



The Function of Sole for Movement with Anterior Transverse Arch (ATA)

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Abbreviation

MLA: Medial Longitudinal Arch; LLA: Lateral Longitudinal Arch; ATA: Anterior Transverse Arch; DTML: Deep Transverse Metatarsal Ligaments

Currently, the important sports news in the world would be Tokyo Olympic and Paralympic Games in next year [1]. They include variety kinds of competitions, in which the athletics are one of the major competitions. The authors are continuing to teach several Japanese Paralympic athletes.

Originally the authors have been working on track and field sports for Masters' Athletics. In the light of sports medicine, we have given lectures of theory and practice in various situations. For example, we have continued how to run safer and faster in the case of Masters' Athletes from 30 to more than 80 years old, how to stretch neck, shoulder and joints with pole exercise, with seminars and workshops using multiple textbooks [2].

In our activities and guidance, there are several frequent problems. They include injuries, lumbago, hip, knee and ankle pains. Among them, one of the reasons would be a mismatch between the inconsistency of direction for foot and the knee, which can cause functional disorder and pain in the movement [3]. When a proper grounding method for this problem is given to an athlete, his pain in the joints would be alleviated and he can run well. Consequently, the axis directionality of the foot and knee would be one of the important problems.

For the speculation of these problems, there are three fundamental crucial aspects.

The first aspect is the three important points in the sole of the foot. We have to walk and run smoothly and keep balance. Therefore, three important points are known on the soles of the feet. This is derived from the concept from Japanese old martial arts

[4]. These three points are explained by simultaneous English + (Japanese) language [4,5].

- a) Medial (Uchi, U) and Middle point (Mannaka, MA) = UMA in Japanese. This is situated at the MAP of the first finger of the foot, which has been the point of thumbball (football, sole hallucal area).
- b) Lateral (Soto, SO) and Middle point (Mannaka, MA) = SOMA in Japanese. This is situated at the MAP of the fifth finger of the foot.
- c) Medial (Uchi, U) and Inside point (Naka, NA) = UNA in Japanese. This is situated the valuable point, where the center of the gravity of our body is just here, when we are standing with completely relaxed muscle tension.

The second aspect is the three important arches present in the sole. They include a) Anterior Transverse Arch (ATA), b) Medial Longitudinal Arch (MLA), c) Lateral Longitudinal Arch (LLA).

- a) ATA has five metatarsal heads, which is formed at the anterior portion of the sole and on the coronal plane in the forefoot [6]. The position of thumb in ATA is situated at UMA, and the position of 5th finger in ATA is situated at SOMA. Furthermore, there are Deep Transverse Metatarsal Ligaments (DTML) in the deeper layer of ATA. By combination of the function of ATA and DTML, the reflection power from the earth can be amplified. The significant function for ATA has been gradually investigated and reported [7]. In the medical practice, there are lots of cases complaining of pain in the forefoot. Some cases may be involved in the impaired function of ATA [8]. Consequently, forefoot problems about ATA and DTML would be studied in detail from now.
- b) MLA is situated in the medial side at the sagittal plane from forefoot to the rear foot. MLA has the function of reduce the impact from the earth.
- c) LLA is situated in the lateral side at the sagittal plane, and it is similar to the function of MLA. From men-

tioned above, these three arches, ATA, MLA and LLA has triangle formation. Consequently, these arch triangle would be studied for further research concerning the sole problem.

The third aspect is two axis of foot (biaxial feet). When a person walks or runs, there are two methods of placing feet on the ground roughly. One is uniaxial way with rotating the pelvis, where both feet are placed on a straight line. This walking way is observed in the cases of female professional model. The other is biaxial [9]. This phenomenon is observed when a person is walking with the pelvis stable. From anatomical point of view, the femoral neck (Collum femoris) extends outward from the femoral head (Caput femoris) and the skeleton of the bone extends downward. Therefore, the distance between the both feet are wider than that between the bilateral femoral heads. When a person is standing in relaxed posture, the position where both feet are placed is moderately apart. There is usually a fist-size space between both feet.

Combined these three aspects mentioned above, one of the recommended concepts about the function of the sole would be shown in Figure 1. There are several characteristics. Firstly, the direction of the bilateral ATAs are perpendicular against the front and rear axis. Because the DTML in the deep layer was also perpendicular, the force is transmitted effectively to the front direction, and the body can be smoothly moved forward and straight. Next, there is a space between the bilateral feet. Although it differs depending on the person, it is roughly about fist - size. This space is made where the lower limbs are relaxed and straight downward. Furthermore, the outer lines of both feet are generally oriented forward and the line passing through the second finger and the heel is directed slightly inward [10]. Conventionally, the center line passing through the tip of the second finger and the heel is known. This direction means the centerline for the weight balance at the sole in the previous several reports [11].

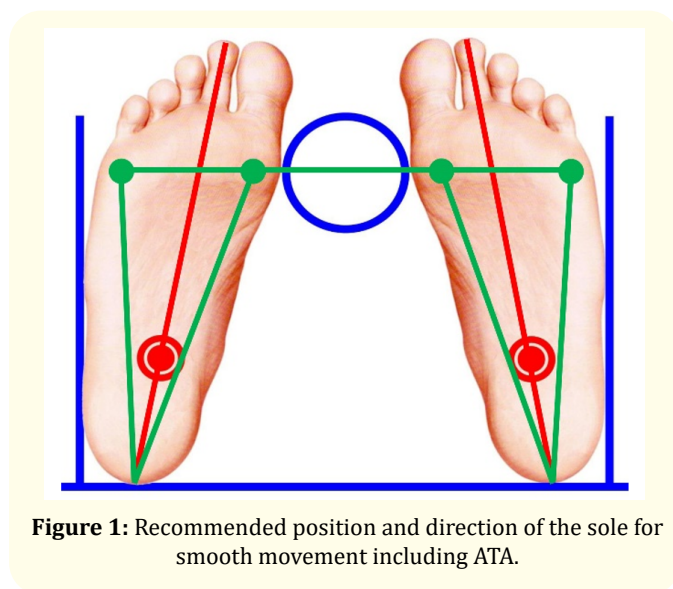


Figure 1: Recommended position and direction of the sole for smooth movement including ATA.

To summarize the above, the function of the sole is important in sports [12]. When the position and directionality of the bilateral feet are optimized, ATA works effectively in cooperation with DTML, MLA and LLA [13]. Further research development on these arches would be expected in the future.

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