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Assessment of the Locomotion and the Long-term Efficacy of Biomechanics Foot Orthotic for the Subjects with Adolescent Idiopathic Scoliosis

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Abstract: Scoliosis is the most common type of spinal deformity of the young adults, and women outnumber men about 10:1 [1], in which the Adolescent Idiopathic Scoliosis (AIS) is up to 90% for ages 10 to 16year-old teenagers [2]. Studies revealed that due to the 3-dimensional musculoskeletal deformities, the AIS subjects to the dynamic postural instability including vestibular and proprioception disorders [3-5]. Dynamic postural Balance is monitored by integration of cortical modulation and somatosensory response [6], and the either motor or sensory impairment lead to balance dysfunction as well as pathologic gait. Studies revealed that the biomechanics functional foot orthotics can effectively control the foot motion and pressure redistribution, therefore, increase body stability during gait [7]. Control of the whole-body center of mass is critical in maintaining the dynamic stability particularly when across an obstacle [8]. The aim of this study was to evaluate the efficacy of the semi-custom-made functional foot orthosis in promoting the postural stability as crossing a 30%of body height obstacle. Six AIS patients aged 12.86±1.73, BMI:18.03±1.61, and Cobb's angle: 22.68±7.06°, were recruited from the out-patient service of the medical center (IRB) to perform a 30% of the subject's height during a crossing obstacles gait analysis, in two randomized conditions: barefoot and with functional insoles. The COM parameters were obtained by the Vicon motion capture system and the COP parameters were collected by the AMTI force platform. The COP-COM inclination angle was divided into six phase (T1: trailing heel-strike, T2: leading toe above the obstacle, T3: leading heel-strike, T4: trailing toe-off, T5: trailing toe above the obstacle, T6: trailing heel-strike) (Fig. 1) and were used to discriminate the postural control ability between the one-month intervention of the functional insoles. The inclination angle was analyzed during the obstacle crossing stride, which was defined as the heel-strike of the trailing limb (the limb crosses the obstacle last) to the heel-strike of the same limb after stepping over the obstacle. The significance level was set at P value to 0.1 for all statistical tests. All statistical analyses were performed with SPSS 24. Results showed that no matter when subjects on the barefoot situation, the trailing leg heel strike (T1, $p = 0.05$; T6, $p = 0.05$) or on the functional insoles situation, the leading leg heel strike (T3, $p = 0.07$) and trailing toe above the obstacle (T5, $p = 0.05$), the inclination angle at the AP and the ML direction had a significant decreased after one-month intervention of functional insoles during crossing obstacle (Tab. 1). Excessive frontal and sagittal plane COM-COP inclination angles during gait may cause a loss of balance [9]. This may indicate that before wearing the functional insoles, scoliosis have more difficulties controlling sideways and have a more inclination COM-COP angle. These measures may allow us to better identify the adolescent idiopathic scoliosis whose intervention of the functional insoles showed long-term effective improvement in the postural balance.

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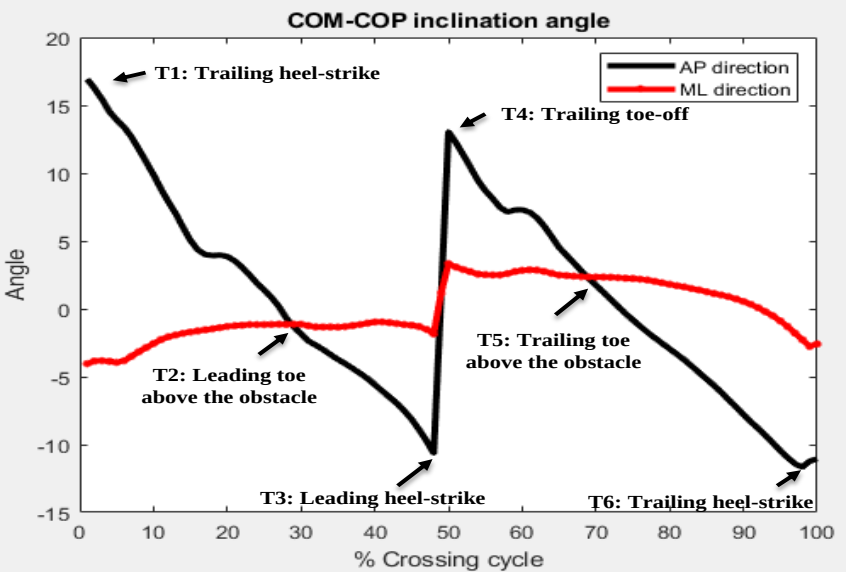

Figure 1: Patterns of COM-COP inclination angles

Table 1: COM-COP Inclination Angles When crossing the Obstacle

Unit (Angle) AP direction	Barefoot		Functional Insoles		Unit (Angle) ML direction	Barefoot		Functional Insoles	
	Before	After	Before	After		Before	After	Before	After
T1	12.21±2.03	12.94±1.39	11.12±3.55	13.51±0.7	T1	**4.07±0.99**	**3.07±0.46***	-3.62±2.52	-5.00±0.64
T2	-3.11±1.13	-3.23±1	-2.51±1.01	-3.43±1.2	T2	1.76±0.31	1.80±0.35	-1.77±0.72	-1.72±0.47
T3	8.90±10.54	4.35±7.06	10.92±6.61	5.24±5.66	T3	-0.75±1.8	-1.61±0.71	**3.38±1.67**	**0.92±0.55***
T4	8.70±0.87	7.83±1.63	6.96±1.04	7.07±1.09	T4	-2.22±0.67	-2.81±0.39	3.66±0.90	3.12±0.6
T5	0.03±0.95	-0.74±0.86	-0.86±1.21	-1.53±1.4	T5	-1.94±0.7	-2.58±0.53	**2.81±0.39**	**2.19±0.62***
T6	**-12.44±2.37**	**-9.14±2.5***	-9.45±1.72	-8.54±3.48	T6	-1.59±2.11	-3.23±2.47	3.89±1.63	3.37±1.99

T1: trailing heel-strike, T2: leading toe above the obstacle, T3: leading heel-strike, T4: trailing toe-off, T5: trailing toe above the obstacle, T6: trailing heel-strike;*p<0.1 compared with Before and After

Keywords: Adolescent idiopathic scoliosis; functional insole; COM–COP inclination angle; balance control

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