

PELVIC AND SHOULDER ROTATIONS OF IDIOPATHIC SCOLIOTIC ADOLESCENTS DURING WALKING

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INTRODUCTION

Scoliosis is a 3D deformation of the spine and thoracic cage. Female adolescents are mostly affected by this pathology and major changes occur during rapid growth periods and affect bones, ligaments as well as muscles [1,2]. These changes have consequences on gait pattern. Kinematics have been largely studied but most researchers reported angular displacement only in the sagittal plane. It is believed that asymmetric trunk rotations during walking could be a detrimental factor related to scoliosis. Therefore, the purpose of this study is to quantify pelvic and shoulder rotations in coronal and frontal planes in both idiopathic scoliotic patients (ISP) and control adolescents (CTRL). Asymmetry and coordination will be compared.

METHODS

Ten control adolescents and nine ISP walked at a comfortable speed for ten trials on a 10m walkway. Table 1 shows the mean age, height and weight (with standard deviation) for both control and ISP groups. Kinematics were extracted from 18 reflective markers attached bilaterally on the lower limbs and acromions and 6 on different levels of the spine. Data were collected at 60Hz from 8-cameras VICON motion analysis system (Oxford Metrix, UK).

Table 1: Mean (SD) age, height and weight for both control and idiopathic scoliotic patients.

	CTRL	ISP
Age (years)	14.4 (0.9)	15.0 (0.9)
Height (cm)	161.2 (9.7)	158.0 (7.6)
Weight (kg)	55.0 (9.5)	51.5 (9.8)

Shoulder and pelvic angles were calculated, for a gait cycle, using the equation ($\theta = \arctan(\Delta y / \Delta x)$) and the right side was used as a reference. Asymmetry was determined by the ratio between rotation angles of left and right gait cycles. This was calculated for both planes and separately for pelvis and shoulders. Statistical analyses included Student-t test for paired (left/right) and unpaired (CTRL/ISP) subjects. To evaluate coordination between the pelvis and shoulders, cross-correlations were used to compare groups and a Student-t test was also used.

RESULTS AND DISCUSSION

Control adolescents walked at a slightly but not statistically significant faster speed than ISP. No other tendency is reported for cadence, stride length, stance and double support phase durations. Table 2 presents angular measurements of both groups first in the coronal plane and second, the frontal plane. The only variable that reached the level of signification was the right vs. left pelvic angle in coronal plane for the control group ($p = 0.01$).

Table 2: Mean (+/-1SD) pelvic and shoulder range of motion in CTRL and ISP subjects.

	Coronal Plane				
	Pelvis		Shoulders		
	L	R	L	R	
CTRL(°)	8.3 (2.6) *	7.7 (2.4)	7.0 (2.4)	7.1 (2.2)	
ISP(°)	6.1 (3.0)	6.3 (3.0)	6.1 (1.6)	5.7 (2.5)	
	Frontal Plane				
	CTRL(°)	8.5 (2.4)	8.3 (2.4)	2.5 (1.0)	2.5 (1.0)
	ISP(°)	7.0 (2.4)	7.0 (1.7)	2.1 (0.5)	2.1 (0.6)

*p=0.01 between control group left and right cycles.

To compare coordination between pelvis and shoulders, cross-correlations were used. This statistical tool was used to show whether the pelvic and shoulder rotations were in phase or out of phase. Figure 1 gives examples of rotation angles in the frontal plane.

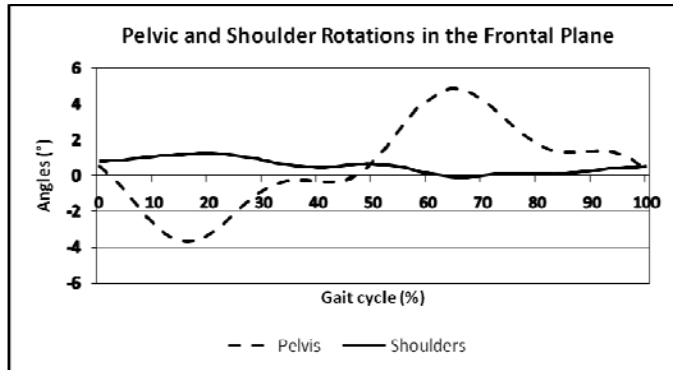


Figure 1: Pelvic and shoulder rotations angles in frontal plane.

Cross-correlation is presented in Table 3. Significant differences were found between CTRL and ISP groups in the frontal plane.

Control and ISP subjects were not different for range of motion. Angle values were similar to those found previously in literature [3,4]. However, in this study, ISP Cobb's angles were 15 degrees or less. At this point, the deformation may not be significant enough to modify the walking pattern. It did however have an influence on the coordination between the pelvis and the shoulders. With higher cross-correlation coefficients, the pelvis and

Table 3: Cross-correlation results.

	Cross-correlation coefficients			
	CL	CR	FL	FR
CTRL	-0.74	-0.71	-0.69	-0.66
ISP	-0.68	-0.65	-0.64	-0.63
p value	0.02*	0.01*	0.06	0.12

C = coronal, F = frontal, L = left, R = right

p: Student-t test between CTRL and ISP, *: $p \leq 0.05$.

shoulders of the control group appeared to be more synchronized than those in the ISP group in the frontal plane only.

CONCLUSIONS

Pelvic and shoulder rotations of ISP and CTRL subjects were not statistically different in frontal plane or in coronal plane during normal walking. ISP have shown less asymmetry and their coordination was significantly poorer than the CTRL group.

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