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Weight Bearing Ankle Dorsiflexıon Range of Motion Correlates with Dynamic Balance in Volleyball Players with Chronic Ankle Instability

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Abstract

The aim of this study was to investigate the relationship between weight bearing ankle dorsiflexion range of motion (ROM) and dynamic balance in volleyball players with chronic ankle instability. Thirty-five female volleyball athletes were included in the study. Dynamic balance was evaluated by star excursion balance test with anterior, posteromedial and posterolateral reach distances. Weight bearing lunge test was used to measure ankle dorsiflexion ROM. Spearman correlation test was conducted for statistical analysis. There were significant correlation between ankle dorsiflexion ROM and SEBT anterior ($p=0.006$) and posteromedial reach ($p=0.009$) distances in injured ankle. Posterolateral reach of SEBT was not correlated with ankle dorsiflexion ROM ($p>0.05$). Deficits in ankle dorsiflexion ROM due to chronic ankle instability may be responsible for decreased balance performance in volleyball athletes.

Keywords: Ankle joint, sprain, star excursion balance test, adolescent, volleyball

INTRODUCTION

Lateral ankle sprain (LAS) is one of the most common sport injuries which constitutes % 15 to % 45 of all sport injuries (Ferran and Maffulli, 2006; Malliaropoulos et al., 2009). Sports involving jumping, landing and cutting maneuvers such as volleyball and basketball are at greater risk due to injury mechanism (Thacker et al., 1999; Wright et al., 2000). Lateral cutting maneuvers are very frequent in volleyball. During cutting movements, a large supination torque that moves the foot inward excessively, overloading and damaging the lateral ankle ligaments. Although LAS is usually considered as an innocuous injury, some of athletes have to stop their career since repetitive LAS causes ankle instability and serious ankle cartilage problem (Verhagen et al., 1995).

Repetitive frequencies of ankle sprains defined as chronic ankle instability (CAI) which is characterized by unstable ankle joint and 'giving-way' feeling (Freeman et al., 1965). Decreased neuromuscular control (functional instability) and lack of ligamentous support (mechanical instability) are main contributors of CAI (Hertel, 2002). Cartilage defects (Valderrabano et al. 2006), lack of postural control (Hertel, 2008, Hoch et al., 2012), muscle weakness (Friel et al., 2006; Arnold et al., 2009) and decreased dorsiflexion range of motion (ROM) (Hoch et al., 2012) are the most common problems showing up with CAI. Athletic performance are also affected by decreased dorsiflexion ROM and altered neuromuscular control (Fong et al., 2011; Basnett et al., 2013). Reduced knee flexion and increased varus and valgus displacements are occurs during squatting and landing with limited dorsiflexion (Fong et al., 2011; Dill et al., 2014).

Star Excursion Balance Test (SEBT) is one of the most common test batteries to assess dynamic balance of single limb while opposite limb reaching as far as possible in a predetermined direction (Gribble and Hertel, 2003). Greater reach distances indicates better dynamic balances and people with CAI shown to have lower reach distances compared to asymptomatic persons (Hertel et al., 2006; Hoch et al., 2012). Deficits in dorsiflexion ROM was shown to decrease anterior reach direction of SEBT (Fong et al., 2011; Hoch et al., 2011; Hoch et al., 2012; Basnett et al., 2013). Although there are studies investigating the effects of dorsiflexion ROM on balance (Olmsted et al., 2002; Hoch et al., 2011; Hoch et al., 2012; Basnett et al., 2013), current knowledge about the relationship between CAI and dynamic balance is inadequate in volleyball athletes.

The aim of the study was to investigate the relationship between weight bearing ankle dorsiflexion ROM and dynamic balance in volleyball players. It was hypothesized that decreased dorsiflexion ROM would be positively correlated with dynamic balance in volleyball players with CAI.

METHODS

Subjects

Thirty-five volleyball players (age: 14.5±1.2 years, height: 170.5±5.5 cm, body mass: 59.3±6.8 kg, time participating in sports activity: 5.3±1.4 h/wk, experience in sport: 4.1±1.8 years) with CAI volunteered to the study. All participants reported a history of at least one ankle sprain and repetitive episodes of 'giving way' feeling on the same ankle. Participants who had a history of ankle surgery, other lower extremity injuries for the last six months and diagnosed ankle joint osteoarthritis were excluded from the study. To avoid acute symptoms of the injury, participants who had ankle sprain for the past 2 months were also excluded from the study. This study was approved by the Ethics Committee of Hacettepe University.

Data collection

Weight bearing ankle dorsiflexion range of motion measurement: Ankle dorsiflexion ROM was measured with weight bearing lunge test (WBLT). It is reliable measurement for ankle dorsiflexion ROM by assessing the anterior displacement of tibia over the talus during weight bearing position (Bennell et al., 1998; Denegar et al., 2002). During testing procedure, participants were in standing position in barefoot and facing the wall. The tested foot was on the front on a tape while other foot was positioned approximately 1 foot behind the tested foot and the knees were perpendicular to the wall. Participants allowed to place their hand to the wall to maintain their balance. In this position participant were instructed to perform lunge and try to reach the wall with the tested extremity's knee while protecting the ground contact with the heel. When the participants able to perform the knee touch without heel rise, the extremity progressed 1 centimeter away from the wall and test was performed again. The test was repeated until the heel contact could no longer be maintained. After this point with small adjustments the maximum distance between the big toe and the wall was measured while maintaining heel contact (Bennell et al., 1998; Hoch et al., 2012). Tree trials were performed and average of trials was recorded (Figure 1).

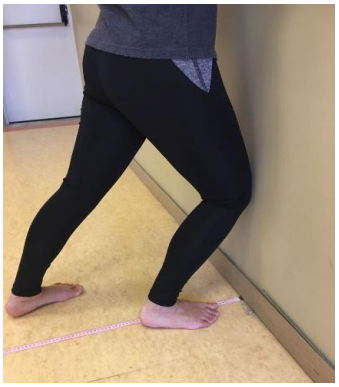

Figure 1. Weight bearing lunge test

Dynamic balance measurement: Anterior, posteromedial and posterolateral direction of the SEBT were used to assess the dynamic balance following Hertel et al.s' (2010) recommendations. Participants were instructed to stand in the middle of the grid with tapelines extending out 100 centimeters. The angle between anterior (ANT) and posteromedial (PM) or posterolateral (PL) directions was set at 135˚, and between PM and PL was set at 90˚. The participants were instructed to reach as far as possible along each of the three lines, make a light toe-touch on the line without shifting weight, and return to the center of the grid whilst maintaining single-leg balance. Measurements were taken from the most distal aspect of the toes. Three practice trials were given for each limb for each direction. The participants then performed three trials in the three directions for each limb. The average of the three reach distances was recorded (Gribble and Hertel, 2003; Hertel et al., 2010) (Figure 2).

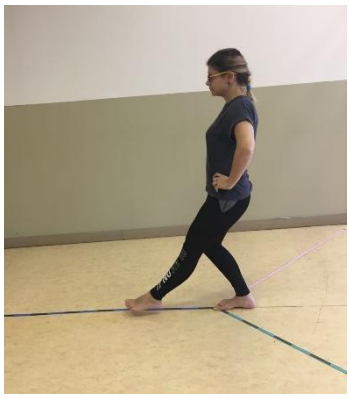

Figure 2. Star excursion balance test anterior reach

Data analysis

SPSS version of 22.0 was used for statistical analysis. Spearman correlation analysis was performed to determine the relationship between ankle dorsiflexion ROM and SEBT anterior, posteromedial and posterolateral directions. The relationships were interpreted as; little or no relationship (r = 0.0-0.25), fair relationship (r = 0.25-0.50), moderate to good relationship (0.50-0.75), good to excellent relationship (r > 0.75)(Portney and Watkins, 2015). Statistical significance was set at $p<0.05$.

RESULTS

Descriptive statistics for weight bearing lunge test and star excursion balance test outcomes were shown in Table 1.

Table 1. Mean± SD for SEBT and ankle dorsiflexion range of motion for involved and uninvolved ankle.

	SEBT Anterior (cm)	SEBT Posteromedial (cm)	SEBT Posterolateral (cm)	Dorsiflexion ROM (cm)
Uninvolved	67.6±4.5	83.0±7.3	77.4±8.0	12.6±2.2
Involved	65.3±4.8	78.3±8.5	74.4±7.0	10.2±2.1
p value	0.04*	0.02*	0.09	<0.001*

* Shows significant difference between involved and uninvolved sides ($p<0.05$)

The correlation between weight bearing lunge test and dynamic balance test was found significant ($p<0.05$). Dorsiflexion ROM of the involved side positively correlated with SEBT anterior and posterior reach directions while uninvolved sides' dorsiflexion ROM was only positively correlated with SEBT anterior reach directions (Table 2).

Table 2. Correlation between ankle dorsiflexion and Star excursion balance test outcomes

	SEBT Anterior	SEBT Posteromedial	SEBT Posterolateral
Involved Dorsiflexion ROM	p=0.006* r=0.51	p=0.009* r=0.44	p=0.19 r=0.27
Uninvolved Dorsiflexion ROM	p=0.03* r=0.38	p=0.22 r=0.28	p=0.58 r=0.09

DISCUSSION

The purpose of this study was to determine the relationship between a weight-bearing measure of ankle dorsiflexion ROM and dynamic balance measured using the SEBT in volleyball athletes with chronic ankle instability. The results indicate that there was a significant positive relationship between ankle dorsiflexion ROM and dynamic balance outcomes in these athletes. Ankle dorsiflexion ROM of the injured side correlated with the anterior and posteromedial reach directions of the SEBT that suggests deficits in ankle motion could affect the dynamic performance during a balance task.

Previous studies observed that individuals with chronic ankle instability had a deficits in ankle dorsiflexion ROM and anterior reach of SEBT (Arnold et al., 2009; Hoch et al., 2012; Basnett et al., 2013). Hoch et al., (2012) found a moderate correlation between ankle dorsiflexion ROM and the anterior reach component of the SEBT, while they observed no correlation between ankle dorsiflexion ROM and, posteromedial and posterolateral directions in individuals with chronic ankle instability and healthy control. As the nature of SEBT reach directions, ankle dorsiflexion ROM is more required in anterior reach compared to posteromedial and posterolateral reach directions (Terada et al., 2014; Gabriner et al., 2015) since this direction is performed on sagittal plane movement. Hoch et al., (2011) reported a positive correlation between the WBLT and anterior reach distance in healthy individuals. The current study identified a similar relationship between the WBLT and anterior reach of SEBT also in uninvolved ankle. Anterior reach of SEBT is performed in sagittal plane unlike posteromedial and posterolateral reaches.

Gabriner et al., (2015) postulated that anterior reach of SEBT might be more affected by mechanical restrictions while posteromedial and posterolateral reaches relied more on muscular strength and postural control. Contrary to previous findings, we found a significant correlation between ankle dorsiflexion ROM and posteromedial direction of SEBT only in injured ankle so we suggested that posteromedial reach of SEBT might be also influenced by deficits of ankle dorsiflexion. The decrease in ankle dorsiflexion was shown to affect squat and step biomechanics, postural control and it was thought to increase knee and lower extremity joint pathologies (Fong et al., 2011; Macrum et al., 2012). Therefore, restriction of dorsiflexion motion might affect the neuromuscular control of the lower extremity which cause a decrease in posteromedial reach of the participants in present study.

There were some limitations of the study. We could only include female athletes in the study so the results of the study might not reflect the male counterparts. As we could not objectively monitor the proximal joint during SEBT, we could not suggest that the decreased ankle dorsiflexion was the primary contributor factor to cause a decrease in anterior and posteromedial reaches of SEBT.

CONCLUSIONS

As a result, weight bearing ankle dorsiflexion ROM of injured and health ankles positively correlated with anterior and posterolateral reach directions of SEBT in volleyball athletes with CAI. Those with CAI showed less dorsiflexion ROM on the weight bearing lunge test and shorter anterior reach distance in SEBT. Therefore, deficits in ankle dorsiflexion ROM due to chronic ankle instability may be responsible for decreased balance performance in volleyball athletes. Joint mobilization techniques or taping applications which may increase ankle dorsiflexion ROM could help volleyball athletes to enhance their dynamic balance.

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