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4. Forefoot plantar pressure distribution inside the soccer boot during running.

4.1 Introduction:

Incidences of foot pain in soccer players have been found to coincide, in many cases, with the positioning of cleats on the football boot outsole, particularly in the regions of the medial and lateral metatarsal-phalangeal joints (Lafortune, 1998). Although no definite relationship between pressure induced by cleats and foot injury have been proved, it has been suggested that localised high-pressure may lead to foot damage. These findings of elevated pressure due to stud loading have been confirmed by Shorten (1998) and Majid and Bader (1993), however, sole plate stiffness, cleat configuration and stud penetration were also outlined as factors which may effect plantar pressure distribution. The aim of this investigation was to determine whether in-shoe pressure measurement can detect differences between commercially available football boots designs, taken into consideration individual foot structure. Also, whether these pressure distribution patterns are comparable on different surfaces, thus determining whether boot designs must be analysed on the surface for which they are intended.

4.2 Procedures:

Eight healthy males (UK size 8 feet), were requested to run on a motorised treadmill and on natural turf at a speed of 4.5 m/s. Running speed on the turf was monitored using timing lights, any trial which fell outside a +/- 5% error margin was discarded. Three different football boots were worn which all exhibited differing cleat dimensions and configurations. Plantar pressures were measured using footscan® insoles (RSscan international, Belgium), which were secured inside each boot. The insoles were 1.5 mm thick, plastic coated and shaped specifically for the football boots examined. The polymer sensors used within the insoles measured 5 mm, which gave a resolution of up to 4 sensors per cm², with a sampling frequency of 500Hz. A total of 10 to 12 foot contacts were recorded for each subject under each condition, from which 5 foot contacts were then selected from the middle of the sampling period for averaging purposes. Stud position and key foot structures were identified for each boot and individual subject respectively. The individual foot structures were determined by palpating the first (M1), second (M2) and fifth (M5) metatarsal head whilst loading under normal body weight. These positions were then marked on the skin and a photograph taken of the plantar surface.

Pressure data were analysed using a masking procedure, where the masks were positioned over the key foot structures for each individual subject. For each masked area, peak pressure, average pressure (over each complete stride) and load rate were recorded. The positioning of the cleats on the football boots were then compared to the positioning

of the individual foot structures to assess whether areas of high pressure experienced under these structures were the result of direct loading through the cleats.

Results and discussion:

Generally the distribution of pressure across the forefoot was not consistent between subjects for the different boots, irrespective of the cleat positioning relative to the key foot structures. Neither peak pressure or load rate, could significantly differentiate between the three boots analysed ($p > 0.05$).

Although some subjects exhibit higher peak pressures where the key foot structures were directly over the cleat positions, this was not evident for the whole subject group. In fact, for significant reduction in peak pressure was observed under this structure. The lack of discernible differences between boots could be attributed to the similarity in number and configuration and outsole plate stiffness was sufficient to distribute the pressure across the forefoot, so reducing potential localised high pressure areas under the studs, which supports the theories outlined for Shorten (1998).

When peak pressures were compared between surfaces, the distribution patterns across each subject's foot were not congruent, with the majority of subjects exhibiting a re-distribution of pressure from M1 to M2 during turf running, despite a consistent running speed for both treadmill and turf.

Although unable to differentiate between the test boots, the study did emphasise the individual nature of plantar pressure distribution and the need to consider all factors of outsole design when analysing football boots, not simply stud location. It is also suggested that, when assessing pressure distribution of football boots, that trials should be undertaken on the appropriate surface to ensure distribution patterns are reflective. Future study will aim to compare boots of greater variation in outsole design, where the potential for high pressure loading increased.