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Comparison of static postural stability between individuals with ankle sprain injuries and ACL reconstruction individuals

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Abstract

This study aimed to determine static postural stability between individuals with ankle sprain injuries and ACL reconstruction. Thirty subjects (74.10±8.82 kg, 180.05±7.64 cm 19.94±2.18 yr) were divided into three groups which include ACL-R (n=10), ankle sprain (n=10) and healthy individuals (n=10). Subjects were required to balance on a single leg and remain motionless for 30s on an emed platform. The results were compared by center of pressure sway (cop), average velocity of COP and excursion of COP as measured by a pressure platform (emed-C50, novel, Germany). The ankle sprain and ACL-R groups had greater sway area than the healthy group. In addition there were significant differences between ankle sprain, ACL-R and healthy groups in COP excursion and the average velocity of COP in all the great measures are belonged to ACL-R specially ankle sprain. This study suggested that individuals with ACL-R and ankle sprain had changes in posture stability.

Keywords: Anterior Cruciate Ligament, Ankle Sprain Injury, Static Postural, Center of Pressure,

INTRODUCTION

Ankle sprain and ACL injuries are among the most common injuries in athletics whom participated in activities that require jumping and landing such as basketball, soccer and volleyball (9,11,21,22). Following the injuries some changes which include impaired propriception, weakness, mechanical instability, decrease range of motion may occur (4,15,19). Proprioception is the afferent information arising from internal peripheral areas of the body that contribute to postural control, joint stability, and several conscious sensations (6,18). Direct evidence supporting the importance of articular afferent information to the postural-control system in healthy individuals is largely debated (32). Since, ACL (5) and ankle joint (33) are responsible for somatosensory system of posture control. Postural stability alternate in patients with ankle sprain and ACL reconstruction history (26,28). The mission of postural control system (PCS) is to control the body`s position in space during all motor activities (13,33,41). The basic human locomotion is standing (34). Musculoskeletal injuries lead to decrease static stability (3,18,40). Despite of rehabilitation and surgery which were done, athletics often find it difficult to recover full function (14,20,31). It was reported 8% and 50% of those with ACL reconstruction did not return to the same sports after surgery (30,29) and also ankle sprain can influence on ADL (activities daily of living) and functional activities (31). Recently, various methods are used to detect and explain deficits in patients in both clinical and laboratory measures (35,37). One of the most efficient methods is quantification of balance (2,26), a factor which is used as individuals of balance control and posture is COP (34,39). COP or center of pressure is the mean of all pressure applied to the sole of the foot which for evaluating the posture control in static position, the key measure used to calculate balance is COP sway (1,27). To measure this force platform is used. Increasing the knowledge about the side effects of these injuries can be used to prevent, assess and rehabilitate this group of individuals. This would benefit clinicians by aiding in the detection of problems that would otherwise go undetected. Understanding the differences between individuals with Anterior cruciate ligament reconstruction(ACL-R) and ankle sprain injuries can help to develop more efficient rehabilitation guideline to return to sport as well (25,30). This method also can be used for monitoring effectiveness of rehabilitation which is very notable to return to the sport. The purpose of this study was to compare static posture stability between ACLR and ankle sprain. We hypothesized static posture is different between these two groups.

MATERIAL & METHOD

Subjects

Postural stability was evaluated in 30 soccer players who were divided in three groups included ACL-R (10 males), ankle sprain (10 males), healthy individuals (10 males) with the mean age of 19.94±2.18 years, a body height of 180.05±7.64 cm, and a mean body mass of 74.10±8.82 kg were recruited (table 1). Healthy subjects had no history of musculoskeletal disorder or lower extremity injury within the previous year. The ACL-R sustained the surgery 6m to 1yr (mean=7.60±1.14). The ankle sprain group had ankle sprain history in 1 year prior to testing (mean=10±1.58). All subjects exhibited full joint range of motion, no joint swelling and no pain during movements and also had normal knee and ankle joint on their contralateral extremity.

Table 1. Descriptive data of subjects for age, height, mass and time since injuries.

	Group	Mean	SD
Age(year)	Healthy	18.5	0.53
	ACL-R	20	2
	Ankle sprain	22.2	2.28
Height(cm)	Healthy	184	8.84
	ACL-R	177.80	5.89
	Ankle sprain	176	4.30
Mass(kg)	Healthy	75.11	8.87
	ACL-R	74.92	10.73
	Ankle sprain	71.68	8.20
Time since injured (month)	Healthy	-	-
	ACL-R	7.60	1.14
	Ankle sprain	10	1.58

Procedure

Each subject was tested during a single test session, at which time the subjects read and singed the informed consent. Subjects were asked to remain as motionless as possible during single-leg stance on the pressure plate for 30s. They should lift their non-test foot, while the thigh angle was about 0 and the knee angle was about 90°, and hands placed on pelvis. The patient was asked to stare a point marked on the opposite wall and to keep his condition during the test. Prior to the test they performed two 15s practice trails, then subjects carried out 30s testing trails with 20s resting time between each trail. Test was repeated 3 times if subjects touchdown or stepped with the non-test foot were omitted. We also used a pressure platform (emed-C50, novel GmbH, Munich, Germany) was used which has a resolution of 4sensors/cm^2, accuracy ±5% and sampling rate of 50 Hz for measuring the COP data (Figure 1).

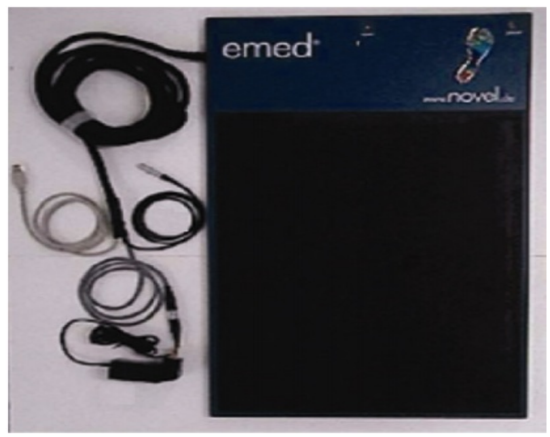

Figure 1. The emed platform.

Data analysis

The average of 3 trails was considered as final outcome. COP excursion and the average velocity of COP were analyzed by using novel software. COP area was also analyzed(Figure2). The emed basics was used to measure the range of motion in medial/lateral (ML) and

Anterior/posterior (AP) directions. The area of sway was calculated by multiplying the AP to ML direction according to the below formula (1a).The ellipse represents the 95% of all COP positions (sway area).

$$\text{Ellipse area} = \frac{AP*ML*\pi}{4} \quad (1a)$$

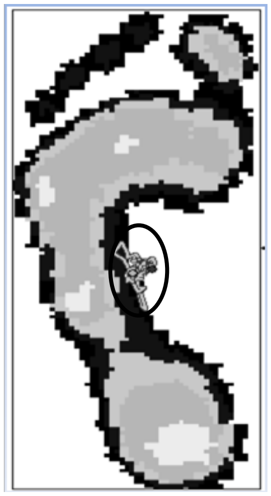

Figure 2. Ellipse area of COP.

Statistical analysis

Means and standard deviations were calculated for variables. Kolomogorov-Smirnov test were used for identifying if variables had normal distribution ($p>0.05$) since KS test confirm the normal distribution (table 2). Then parametric test were used for analysis. The differences within the groups and between groups were compared by using one-way ANOVA and Bonferroni`s post hoc with a significance level at $p<0.05$. All data were analyzed by the Statistic Package of Social Science (SPSS) version 16.0.

RESULT

Table 2 represents the mean and SD of COP measures for individuals with ankle sprain, healthy and ACL-R. As can be seen the maximum COP sway area, high average velocity of cop and COP excursion are belonged to ankle sprain. Table 3 shows significant differences between 3 groups during single-leg stance in all parameters ($p<0.05$) the subjects showed significantly differences in COP sway area (0.001), average velocity of COP (0.002) and COP excursion (0.007). Bonefforni post hoc test showed that there were significant differences between injured groups (ACL-R and ankle sprain) and healthy subjects in COP sway area. The result of average velocity of COP shows that only ankle sprain and ACL-R individuals have no differences (sig=0.164). Additionally, the result of COP excursion presents statistical significance among healthy subjects and ACL-R (sig=0.025) and also between ankle sprain and healthy subjects (sig=0.03). (table 4).

Table 2. summary of variable related to during single leg stance on platform.

	Group	Mean	SD	Sig
COP sway area	Healthy	2.60	0.24	0.96
	ACL-R	5.37	0.53	0.99
	Ankle sprain	6.58	0.7	0.71
Average velocity of COP	Healthy	0.10	0.02	0.76
	ACL-R	0.20	0.05	0.96
	Ankle sprain	0.23	0.07	0.99
COP excursion	Healthy	40.60	4.9	0.89
	ACL-R	47.41	6.5	0.36
	Ankle sprain	50.38	1.65	0.95

Table 3. ANOVA table for variation of subjects

	Group	Sig.	F ratio
COP sway area	Healthy	0.001	108.30
	ACL-R		
	Ankle sprain		
Average velocity of COP	Healthy	0.002	9.48
	ACL-R		
	Ankle sprain		
COP excursion	Healthy	0.007	7.6
	ACL-R		
	Ankle sprain		

Table 4. Bonferroni post hoc multiple comparison

	Group	Group	Sig.
Cop sway area	ACL-R	Healthy	0.001
	Ankle sprain	Healthy	0.001
	ACL-R	Ankle sprain	0.002
Average velocity of COP	ACL-R	Healthy	0.02
	Ankle sprain	Healthy	0.01
	ACL-R	Ankle sprain	0.164
COP excursion	ACL-R	Healthy	0.025
	Ankle sprain	Healthy	0.003
	ACL-R	Ankle sprain	0.346

DISCUSSION

The findings in this study revealed those patients who have an ankle sprain or ACL-R have impaired static postural stability than healthy subjects. The current results support the hypothesis that individuals with ankle sprain, ACL-R history have different static postural stability in comparison with healthy subjects. In addition, they are also consistent with the recent results by several investigations which are mentioned below.

Ankle sprain and healthy subjects

Recognizing that a patient`s center of pressure changes during single leg stance and that this is under control of both the central and peripheral nervous system. Cheng-Feng et al. (12), Shirvi et al. (36) and Jay et al. (23) who found that unilateral ankle sprain affects the postural stability in single leg stance and were able to identify static postural differ between healthy and ankle sprain individuals. Researchers have mentioned that individuals with ankle sprain show different COP pattern during single-leg stance (10,24). Tropp et al characterized the change in athlete`s center of gravity and related it to the risk of suffering from ankle injury. Postural sway was measured during the preseason in soccer players who were then followed for a complete season. An increased postural-sway value identified a patient at raised risk of suffering an ankle sprain. The results of the current investigation support this finding moreover leads to differ static postural stability between healthy and ankle sprain.

ACL-R and healthy subjects

Within our study, the statistical differences observed among ACL-R and healthy individuals. These findings indicate that the postural control impairment after ACL-R which is in agreement with previous studies (40). While in some studies were emphasized on the sensory roles of ACL more than its mechanical role (7,8). This fact(postural deficiency) may have occurred primarily because the postural alignment is an association between the visual stimuli, proprioceptive sensitivity and the vestibular apparatus. Loss of function in any of these systems can lead to balance deficits and affect the individual's postural awareness through afferent stimuli (16). This study support the results found by Foster et al. (17). The ACL injury generates biomechanical changes that affect the postural pattern even after its reconstruction as the postural control is decreased, even though there is some subtle improvement in trying to maintain an upright posture.

It should be emphasized that by the current study lack of some limitation including the lower sample size which was due to difficulty in finding ACL-R and ankle sprain subjects who had injury at 6m-1yr prior to study and were 18-25 years. Studying more balance parameters on more subjects is highly recommended.

This research suggested that individuals with ACL-R and ankle sprain had changes in posture, which demonstrated the effects of these ligament injuries even after successful completion of rehabilitation. The evaluation of postural changes is an essential tool for healthcare professionals as it reveals the individual's adaptation to the treatment, which can determine a correct intervention, and therefore, provide a faster recovery and prevent the occurrence of functional impairment of the skeletal muscles. The parameters related to COP such as velocity, sway area, and cop excursion are appropriate to describe the postural status. Hence, this reliable method can determine when athletes are ready to return to sport.

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