COMPARISON OF FOOT-ANKLE MECHANICS AND MUSCULAR ACTIVATION BETWEEN RUNNING DRILLS AND RUNNING ACROSS DIFFERENT SPEEDS.

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Introduction

Running drills are frequently used on the field by athletic coaches to improve technique and strengthen the foot-ankle complex [1]. A previous study has shown that the form of the running drills can influence the plantarflexor musculotendon unit output [2]. However, this study has used a simplified rigid foot-model widely overestimating the ankle kinematics and energetics [3]. The aim of this study is to compare the foot-ankle joint mechanics in using a multi-segment foot model during running drills and running across different speeds. We hypothesise that the results could contribute to enhance the track and field coaches' understanding of the mechanism underlying the running drills.

Methods

Thirteen long-distance runners performed five popular running drills (A-skip, B-skip, bounding, heel flicks, straight leg run (SL)) and run across three different speeds (2.75 m/s, 3.88 m/s, 5.00 m/s) on an indoor running track. Kinematics, kinetics and energetics values were calculated among the ankle, the midtarsal (MT) and the metatarsophalangeal (MP) joint according to the multi-segment foot model developed by Bruening [4]. Muscular activation was recorded for soleus, gastrocnemius medialis and lateralis and abductor hallucis in using surface electromyography. Repeated measures analysis of variances was used to compare variables between running drills and running across the three different speeds.

Results

Ankle and MP range of motion are lower during the running drills than running at 3.88 m/s and 5.00 m/s (p-value < 0.001, diff: ± 10°), except for bounding. The ankle joint moment, ankle positive and negative work are similar between running drills and running at 5.00 m/s, except for bounding inducing a larger positive (p-value < 0.001, diff: ± 0.35 J/kg) and negative work (p-value < 0.01, diff: ± 0.43 J/kg). MT and MP joint moments during the A-skip, heel flicks and SL are close to running at 3.88 m/s (MT ≈ 2.10 N.m/kg & MP ≈ 0.32 N.m/kg) whereas the MT and MP joint moments of the B-skip are close to running at 2.75 m/s (MT ≈ 1.80 N.m/kg & MP ≈ 0.23 N.m/kg). Contrariwise, the bounding induces a similar MT and MP joint moments compared with running at 5.00 m/s (MT ≈ 2.25 N.m/kg & MP ≈ 0.45 N.m/kg). Abductor hallucis, gastrocnemius medialis, gastrocnemius lateralis and soleus activation were statistically similar between running drills and running at 5.00 m/s. However, each percentage of muscular activation during the running drills were superior to running at 5.00 m/s (except for A-skip which was closer to running at 3.88 m/s).

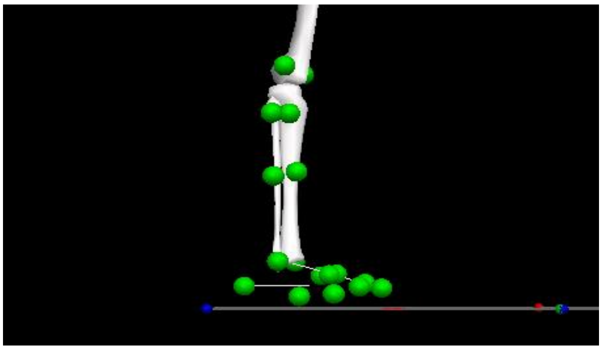

Figure 1: Visualisation of the multi-segment foot model in Visual3D software. Markers within the foot were placed on the distal phalanges of the first toe, head of the first, second and fifth metatarsals, base of the first and second metatarsals, posterior calcaneus, navicular tuberosity and the cuboid bone.

Discussion

The most original aspect of this study is the exploration of the foot and ankle mechanism using a multi-segment foot model while performing the running drills. Compared to running at 5.00 m/s, running drills require stiffening the foot-ankle complex in reducing ankle and MP range of motion while also increasing activation of the plantarflexor and abductor hallucis. According to the foot-ankle moment estimated, the B-skip is the softest and the bounding is the hardest of the running drills. Track and field coaches should be aware that running drills induce similar or higher eccentric work on the ankle than running at 5.00 m/s.

References

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