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SOCCER SPECIFIC PLAYER-SURFACE-SHOE INTERACTION DURING 180° CUTTING MOVEMENT ON DRY AND WET ARTIFICIAL TURF

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SUMMARY

Fast cutting manoeuvers are essential in soccer and require sufficient traction between shoe and surface. The aim of this study was to quantify the influence of moisture (dry and wet artificial turf), in combination with three realistic stud configurations (artificial grass, firm ground, turf field), on cutting performance and on the underlying biomechanical interaction between player, shoe and surface. Twelve experienced soccer players performed a 10x5m shuttle run test. 3D kinematics and ground reaction forces of the open stance phase of the 180° turns were measured and traction was calculated. Players perception was also measured.. On dry AT no performance differences between the three tested sole configurations could be measured. The Artificial Grass and Firm Ground designs performed evenly well on the wet AT. When wearing the Turf Field shoe, equipped with 72 short studs, significant surface x shoe interaction effects (two-way 2x3 Anova repeated measures with LSD post hoc tests) indicated decreased performance and traction on the wet surface: SHR performance was 0.731s slower ($p<0.01$); average executed traction dropped from 0.81±0.05 to 0.76±0.05 ($p=0.06$). In kinematics a 6.2° less outward tilted touch down position of the foot ($p<0.05$) was found but no other proximal movement adaptations, including the inclination of the entire outward limb, occurred. Therefore a “distal” mechanism could be hypothesized. Interestingly, all players perceived less grip ($p<0.005$) and less foot-ankle stability ($p<0.05$) in the wet x turf field shoe combination indicating that these experienced elite players perceive shoe x surface evoked differences in performance and the related cutting biomechanics very well.

INTRODUCTION

The ability to perform fast cutting manoeuvers is essential in soccer. These cutting manoeuvers are characterized by substantial changes in speed, combined with dynamical body balance, requiring large horizontal force impulses exerted by the feet. Therefore players need sufficient traction between shoe and surface. Artificial turf (AT) becomes more widely used in soccer e.g. through the FIFA Quality Concept for Football Turf. The amount of traction that can be developed on artificial turf depends on multiple factors possibly interacting with each other [1]: among others turf humidity, shoe design,…? In wet AT conditions, subject field experience and mechanical tests demonstrate a reduction in traction, depending however on stud configuration of the soccer shoe. Yet little is known about the influence of wet AT on cutting performance and the underlying biomechanical interaction between player, shoe and surface. The aim of this study was to quantify the influence of moisture (dry and wet AT), in combination with three realistic stud configurations, on cutting performance and on the underlying biomechanical interaction between player, shoe and surface. The available traction was hypothesized to be less on wet AT, although with an interaction effect for the outsole profile of the soccer shoe.

METHODS

Twelve experienced soccer players performed a maximal 10x5m shuttle run test (SHR), allowing performance measurement, and requiring multiple 180° turns with high traction needs. The subjects performed also 90° and 45° cutting movements in order to verify generalization of the 180° test results. In a 3 (turn) x2 (moisture) x3 (studs) randomized design, players wore the Nike Tiempo Mystic III model with three different types of stud configurations (Turf Field sole, Artificial Ground sole and Firm Ground sole; ranked from small to average stud length) on wet (1,5 $(L\ m^{-2})/h$) and dry Desso Challenge Pro^2 artificial grass with SBR-infill. Mechanical tests for impact, rotational resistance and linear friction fulfilled the FIFA ** requirements [2], but did not differentiate between dry and wet AT condition. Performance (SHR time), players perception on traction, stability, rotational load, comfort, general appreciation (Visual analogue scale) and biomechanical interaction during the open stance support phase with the 180° directional change (3D kinematics @ 200Hz with 12 Qualisys Pro Reflex cameras, 12 segment model in Visual 3D ; ground reaction forces @ 1000Hz with 1m long AMTI force plate, fig. 1) was measured. ICC’s for 5 trials gave good to high intra-subject repeatability, especially for the 180° test (77% of all variables ICC > 0.8). The 180° test discriminated best between conditions (two-way 2x3 Anova repeated measures with LSD post hoc tests).

RESULTS AND DISCUSSION

All players adopted open stance 180° turns. Consistent with literature, the directional change is almost entirely accomplished by the by the outward foot.

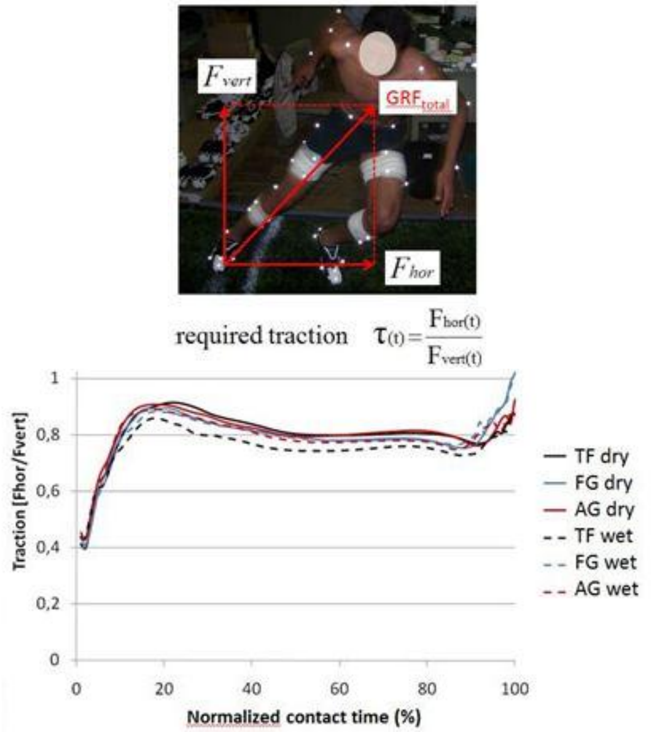

Figure 1: Temporal evolution of the required traction, calculated as ratio of the horizontal/vertical component of the ground reaction force [3], executed during the 180° turn by the outward foot; conditions: 3 shoe types (Turf Field, Artificial Grass, Firm Ground) x Wet and Dry AT. Average curves for 11 subjects.

A main surface effect, i.e. for all shoes, was seen in the horizontal ground reaction force during the initial foot contact phase wherein players exerted a less impulsive deceleration on the wet surface, nevertheless with no overall negative effect on performance nor traction.

However, when wearing the Turf Field shoe, equipped with 72 short studs, significant surface x shoe interaction effects indicated decreased performance and traction on the wet surface: SHR time increased from 14.662±0.137s to 15.393±0.197s (i.e.0.731s slower; $p<0.01$); average executed traction dropped from 0.81±0.05 to 0.76±0.05 ($p=0.06$; fig. 1). In literature, realistic changes in surface or shoe conditions cause comparable differences (5%) in performance [4]. Additionally, during the entire experiment 7 of the 8 real slips of the outward foot, i.e. with complete loss of body balance, occurred in the wet x TF shoe condition. These results make clear that wearing a Turf Field shoe equipped with 72 short studs on wet turf can be detrimental for cutting performance and can be related to the loss of traction by the moisture of the AT. On the other hand, two other common and not too aggressive studded AG and FG designs perform well both on the dry and the wet AT. On dry AT no performance differences between the three tested sole configurations could be measured.

Influences on the kinematics of the 180° turn were small, but again consistent for the wet x TF shoe condition (fig. 2): a 6.2° less outward tilted touch down position of the foot ($p<0.05$, see fig.1) is followed by a less explicit ROM to foot flat (28.2±9.2° versus 36.2±9.8°, $p<0.05$). No other proximal movement adaptations, including the inclination of the entire outward limb, are found. Therefore a "distal" mechanism could be hypothesized, e.g. to increase traction by enlarging the initial contact area between the multi-studded shoe sole and the wet AT.

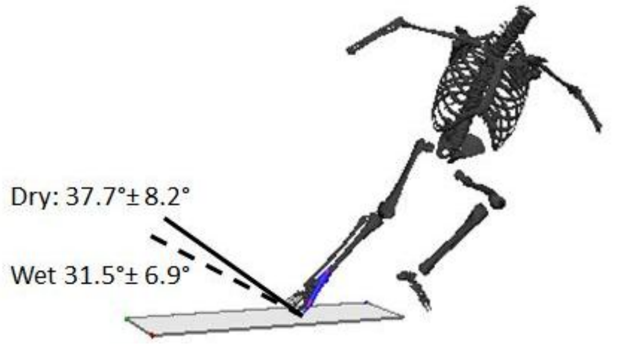

Figure 2: Frontal plane kinematics at touch down in maximal speed 180° turn on wet and dry AT, wearing Turf Field shoe.

Interestingly, perception of experienced players goes along with the shoe x surface differences in performance and the related cutting biomechanics. All players perceived less grip ($p<0.005$) and less foot-ankle stability ($p<0.05$) in the wet x TF shoe combination. The general shoe comfort score concurred with the latter two ($p<0.05$), and not with experienced rotational load, indicating that for selection of shoes, experienced elite players put a lot emphasis on comfort and performance as demonstrated by [5].

CONCLUSIONS

Wet AT offers less available traction and compared with dry AT, soccer players wearing a multi-short-studded Turf Shoe, exert less traction on the pivot foot on wet AT. These less impulsive cuttings relate to slower Shuttle Run performance. Performance is not affected when players wear other common not too pronounced stud designs. Experienced players perceive these small differences in performance and related features.

ACKNOWLEDGEMENTS

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