

Evaluation of Trunk Muscle Endurance in Chronic Ankle Instability

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Article History	Abstract
<p>Received: 06 June 2023 Revised: 05 Sept 2023 Accepted: 24 Nov 2023</p> <p>CC License CC-BY-NC-SA 4.0</p>	<p>Background: Testing the association between trunk muscle endurance and chronic ankle instability (CAI) is very important to recognize risk factors related to CAI. This facilitates prevention of injury and management of the associated musculoskeletal deficits of CAI. Objective: to assess endurance of trunk muscles in females with CAI. Methods: This study consisted of 62 females, allocated into two equal groups of 31; the experimental group (A) included females with CAI and the healthy control (Group B) included healthy females. McGill core endurance tests (prone-bridge, right side-bridge, left side-bridge, trunk flexion and horizontal back extension) were administered to assess trunk muscle endurance. Results: Statistical analysis revealed no significant differences in trunk muscle endurance between the two tested groups ($p > 0.05$). Conclusions: Although, the results indicated higher values of trunk endurance in the CAI group compared with their healthy controls, no statistically significant differences were observed between the two groups. This denotes the compensatory mechanism that altered ankle-hip strategy.</p> <p>Keywords: Trunk; Endurance; Ankle; Joint Instability.</p>

1. Introduction

Chronic ankle instability (CAI) is a serious musculoskeletal disorder affecting 70% of the predictable 23,000 individuals who have ankle sprain in the United States daily [1]. The CAI is related to numerous deficits that lead to recurrent ankle sprains, giving way, and instability [2] It is accompanied with reduced physical activity and life quality throughout the lifespan. It is also related to increased risk for joint osteoarthritis [3]. Although CAI is hypothetically worsened by decreased lumbopelvic stability, this relationship is still theoretical. Lumbopelvic stability can be examined via tests challenging the ability to keep trunk and hip alignment. However, till now, no studies examined performance level in individuals with versus without CAI. Additionally, while lumbopelvic stability is affected by both trunk and hip muscular deficits. However, few research exists concerning trunk muscle structure in those with CAI [4].

The CAI leads to neuromuscular impairments in hip joint that in turn results in diminished lumbopelvic stability. Then, improper positioning of lower body part during functional activity occurs. Lumbopelvic stability, known as core stability (CS), is further diminished by deficits in trunk muscle contraction. However, CS and trunk muscle contractility weren't compared between individuals with and without CAI [4]. Core endurance is the most predictable method of CS measurement, NMC and function evaluation. Core endurance tests were used to identify athletes who have higher incidence of injuries and evaluate the effectiveness of rehabilitation programs [5]. Up to the authors' knowledge, few studies have examined the relationship between core endurance and lower extremity injury [6] and no previous studies have investigated the relationship between CS and CAI. Therefore, it is crucial to assess endurance of the trunk muscles in females with CAI.

2. Materials And Methods

Participants

The study involved 62 females, classified into two equal groups of 31; the experimental (Group A) included females with CAI and the healthy control (Group B) included healthy females. The mean values \pm SD of age, body mass, height and body mass index (BMI) were 24.36 ± 3.01 years, 65.98 ± 11.06 kg, 163.29 ± 5.53 cm, 24.52 ± 3.75 kg/m² respectively for the experimental group (A). The data of the healthy control group (B) were 23.52 ± 2.43 years, 67.45 ± 21.80 kg, 160.25 ± 21.27 cm, 23.60 ± 3.94 kg/m² respectively. Before the assessment, all female participants read and signed an informed consent form. The participant's name, age, address, body mass, height, and phone number were recorded. The research study was approved by Faculty of Physical Therapy research ethics committee, Cairo University (P.T.REC/012/003263).

McGill Trunk Endurance Tests

The endurance of trunk muscles was evaluated using the McGill trunk endurance tests and they are highly reliable tests [7]. The tests were prone-bridge, right side-bridge, left side-bridge, trunk flexion and horizontal back extension tests. Each participant was informed to hold the test position as long as possible. The examiner recorded the duration in seconds [8]. Multiple repetition McGill trunk endurance tests were performed. Each test was repeated three times and the results were averaged for analysis.

Prone plank endurance test (Prone-bridge test)

The frontal and dorsal core muscles were assessed using the prone-bridge test. The participant was instructed to support her body using her elbows and toes, while maintaining a neutral position of the pelvis and a straight body posture (Figure 1). The investigator used a stopwatch to measure the duration for which the participant was able to maintain the neutral position of pelvis. Time was stopped if the participant lost the straight body position or assumed anterior pelvic tilting [9].

Right side plank endurance test (Right side-bridge test)

The lateral core muscles endurance, especially the quadratus lumborum, was assessed using the side-bridge test. The participant was instructed to lie on her right side with the upper foot positioned in front of the lower foot, while keeping the hip in a neutral position. The participant was asked to keep the hips off the table, supporting herself on her right elbow and feet. The left arm was crossed over the chest with the hand resting on the right shoulder (Figure 2). The investigator used a stopwatch to measure the duration for which the participant was able to keep his lower pelvis off the table. Time was stopped if the participant lost the straight body posture and fall into the table.

Left side plank endurance test (Left side-bridge test)

The same procedures of right-side plank were repeated but for the left side (Figure 3).

Trunk flexors endurance test

The flexors endurance test evaluates the frontal core muscles. The test started by asking the participant to support her body against a wedge at 60° trunk flexion, 90° hips and knees flexion and neutral head position. Both participant's arms were crossed over her chest. The angles of trunk, hips, and knees were measured using a goniometer. The wedge was positioned as a reference point to ensure that the participant did not touch it with her back during the test. Then, the examiner moved the wedge away and the participant was instructed to hold her position without back support (Figure 4). The total duration the participant was able to keep this position was recorded by a stopwatch. The test was ended when the participant's trunk fell below 60° (touch the wedge).

Horizontal back extension endurance test (Modified Biering-Sorensen test)

The endurance of the dorsal core muscles was assessed using the horizontal back extension test [10]. The participant was asked to assume prone lying position while keeping the trunk straight out of the table with the anterior superior iliac spines were positioned at the edge of the table, and the lower legs were supported by the examiner on the table (Figure 5). The investigator used a stopwatch to measure the period of time the participant was able to keep the trunk in a horizontal position. The test time was stopped when the participant was no longer able to maintain horizontal back posture and flexed her trunk.

Statistical analysis

First, sample size calculation was done using the G*Power 3.1.9.7 software, which is a valid and objective method to calculate the sample size as a priori type of power analysis. A large effect size f^2 (V) of 0.4 was administered to the software as suggested by Cohen [11] and many recent studies [12, 13, 14]. The alpha error of probability was set at 0.05 and the power of the study ($1-\beta$ err prob) was set at 0.8. The software calculated the sample size and revealed that the minimal total required sample size for both groups was 44. The authors examined a larger sample size of 62 females for eligibility to participate in the study to avoid participant drop during the testing procedures and to ensure a good power of significance.

Parametric statistical analysis one-way multivariate analysis of variance (MANOVA) was done to compare the core endurance tests times (dependent variables) between the two tested groups. The alpha level was adjusted at 0.05 for all the statistical tests ($P < 0.05$). The statistical analysis was conducted using version 20 of the Statistical Package for Social Sciences (SPSS).

3. Results and Discussion

Participants' characteristics:

The homogeneity between the two tested groups in the demographic data was tested by independent t-tests. It revealed no statistically significant difference in the average values of the age, body mass, height, and BMI between groups ($p > 0.05$) (Table 1).

Table1: Descriptive statistics and independent t-tests for the mean age, body mass, height, and body mass index (BMI) in experimental group (A) and control group (B):

	Experimental Group (A) (N=31) $\bar{X} \pm SD$	Control Group (B) (N=31) $\bar{X} \pm SD$	t-value	p-value
Age (years)	24.36 \pm 3.01	23.52 \pm 2.43	1.605	0.114
Body mass (kg)	65.98 \pm 11.06	67.45 \pm 21.80	0.308	0.759
Height (cm)	163.29 \pm 5.53	160.25 \pm 21.27	0.769	0.445
BMI (kg/m ²)	24.52 \pm 3.75	23.60 \pm 3.94	1.058	0.294

Table 2: Descriptive statistics and one-way MANOVA of tested dependent variables in experimental group (A) and control group (B)

Measured Variables (in seconds)	Experimental Group (A) (N=31)	Control Group (B) (N=31)	<i>experimental group vs. control group</i>	
	$\bar{X} \pm SD$	$\bar{X} \pm SD$		
Prone plank endurance time	30.37 \pm 12.86	29.98 \pm 12.37	F=0.015	P=0.902
Right side plank endurance time	29.75 \pm 10.45	25.94 \pm 11.76	F=1.813	P=0.183
Left side plank endurance time	30.31 \pm 12.09	25.11 \pm 11.66	F=2.973	P=0.090
Trunk flexors endurance time	67.83 \pm 34.46	65.19 \pm 32.39	F=0.097	P=0.757
Horizontal back extension endurance time	60.52 \pm 20.79	58.39 \pm 17.13	F=0.195	P=0.661



Figure 1: Prone plank endurance test



Figure 2: Right side plank endurance test



Figure 3: Left side plank endurance test



Figure 4: The trunk flexors endurance test



Figure 5: Horizontal back extension endurance test

Results detected no significant differences in the mean values of endurance times (sec); prone plank, right side plank, left side plank, trunk flexors and horizontal back extensors tests between both experimental group (A) and healthy control group (B) ($p > 0.05$) (Table 2).

In the current study, the average values of trunk muscle endurance times are higher in experimental group (A) compared to the healthy control group (B) but did not reach the statistical significance. The unexpected findings of higher endurance times in the experimental group compared to the healthy control group may be explained by the fact that individuals with a long history of CAI might complain of neuromuscular impairment than a healthy person or even a person with a recent injury. The healthy individuals used ankle strategy, whereas patients with CAI switched from an ankle to a hip-dominant strategy to keep the postural stability. This altered myoelectric activity of the proximal muscles of the trunk and hip, leading to an increase in their strength [15, 16]. Moreover, the early and higher activity of the trunk muscles in patients with CAI is a protective method to support the spine [17] or due to ankle dorsiflexion restriction [18]. This finding [17] comes also in line with the current study as the patients with CAI have greater trunk muscle endurance compared with healthy controls. The findings of the current research are in agreement with the research of Pathan and Jethwani [19]. They reported that there was no significant difference in the trunk flexors and extensors endurance tests between the players with and without ankle sprain injuries. On the other hand, they reported a significant decrease in lateral musculature endurance in players with ankle sprain injuries.

Similarly, Calicchio et al. [20] reported a weak correlation between the core muscle endurance and measures of CAI (Balance Error Scoring System), the Foot and Ankle Disability index (FADI), the FADI sport survey and Ankle Joint Functional Assessment Tool (AJFAT) in athletes.

On the other hand, Razeghi et al. [21] disagreed with the findings of the current study. They concluded that athletes with CAI had a significantly lower time of endurance tests in relation to healthy athletes. Concerning the reduced muscular endurance, the back extensors are the most related muscles to the core endurance impairment followed by trunk flexors, right side flexors and left side flexors. These opposing findings might be explained by the nature of their sample. Their sample was athletes suffering from CAI and they also did not exclude the athletes with LBP. In addition, the athletes are vulnerable to different stresses that affect measures of strength and endurance due to the nature of their sports.

Abdallah et al. [22] assessed the core endurance in athletes with non-contact lower extremity injury (sprain or strain) using McGill core endurance testes. The average values of time of prone-bridge and side-bridge tests were significantly shorter in athletes with non-contact lower extremity injury when compared with the healthy athletes. Their findings may not be applicable to all athletes in general. They also conducted their study on athletes with non-contact lower extremity injury (sprain or strain) and did not determine the site of injury unlike the current study which was conducted specifically on ankle joint. They recruited the athletes to participate in the study during the season and they did not determine the stage of their injury (acute, subacute, or chronic), while the current study was carried out specifically on patients with CAI. This may interpret their different findings from the current study.

The ability of the lumbo-pelvic stability tests to identify ankle sprain injury has not been investigated. The static CS tests may not represent the lumbo-pelvic stability impairments in CAI patients [23]. Marshall et al. [23] used another core endurance test in cases of ankle sprain. They evaluated the trunk stability during the unloading task. They reported higher latent period of the rectus abdominis and erector spinae muscles and increased trunk displacements in individuals with CAI compared with healthy control group. Also, the higher latency period means more time needed to stabilize the spine after the sudden disturbances. The unloading task gives special dynamic challenges not included in the static core endurance tests. Sudden disturbances decreased the sensorimotor system preparation, compared with predictable tasks [24].

In the current study, it is not obvious why no other clear link was identified between trunk endurance and CAI, but the McGill core endurance tests may not truly represent the lumbo-pelvic stability in patients with CAI and unable to discriminate the individuals with and without CAI. The sudden disturbances were required to evaluate the trunk stability impairments in CAI patients. The chosen static tests would not do this.

This study has some limitations; 1) inability to be confirmed of the maximum exertion of the participants' efforts during testing when they were asked to exert their greatest efforts., 2) McGill core endurance tests are used to evaluate a group of muscles and cannot evaluate a separate or specific muscle., 3) although the core endurance was assessed with widely applicable tests (McGill core endurance tests), but as explained earlier, the tests couldn't sufficiently challenge the sensorimotor system of the participants to detect the between group differences. These tests assess the static core endurance only. Last, there is inability to generalize the findings upon gender as the collected sample was younger females only.

4. Conclusion

Although, the results showed higher values of trunk endurance in the group of CAI compared with their healthy controls, no statistically significant differences were detected between them.

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Conflict of Interest:

The authors have no conflicts of interests.

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