

Does Peroneal tertius in absentia affect the range of motion of foot dorsiflexion and eversion? A kinesio-anatomical study.

Oladayo Sunday Oyedun*, Love Chioma Kanu , Olubunmi Ayobami Onatola and Phoebe Onyinye Zelibe

Department of Anatomy, Faculty of Basic Medical Sciences, University of Ibadan, Nigeria.

*E-mail of corresponding author: oyedundayo@yahoo.com

Abstract

Ankle dorsiflexion and eversion are key swing phase gait movements attributed to peroneus tertius (PT) muscle. PT muscle has been reported to be absent in the different populations. Whether absence of PT muscle leads to changes in Range of Motion (ROM) of ankle dorsiflexion and eversion or not is uncertain.

The study was conducted on 338 legs taking from 169 subjects with age ranging from 15 to 70 years. The presence of PT was determined using surface visualization of the tendon marking and the range of motion of ankle dorsiflexion and eversion was measured.

The peroneus tertius was absent in 39 (21 right and 18 left) out of 338 legs studied. There was no significant difference between the mean ROM of foot dorsiflexion and eversion in subjects without PT relative to subjects with PT. The ROM of foot eversion was significantly higher in females. The ROM of leg dorsiflexion showed a significant negative correlation with age.

In the absence of PT, there is recruitment of neighboring muscles (Extensor digitorun longus, Peroneus longus and brevis) which interact with biomechanical changes in the structures around the ankle joint to prevent functional compromise of ankle dorsiflexion and eversion.

Keywords: Peroneus tertius, range of motion, dorsiflexion, eversion, absentia.

Introduction

Ankle dorsiflexion and eversion are key movements essential for the swing phase of gait which adapt man to terrestrial bipedalism (Williams *et al.,* 2005). These movements are attributed to the peroneus tertius (PT) muscle, a small unipennate muscle situated in the anterior compartment of the leg (Williams *et al*.,2005). Many investigators have reported the absence of PT in the different populations (Sawant *et al.*, 2012; Das *et al*., 2009; Rourke *et al*., 2007). An absent PT may not be missed functionally due to the compensatory hypertrophy of the fourth tendon of extensor digitorum longus (Witvrouw *et al*., 2006).The normal range of motion of foot dorsiflexion and eversion in white populations are 0-20° and 0-25°respectively (Roaas and Andersson, 1982 ; Norkin and white,1988; Ahlberg *et al.,*1988). Factors such as the shape of articulating bone, tautness of the joint ligaments, tension and arrangement of muscles around the joint, apposition of neighboring soft tissue, age, and joint disuse have been shown to affect the Range of Motion (ROM) at the ankle joint. Whether the reduction in the total tension of the muscles around the ankle joint following the absence of PT, leads to changes in ROM or not is uncertain. This study therefore aimed at testing the hypothesis that states that there is an association between absent PT and ROM of ankle dorsiflexion and eversion. With the increasing practice of harvesting PT for muscle flap transposition and corrective ankle laxity surgery, there is a need to assess the effect of such practice on the ROM of ankle dorsiflexion and eversion.

Materials and Methods

1. Sample source: This descriptive anatomic study was conducted on 169 subjects (115 males, 54 females) taken from the three major tribes (Yoruba, Igbo & Hausa) in Nigeria. The subjects with age range (15 – 70 years, mean

36.5±14.7 years) were recruited from churches, market place, tribal community groups and schools between the September, 2013 and February, 2014. A total of 338 lower limbs were studied.

2. Data collection: The information regarding the tribe, age, sex, presence of PT, past history of ankle injury was documented for every subject examined.

3. PT evaluation technique: The presence of PT was determined using the surface visual localization of the tendon marking according to the technique described by Tixa (2006) and Kendal *et al* (2000). (Fig 1).

4. The Range of Motion measurement technique.

The ROM for ankle dorsiflexion and eversion was measured in a non weight bearing position following the technique described by Norkin and White (1988).

a. Dorsiflexion
Positioning: The subject was seated with the knee flexed at 30^0 and the foot positioned at 0^0eversion and inversion. The tibia and fibula was stabilized to prevent movement of the knee.
Measurement: With the goniometer fulcrum centered over the lateral aspect of lateral malleolus, the proximal arm was aligned parallel to long axis of fibular, pointing towards the fibula head. The distal goniometer arm was aligned parallel to the long axis of the 5^{th} metatarsal bone and the initial reading was taken. The subject was instructed to maximally dorsiflex the ankle and the final reading was taken.

b. Eversion.
Positioning: The subject was seated with the knee fixed at 90^0 and the lower leg positioned over the edge of a supporting surface. The hip was kept in 0^0 rotation, adduction and abduction. The tibia and fibula was stabilized to prevent lateral rotation and flexion of the knee. Medial rotation and adduction of the hip was also prevented.
Measurement: With the goniometer fulcrum over the anterior aspect of the ankle, midway between the malleolus, the proximal arm of the goniometer was aligned with anterior midline of the lower leg (using tibial tuberosity as reference point). The distal arm was aligned parallel to the anterior midline of 2^{nd} metatarsal and the initial reading was taken.
The subject was instructed to maximally evert the foot and the second reading was taken.

Figure 1: Showing tendons of PT and EDL muscles.

EDL – Extensor Digitorium Longus, PT – Peroneus Tertius

Results.

Out of the 338 legs evaluated, PT was absent in 21 right (6.21%) and 18 left (5.33%) legs. (Table1). PT was observed in 229 out of 338 legs and this translates to a prevalence of 67.75%. (Table1). PT in absentia occurred more frequently in males than in females in both legs (Fig 1and 2).

Peroneal tertius in absentia was unilateral in 19 subjects (11.24%) and bilateral in 10 subject (5.92%).

There was no significant difference between mean ROM of right foot eversion in legs without PT (10.33±5.51) and mean ROM in legs with PT (9.82±4.38) P = 0.26.(Table2).

The mean ROM of right foot dorsiflexion in the legs without PT (25.48±9.86) was not significantly higher than the mean ROM of right foot dorsiflexion in legs with PT (23.83±9.69) P = 0.80. (Table 2).Comparisons between the group of subjects with PT and the group without PT showed no significant difference in the ROM of left ankle eversion and dorsiflexion. (Table 2).

The mean ROM of foot eversion in both legs was significantly higher in females(Table3). There was no significant difference in mean ROM of foot dorsiflexion in both sexes.

There was a significant negative correlation between age and ROM of dorsiflexion in the right and left legs (r= -0.29, p <0.05; r = -0.27, p <0.05 respectively). There was no significant correlation between age and eversion. (Table 4).

Table 1: Occurrence of PT in the right and left legs

	Right	**Left**	**Total**
Present	148	151	229
Absent	21	18	39
Total	169	169	338

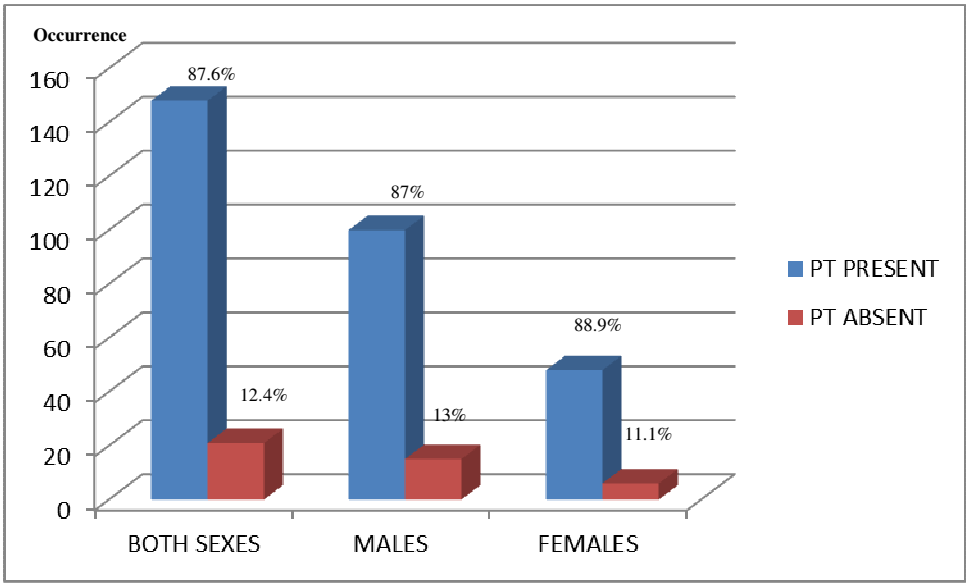

Fig 1: Sex distribution of the PT in the right legs.

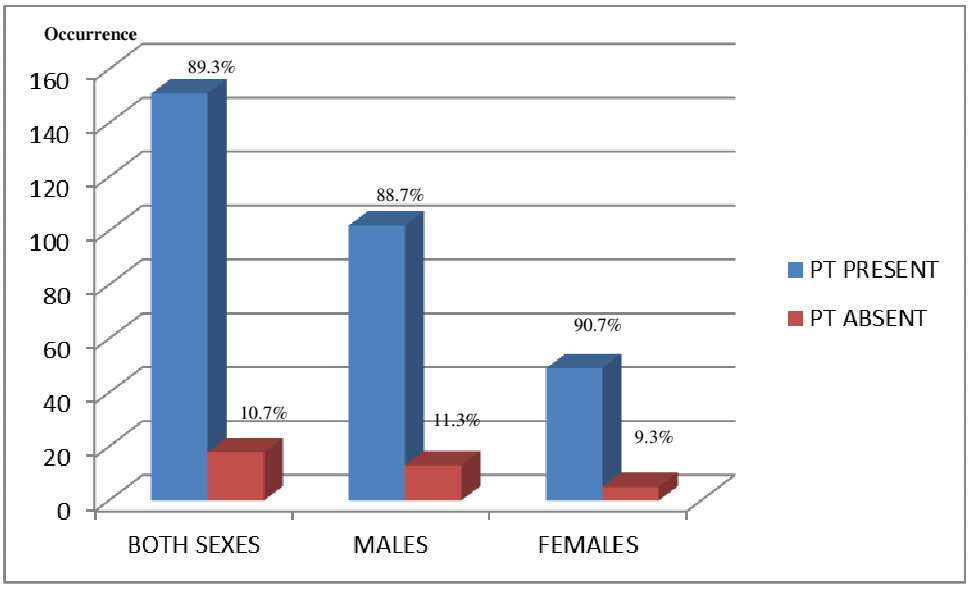

Fig 2: Sex distribution of PT in the left legs.

Table 2: Comparison of mean of ROM of ankle dorsiflexion and eversion in subjects with and without PT.

	PT Absent	PT present	P –value
Mean ROM of Rt Leg eversion	10.33±5.51	9.82±4.38	0.26
Mean ROM of Rt leg dorsiflexion	25.48±9.86	23.83±9.69	0.80
Mean ROM of Lt leg eversion	10.61±4.96	10.18±4.30	0.76
Mean ROM of Lt leg dorsiflexion	23.72±7.43	24.23±9.14	0.07

Table 3 : Comparison of mean ROM of ankle dorsiflexion and eversion in males and females.

	Males	Females	P-value
Mean ROM of Rt foot eversion	8.83±3.75	12.13±5.19	0.007
Mean ROM of Rt leg dorsiflexion	9.46±3.71	26.24±11.95	0.061
Mean ROM of Lt Leg eversion	23.00±8.29	26.24±11.95	0.06
Mean ROM of Lt leg dorsiflexion	23.45±8.52	26.39±9.54	0.510

Table 4. Correlation of ankle dorsiflexion and eversion with age.

Variables correlated	r	p- value
Age Vs Right leg eversion	-0.26	0.74
Age Vs Right leg Dorsiflexion	-0.29	0.00
Age Vs Left leg eversion	-0.04	0.63
Age Vs Left leg Dorsiflexion	-0.27	0.01

Discussion:

Contrary to the prediction on functional anatomy ground, our study showed no relation between absence of PT and changes in ROM of foot dorsiflexion and eversion.

Previous studies implicated PT in the swing phase of gait where it dorsiflexes or everts the foot (Jungers *et al.* 1993). In individuals without PT, the above roles are taken over by PL (Peroneus Longus) and PB (Peroneus Brevis) (Jungers *et al.* 1993). This compensation is less efficient as it produces plantar flexion instead of dorsiflexion at a stage in the gait cycle (Johnsohn *et al.*, 1992).

The range on motion at the ankle following PT contraction is influenced by many other factors. Age induced changes in joint ligament, capsule and surfaces rank as leading physiological causes. From our study, the range of motion of ankle dorsiflexion has been shown to decrease with advancing age. This is in agreement with the generally acclaimed fact that ROM reduces with age (Nigg *et al.*, 1992, Grimston *et al.*, 1993). Nigg *et al.*, (1992) in a study involving subjects with age range 20-80 years, demonstrated a reduction in ankle ROM with advancing age. The age related reduction in ROM is believed to be due to increase in joint stiffness that follows aging .Hayflicks, (1985) in his physiological theory of aging, proposes that there is age induced cross linking of collagen, which alters its mechanical and biochemical properties. This cross-linking results in joint stiffness and

reduced ROM of movement across joint. Contrary to expectation, our study failed to show a significant negative correlation between foot eversion and age. This may be due to the age distribution of our subjects in which only 8% were 60 years and above. Also the age- induced degenerative changes, which exhibit individual variability, seem to be mild in the selected elderly subjects.

The prevalence of PT from our study was 67%. This parallels 63% reported by Ashaola *et al*.,(2013) in a study involving 100 subjects from South western Nigeria. While this earlier study recruited mainly from a tribe in the country, ours has a wider recruitment from the 3 major tribes in the country. The observed prevalence of PT contrasts significantly with 100% reported in Bolivian population (Larico and Jordan, 2005) and 10% reported in the Jewish population (Tixa, 2006)**.**

Of the 169 individuals studied, PT was absent in 29 (17.2%). This concurs with 18.8% observed in Belgian population (withrouwl *et al.*,2006). The absence of PT is functionally protective in athlethes as it protects against Jone's fracture and talocrural joint injuries (Verullo, 2004).

Conclusion

In the absence of PT, there is recruitment of neighboring muscles (PL and PB) which interact with biomechanical changes in the structures around the ankle joint to prevent functional compromise of ROM of the ankle joint dorsiflexion and eversion. Against this background, the practice of harvesting PT for corrective ankle laxity surgery and muscle flap transposition may not necessarily lead to compromise of ROM of ankle dorsiflexion and eversion. Also changes in ROM of ankle dorsiflexion and eversion has little predictive value towards ascertaining the presence or absence of PT.

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