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SOME FOOT MUSCLES PREVENTING INVERSION TRAUMATISMS

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Abstract

Tennis players often perform landings on one foot in inverted position. In Sports Medicine therefore, ankle sprains after inversion traumatisms of the foot are the most common tennis injuries.

In this theoretical study, the role of some foot muscles in preventing inversion traumatisms was examined. During the swing phase of normal gait, some intrinsic foot muscles may be active in everting the foot prior to landing. Our kinematical approach consists of assessment of metric parameters measured in radiographs of lower legs and feet of anatomical specimens. The study confirms that *m. peroneus longus* is a strong evertor. The transverse head of *m. adductor hallucis* may evert the foot as well and prevent inversion traumatisms. Remarkably, this *caput transversum* of *m. adductor hallucis* was absent in 3 out of 10 anatomical specimens.

Introduction

The normal human stepcycle of each leg consists of a stance phase and a swing phase. The end of each stance phase is preceded by take-off of the heel, after which the medial side of the foot looses contact with the substratum. Initially, the lateral side of the foot stays in contact with the ground. Hereby the sole of the foot increasingly faces medially, which movement is called inversion of the foot. This becomes obvious from changes in foot pressure distribution[1] as well as from plantar views after heel-off [2]. Following toe-off, the swing phase is initially characterized by a somewhat inverted position of the foot. During the swing phase the foot is actively repositioned into eversion. Meanwhile the medial side of the foot is progressively lowered; this process continues until mid-stance.

Inversion traumatisms

Although recently the reflex activities of lower leg muscles with regard to inversion and eversion have been studied [3], it is not quite clear currently, which intrinsic foot muscles in particular may contribute to the repositioning from inversion into eversion, during the swing phase of gait. Absence of such muscle activity will certainly contribute to the incidence of the

so-called inversion traumatisms. These frequent injuries in otherwise healthy subjects, during normal walking and various kinds of sports e.g. tennis [4], can occur when a person lands on his foot while it is still in inversion. Therefore a morphological pilot study was performed, to theoretically analyse how intrinsic foot muscles can contribute to eversion of the foot, so as to prevent inversion traumatisms.

Background

Lowering the medial side of the right foot during sway consists of an anticlockwise rotation of this foot, as seen from the rear [2], around the longitudinal axis of the transverse tarsal joint (*Chopart's* joint). This axis of inversion and eversion was recently defined as an oblique line passing through the lateral tubercle of the *tuber calcanei* of the heel bone and the calcaneal process of the cuboid, up to the first interdigital space of the foot [2, 5, 6].

Schematically, the action of a given foot muscle may be represented by a force vector, which can be resolved into a translational component and a rotational component with respect to this longitudinal axis of inversion and eversion. The angle between this force vector and the axis is proportional to the rotational effect with respect to foot eversion. The distance between the line representing the vector, and the axis of inversion, measured between the points of crossing of these two elements, may be interpreted as the moment arm length of its rotational component. The length of the moment arm thus adds to the rotatory effect of the muscle force. Examples of intrinsic foot muscles are *m. extensor hallucis brevis* and *m. adductor hallucis*, the latter being composed of a *caput obliquum* and a *caput transversum*. Given the fact that these two muscles originate from the foot's lateral side, running inferior to the oblique longitudinal axis of inversion and eversion, to eventually insert on the medial side of the foot, they can lower the medial side of the foot. In this concept it is explicitly presumed, however, that the foot's medial side is more mobile than its lateral side. They then turn e.g. the right foot, as seen from the rear, in an anticlockwise direction, thus contributing to eversion of the foot, helping to prevent inversion traumatisms.

Material and methods

In a small number (10) of anatomical specimens of the lower leg and foot, of otherwise normal subjects, as currently used during the practical courses of gross anatomy organized by our department, the above-mentioned intrinsic foot muscles *m. extensor hallucis brevis* and *m. adductor hallucis* were selected for theoretical analyses of their functions. For each muscle, the angle between the muscle and the axis of inversion was determined. Measurements were

performed using a goniometer, on tracings of dorsoplantar radiographs, taken from these foot specimens. In the radiographs the bony structures mentioned above, served as landmarks. The axes of inversion and eversion were introduced to the tracings. The direction of each muscle was identified in the radiographs by means of metal wires, wound around the muscle at origin and insertion prior to examination. Each muscle was thus represented by a straight line between its markers, indicated on these tracings. The same procedure was applied to the tendons of two extrinsic foot muscles inserting on the foot, *m. tibialis anterior* and *m. peroneus longus.*

The angle between vector and axis is correlated with the efficiency of the muscle with respect to foot eversion. The distance between each muscle's straight line representing its course, and the axis of inversion at their crossing is related to length of the moment arm of the muscle with respect to eversion.

Results

The measured parameters confirm that *m. tibialis anterior* is a strong invertor and that *m. peroneus longus* is a strong evertor. Also *caput transversum* of the intrinsic foot muscle *m. adductor hallucis* may be involved in performing eversion, especially during sway. Although this small transverse head contributes for only 2 % to the total mass of the intrinsic foot muscles [7], the angle between its force line and the axis of inversion and eversion is more than twice that of *m. peroneus longus.* Also the moment arm is indicative. The length of the moment arm of *caput transversum* of *m. adductor hallucis* is almost twice that of *m. peroneus longus*, which is a strong evertor.

Remarkably in this study, this caput transversum was absent in three out of ten specimens, which is a much higher percentage than indicated in literature [8].

Conclusions

We can conclude that, in particular, *caput transversum* of *m. adductor hallucis* may play a preparatory role during the swing phase of normal gait, in preventing inversion traumatisms after landing of the foot. Persons with *m. adductor hallucis* consisting of *caput obliquum* only, would theoretically be more sensitive for inversion traumatisms. Further research is necessary to support this hypothesis.

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