CORRELATIONAL OF NAVICULAR DROP AND DYNAMIC BALANCE IN TAEKWONDO PRACTITIONERS

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ABSTRACT

Introduction: It is well established that people with excess navicular drop have poorer balance compared to regular foot people and that participating in Taekwondo positively affects a person's balance ability, but the association between excess navicular drop excursions on Taekwondo participants has not been studied.

Aim: To find the relationship between the amount of navicular drop and dynamic balance performance among Taekwondo practitioners.

Study design: Quantitative research with a correlational study design.

Methods: 30 participants were recruited based on judgmental sampling aged 18 to 25 years old after screening through the inclusion and exclusion criteria. Participants' navicular drop, lower limb length and Y balance reach distance were measured and the navicular drop value was compared with the composite score obtained from the Y balance test.

Results: Pearson's correlation results displayed a negative correlation between the navicular drop and dynamic balance where the right side has a higher negative linear relationship (Rt r =-.21 Vs Lt r =-.58) between the variables but the data analysis indicates both are not statistically significant (Rt p=.25, Lt p=.76).

Implications: The study shows that there is a negative correlation between the amount of navicular drop and that it may affect dynamic balance, but more factors should be explored further such as gluteus medius and intrinsic foot musculature strength and proprioception which all contribute to dynamic balance performance in Taekwondo practitioners.

Keywords: *Dynamic balance; Navicular drop; Taekwondo; Y-balance reach test*

INTRODUCTION

Dynamic balance ability relies on the body's ability to react to impulses from the senses of the somatosensory, vestibular, and visual systems (Nasher, 1997). As the contact point between the body's kinetic chain and the surface, the foot is important to support where static and dynamic balance is maintained, especially in a unilateral stance (Dabholkar, 2012). The possibility of foot abnormalities resulting in malalignment issues that will affect the more proximal joints becomes more apparent along with altered static and dynamic balance strategies.

Sports training such as martial arts involved quick and immensely coordinated movements that were found to boost a person's balancing ability. Studies made on gymnasts (Bressel, 2007) as well as Judokas indicate that they have better sensorimotor adaptabilities compared to dancers (Perrin, et al, 2002). Static balance or stableness refers to the body's ability to stay as static as it can in a particular position and situation (Goldie, 1989). In particular, the ability of a person to stabilize or balance the center of gravity within the support base when the balance status is achieved in a given weight-bearing position (Winter, 1998).

The right postural alignment depends on variables such as the right placement of the ankle-foot and the height of the foot arches. Differences in the foot type affect gait patterns and dynamic balance (Twomey et al, 2010). The foot arch may lower as a person ages as it is part of the aging process (Menz, 2015). This increases the risk of falling and is detrimental to the quality of life (Whitney, 2003). Volpon J. B, (1994) discovered feet grew quickly up to three years of age and maintained a steady rate of growth; development of the plantar arch was noted between two and six years of age. In a study by Tsai et al. (2006), which compares different structural foot types on static balance control it was observed that participants with excessively flat or high arch foot types have lesser dynamic balance when compared to neutral foot type participants (Tsai, 2006). Cote (2005) researched the impacts of pronated and supposed foot postures on stabilization of static and dynamic equilibrium. He found that dynamic reaching differed among groups in some directions: pronated foot type was found to reach farther in the posterior and antero-medial directions while supinated feet fared better in the posterior and postero-lateral directions (Cote, et al, 2005). This would suggest that dynamic balance of foot type differs based on structural differences and not peripheral input.
Taekwondo (TKD) is a well-known Korean martial art focused primarily on kicking (Pieter and Heijmans 1997). A TKD practitioner must execute quick and coordinated kicks in free

sparring to strike and defense with hands also. Nien et al, (2007) discovered that a typical kick's time and peak speed ranged from .22 seconds to .31 seconds and 13.43 m / s to 16.48 m/s. It takes proper stance and footwork to perform these fast and strong kicks to maintain balance and prevent injury.

In TKD, martial art involves a high number of weight shifting and jumping which is similar to gymnastics and ballet. Therefore, TKD practitioners would also need to stimulate balancing senses which in turn enhances dynamic balance as reported for other sports. Some research has shown that TKD improves muscular strength and flexibility in the elderly (Brudnak et al. 2002). A study that compares adolescent TKD athletes reported with ankle instability on balance performance discovered that there is substantially more deviation of center of pressure in the ankle of unbalanced subjects compared to stable ankles (Yen and Fu, 2008). However, the correlation between navicular drop value and dynamic balance of TKD practitioners has not been studied. Due to the need for maintaining dynamic balance during kicks and punches in TKD and the consequence of losing points due to a fall in a sparring competition as well as the risks of sustaining injuries, it is vital to study the risks of excess navicular drop on the dynamic balance of practitioners of TKD so as to be able to prescribe a balanced training plan to improve their dynamic balance and for the prevention of injury.

METHODOLOGY

The research design that is used in this study is a quantitative type correlational study to explore the relationship between the amount of navicular drop value on the dynamic balance amongst Taekwondo practitioners. A correlation study design is used to determine if two variables or groups are correlated, meaning that a rise or reduction in one variable corresponds to a rise or reduction in the other (Szekely et al. 2007).

Sampling methods

A judgemental sampling was done where only Taekwondo practitioners were recruited from MAHSA University and practitioners that were able to travel to Mahsa University to take part in the study and who passed the inclusion criteria were chosen as the study involved a specific age group of 18-25 years (Tsai et al, 2005). According to Pingale (2017), the sample size was calculated using the incidence rate of 50% musculoskeletal injuries in Taekwondo athletes. This expected frequency was used to calculate the sample size of 32 using the Epi Info® Version 7.2.0.1.

In this study, 30 subjects were able to be recruited to take part in the research and were selected based on the inclusion and exclusion criteria. Inclusion criteria comprise (a) Ages between 18-25 years of age, (b) Taking part in Taekwondo for the past 1 year and practicing at least once per week (Tsai Y. J, et al. 2005). Exclusion criteria include; (a) any recent soft tissue injuries within six months present in the lower extremities such as ligament sprains or muscle strains, (b) consumption of any substance that may affect dynamic balance such as alcohol in the past 24 hours (Pons Van Dijk G, 2013). (c) participation in any other regular sports training besides Taekwondo (Machado S. M, et al, 2010), (d) presence of a rigid arch where there is a lack of medial longitudinal arch height change regardless in weight-bearing or non-weight-bearing position (Harris E. J, et al, 2004).

Ethical considerations

Information pertaining to the benefits of the study was explained in a language the subjects understood as sufficient information on the study is needed according to Oman (2003), in order for patients to make a decision on participating in the research. A consent form is needed to be read and signed by the participants as an agreement to take part in the study as subjects understand the reasoning behind the research (Burns and Grove, 2009). The study was conducted after the ethical review was cleared by the Faculty of Health and Sports Sciences Research Review committee. Confidentiality of information obtained will be protected by providing the participants with numbers so as to remain anonymous. The confidentiality of the subjects would not violate the Data Protection act 1998, which are rules regarding the use of personal information relating to people (Hickson, 2008).

Measurement tools - Primary Research Instruments

The main research instrument would be the Y-balance test (YBT). During the test, the subjects were required to be in a unilateral stance and is asked to reach out in three different directions with the opposite lower limb which are the anterior, posterolateral and posteromedial. Another primary research instrument would be the navicular drop test which was first introduced by Brody (1982) as a way to quantify the amount of foot pronation excursion in runners. The purpose of the navicular drop test is to represent the sagittal plane malalignment of the navicular bone from a neutral position to a weight-bearing position in standing (Vinicombe et al, 2001). The test is performed by first marking the location of the navicular tuberosity and measured with a graduated index card to measure the distance from the supporting surface to the navicular tuberosity in this relaxed position. Next, the participant is then asked to weight bear fully to subtalar joint neutral position along with the amount of sagittal plane excursion of the navicular tuberosity marked on the index card, and the change is measured with a ruler.

Procedure

The study was conducted in MAHSA University's practical classroom spaces and participants were recruited from around Mahsa University as well. The 30 participants who volunteered for the study were first screened by a questionnaire and by meeting all criteria for inclusion and exclusions. All subjects were given information regarding the study and a consent form to be signed before the testing procedure starts. This study only has a single group to study the correlation between the navicular drop value and the dynamic balance ability measured with the Y-Balance instrument which gives a composite score as a measurement of dynamic balance.

Firstly, the navicular drop was measured where the navicular tuberosity was identified and indicated with a marker pen and an index card was placed perpendicular to the navicular tuberosity. The first measurement would be taken whilst the subject is seated and marked on the index card, and the next measurement would be taken whilst the participant is standing. After taking the measurements, the difference between the two values was taken as the value of navicular drop for each individual foot's excursion is tabulated as described in a study done by Vinicombe, et al, (2001). Next, the lengths of the lower limbs of the participants were quantified with a tape measure and recorded to calculate the composite Y-balance test scores with the 3 reach distances as described by Neves et al, (2017). The participants were instructed on the procedure of the Y-balance test and were instructed to go barefoot and reach as far as they can in the order of right anterior, left anterior, right posteromedial, left posteromedial, right posterolateral, and left posterolateral directions. The participants were allowed 3 attempts with each direction and were required to reach as far as possible and return to the starting position with control, if not that attempt would be considered a fail.

DATA ANALYSIS AND RESULTS

In the present research, the main variables are distances such as the navicular drop measured in centimeters and the composite score of the reach distances both of which are of ratio level data with meaningful zero values as they both are a measure of distances (Allen, 2007). The navicular drop value is measured in millimeters (Picciano, 1993) and the composite score from the Y-balance test is in percentage after combining all 3 reach distances and dividing by the lower limb length which is multiplied by three (Plisky, 2009). Age, gender, dominant side, and duration trained were analyzed with descriptive statistics to get the mode and percentage while navicular drop and composite scores were analyzed to get the mean and standard deviation through descriptive statistics.

Both measurement tools will be analyzed with a parametric statistical test of correlation between the variables of the amount of navicular drop and dynamic balance measured with the Y-balance test have any correlation between them. Therefore the Pearson's correlation test was used to compare the two variables and produces a correlation coefficient which also measures the direction of the linear relationship between the two variables and gives a value of *r*. The Pearson's correlation is to measure the strength of the linear association between the 2 variables where the closer the *r* value is to +1 or -1 the stronger the positive or negative the correlation is (Sedgwick P, 2012). The statistical treatment of data used Statistical Package for Social Sciences (SPSS) Version 24. The confidence interval was set at 95 percent while *p*-value was set at less than .05.

Results

Table 3.1: Demographic data of participants

Number of participants (n)	30
Gender (Mode, percentage)	Male (18, 60%)
	Female (12, 40%)
Dominant side (Mode, percentage)	Right (30,100%)
	Left (0, 0%)

Table 3.2 : Descriptive analysis of variables

Variables	(n)	Mean, SD
Age (Mean, SD)	30	23.27 ± 2.08
Duration trained [months] (Mean, SD)	30	52.0 ± 42.75
Navicular drop [cm] (Mean, SD)	30	Right: 8.53 ± 2.95
	30	Left: 8.63 ± 3.86
Lower limb length [cm] (Mean, SD)	30	Right: 89.77 ± 5.44
	30	Left: 89.89 ± 5.81

Composite score [%] (Mean, SD)	30	Right: 97.43 ± 8.74
	30	Left: 99.12 ± 8.27

Table 3.3 Inferential statistics

Variables	n	*r*-Value	*p*-Value
Right NVD and right composite score	30	-.21486	.25
Left NVD and left composite score	30	-.05758	.76

DISCUSSION

The results from this study show a negative correlation between the amount of the navicular drop and composite scores where the right side has a greater negative correlation at $r = -.21486$ compared to the left at $r = -.05758$ but to be considered a small correlation the value would have to be within $.1 < | r | < .3$ and the right side is within these values whereas the left is not, therefore the right side has a better negative correlation although small when compared to the left side. The data obtained is not significant enough to be considered relevant as the *p*-values obtained is too large to be considered statistically significant ($p = .25$ and $p = .76$). Therefore, the alternate hypothesis is rejected, and the null hypothesis is accepted.

A reason for a more negative correlation between the amount of navicular drop and composite score on the right side is that for the participants that took part in the study, all were dominant on the right foot meaning they kick with their right leg but the balancing foot would be the left foot which implies that the participants would spend more time balancing off the left foot leading to improved balance on the left. Therefore the higher negative correlation of the right may be due to a lack of training leading to a higher correlation as explored in a study by Dabholkar (2012) found that the higher the navicular drop and calcaneum angle as a measure of degrees of pronation of foot does affect dynamic balance significantly compared to normal feet and the study found that perturbations in the lateral directions are most affected as an excessive medial collapse of the ankle reduces the ability of the foot to maintain stable support during weight-bearing in static and especially during dynamic balancing. The altered foot posture characterized by increased navicular drop value is further supported in a study by Cote (2005) suggested that dynamic balance is affected by the foot and structural stability is one of the causes of reduced dynamic balance.

CONCLUSION

Dynamic balance is important for Taekwondo practitioners and although the results displayed a weak correlation the negative linear relationship between navicular drop with regards to dynamic balance performance gives insight that there may be a possible relationship between these variables. Through the research explored above, there is reason to believe that the deformity present in people with excess navicular drop is a valid point that should be looked at when looking at balance performance as it is crucial that the martial artist is able to perform kicks on both sides instead of only the dominant side to be a more well-rounded practitioner through suggestions on short foot exercise, proprioceptive balance training and hip strength training to be done on the dominant leg as well to not limit themselves with only one leg for kicking. This gives an insight for physiotherapists to investigate the balance performance of such martial artists and their ability to balance on their dominant side should be looked into should they have difficulty in executing kicks efficiently on their non-dominant side which requires balancing on their non-dominant leg.

REFERENCES

Bressel E, Yonker J. C, Kras J and Heath E. M. (2007). *Comparison of static and dynamic balance in female collegiate soccer, basketball, and gymnastics athletes.*

Brudnak M. A, Dundero D, and Van Hecke F. M. (2002). *Are the 'hard' martial arts, such as the Korean martial art, Taekwon-Do, of benefit to senior citizens?*

Butler R. J. et al. (2013). *Dynamic balance performance and noncontact lower extremity injury in college Football players.*

Cote K. P, et al. (2005). *Effects of pronated and supinated foot postures on static and dynamic postural stability.*

Pingale N and Ghagare J. (2017). *Prevalence of musculoskeletal injuries in young Taekwondo athletes.* [

Goldie P. A, Bach T. M, and Evans O. M. (1989). *Force platform measures for evaluating postural control: reliability and validity.*

Menz H. B. (2015). *Biomechanics of the ageing foot and ankle: A mini-review.*

Nasher L. M. (1997). *Practical biomechanics and physiology of balance from The Handbook of Balance Function Testing, Lewis M. Nasher. Mosby-Year Book, Inc, GP Jacobson, CW Newman, JM Kartush.*

Nien Y. H, Chang J. C, and Tang W. T. (2007). *The comparison of kinematics characteristics of two roundhouse kicking techniques in elite Taekwondo athletes.*

Perrin P, Deviterne D, Hugel F, and Perrot C. (2002). *Judo, better than dance, develops sensorimotor adaptabilities involved in balance control.*

Plisky P. J, et al. (2006). *Star Excursion balance test as a predictor of lower extremity injury in High School Basketball players.*

Shaffer S. W, et al. (2013). *Y-Balance Test: A reliability study involving multiple Raters.*

Pons Van Dijk G, Lenssen A. F, Leffers P, Kingma H, and Lodder J. (2013). *Taekwondo training improves balance in volunteers over 40.*

Szekely G. J, Rizzo M. L and Bakirov N. K. (2007). *Measuring and Testing Dependence by Correlation of Distances .*

Tsai L. C, et al. (2006). *Comparison of different structural foot types for measures of standing postural control.*

Tsai Y. J, et al. (2005). *The Biomechanical analysis of the Taekwondo front-leg axe kick.*

Twomey D, Mcintosh A. S, Simon J, Lowe K, and Wolf S. I. (2010). *Kinematic differences between normal and low arched feet in children using the Heidelberg foot measurement method.*

Whitney K. A. (2003). *Foot deformities, biomechanical and pathomechanical changes associated with aging including orthotic considerations, part 2.*

Winter D. A, et al. (1998). *Stiffness control of balance in quiet standing.*

Yen S. R, Fu L. L. (2008). *Dynamic balance assessed by force plate and star excursion balance test in Taekwondo athletes with ankle instability.*