Original Article

Cognitive task versus focus of attention on dynamic postural control in recurrent ankle sprains

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ABSTRACT

The present study was performed to investigate the effect of continuous cognitive tasks on dynamic postural control concerning an external or internal focus of attention in a recurrent ankle sprain. Forty-three patients who suffered from recurrent ankle sprain were randomly allocated into 3 groups, (A) external focus of attention (n=14), (B) internal focus of attention (n=15), (C) continuous cognitive task (n=14). Dynamic postural control was determined in each group in 2 difficulty levels of the Biodex Balance System (BBS).
To compare between and within-group differences repeated measures MANOVA was used, no significant difference was observed within groups in Mediolateral Stability Index (MLSI), Anteroposterior Stability Index (APSI), and Overall Stability Index (OASI) in both difficulty levels except in group (C) in OASI. Nevertheless, between groups (A & C) there was a statistical reduction in group C in both levels OASI, APSI levels 7 and 5 (0.015 & 0.006) respectively, and MLSI in both levels (0.00). Furthermore, between (B and C) there was a significant reduction in dynamic postural control in group C in OASI in 5 & 7 (0.006, 0.018), respectively, MLSI in 7 and 5 (0.001, 0.019) respectively without any significant difference in APSI in both levels. The postural control automaticity in patients with recurrent ankle sprain decreased with dual tasks (continuous cognitive task) vs. the focus of attention.

Keywords: Ankle sprain, Continuous cognitive task, Focus of attention, Dynamic postural control

Introduction

Ankle sprains among athletes and other young active adults are considered one of the most serious injuries [1-3]. Lateral Ankle Sprains (LAS) are often treated as injuries that have no lasting impact. At least one-third of people with LAS will experience residual symptoms [4]. Postural control reduction is obvious 6 weeks after LAS. The rate of recurrence has been reported to be 70%-80%, while Functional Ankle Instability (FAI) is evident in 33% to 42% of acute ankle injury patients [5].

The FAI was described by Freeman [6] as the foot tendency to give way after an acute ankle sprain, which relates to the incidence of recurring ankle instability, besides proprioception and neuromuscular deficits may lead to the feeling of joint instability [7-9]. Mechanical Ankle Instability (MAI) and (FAI) are considered the factors contributing to Chronic Ankle Instability (CAI) [10, 11]. MAI involves impaired arthrokinematics, pathologic laxity, degenerative, and synovial modifications. FAI includes a defect in proprioception, neuromuscular activity, strength, and postural control [10].

Postural control was thought to be an automatic operation, caused by sensory feedback and reflex loops. On the other hand, the most recent studies related to posture-cognition dual-task are strongly sensitive to each other [12, 13].

Automatic control procedures tend to interfere with motivating subjects to focus on the swaying of their posture [14, 15], while

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shifting the focus from one's stability such as utilizing a dual-task, promotes the automaticity of postural control, producing more productive motion [16].

Limited center of pressure displacements accompanied by increased components of higher frequency typically have a positive effect on posture after attention shifting from postural function [17].

Instructions that shift attention to the target or ending movement on an instrument as an external focus improve performance of motor skills in comparison with an internal focus, which directs the attention to the sequences of the movement [18].

There is limited information on whether Cognitive tasks or focus of attention in dynamic postural control is effective in musculoskeletal diseases, especially ankle sprain. So the purpose of this research was to evaluate if shifting attention from postural control by a continuous cognitive task would promote dynamic postural control more than the focus of attention (external and internal) in recurrent ankle sprain patients.

Materials and Methods

Study design

This study was planned as a randomized, single-blind, prospective study. Ethical clearance was received before research by the ethical committee of the Faculty of Physical Therapy, Cairo University. The report followed the Principles of the Helsinki Declaration on Human Testing Actions. Documentation of written consent from patients has been received. The purpose and benefits of the research were addressed with the participants, who were told that they had the right to reject or withdraw at any time; the confidentiality of any information gathered was also discussed with the participants.

Forty-three non-athletic male and female subjects were recruited from the Faculty of Physical Therapy, Cairo University outpatient clinic; their ages were between 18-35 years, enrolled and tested for their ability to participate in the research. The inclusion criteria were as follows: suffering from ankle sprain instability, who had at least one acute ankle sprain that resulted in pain, swelling, and temporary loss of function, and not exposed to a lateral ankle sprain in the last three months before the study. History of multiple ankle episodes of "giving way" over the past 6 months considered as inclusion criteria. Patients would be excluded if they had one or more of these criteria: any musculoskeletal dysfunction, fracture, or disease other than lateral ankle sprain affecting the lower extremity; i-e deformities of the lower limb or malalignment of the posture, any pathological disease that can affect coordination, such as vestibular system disorders, middle ear, or any neurological condition, any condition that affects the cognitive function or focus of attention, participants have been trained on Biodex Balance System, and body mass index more than 25 or less than 18.

Participants were randomly included in one of the 3 groups:

Group A: External Focus of Attention (EFA) consisted of 14 patients assessed with EFA. Group B: Internal Focus of Attention (IFA) consisted of 15 patients assessed with IFA. Besides, Group C (continuous cognitive task): consisted of 14 patients assessed with a continuous cognitive task.

Randomization

Participants were randomized to 3 groups (A, B, and C) by a blinded, independent research associate who opened sealed cards containing computer-generated randomized cards.

Dynamic balance testing

The balance was measured by the BBS at the balance unit of the Faculty of Physical Therapy, Cairo University. The BBS consists of a mobile balancing platform that offers a surface tilt of up to 20° in a range of 360° and is interfaced with a microprocessor-based actuator, which controls the manually preset degree of level surface instability, varying from a very uneven surface (stability level 1) to a flawed firm surface (stability level 8). It is used to measure APSI, MLSI, and OASI.

For dynamic balance assessments, a subject was instructed to wear loose clothes and without footwear or socks. Subjects began the test by balancing on a single leg. They were instructed to stay as long as possible without movement, keeping their non-weight-bearing leg in hip flexion at roughly 20°, their hands on their hips, their eyes open, and knee flexion at 45°. The weight-bearing leg had a knee flexion of around 5°, with the foot in a neutral stance [19].

The subject was instructed to maintain a central position. The swing limb was kept parallel to the stance limb with 60° knee flexion, gazing to a fixed point on the wall without hand support. Once the participant was in position on the locked BBS platform, to allow motion, the stability platform was unlocked. Adjusting the supporting foot's position till maintaining platform stability, keeping the cursor centered on the screen grid [20].

Then the platform was locked, with the subject keeping his foot in a balanced position. The test was repeated if the subject lost balance by getting his foot down. Balance assessment was performed at two levels of postural difficulty level 7 and 5, which is more difficult; the test was performed through two 20 s trials for all groups [21].

The EFA group was instructed to “keep the platform stable”, the IFA group was told to “keep your body stable”. The cases were told to secretly count the cumulative amount of times a pre-selected digit (for example 0–9) was verbalized by an audio recording in a 3-digit sequence for the cognitive task state. With a new sequence introduced every 2s, the sequence consisted of thirty numbers. Without any delay, the task continued for the full duration of the experiment. It required cases to count the occurrence of the selected digit, MD, and simultaneously add it to their running total. The use of fingers for counting was prohibited; if the result was off by three or more, the trial was restarted [22].

The experiment was repeated if the non-supported foot met the supported one or if the subject touched the guardrail.

Statistical analysis

IBM SPSS statistical package for Windows (IBM SPSS, Chicago, IL, USA), version 23 was used for all statistical analyses. The significance level was P<0.05. Subject characteristics were compared between groups using ANOVA. Gender distribution was compared by the Chi-squared test. The normal data distribution was checked by the Shapiro-Wilk test and the between-groups homogeneity was tested by Levene's test for variances' homogeneity. Within and between-group comparisons were carried through mixed design MANOVA. The subsequent multiple comparisons were performed by Post-hoc tests using the Bonferroni correction.

Results and Discussion

Subject characteristics

The characteristics of subjects in the groups are shown in **Table 1**. No significant difference was found among the groups in terms of height, weight, and age where P-values were 0.93, 0.74, and 0.62 respectively.

Table 1. Subject Characteristics for the Three Groups

	A	B	C	p-value
	mean±SD	mean±SD	mean±SD	
Age (years)	22.85 ±4.25	24.1 ±5.21	35.86 ± 3.66	0.96
Weight (kg)	64.07±13.12	70.4±8.35	74.66 ± 3.97	0.74
Height (cm)	161.93±9.19	162.67±9.16	165.4 ± 3.81	0.93

p-value, Significance Level; SD, Standard Deviation

Within group comparison

No significant difference was observed in all variables (OASI, APSI, and MLSI) between level 7 and level 5, except in group C a significant reduction in OASI was observed between the 2 different stabilities **(Table 2)**.

Between groups comparison

Comparisons of the two groups (group A and C) showed significant differences in MLSI, APSI, and OASI in level 7 in favour of group C (p=0.000*, 0.015*, and 0.000*), respectively, in addition to comparison showed a significant reduction of MLSI, APSI, and OASI in level 5 in favour of group C with a p-value of (0.000*, 0.006*, and 0.000*), respectively **(Table 3)**.

A significant difference was observed between groups B and C in OASI, MLSI in level 7 (p=.018*and 0.00*), respectively. Besides, there was a significant reduction in level 5 of MLSI and OASI in favour of group C (p=0.019 and 0.006*), respectively. Whereas, there was no significant difference between levels 7 and 5 in APSI with p-value (0.204, 0,183), respectively **(Table 3)**.

Table 2. Mean Values of Stability Index in Two Different Levels (Level 5, Level 7) of Groups A, B, & C

	A		B		C	
	mean ± SD		mean ± SD		mean ± SD	
	Level 5	Level 7	Level 5	Level 7	Level 5	Level 7
Overall Stability Index	3.3107±0.917	3.21±1.083	4.59±1.00	4.15±2.29	7.52±3.14	6.24±2.73
	p =.660		0.101		*p* =0.08*	
Anteroposterior Stability Index	2.989±1.009	2.586±0.81	3.75±0.90	3.66±2.47	5.28±2.75	4.52±2.53
	p =0.335		*p* =0.296		*p* =0.464	
Mediolateral Stability Index	2.067 ±.594	1.986 ±.698	4.67 ±2.21	3.92±1.57	4.761 ±2.207	3.939±1.574
	p =0.674		*p* = 0.340		*p* = 0.246	

p-value, Significance Level; *, Significant; SD, Standard Deviation

Table 3. The Comparison of Stability Index in Two Different Levels between Group A, B, and C

		Level 5		Level 7	
		MD **(95% CI)**	**P-value**	Means ± SD	**P-value**
Groups A vs. C	OASI	4.21(3.31: 7.52)	0.000*	3.03(3.21:6.24)	0.000*
	APSI	2.3(2.9:5.2)	0.006*	2(2.5:4.5)	0.015*
	MLSI	2.7(2.06:4.76)	0.000*	1.95(1.98:3.93)	0.000*
Groups B vs. C	OASI	2.93(4.59: 7.52)	0.006*	2.09(4.15: 6.24)	0.018*
	APSI	1.53(3.75: 5.28)	0.183	0.86(3.66: 4.52)	0.204
	MLSI	1.72(2.95: 4.67)	0.019*	1.49(2.43: 3.92)	0.001*

MD, Mean Difference; CI, Confidence Interval; p-value, Level of Significance; *, Significant.

The present study aimed to investigate whether using a continuous cognitive task, withdrawing attention from postural control could facilitate more postural stability than the focus of attention (external and internal). Findings from this study showed that in patients with a chronic ankle sprain, the dynamic postural control decreased with a continuous cognitive task vs. the focus of attention.

Negahban *et al*. (2015) investigated the effects of silent backward counting as a cognitive task on postural control in knee osteoarthritis patients; the authors concluded that cognitive loading affects postural sway in dual-task in comparison to single-task conditions, which support the result of our study [23].

Shiravi *et al*. (2017) investigated the effect of a cognitive task on standing postural regulation on injured and non-injured legs of athletes with CAI. They reported improvement of single-leg standing balance with concurrent digit-backward memory task [24].

Pellecchia (2003) investigated whether the postural sway differed with the cognitive task's complexity. In the counting backward by 3s condition, the variability AP Sway and in general sway path are higher than all other cognitive conditions, concluding that increasing cognitive demand from an action-oriented perspective could make it more difficult to incorporate tasks into a combined action plan, however, by increasing the difficulty of the postural mission, standing on a flexible surface may have contributed to higher postural sway [25].

Swan *et al*. (2007) examined whether a decline in postural sway is based on the cognitive task's requirement, the postural task's difficulty, or the mixture of both. They concluded that a cognitive task's difficulty level has a significant effect on young adults' stability and also proposed that cognitive processes may potentially eliminate attention from posture control, helping the mechanism to work better, which contradicts the current study [26].

Burcal *et al*. (2014) found that both cognitive and postural instructions similarly improved postural stability relative to the conditions with no instruction, but with the cognitive emphasis instruction, AP sway was further improved [27]. Siu and Woollacott (2007) [28] observed that there is no substantial variation in postural sway between the posture and cognitive task instructions. However, postural sway was enhanced with the implementation of a cognitive task in a single task state.

On the other hand, the results of the current research are contrary to the results of Polskaia *et al*. 2015 [22], which compared the impact of the focus of attention (internal and external) and continuous cognitive tasks on postural stability. In comparison with the external and internal focus conditions, findings showed improved stability while performing the cognitive task, as shown by a decline in the sway area, the variability of sway in the posterior-anterior and lateral-medial directions, and mean velocity.

Conclusion

The findings of this study revealed that the automaticity of control of posture in the patient, who complains of recurrent ankle sprain decreased in dual tasks (continuous cognitive task) vs. the focus of attention.

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