COMPARING THE FRICTION OF TENNIS SHOES

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There are currently no regulations that govern the design of tennis shoe outsoles used in hard court tennis. Consequently, patterns used on the rubber outsoles of hard court tennis shoes vary greatly from one shoe to another. In this study, the dynamic friction (μ_k) of eight tennis shoes from four different brands, was measured (Fig.1). Shoes A – F were marketed as hard court or multicourt shoes, while shoes G and H were clay and carpet shoes, respectively. The friction tests were conducted on a hard court surface, using a mechanical shoe friction test device testing at a slide speed of 0.1 m/s [1]. Each shoe was tested five times, at five different orienatations (total of 25 friction tests per shoe). A two-way ANOVA with Bonferroni post hoc test was used to investigate significant frictional differences between shoes and orientations. To explain the friction results, contact area analysis was conducted using a total internal reflection approach [2]. Additionally, measurements were taken by hand of the eight shoes' component (outsole, midsole and insole) heights (mm) and hardnesses (ShoreA).

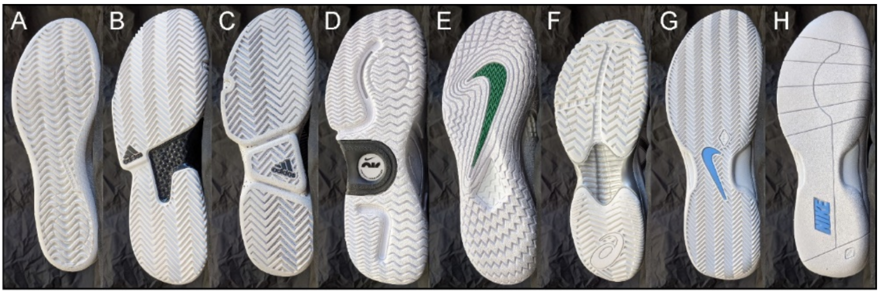

Fig. 1: All shoes analysed in this study. All were size UK 9.5.

μ_k was shoe and orientation dependent ($p < 0.01$ for both). Shoe D produced the highest overall mean friction (Mean (M) = 1.25), and Shoe A produced the lowest mean friction (M = 0.92). The friction results for all eight shoes are shown in Fig. 2. All test orientations produced significantly different μ_k readings ($p < 0.01$) except for 90° with 65° ($p = 1$) and 0° with 22.5° ($p = 0.3$). The 90° orientation (shoe orientated perpendicular to sliding direction) produced the highest overall mean μ_k (1.25) and the 0° orientation (shoe orientated parallel to the sliding direction) produced the lowest mean μ_k (0.96).

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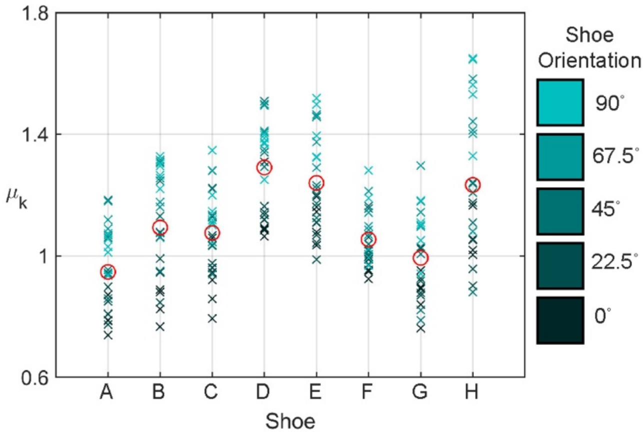

Fig. 2: All μ_k readings for all shoes across all orientations. Red circles indicate μ_k means.

Contact area analysis was unable to explain the frictional differences between shoes, except for the comparison of Shoe G and Shoe H. Shoes G and H were the same model (Nike Prestige), and varied only in their outsole tread pattern. Due to the flat outsole of Shoe H, it produced higher contact areas (e.g. 36.72 cm^2 at 45°) than Shoe G (e.g. 16.89 cm^2 at 45°). This is thought to be the cause of the higher friction observed for Shoe H, than Shoe G.

Different tennis shoes and orientations can produce significantly different friction results on hard courts. Thus, the selection of footwear for hard court tennis could influence the performance of change of direction movements like steps and slides. Though more frictional analysis is required to identify the exact tread design characteristics that increase/decrease friction, it is suggested that high contact area tread patterns produce a higher friction than the same shoe with a lower contact area tread pattern.

1. Clarke J, Carre MY, et al. (2013) The development of an apparatus to understand the traction developed at the shoe-surface interface in tennis. Part P: Spts Eng and Tec 227:149-160.
2. Needham J, Sharp J (2016) Watch your step! A frustrated total internal reflection approach to forensic footwear imaging. Sci Rep 6.1:1-7.

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