture patterns of adolescents diagnosed with adolescent idiopathic scoliosis (AIS) in a scoliosis school screening (SSS).

Methods: Two-dimensional photogrammetry was used to assess the posture of 37 adolescents diagnosed with scoliosis (scoliosis group, SG) (Cobb angle ≥10°) and 76 adolescents with a false positive diagnosis (false positive group, FPG) (Cobb angle <10°, angle of trunk rotation ≥7°). In total, 2562 10- to 14-year-old adolescents were enrolled in the SSS, which was performed in public schools in the cities of Amparo, Pedreira, and Mogi Mirim in the state of São Paulo, Brazil. Their posture was analyzed using Postural Analysis Software. Continuous variables were tested using Student t test, and categorical variables were tested using a $\chi 2$ test. The SG, FPG, simple curve group, and double curve group were all compared. Bivariate analysis was used to identify associations between postural deviations and scoliosis. The adopted significance level was $\alpha = .05$.

Results: The SG (2.7 ± 1.9°) had greater shoulder obliquity than the FPG (1.9 ± 1.4°) ($P = .010$), and this deviation was associated with scoliosis (odds ratio [95% CI] $P = 1.4$ [1.1-1.8] 0.011). The SG had asymmetry between the right- and left-side lower limb frontal angle, shoulder sagittal alignment, and knee angle. The double curve group (3 ± 1.7°) presented a greater value of the vertical alignment of the torso than the simple curve group did (1.9 ± 1°; $P = .032$).

Conclusions: Adolescents diagnosed with AIS in an SSS had greater shoulder obliquity and asymmetry between the right and left sides. Shoulder obliquity was the only postural deviation associated with AIS. (J Manipulative Physiol Ther 2017;40:441-451)

Key Indexing Terms: *Posture; Adolescent; Scoliosis; Mass Screening*

Introduction

Posture asymmetries associated with adolescent idiopathic scoliosis (AIS) are common; they are associated with the risk of progression of scoliosis[1,2] and the limitation of functional activities.[2-5] The common posture deviations are right and left height asymmetry of the pelvis, scapulae, shoulders, and head.[6,7] Most studies describe posture by using 3-dimensional (3D) posture techniques, such as Optotrak (Northern Digital Inc., Waterloo, Canada), Vicon (Vicon Motion Systems, Oxford, UK), Motion Analysis (Motion Analysis Corporation, Santa Rosa, CA), and surface topography systems.[6-11] Although these techniques are reliable and reproducible, they require expensive equipment and systems that are not accessible to most clinicians.

Two-dimensional (2D) photogrammetry can be used for clinically quantitative posture assessment by calculating body angles and distances using photographs.[2,12-14] 2D photogrammetry is a quick, easy, and accessible tool for most clinicians.[2,12-14] Fortin et al[2] evaluated the reproducibility and inter-rater reliability of the use of 2D photogrammetry to assess the posture of people with idiopathic scoliosis. The authors verified a good level of test-retest reliability for all posture indices, good inter-rater reliability for 29 out of 32 posture indices, and moderate inter-rater reliability for 3 posture indices.[2] According to Fortin et al,[2] the most reproducible indices were the waist angles, the trunk list, and the knee valgus and varus, whereas the least reliable were the tibiocalcaneal angles, the Q angles, and the frontal lumbar angle.

This study assumes (1) that 2D photogrammetry can be a useful tool for the clinical assessment of AIS,[2] (2) that correction of posture is an important goal of physiotherapy interventions for people with idiopathic scoliosis,[2] and (3) that there were few previous studies using photogrammetry for the posture analysis of people with idiopathic scoliosis.[15] Based on these assumptions, the objective of this study was to

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use 2D photogrammetry to describe the posture patterns of adolescents diagnosed with AIS in a scoliosis school screening (SSS).

Methods

Setting

This descriptive, cross-sectional study was carried out in public schools located in 3 cities of the state of São Paulo, Brazil.

Participants

The study sample population was composed of adolescents of both sexes between the ages of 10 and 14 who were participating in an SSS as described in the SOSORT consensus paper.[16] All 2562 adolescents (1072 boys and 1490 girls) were examined in SSSs undertaken between 2012 and 2015; 129 with positive scoliometer measurements (with an angle of trunk rotation [ATR] ≥7°) were referred for x-ray examination, but 16 did not appear for the exam. Thus, 113 adolescents were investigated, a number high enough to meet the proposed objectives, considering the maximum percentage of postural changes was 97.4% and the minimum was 5.4%, with a margin of error of 0.05 in 95% of possible samples. Standing radiographs were used to confirm that 37 had scoliosis (SG: 32 girls and 5 boys) and 76 had normal spine curvatures (ATR ≥7° and a Cobb angle <10°; FPG, 49 girls and 27 boys). The SSS exclusion criteria were a leg length discrepancy ≥1.5 cm[17,18] or any problems interfering with the ability to perform an Adams test (a forward bend test) properly.[19]

After being given an explanation of the procedure used in this study to assess the adolescents' posture, each adolescent and his or her legal representative signed an informed consent form (Resolution 196/96). This study was approved by the Ethics Committee of the School of Medicine of the University of Sao Paulo (research number: 254/12).

Procedure

First the adolescents were assessed using a scoliometer in an Adams test. The mark zero of the scoliometer was placed on all the vertebral body levels at thoracic, thoracolumbar, and lumbar, and the higher value of ATR was recorded.[20,21] Those with positive scoliometer measurements (ATR ≥7°) were examined by radiograph and were photographed for the purpose of 2D photogrammetry. AIS was confirmed when an adolescent's Cobb angle was >10°.

Each adolescent's posture was assessed using 1 digital Sony Cyber-shot camera, model DSC-WX100 (Sony, Tokyo, Japan), 1 tripod, 15-mm polystyrene balls, double-sided adhesive tape, a 70 × 74 cm rubber mat, white chalk, 1 plumb line marked with 3 polystyrene balls, and a reliable tool, Postural Analysis Software/Software of Postural Analysis (PAS/SAPO).[22,23] The camera was mounted on the tripod at a height of 1 m and placed 252 cm away from the participant being photographed.[13,22] For photo calibration purposes, the plumb line was affixed to the ceiling and marked with 3 polystyrene balls with a distance of 50 cm between each ball.[22] The participants were tested in the classroom, and efforts were made to control the temperature, noise, and distractions.

Six 2D photographs (1 anterior, 1 posterior, and 2 each right and left lateral views, 1 with the elbow extended and 1 with the elbow bent and with the hand placed at the opposite shoulder level) were taken while each participant was standing on the rubber mat.[21,22] The lateral-view photographs with the elbow bent were used only to measure the vertical alignment of the torso and knee angle. To ensure the same positions for the feet in all 6 photographs, all participants were instructed to position themselves on the mat while an outline was drawn around their feet using chalk.[22] After each photograph was taken, the mat was rotated 90° from its initial position in order to photograph a different view, and participants were instructed to place their feet on the outlines marked on the mat.[22] Marks were made on the floor so that the mat would always be placed in the same position.[22]

A number of bone references were marked on each adolescent: the earlobes, the prominence of the seventh cervical vertebra (C7), the acromia, the inferior angle of each scapula, the anterior superior and posterior superior iliac spines, the greater trochanter of femurs, the head of the fibulae, the tibial tuberosity, the superior pole of the patella, the mid-calf at fibulae height, the lateral malleoli, the middle point of the calcanei, and the insertion of each Achilles tendon.[13,21,22]

In an attempt to minimize data collection errors, the research assistant received comprehensive training to ensure the correct placement of the anatomic markers, the positioning of the participant, and camera placement. Each screening exam lasted for 2 to 5 minutes and data acquisition lasted for 20 to 25 minutes on average per participant, including marker placement.

The posture variables are described in Table 1.[24-26] Figures 1, 2, and 3 illustrate the angles measured by each view. Most of the posture variables were measured by the PAS/SAPO protocol.[22] However, the sagittal alignment of the shoulder, the horizontal alignment of the scapula, the knee angle, and the leg and rear foot angles were measured using the free marking points of PAS/SAPO.

Statistical Analysis

The data were analyzed using descriptive statistics. The variables analyzed indicated a normal distribution, as verified by the Anderson-Darling test. The continuous variables were tested using Student *t* test: horizontal