Evaluation of Foot Posture Index in Dominant and Non–Dominant Leg Among Sprinters

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Abstract

Background: Sprinting requires lower limb muscle strength along with ankle and subtalar joint range of motion. Dominancy can influence strength and flexibility differences in lower limb increasing risk of injury. The purpose of the research is to find Foot posture Index (FPI) differences in Dominant and Non - Dominant limb among runners.

Method: 50 shoed sprinters were evaluated for foot posture index using (FPI) scoring criteria. Also musculoskeletal pain in lower limb since last 3 months was reported along with recording ankle and subtalar joint range of motion. Analysis was done using Primer 6 software.

Results: Out of 50 shoed sprinters, 40 % have highly pronated feet in non dominant limb compared to 18% in dominant limb. Also pronated foot was more associated with knee and ankle pain. No differences were reported for ankle and subtalar joint passive range of motion in dominant versus non dominant limb.

Conclusion: Sprinters have reported pronated foot posture presence greater in non dominant limb.

Keywords: Running; pronated feet; Highly pronated feet; Musculoskeletal pain.

Introduction

Running as compared to walking requires more energy to cover same distance [1]. During sprinting greater foot loading occurs in 1st and 2nd metatarsals [2]. It involves use of lower limb muscles on feet. Use of certain muscles has depressing effect on medial longitudinal arch while some muscles usage supports its formation [3].

In male sprinters usage of foot inverters of dominant along with evertors of both limbs is required for 100 m sprint performance [4]. So depending on lower limb muscles in usage during running, sole of feet will show compensatory changes [5].

Foot along with its arches plays vital role in humans. It not only allows weight transmission but also helps with greater force absorption while walking or standing. During propulsion phase subtalar joint is required to generate torque [6]. So foot allows both stability along with adaptability to body weight and surface [7,8]. Any biomechanical alteration in this distal most segment will affect lower leg function, along with posture control strategies/ balance [9].

In 2014, a study has reported sprinters reporting more pronated foot as compared to non-sprinters using foot print index and navicular drop [5].

A study in 2000 has reported incidence of 27-70% overuse injuries among sprinters [10]. Also sprinters with flat foot has shown significant relationship with Achilles tendinitis and runners knee (iliotibial band syndrome) [11]. This shows that ankle and foot structures can have greater effect on upper part of lower limb [12]. Another study in 2005 (Butler) shows runners with low/high arches are prone to lower limb overuse injury [13].

Humans have tendency of lateral preference i.e preferring use of one limb over other during performance tasks. In foot, dominant leg leads and non dominant provides stability. With bilateral tasks, dominant leg becomes supporting leg in unipodal balance tasks [14]. At faster speed, such as sprint running, dominant limb helps with greater propulsion as reported by higher Electromyographic (EMG) activity [15,16]. Such interlimb differences are risk factors for increased injury [17].

Running like symmetric movement pattern sport even present with strength asymmetry between limbs [18]. It is important to quantify the same both during assessment and treatment of sport injuries.

Sprinting requires both lower limb muscle strength along with ankle and subtalar joint Range of motion [19, 20]. Dominancy results in differences between limb for strength and flexibility [21]. It even increases risk of injury [22]. This study is an effort to find difference in foot index between dominance and non-dominant limb. Also if such difference is having any effect on injury reported.

Material and Methods

After the institutional ethical committee approval, 50 shoed sprinters were included in observational study. All those who gave written informed consent and mean age 20.52 ±2.28 (18-25 years) with one year of minimum training experience were recruited. Mean Body mass index(BMI) calculated was 20.72± 1.99 for sprinters. Exclusion criteria followed was barefoot sprinters, any lower limb fracture or acute trauma to lower limb in last one month. After recording for demographic data, foot dominance was found using waterloo

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Table 1. Comparison of type of foot posture in Dominant and Non-Dominant foot among male sprinters.

Dominancy of lower limb	Type of foot			Total
	Highly pronated n(%)	Pronated n(%)	Normal n(%)	
Dominant leg(n=50)	9(18%)	24(48%)	17(34%)	50
Non dominant leg(n=50)	20(40%)	17(34%)	13(26%)	50
Total	29(58%)	37(74%)	30(60%)	100

Table 2. Comparison of Musculoskeletal (MSK) pain in Dominant and Non - Dominant foot between highly pronated, pronated and normal foot posture among n=50 sprinters.

MSK pain	Type of foot posture					
	Normal(n)		Pronated(n)		Highly pronated(n)	
	Dom	Non dom	Dom	Non dom	Dom	Non dom
Ankle pain	4	1	8	10	5	6
Knee + Ankle pain	0	1	5	0	2	6
Knee pain	0	0	2	0	0	2
Lower back pain	2	3	2	0	1	2
Thigh + Knee pain	0	0	1	0	1	2
Thigh pain	1	0	0	1	0	0
No pain	10	8	6	6	0	2

Note- Dom - Dominant limb, Non dom - Non dominant limb

Table 3. Comparison of passive Range of motion (ROM) in Dominant and Non - Dominant foot between highly pronated, pronated and normal foot posture among sprinters.

Passive ROM	Type of foot posture					
	Normal(Mean±SD)		Pronated(Mean±SD)		Highly pronated(Mean±SD)	
	Dom	Non dom	Dom	Non dom	Dom	Non dom
Dorsiflexion	18.11 ± 2.12	17.92 ± 2.13	17.04 ± 2.12	17.64 ± 2.13	16.77 ± 2.13	16.75 ± 2.13
Plantarflexion	54.4 ± 2.92	53.84 ± 2.91	53.79 ± 2.89	55 ± 2.89	52.66 ± 2.86	52.75 ± 2.90
Eversion	16.64 ± 5.16	16.3 ± 5.38	16.79 ± 5.03	17.17 ± 5.11	20 ± 5.31	18.1 ± 5.16
Inversion	36.23 ± 3.04	36 ± 3.13	34.79 ± 3.12	35.64 ± 5.01	33.66 ± 3.09	34 ± 3.18

Note- Dom - Dominant limb, Non dom. - Non dominant limb

footedness questionnaire-revised [23]. Then FPI and ankle along with subtalar joint range of motion (ROM) were recorded first for dominant and then for non-dominant limb using the Foot posture index scoring criteria and universal goniometer. Data was analysed using Primer 6 software.

Results

The results found that sprinters were having pronated foot posture more in their non dominant foot. We found that out of 50, 26% sprinters were having normal foot posture. 34% pronated foot posture and 40% sprinters were having highly pronated foot posture in their non-dominant foot. When results were compared with dominant foot, 34% sprinters were having normal foot posture, 48% sprinters were having pronated foot posture and 18% were having highly pronated foot posture in there dominant foot.

On comparison of FPI scores with musculoskeletal pain assessment among sprinters in last 3 months it was found that for dominant foot 20% sprinters with normal foot posture were having no pain, 16% sprinters with pronated foot complained of having ankle pain and 10% complained of having knee with ankle pain. Also 10% sprinters with highly pronated foot complained of having ankle pain. Similarly for non dominant foot 16% sprinters with normal foot posture were having no pain, 20% sprinters with pronated foot complained of having ankle pain and 12% sprinters with highly pronated foot complained of having ankle pain. In non dominant foot 12% even complained of having knee and ankle pain.

On comparison of dominant and non dominant foot for Passive ROM of ankle joint and subtalar joint no difference was reported.

Discussion

Running, a locomotor activity requires greater strength and balance than normal walking. Energy generated is even higher to support and raise head, arm, trunk during gait cycle. During running entire centre of gravity of body is over single foot in contact with the ground. This causes reduced base of support which is compensated as increased functional limb varus [24]. Same is responsible for foot pronation in running compared to walking.

Foot preference in humans is responsible for asymmetries noticed during running [18]. It presents as interlimb lower extremity differences for kinetics and kinematics [25]. Also in shoed runners compared to barefoot, small planter muscles atrophy occurs as they are immobilized. Lesser efficiency in these muscles consequently causes excessive pronation [4]. Strength training for both invertors and evertors results in better 100 meters sprint performance [4]. In our study maximum runners have pronated feet in dominant limb though highly pronated foot is reported maximum for non-dominant limb.

Pronated foot posture is associated with lower EMG amplitude of evertors. Activation of invertors specifically tibialis anterior and extensor halluces longus have depressing effect on medial longitudinal arch [3]. Another study in 2014 have found similar results of pronated foot posture among sprinters compared to non sprinters [5]. In contrast to our study, Serapetal have measured isokinetic strength among male sprinters. Strength asymmetries were found for right and left ankle with weaker inverters in non dominant and strong invertors along with evertors of dominant limb [4].

Type of foot posture is affected by the age and the presence of pathology, but not influenced by gender or BMI [26]. In present study mean BMI reported for sprinters falls in normal category only.

Causes of Injuries in runners reported are mostly due to overuse and trauma [27]. Also runners with higher or lower arches have more prevalence of injuries compared to neutral foot [28]. Foot remains contact point with the supporting surface all throughout running [6]. Foot arches as maintained by muscles and ligament acts as spring during running by elongating and recoiling action. Changes in the foot posture by alteration of foot arches can affect its function and make it more prone for injury. Foot malalignments also influence optimal function of lower leg during weight bearing stance [9]. Due to flat foot iliotibial band syndrome, Achilles tendinitis and knee injuries are seen among runners [10, 27]. Changes in quadriceps angle due to change in foot posture is responsible for anterior knee pain. Puckree et al study has shown runners with abnormal Q angle suffered knee injuries [29]. Cowen et al reported height of foot arch increases risk of knee overuse injury [28]. In our study those with pronated foot reported higher for musculoskeletal pain in ankle and knee both in dominant and non dominant limb. Lessor shock absorption with greater forces transmission could be causal factors. In runners with neutral foot, maximum have reported no pain in foot. Along with strength joint range of motion is essential in running to position foot in mid foot strike and toe off [20, 30]. Plantarflexion ranges positively affect sprinting activity [4]. In our study neutral and pronated foot posture has shown no significant effect on ankle ROM. A study in runners reported limited dorsiflexion with supinated foot posture only [4].

Strength- This study highlights role of limb asymmetry over athletes performance and directs the need to address strengthening of ankle and foot muscles.

Limitations- Small sample size and reporting of functional scales can be done in further study.

Conclusion

Evaluation of foot posture index among sprinters have reported pronated foot posture presence greater in non dominant limb.

Clinical Relevance

Limb asymmetries have to be considered important to improve overall performance of athletes. Also as lowering of arch has greater impact on foot loading, strengthening the affected muscles not only will prevent injuries rise but also modify plantar loading patterns.

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