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Original scientific paper

Dorsiflexion range of motion does not significantly influence balance in physically active young women

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Abstract

Dorsiflexion range of motion is a measure of flexibility of the ankle joint. The amount of influence of ankle range of motion on balance performance is still not clear. It is known that ankle injuries could affect reduced ankle range of motion, that inflexible ankles have nearly five times greater risk of ankle sprain, and that leg with history of ankle injury has a worse proprioceptive ability. The objective of this study was to examine the relationship between ankle flexibility and unilateral balance. Fourteen healthy young women (age: 21,00 ± 2,50 years, height 167,285 ± 4,496 cm, weight 61,071 ± 5,827 kg, body fat 26,514 ± 4,214 %, students of kinesiology), participated in this study. The sample of variables included three tests of unilateral balance abilities (Overall, Anterior-Posterior and Medio-Lateral Stability Index), and one ankle flexibility measure (maximal dorsiflexion range of motion) estimated by performing Weight Bearing Lunge Test. There was no significant correlation between the Overall (mean: 2.04 ± 0.60; r=0.38, R^2=0.14, *p*=0.18), Anterior-Posterior (mean: 1.66 ± 0.56; r=0.28, R^2=0.08, *p*=0.33) and Medio-Lateral Stability Index (mean: 14,32 ± 3,4; r=0,11, R^2=0,01, *p*=0,71) with the maximal dorsiflexion range of motion. Based on these findings it could be concluded that better results of unilateral balance measured on Biodex Stability System, among young, healthy physically active women, does not depend on greater dorsiflexion range of motion.

Key Words: *Ankle flexibility, healthy young women, ankle sprains, proprioceptive abilities*

Opseg pokreta skočnog zgloba ne utječe značajno na ravnotežu kod tjelesno aktivnih žena

Sažetak

Opseg pokreta pri dorzalnoj fleksiji jedna je od mjera fleksibilnosti skočnog zgloba. Utjecaj opsega pokreta pri dorzalnoj fleksiji u skočnom zglobu na ravnotežu još nije do kraja poznat. Naime, poznato je da ozljede skočnog zgloba utječu na smanjenje opsega pokreta, da nefleksibilni skočni zglobovi imaju pet puta veći rizik od uganuća, te da skočni zglobovi s poviješću ozljeđivanja imaju lošije proprioceptivne sposobnosti. Namjera ove studije bila je utvrditi povezanost između fleksibilnosti skočnog zgloba i unilateralne ravnoteže. U studiji je sudjelovalo četrnaest zdravih, mladih, tjelesno aktivnih žena, studentica kineziologije (dob 21,00 ± 2,50 godina, visina 167,285 ± 4,496 cm, masa 61,071 ± 5,827 kg, masno tkivo 26,514 ± 4,214 %). Uzorak varijabli sastojao se od tri testa za procjenu unilateralne ravnoteže na Biodex Stability sustavu (ukupni indeks stabilnosti, indeks stabilnosti u smjeru naprijed-natrag, indeks stabilnosti u smjeru lijevo-desno) i jednog testa za procjenu maksimalne fleksibilnosti skočnog zgloba (Weight Bearing Lunge Test). Rezultati istraživanja su pokazali kako nema statistički značajnih korelacija između ukupnog indeksa stabilnosti (2.04 ± 0.60; r=0.38, R2=0.14, p=0.18), indeksa stabilnosti naprijed-natrag (1.66 ± 0.56; r=0.28, R2=0.08, p=0.33) i indeksa stabilnosti lijevo-desno (14,32 ± 3,4; r=0,11, R2=0,01, p=0,71) s maksimalnim opsegom pokreta u skočnom zglobu. Na temelju rezultata ovog istraživanja može se zaključiti kako kod mlade, zdrave, tjelesno aktivne ženske populacije veći opseg pokreta u skočnom zglobu ne utječe statistički značajno na bolji rezultat u unilateralnoj ravnoteži mjerenoj na Biodex Stability sustavu.

Ključne riječi: Fleksibilnost skočnog zgloba, zdrave mlade žene, uganuće skočnog zgloba, proprioceptiva sposobnost.

Introduction

There are lots of different considerations for maintaining joint stability. Joint stability could depends on leg strength muscle, core strength muscle, proprioceptive abilities, age, sex, body high, body mass etc., and of course, dorsiflexion range of motion (DROM), as a measure of flexibility of the ankle joint, is one of them. There are few studies (Gribble & Hertel, 2003; Hoch, Staton & McKeon, 2011) that have examined the impact of DROM on unilateral balance performance, but there is still limited evidence regarding the relationship between DROM and performance on clinical assessments of balance measures such as the Star Excursion Balance Test (SEBT) (Hoch, et al., 2011.), or Biodex Stability System (BSS) etc.. Dorsiflexion range of motion could be particularly important for understanding lower extremity injury mechanisms. Namely, the amount of influence of ankle range of motion on dynamic balance performance is still not clear. The reason for this is probably multifaceted. First off all, period of last 15 years of studying dynamic postural stability probably is not enough to get the final conclusion. Furthermore Y balance test (YBT) or SEBT test measures across all domains of movement (range of motion, strength, proprioception, core stability, etc.), one faulty component of any of these systems will cause a positive test (Cook, Burton, Kiesel, Rose & Bryant, 2010).

It is well known that ankle injuries could affect reduced ankle ROM. For example, during jogging, individuals with the chronic ankle instability (CAI) have significantly less DROM (~5%) when compared with individuals without CAI (Drewes, McKeon, Kerrigan & Hertel, 2009). Also, 59% of athletes with history of ankle sprain, complained on some residual problems, including the stiffness (15%) (Yeung, Chan, So MPhil & Yuan, 1994). Furthermore, inflexible ankles have nearly five times greater risk of ankle sprain than the people with an average flexibility (Noronha, Refshauge, Herbert & Kilbreath, 2006).

It is known that leg with history of ankle injury has a worse proprioceptive ability than the leg without history of leg injury (Freeman, Dean & Hanham, 1965.; Watson, 1999.; Liu, Jeng & Lee, 2005.; Ross & Guskiewicz, 2004). Also, the previous studies showed that specific proprioception deficits (Payne, Berg & Latin, 1997), postural sway deficits (Wang, Chen, Shiang, Jan & Lin, 2006) or balance deficits (Brown & Mynark, 2007) could be identified as the predictors in ankle injury. Still, it doesn't means that the balance of uninvolved leg is not impared after acute contralateral ankle sprain (Wikstrom, Naik, Lodha and Caraugh, 2010). Figure 1 presents hypothetic closed circle.

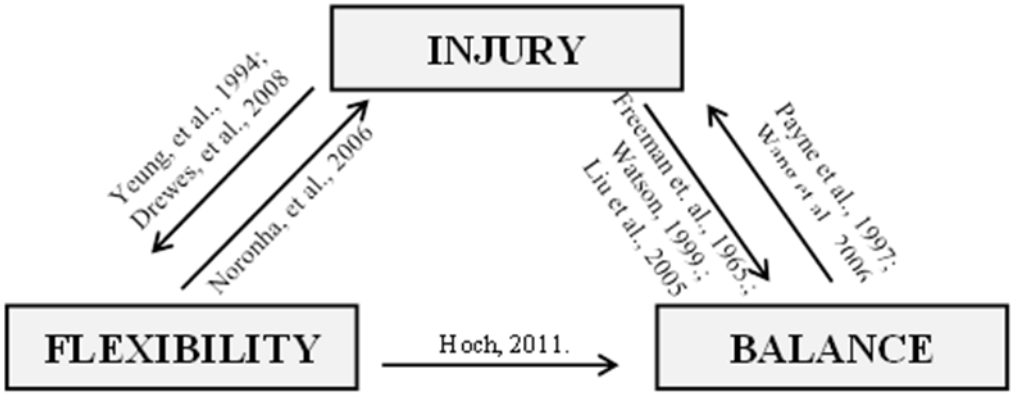

Figure1. Hypothetic closed circle: flexibility, balance and injury relations.

Reduced ankle flexibility correlates with balance deficits (Hoch, et al., 2011), balance deficits could be identified as an ankle injury predictor (Payne, et al., 1997; Wang, et al., 2006), injury affects reduced DROM (Yeung, et al., 1994; Drewes, et al., 2009) - OR - inflexible ankles have nearly five times bigger risk of ankle injury (Noronha, et al., 2006), ankle injury has a worse balance ability (Freeman, et al., 1965.; Watson, 1999.; Liu, et al., 2005).

Based on these findings, it was assumed that greater ankle flexibility is related with better dynamic balance measured on BSS. Analyzing the results of the BSS and ankle flexibility measures could advance our knowledge of their relationship.

Methods

Fourteen healthy, physically active (current or former athletes) young women (age 21,00 ± 2,50 years, height 167,285 ± 4,496 cm, weight 61,071 ± 5,827 kg, body fat 26,514 ± 4,214 %, students of kinesiology, University of Sarajevo, Bosnia and Herzegovina), participated in this study, with no history of lower extremity surgery, or any others lower extremity injuries in the last two years. Investigation of Willems, et al. (2002) showed no statistically significant differences between groups of subjects with no history of leg injury in the last two and last three to five years in strength and balance. Therefore, it is assumed that the period of two years without leg injury is appropriate for this study. Our Institutional Review Board approved this study and all subjects provided a written informed consent.

All subjects reported to the research laboratory on a single occasion and performed all tests. They made a standard warm up (5 minutes of bicycle an 3 to 5 minutes of dynamic stretching). The sample of variables included one ankle flexibility measure, and three tests of unilateral balance abilities.

Ankle flexibility or maximal DROM was estimated by performing Weight Bearing Lunge Test (WBLT). See Picture 1.

Picture 1. Subject in the position for the Weight-Bearing Lunge Test.

The WBLT was performed using the knee-to-wall principle described by Vicenzino, Branjerdporn, Teys, & Jordan, 2006; Hoch, et al., 2011. During the test the subject kept her heel firmly planted on the floor while her knee was flexed to the wall. The opposite leg was used to maintain stability during the test and it was positioned behind the test foot. The hands were placed on the wall and they were used for stability, too. When subjects were able to maintain heel and knee contact, they moved the foot backward from the wall and repeated the modified lunge. The main objective of the test is to achieve maximum DROM, while the heel is touching the floor and the knee is touching the wall. Maximum dorsiflexion was measured in cm and defined as the distance of the great toe from the wall based on the furthest distance the foot was able to be placed, without the heel lifting off the ground, while the knee was able to touch the wall (Vicenzino, et al., 2006). Three trials were collected on each limb, averaged, and used for analysis.

Balance abilities or single-limb postural stability was assessed on a Biodex Stability System (BSS) (Biodex, Shirley, New York, USA). System reliability (coefficient of variations) is 5%. The tests of balance performance on BSS were: Overall Stability Index (OSI), Anterior–Posterior Stability Index

(APSI), and Medio-Lateral Stability Index (MLSI). BSS was used in a numerous of studies before (Arnold & Schmitz, 1998; Paterno, Myer, Ford & Hewett, 2004; Rein, Fabian, Weindel, Schneiders, & Zwipp, 2011; Rein, Fabian, Zwipp, Rammelt & Weindel, 2011; Kim, Cha & Fell, 2011).

In sports shoes, with open eyes and visual feedback each subject performed 3 practice trials for each leg, alternately. All together balance testing for one subject lasted for 3 to 5 minutes. Level of stability was set at 5. The trials were collected, averaged, and used for analysis.

OSI, APSI, MLSI and the mean of the WBLT for each limb were dependent variables. To determine the presence of limb differences for each dependent measure were conducted dependent t-test. Simple Linear Regression analysis was used to examine the correlation (r) and proportion of variance (r^2) explained among the 4 dependent variables. Alpha level was set a priori at $p<0.05$.

Also, the number of 14 subjects is actually 28 entities because each subject tested both legs. Population off young, healthy, physically active women is large population. For a large population, and for a significance tests of a sample r at $\alpha = 0,05$, the necessary sample size = 28. So, the 28 is the minimum number of entities for medium effects size at Power 0,80 (Cohen, 1992).

Results

The MLSI variables of the BSS (mean: 1,4 ± 0,49) was not significantly correlated to the WBLT (mean: 14,32 ± 3,4; r=0,11, R^2=0,01, p=0,71). There was no significant correlation between the WBLT and APSI variables (mean: 1.66 ± 0.56; r=0.28, R^2=0.08, p=0.33). Also there were no significant correlations between the WBLT and OSI variables (mean: 2.04 ± 0.60; r=0.38, R^2=0.14, p=0.18).

Discussion

The main findings of this investigation showed that greater DROM does not significantly influence balance measured on BSS in the population with no history of ankle injury in the last two years. The authors are not familiar with research on the relationship between ankle DROM and balance ability measured on BSS. There are few studies which investigated correlations between ankle DROM and dynamic balance measured with SEBT test (Gribble & Hertell, 2003., Hoch, et al., 2011), and their findings are similar with ours.

Both of these investigations made a normalizations excursion data to the leg length. In our study correlation between height and ankle DROM measured by WBLT was not significant (0,066), and therefore any kind of normalization was not applied.

Gribble and Hertell (2003) investigated correlation between DROM (measured by goniometer) and distance in SEBT test. There was no significant relation between the ankle DROM and excursion distance. In other words, there is no significant correlation between DROM and balance abilities. Our study showed the same.

Similar findings had a Hoch, et al. (2011). They investigated relationship between the DROM (measured by WBLT) and excursion distance. The result showed that WBLT explained a significant proportion of the variance only within the anterior reach distance. In posteromedial and posterolateral directions there were no significant correlations with the result in WBLT. Their findings are contradicted to the findings off Gribble and Hertell (2003) only in the part of anterior reach distance. Our study showed that DROM does not significantly influence balance performance on BSS in any direction. The reason for these contradictory results of correlation DROM and balance in anterior reach

distance may be in the facts that balance was measured in different ways. SEBT test uses a solid base (ground) and BSS use a circular platform that is free to move around the anterior-posterior and medial-lateral axes simultaneously.

Conclusion

The samples of entities in this study were healthy, physically active young women with no history of leg injuries in the last two years, so it is assumed that their DROM was not decreased. Based on these findings it could be concluded that better results of unilateral balance measured on Biodex Stability System, among young, healthy physically active women, does not depend on greater dorsiflexion range of motion. And opposite, greater DROM does not significantly influence balance in physically active young women.

The future investigations should examine the relationship between DROM and balance performance, especially in the part of anterior reach distance, among different population. This especially refers to the population with history of leg surgery or injuries. It is important to find out does decreased DROM influence balance performance and in witch directions.

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