Comparison of Dynamic Balance between East Java Puslatda Athletes with Plantar Fasciitis and without Plantar Fasciitis

Wicaksono Alim Budihartanto[1], Hening Laswati Putra[2], Indrayuni Lukitra Wardhani[2], Yudith Dian Prawitri[2], Rosy Setiawati[3]

[1]Resident, [2]Staff, Physical Medicine and Rehabilitation Department, Faculty of Medicine, Universitas Airlangga - Dr. Soetomo General Academic Hospital, Surabaya, Indonesia, [3]Staff, Radiology Department, Faculty of Medicine, Universitas Airlangga - Dr. Soetomo General Academic Hospital, Surabaya, Indonesia

Abstract

Lower extremity injuries are the most common cases of athlete's injury. Sports athletes often experience perturbations that disturb their balance. Poor balance is associated with an increased risk of injury in athletes. Plantar fasciitis affects the biomechanics of the foot and impairs pressure distribution and balance during walking and running. To compare the dynamic balance between athletes with plantar fasciitis and without plantar fasciitis. This analytic observational with a cross sectional retrospective study design was performed on 101 athletes, aged 16-32 years. There were 49 male athletes and 52 female athletes have undergone dynamic balance checked with the star excursion balance test (SEBT) and plantar fasciitis examinations based on ultrasonography (USG) examination. There was no difference in the normalized SEBT value between the athlete's group with plantar fasciitis and the athletes without plantar fasciitis, with p value for the anterior direction = 0.317, anterolateral = 0.215, lateral = 0.062, posterolateral = 0.180, posterior = 0.246, posteromedial = 0.354, medial = 0.409, and anteromedial = 0.245. In summary, there is no difference in the dynamic balance between athletes with plantar fasciitis and without plantar fasciitis. Further research is needed to determine the compensation mechanism in athletes with plantar fasciitis and specific exercises for different sport.

Keywords: *athletes, dynamic balance, plantar fasciitis.*

Introduction

Ankle injuries are common in sports, 40% of sports injuries involve the ankle. These injuries can occur in basketball, volleyball, soccer, modern dance, and ballet. As many as 30,000 cases of ankle injuries in America are reported every day[1,2]. Poor balance can make a person prone to falls and injury. Decreased balance function will result in malalignment of the body and decreased postural control. The athletes are subject to considerable perturbation and require strong stability. Athletes with a good balance have a superior performance than ordinary people. Poor balance is associated with an increased risk of injury in athletes. Standardized assessment to measure and evaluate balance is needed to determine the readiness of an athlete to return to playing on the field[3,4].

In a prospective cohort study conducted by Butler and colleagues, it was concluded that dynamic balance disorders as tested by the star excursion balance test (SEBT) were associated with lower limb injury risk. The lower the dynamic balance performance, the higher the risk of lower extremity injury[4].

Pain can affect dynamic balance control during weight bearing activities and is a significant predictor of performance in any test of balance and functional ability. Chronic musculoskeletal pain in the lower body decreases equilibrium in healthy adults[5]. Alrashidi and colleagues reported that one-tenth of humans have experienced plantar fasciitis at least once in their lives[6].

Corresponding author:
Wicaksono Alim Budihartanto
Email: sonny.ikfr@gmail.com

In subjects with plantar fasciitis, faulty adaptation in the long term, will lead to abnormal muscle activation, impaired normal proprioceptive sensation and ultimately can lead to dynamic balance disorders[7]. Comparison of dynamic balance in plantar fasciitis and without plantar fasciitis, especially in athletes has not been widely studied.

Methods

This research is an analytic observational study with a cross-sectional retrospective study design that was taken from the screening test data for Puslatda athletes in East Java at Dr. Soetomo General Hospital, Surabaya, Indonesia who in accordance with the inclusion and exclusion criteria. The inclusion criteria were data on male and female athletes who underwent a screening test for Puslatda East Java athletes who were willing to take part in the examination and agreed that the results of the examination data were used as research samples as evidenced by signing an informed consent. The exclusion criteria included athletes who had vestibular or visual disturbances that could interfere the examination process, and or had a history of musculoskeletal injuries or surgery in the last 3 months during the athlete's screening test, that could harm or hinder the athlete during the test physical performance.

In this study, 101 athlete's data were obtained. Based on ultrasound results, 57 athletes had plantar fasciitis and 44 athletes did not have plantar fasciitis. All athletes underwent physical examinations such as height, weight, and dynamic balance tests using the star excursion balance test (SEBT). Plantar fasciitis examinations based on ultrasonography (USG) examination. The thickness of plantar fascia more than 4 mm is concluded as plantar fasciitis.

Statistical analysis was performed using SPSS version 23.0. Test for normality using the Shapiro-Wilk test. If data are normally distributed, a parametric test will be carried out using the independent T test. If data were not normally distributed, a non-parametric test would be performed using the Mann Whitney test. The difference was considered statistically significant at $p < 0.05$.

Results and Discussion

The characteristics of the research subjects are shown in Table 1. The mean age of the research subjects was 22.16±3.87 years, the youngest was 16 years and the oldest was 32 years. The mean body mass index of the subjects of this study was 23.25 ± 3.75, the lowest was 16.97 and the highest was 41.11. The homogeneity test of the characteristics of the subjects, including age, body mass index, and sex, did not find any significant differences (Table 1).

Table 1. Characteristics of Research Subjects.

Characteristics	Plantar Fasciitis	Without Plantar Fasciitis	Total	p value
Age (years old)	22.54±4.18	21.66±3.40	22.16±3.87	0.432
BMI	22.85±2.55	23.77±4.88	23.25±3.75	0.577
Sex:				
Male	27	22	49	0.793
Female	30	22	52	

The research subjects came from various sports. The number of athletes with plantar fasciitis was 57 people, and athletes without plantar fasciitis were 44 people. In wrestling there were 17 people (16.8%), in gymnastics there were 3 people (3%), in athletics there were 30 people (29.7%), in wushu there were 8 people (7.9%), in fencing there were 14 people (13.9%), in hockey there were 10 people (9.9%), in handball there were 11 people (10.9%), and in sports basketball amounted to 8 people (7.9%) (Table 2).

Table 2. Types of Sports.

Types of Sports	Plantar Fasciitis	Without Plantar Fasciitis	Total (%)
Wresling	5	12	17 (16.8)
Gymnastics	1	2	3 (3)
Athletics	24	6	30 (29.7)
Wushu	4	4	8 (7.9)
Fencing	5	9	14 (13.9)
Hockey	6	4	10 (9.9)
Handball	8	3	11 (10.9)
Basketball	4	4	8 (7.9)
Total (athletes)	57	44	101 (100)

In the measurement results of the Star Excursion Balance Test, the variables to assess the dynamic balance on the side of the foot with plantar fasciitis and non-plantar fasciitis are the Normalized Reach Distance value in the anterior direction, anterolateral direction, lateral direction, posterolateral direction, posterior direction, posteriomedial direction, medial direction, and anteromedial direction. For each of the dynamic balance check variables, there was no significant difference, with $p > 0.05$ (Table 3).

Table 3. Results of SEBT Normalized Reach Distance in All Type of Sports.

SEBT Directions	Plantar Fasciitis	Without Plantar Fasciitis	p Value
Anterior	87.02±13.71	84.44±11.38	0.317
Anterolateral	90.25±16.39	85.26±12.23	0.215
Lateral	95.57±18.29	89.09±15.39	0.062
Posterolateral	96.63±19.33	91.85 ±15.03	0.180
Posterior	98.03±21.43	93.46±16.59	0.246
Posteromedial	94.68±20.08	91.41±15.31	0.354
Medial	91.14±17.99	88.36±14.85	0.409
Anteromedial	87.75±13.83	84.57±13.19	0.245

SEBT is a test to measure dynamic balance. In this study, there was no significant difference in dynamic balance between the two groups, the athletes with plantar fasciitis group and the athletes without plantar fasciitis group.

Balance is a complex phenomenon that involves many factors including lower extremity muscle strength, peripheral sensation, visual activity, and reaction time. The strength of the ankle dorsiflexor and plantar flexor muscles has been shown to be related to ankle stability. The strength and range of motion of the inversion-eversion ankle also contribute to balance performance[8]. Regular training performed by athletes makes muscle strength superior to that of untrained people.

Voluntary movement in humans, including athletes, will increase with training. The volunteer movement also responds to the feedback mechanism for correction of internal and external changes. This mechanism consists of feedforward and feedback mechanisms. Feedback control is influenced by current conditions and sensory signals that detect changes in perturbation, while feedforward control is an anticipatory mechanism. This anticipatory mechanism relies on experience or training which is essential to the fast action of a perturbation and this anticipatory mechanism can also modify the feedback mechanism[9].

Movement of the extremities initiated by motor commands originating from the central nervous system. Movement of the extremities will undergo postural regulation with a feedback mechanism if there is postural instability. Motor control in the central nervous system consists of motor planning, internal models, state estimation, motor learning, and multiple internal models. Motor planning is a computational process to reduce steps or processes from neural commands to muscle activation. This mechanism selects one of the many consistent patterns for the motor activity. When doing motor activities, the subject adapts to the inverse model which is continuously updated based on input feedback called the motor learning[10].

In this study, the process of daily training for athletes can improve balance with a motor learning mechanism. The adaptations made by the motor system in athletes can change the internal model to match the activity or perturbation received by an athlete. With repetitive training and motor learning, athletes can perform posture stabilization by minimizing the required muscle activity compared to minimizing body sway. This is also influenced by the internal adaptation of the model to the environment and other variables that can affect it[11].

One of the factors that can affect the balance in plantar fasciitis is pain in the soles of the feet, especially if the pain is severe. When performing a closed kinematic chain with ankle dorsiflexion and the soles of the feet in contact with the ground, there will be an anterior movement of the tibia. This causes stretching of the plantar fascia and, consequently, increasing tension and pain. To protect the musculoskeletal system and prevent further discomfort, individuals use compensatory strategies in the ankles and feet, which make it difficult to maintain posture[12].

There is no data on foot pain in this study, this is because the balance check was carried out when athletes take the screening test for the national competition which is suspected to affect the objectivity of the athletes in submitting their complaints. However, regular exercise has also been shown to reduce pain sensitivity, although the exact mechanism is still unknown. Several theories try to explain the effects of exercise-induced hypoalgesia. The mechanism most widely considered is that of activation of the endogenous opioid system during exercise to reduce pain perception. Exercise results in peripheral and central release of beta-endorphins that have been associated with changes in pain sensitivity.

This study is not in line with a study conducted by Agirman (2018) which assessed that there are differences in dynamic balance in 50 patients with plantar fasciitis compared to 19 controls[13]. The research by Agirman was different in the types of research subjects, namely the subjects who were not athletes. The difference in research subjects in this study is an important thing to note. Pozzi *et al*. (2015) research on dynamic balance in subjects with chronic ankle injury shows that there are changes in conditions in physically trained individuals, such as increased muscle strength and neuromuscular adaptation as a compensation strategy to improve joint dynamic stability[14].

There are several limitations in this study, the specific exercise of each sport was not differentiated and the muscle compensation mechanism was not measured which could be assessed by surface EMG examination. In this study also did not stated the complaints of leg pain. Examination of athletes is carried out during screening of PON preparation in athletes, so that biased information about the objectivity of pain can occur.

Conclusion

In summary, there is no difference in the dynamic balance between athletes with plantar fasciitis and without plantar fasciitis. Further research is needed to determine the compensation mechanism in athletes with plantar fasciitis and specific exercises for different types of sports.

Conflict of Interest: The authors declare that they have no conflict of interest.

Source of Funding : None.

Acknowledgements: We thank Arif Nur Muhammad Ansori for editing the manuscript. We additionally to thank Budiono, MD, MSc, Department of Public Health and Preventive Medicine, Universitas Airlangga for statistical analysis.

Ethical Approval: This study had been approved by the Health Research Ethic Committee of Dr. Soetomo General Academic Hospital, Surabaya, Indonesia (0129/LOE/301.4.2/X/2020).

References

1. Brotzman SB, Wilk KE. Clinical orthopaedic rehabiltation. 2nd Edition. Philadelpia: Mosby. 371-392; 2003.
2. DiGiovanni CW, Brodsky A. Current concepts: Lateral ankle instability. Foot Ank Int. 2006; 27(10): 854-866.
3. Bhat R, Moiz JA. Comparison of dynamic balance in collegiate field hockey and football players using star excursion balance test. Asian J Sports Med. 2013; 4(3).
4. Butler RJ, Queen RM. Comparison of dynamic balance in adolescent male soccer players from Rwanda and the United States. Int J Sports Phys Ther. 2013; 8(6): 75.
5. Abd Allah D, Fadl S, Zaki L, *et al*. Assessment of dynamic postural control in plantar fasciitis. Biosci Res. 2018; 15(3): 2200-2206.
6. Alrashidi Y, Barg A, Kampmann M, *et al*. Plantar fasciitis in sport. Foot Ank Sports Ortho. 2016.
7. Kirthika V, Sudhakar S, Padmanabhan, *et al*. Effectiveness of kinesio taping on balance and functional performance in subjects with plantar fasciitis. Research J Pharm Tech. 2018; 11(10).
8. Spink MJ, Fotoohabadi MR, Wee E, *et al*. Foot and ankle strength, range of motion, posture, and deformity are associated with balance and functional ability in older adults. Arch Phys Med Rehabil. 2011; 92.
9. Myer GD, Ford KR, Palumbo JP, *et al*. Neuromuscular training improves performance and lower extremity biomechanics in female athletes. J Strength Cond Res. 2005; 19(1): 51-60.
10. Klous M, Miculic P, Latash ML. Two aspect of feedforward postural control: Anticipatory postural adjustments and anticipatory synergy adjustments. J Neurophysiol. 2011; 105: 2275-2288.
11. Chiba R, Takakusaki K, Ota J, *et al*. Human upright posture control models based on multisensory inputs in fast and slow dynamics. Neurosci Res. 2015.
12. Gonçalves GA, Kamonseki DH, Martinez BR, *et al*. Static, dynamic balance and functional performance in subjects with and without plantar fasciitis. Fisioter Mov. 2017; 30(1): 19-27.
13. Agirman M. Evaluation of balance and fall riskin patients with plantar fasciitis syndrome. Med Bul Sisli Etfal Hosp. 2018; 53(4): 426-429.
14. Pozzi F, Moffat M, Gutierrez G. Neuromuscular control during performance of a dynamic balance task in subjects with and without ankle instability. Int J Sports Phys Ther. 2015; 10(4): 520.