A comparison of cleat types during two football-specific tasks on FieldTurf

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ABSTRACT

Objective: To examine the effect of different cleat plate configurations on plantar pressure during two tasks.

Design: Thirty-six athletes ran an agility course 5 times while wearing 4 different types of Nike Vitoria cleats: (1) bladed, (2) elliptical firm ground, (3) hard ground and (4) turf. Plantar pressure data were recorded during a side cut and a cross cut using Pedar-X insoles.

Setting: Controlled laboratory study

Participants: No history of lower extremity injury in the past 6 months, no previous foot or ankle surgery, not currently wearing foot orthotics and play a cleated sport at least twice a week.

Main outcome measurements: Total foot contact time, contact area, maximum force, peak pressure and the force-time integral (FTI) in the medial, middle and lateral regions of the forefoot were collected. A 1×4 ANOVA ($\alpha = 0.05$) was performed on each dependent variable. A Bonferroni adjustment was conducted ($\alpha = 0.008$).

Results: In the cross cut task, statistical differences between cleats were observed in three variables: total foot peak pressure, lateral forefoot FTI, and lateral forefoot normalised maximum force. In the side cut task, statistical differences between cleats were observed in 4 variables: total foot peak pressure, the medial and middle forefoot FTI, and the medial and middle forefoot normalised maximum force.

Conclusions: Significant differences in forefoot loading patterns existed between cleat types. Based on the results of this study, it might be beneficial to increase the forefoot cushioning in cleats in an attempt to decrease loading in these regions of the foot.

Football is one of the many sports requiring cleated shoes and is the most popular sport in the world, with over 270 million players worldwide.[1] Field composition varies widely between regions and levels of competition, resulting in a variety of different cleat configurations that allow players to maximise both traction and comfort on all types of surfaces. Shoe manufacturers understand this need and therefore offer a variety of cleat configurations, such as a turf, hard ground, firm ground and bladed, designed explicitly for artificial turf, hard natural or artificial surfaces, normal grass and soft grass fields, respectively.

Many different types of injuries occur in football with non-contact injuries being more frequent than contact injuries.[2] Wong and Hong reported the foot as the most commonly injured body part in football .[2] The mechanism for non-contact foot injuries in football is usually due to running or twisting and turning.[2 3] Foot injuries in elite football players are estimated to be between three and nine injuries for every 1000 hours of competition.[3] Stress fractures are common non-contact foot injuries due to excessive repetitive loads on the foot. Current literature lacks conclusive data regarding the incidence of stress fractures in the feet of football players.[4 5] It has been estimated that basketball and football are the sports with the two highest frequencies of stress fractures, with 38% of the 1994 US World Cup football team having been diagnosed with a stress fracture of the foot.[4 5] Also, Ekstrand and Nigg speculated that two thirds of all non-contact football injuries may be due to excessive shoe-surface friction, which was confirmed in a subsequent study.[6–9] Torg and Quedenfield determined that a less aggressive cleat plate configuration, meaning a cleat configuration with both a smaller number of cleats and a decreased cleat size could be beneficial in reducing injury risk.[10] Based on the injury frequencies and locations documented in the literature, the current study will focus specifically on forefoot loading during football-specific cutting manoeuvres.

Although stress fractures have been previously investigated in running and basketball, no studies related to metatarsal stress fractures in cleated sports have been conducted. However, a case study of 23 fifth metatarsal Jones fractures showed that 35% of the fractures were sustained in cleated sports.[11] Previous literature has identified second metatarsal stress fractures as the most common stress fracture site, followed by stress fractures of the third, first, fourth and fifth metatarsals.[12] Studies have also identified recent changes in either footwear or training surface as risk factors for the development of stress fractures.[12 13] Many other factors influence the potential for the development of stress fractures such as bone strength, bone density and changes in the frequency and/or duration of activity. Therefore, examining stress or pressure distributions between different cleat configurations could aid in understanding potential risk factors for the development of stress fractures based on the cleat plate configuration.

Gender differences exist in both the type and rate of sports-related stress fractures. Matheson *et al*.[14] found that males sustain more tarsal fractures (32.4%) than women (19.4%), while females sustain more metatarsal fractures (10.29%) than men (6.09%). Previous literature has also reported that in general women experience significantly more foot injuries then men, however, male football players sustained more foot injuries than female football players.[15] A study by Queen *et al*[16] demonstrated that loading patterns were significantly different between the side cut and cross cut tasks while wearing a hard ground cleat. These two

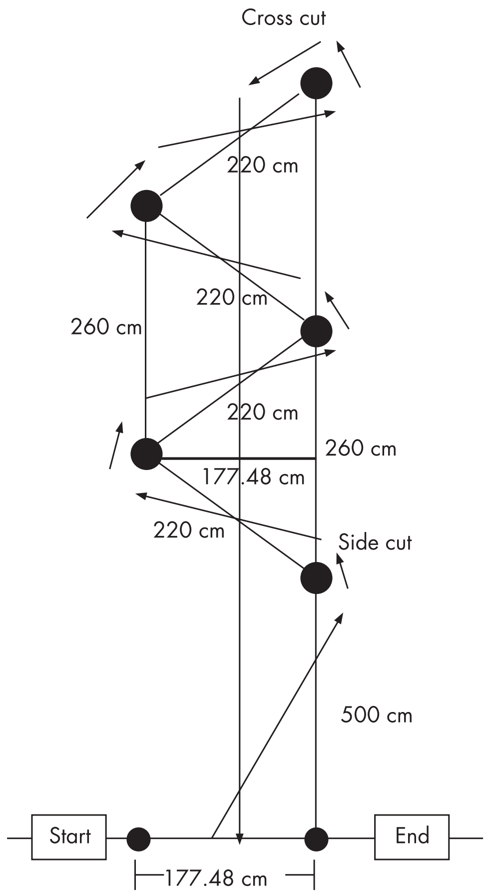

Figure 1 Agility course layout.

findings were the motivation for the current study to focus on the effect of four different cleat plate configurations during two tasks.

In the current study it was hypothesized that significant differences existed in forefoot loading patterns in the four different cleat configurations between the two different cutting tasks for both genders. Specifically, it was hypothesized that the turf shoe would demonstrate a significant decrease in loading in all parameters across genders and cutting tasks due to the construction of the shoe and the addition of a midsole, which increases cushioning beneath the foot. In addition, due to minimal force distribution through the sparsely configured cleats, it was hypothesized that the other three cleat configurations would demonstrate a decreased force when compared to the bladed cleat configuration during both cutting tasks and across genders. Any differences in plantar pressure distribution between cleat configurations could provide useful information for reducing the incidence of stress fractures in the foot.

METHODS

Subjects

Thirty-six athletes (19 male, 17 female: mean (SD) age 20.83 (3.057) years, height 1.712 (0.082) m and weight 71.12 (10.38) kg) completed the study. In order to participate, subjects had to engage in football-related activities at least twice a week, be between 18 and 35 years old and wear men's shoe sizes 9.5 and 10.5 or women's shoe sizes 8 and 9 (all of the shoes sizes are United States sizing). The subjects that participated in this study were collegiate and recreational football players. The recreational players had competed at least at the high school level. Of the 36 subjects tested, 11 were currently competing in a bladed cleat, 4 in a hard ground cleat, 17 in a firm ground cleat and 4 were competing in a turf cleat. Subjects were excluded if they had a history of lower extremity injuries within the past 6 months or an anterior cruciate ligament (ACL) reconstructive surgery within the past 3 years. Prior to participating, each subject was asked to read and sign an informed consent form approved by the university's institutional review board.

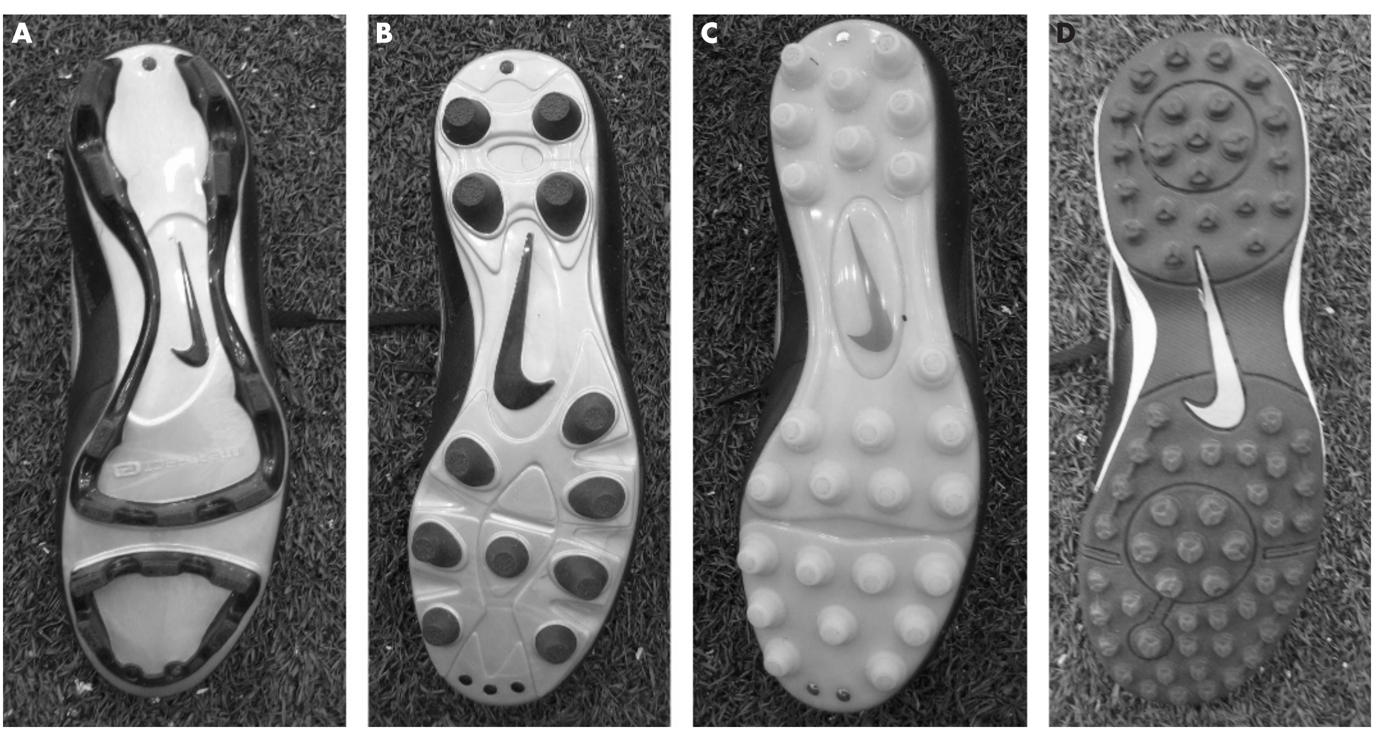

Figure 2 Configurations of the four Nike Vitoria cleat types: (A) bladed, (B) firm ground, (C) hard ground and (D) turf cleat.

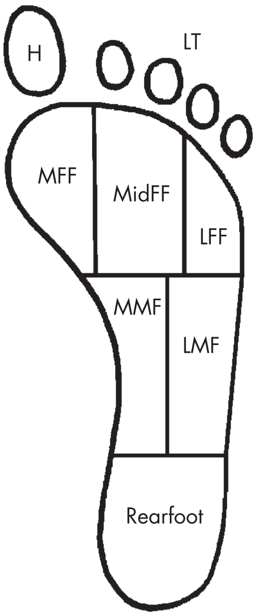

Figure 3 Division of the foot used during statistical analysis. The foot was divided into the rearfoot, medial midfoot (MMF), lateral midfoot (LMF), medial forefoot (MFF), middle forefoot (MidFF), lateral forefoot (LFF), hallux (H) and the lesser toes (LT).

Protocol

Subjects wore an appropriate size shoe and Pedar-X (Novel, St. Paul, MN, USA) insole to collect plantar pressure data. The insoles, which covered the entire plantar surface of the foot, were placed bilaterally inside the subject's shoes. The plantar pressure data were sampled at 100 Hz via Bluetooth technology. All insoles were calibrated prior to data collection (Novel, St. Paul, MN, USA). A potential limitation of the study is the relatively low collection frequency, which could result in the loss of the true peak value. However, in order for information to be obtained for both feet 100 Hz is the maximum collection frequency. Completion of a FieldTurf agility course (fig 1) was demonstrated for each subject prior to data collection. All of the testing was completed on an indoor FieldTurf field to facilitate similar testing conditions from one subject to another. Participants were allowed three practice trials prior to data collection. They were then asked to complete the agility course five times in each of the four different cleat types for a total of 20 trials. Subjects were also allotted 1 min of rest between trials and 5 min rest between shoe conditions to help diminish the effect of fatigue.

Four different Nike Vitoria football shoes were used to minimise variability due to shoe last: (1) bladed cleat, (2) elliptical firm ground cleat, (3) hard ground cleat and (4) turf cleat (fig 2). Since the shoes were all built on the same last, the fit of each shoe was similar, therefore, the effect of accommodation time should have been minimal. Shoe order was randomised and recorded during testing for each subject. The right foot plant occurring around the second flag was identified as the side cut task for each participant (fig 1). The left foot plant during the turning manoeuvre near the end of the agility course was identified as the cross cut task (fig 1).

Table 1 Summary of statistically significant differences between the four shoes during the cross cut task (values given are mean (SD))

	Bladed	Firm ground	Hard ground	Turf
Male				
Total foot contact area (NICA)	0.711 (0.09)	0.711 (0.105)	0.726 (0.102)	0.730 (0.111)
Total foot contact time (ms)	341.64 (50.02)	325.83 (45.43)	318.08 (54.72)	316.32 (61.25)
Total foot maximum force (BW)	2.04 (0.55)	2.00 (0.40)	2.10 (0.50)	1.87 (0.57)
Total foot peak pressure (kPa)*,†,‡	551.00 (167.19)	561.65 (157.68)	555.43 (135.86)	457.59 (134.60)
MFF contact area (NICA)	0.070 (0.016)	0.070 (0.014)	0.072 (0.010)	0.073 (0.008)
MidFF contact area (NICA)	0.084 (0.006)	0.085 (0.005)	0.085 (0.005)	0.084 (0.005)
LFF contact area (NICA)	0.083 (0.006)	0.083 (0.006)	0.083 (0.006)	0.083 (0.006)
MFF force-time integral (Ns)	29.18 (17.55)	30.77 (18.53)	30.91 (18.66)	33.59 (21.46)
MidFF force-time integral (Ns)	61.37 (26.22)	59.02 (23.43)	59.71 (26.32)	53.86 (24.50)
LFF force-time integral (Ns) *	77.12 (29.04)	72.74 (20.34)	72.45 (22.29)	63.20 (25.84)
MFF maximum force (BW)	0.200 (0.104)	0.214 (0.102)	0.221 (0.098)	0.248 (0.126)
MidFF maximum force (BW)	0.410 (0.160)	0.397 (0.133)	0.413 (0.136)	0.380 (0.157)
LFF maximum force (BW)	0.502 (0.189)	0.494 (0.149)	0.501 (0.153)	0.437 (0.178)
Female				
Total foot contact area (NICA)	0.708 (0.107)	0.708 (0.115)	0.724 (0.116)	0.741 (0.127)
Total foot contact time (ms)	316.63 (52.87)	340.12 (71.85)	330.85 (128.35)	328.38 (73.38)
Total foot maximum force (BW)	1.99 (0.36)	1.94 (0.40)	1.85 (0.47)	1.77 (0.38)
Total foot peak pressure (kPa)*,†,‡,§	539.01 (157.28)	570.52 (170.96)	504.47 (167.58)	404.31 (126.02)
MFF contact area (NICA)	0.071 (0.014)	0.074 (0.009)	0.072 (0.012)	0.078 (0.008)
MidFF contact area (NICA)	0.091 (0.007)	0.091 (0.008)	0.091 (0.008)	0.091 (0.008)
LFF contact area (NICA)	0.088 (0.009)	0.088 (0.009)	0.087 (0.010)	0.088 (0.010)
MFF force-time integral (Ns)	22.91 (12.14)	26.60 (14.29)	25.09 (23.58)	27.67 (15.86)
MidFF force-time integral (Ns)	55.10 (17.66)	56.67 (18.97)	49.25 (24.43)	51.58 (20.45)
LFF force-time integral (Ns)§	64.90 (25.27)	68.45 (27.29)	57.54 (25.78)	55.60 (24.36)
MFF maximum force (BW)	0.198 (0.108)	0.211 (0.110)	0.189 (0.101)	0.224 (0.128)
MidFF maximum force (BW)	0.426 (0.141)	0.405 (0.139)	0.364 (0.144)	0.367 (0.133)
LFF maximum force (BW)*,†	0.462 (0.170)	0.460 (0.181)	0.418 (0.182)	0.367 (0.118)

*Significant difference between bladed and turf cleat.
†Significant difference between firm ground and turf cleat.
‡Significant difference between hard ground and turf cleat.
§Significant difference between firm ground and hard ground cleat.
BW, body weight; LFF, lateral forefoot; MFF, medial forefoot; MidFF, middle forefoot; NICA, normalised insole contact area; Ns, Newton-seconds.

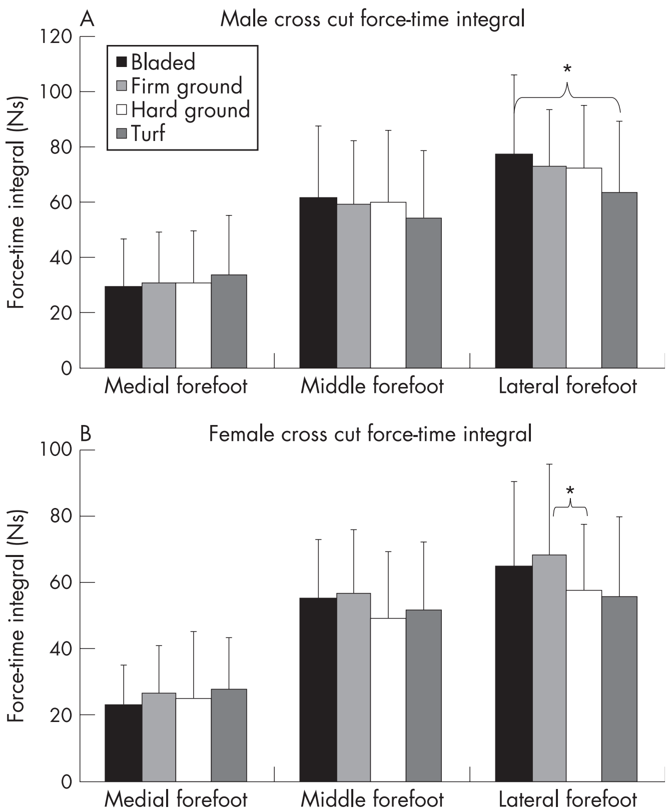

Figure 4 Cross cut force-time integral in the three forefoot regions. (A) Male subjects; (B) female subjects. *Indicates a significant difference in the lateral forefoot ($p<0.001$).

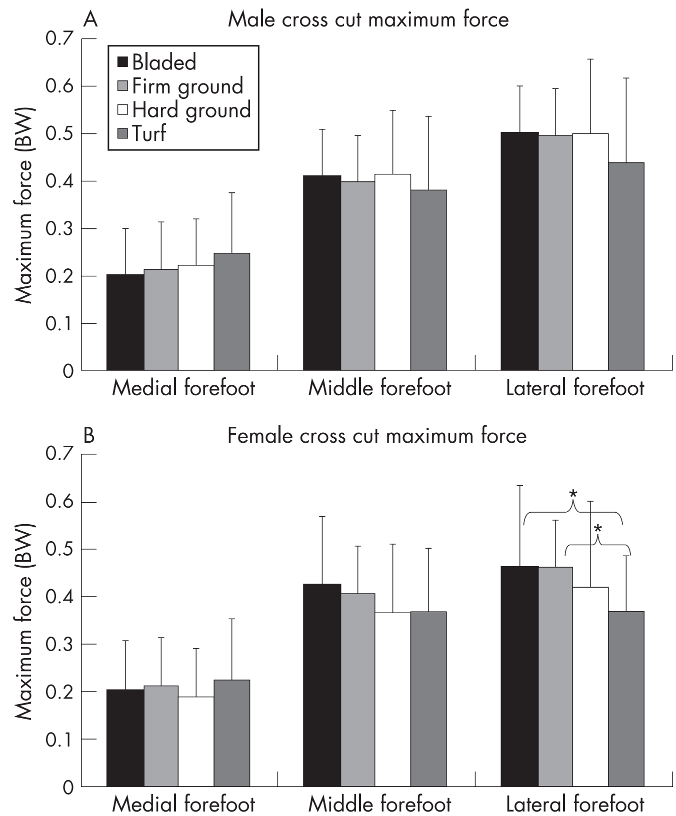

Figure 5 Cross cut maximum force in the three forefoot regions. (A) Male subjects; no significant differences. (B) Female subjects; *indicates a significant difference in the lateral forefoot ($p<0.003$).

Data analysis

In order to analyse the in-shoe pressure data, the foot was divided into eight regions using the Novel Multiproject-ip software (Novel, St. Paul, MN, USA) (fig 3). The forefoot was divided into three anatomical regions (the medial, lateral and middle forefoot) in order to determine the loading differences between the four shoe types and their potential effect on metatarsal stress fractures. In addition to the forefoot, the midfoot (medial and lateral midfoot) and rearfoot were evaluated. All of the plantar loading variables that were examined are based on the vertical force applied to the foot. The insoles that were used for testing are not capable of measuring the medial-lateral forces applied to the foot. Therefore, a potential limitation of this study is the lack of information about the medial-lateral forces that are applied to the foot during the cutting manoeuvres. The plantar pressure variables recorded for each trial were the normalised insole contact area, the contact time, the maximum force normalised to body weight, the peak pressure and the force-time integral (FTI) in all of the foot regions (fig 3).

Five trials for each subject were averaged and used for statistical analysis. The maximum force was normalised to each subject's body weight, in order to facilitate statistical comparisons. Additionally, the contact area of the entire foot and the contact area of each forefoot region were normalised to the contact area of the insole worn by the subject during data collection. Thus, the maximum force data are reported in units of body weight (BW) and the contact area results are reported in units of normalised insole contact area (NICA). Prior to completing the statistical analysis the course speed was analysed to determine if speed needed to be used as a covariate in the analysis. The course speed for both men and women in each of the four shoes was compared using a 1×4 repeated measures ANOVA and no statistically significant differences were found for the men ($p = 0.356$) or for the women ($p = 0.201$). Therefore, each variable was analysed using a 1×4 repeated measures ANOVA ($\alpha = 0.05$) in order to determine statistical differences between the four cleat configurations for both movement task and gender. If any significant differences existed between the four shoe conditions, Tukey's post-hoc analysis was completed to determine which shoe conditions were different from each other. A Bonferroni adjustment was completed and the adjusted alpha level was 0.008.

RESULTS

Cross cut task

Statistical differences between cleats were observed in total foot peak pressure, lateral forefoot FTI, and lateral forefoot maximum force normalised to body weight. The mean and standard deviation for each of the dependent variables as well as an indication of the significant differences for the cross cut task can be found in table 1.

Differences in total foot peak pressure were identified in both genders between the turf cleat and each of the other cleat types (bladed: $p = 0.006$ for males and $p = 0.001$ for females; firm ground: $p = 0.007$ for males and $p<0.001$ for females; and hard ground: $p = 0.005$ for males and $p = 0.006$ for females). Total foot peak pressure differences also existed between the firm ground and hard ground cleats only in females ($p = 0.001$). In the lateral forefoot, FTI differences were observed between the turf and the bladed cleats in males ($p<0.001$) and between the firm ground and hard ground cleats in females ($p = 0.005$) (fig 4).

Table 2 Summary of statistically significant differences between the four shoes during the side-cut task (values given are mean (SD))

	Bladed	Firm ground	Hard ground	Turf
Male				
Total foot contact area (NICA)†	0.903 (0.108)	0.889 (0.099)	0.906 (0.097)	0.918 (0.103)
Total foot contact time (ms)	325.89 (79.50)	328.89 (95.50)	328.74 (86.08)	331.84 (83.78)
Total foot maximum force (BW)	2.53 (0.40)	2.56 (0.32)	2.63 (0.37)	2.53 (0.46)
Total foot peak pressure (kPa)*,†,‡	736.81 (91.68)	758.57 (85.96)	755.41 (75.94)	623.93 (96.44)
MFF contact area (NICA)	0.078 (0.006)	0.078 (0.006)	0.079 (0.006)	0.079 (0.006)
MidFF contact area (NICA)	0.086 (0.009)	0.086 (0.008)	0.086 (0.008)	0.087 (0.007)
LFF contact area (NICA)	0.082 (0.010)	0.079 (0.011)	0.081 (0.010)	0.082 (0.009)
MFF force-time integral (Ns)	90.88 (30.83)	93.87 (32.91)	90.61 (29.83)	86.04 (25.77)
MidFF force-time integral (Ns)	48.96 (23.38)	43.33 (19.91)	45.90 (21.02)	48.16 (21.05)
LFF force-time integral (Ns)	16.50 (12.35)	14.27 (9.90)	17.27 (11.94)	15.95 (10.42)
MFF maximum force (BW)†	0.552 (0.129)	0.566 (0.119)	0.554 (0.126)	0.518 (0.117)
MidFF maximum force (BW)	0.308 (0.083)	0.312 (0.182)	0.292 (0.088)	0.301 (0.066)
LFF maximum force (BW)	0.119 (0.042)	0.106 (0.043)	0.126 (0.047)	0.118 (0.037)
Female				
Total foot contact area (NICA)	0.862 (0.106)	0.850 (0.097)	0.859 (0.085)	0.871 (0.080)
Total foot contact time (ms)	356.88 (73.12)	352.18 (72.14)	352.88 (78.82)	346.00 (73.10)
Total foot maximum force (BW)	2.52 (0.46)	2.58 (0.59)	2.51 (0.52)	2.38 (0.54)
Total foot peak pressure (kPa)*,†,‡	592.37 ± 153.02	630.19 ± 158.48	627.73 ± 162.28	490.23 ± 134.41
MFF contact area (NICA)	0.078 (0.006)	0.078 (0.006)	0.078 (0.006)	0.078 (0.005)
MidFF contact area (NICA)	0.085 (0.008)	0.083 (0.009)	0.086 (0.007)	0.085 (0.008)
LFF contact area (NICA)	0.075 (0.014)	0.069 (0.018)	0.074 (0.013)	0.076 (0.015)
MFF force-time integral (Ns)*,†,‡	74.45 (31.62)	78.24 (29.71)	75.44 (33.26)	64.03 (26.54)
MidFF force-time integral (Ns)	35.46 (13.10)	28.95 (9.75)	31.97 (14.08)	31.81 (11.27)
LFF force-time integral (Ns)	14.84 (5.55)	12.56 (6.16)	13.91 (7.27)	13.39 (6.39)
MFF maximum force (BW) *,†,‡	0.482 (0.148)	0.506 (0.144)	0.485 (0.149)	0.413 (0.133)
MidFF maximum force (BW)§,¶	0.242 (0.0780)	0.205 (0.072)	0.212 (0.065)	0.231 (0.071)
LFF maximum force (BW)	0.119 (0.040)	0.104 (0.048)	0.108 (0.045)	0.113 (0.042)

*Significant difference between bladed and turf cleat.
†Significant difference between firm ground and turf cleat.
‡Significant difference between hard ground and turf cleat.
§Significant difference between bladed and firm ground cleat.
¶Significant difference between bladed and hard ground cleat.
BW, body weight; LFF, lateral forefoot; MFF, medial forefoot; MidFF, middle forefoot; NICA, normalised insole contact area; Ns, Newton-seconds.

Differences in the lateral forefoot normalised maximum force existed between the turf and the bladed cleats, as well as between the turf and the firm ground cleats in females only ($p = 0.001$ and $p = 0.003$, respectively) (fig 5). No other variables showed significant differences between cleat configurations during the cross cut task.

Side cut task

During the side cut task statistical differences were observed between different cleat configurations in total foot peak pressure, total foot contact area, FTI in the medial forefoot and in the medial and middle forefoot normalised maximum force. The mean and standard deviation for each of the dependent variables as well as an indication of the significant differences for the side cut task can be found in table 2.

Differences in total foot peak pressure existed for both genders between the turf and bladed cleats, the turf and firm ground cleats, and the turf and hard ground cleats ($p<0.001$, $p<0.001$, and $p<0.001$, respectively, for both genders). Total foot contact area was significantly different between the firm ground and the turf cleat for the men only ($p<0.001$). The medial forefoot FTI showed significant differences only in females between the turf and bladed cleats, the turf and firm ground cleats, and the turf and hard ground cleats ($p = 0.002$, $p<0.001$, $p = 0.002$, respectively) (fig 6). The medial forefoot normalised maximum force was significantly different for women between the turf and the bladed cleats, turf and firm ground cleats, and the turf and hard ground cleats ($p = 0.001$, $p<0.001$, and $p = 0.001$, respectively) (fig 7). Males demonstrated differences in normalised maximum force in the medial forefoot between the turf and firm ground cleats ($p<0.001$) (fig 7). Finally, significant differences existed in the middle forefoot normalised maximum force between the bladed and firm ground cleats and between the bladed and hard ground cleats in females ($p = 0.004$ and $p = 0.008$, respectively) (fig 7).

DISCUSSION

The plantar pressure distribution results of this study are similar to previous reports.[1 16] Across genders and across tasks, the statistical differences observed between the turf cleat and the other three cleat types in both maximum force and the FTI are most likely due to additional cushioning provided by the midsole of the turf shoe. In addition, turf shoes were constructed to optimise performance on artificial surfaces through the addition of midsole cushioning, an increase in the number of studs, and a decrease in the stud height, which could also aid in explaining the decrease in force and pressure in the turf shoe compared to the other three cleats with a rigid sole. This additional cushioning provided by the midsole potentially dissipates force during ground contact, clearly reducing both the maximum force and the FTI in both genders and in both tasks. This cushioning combined with the dense cleat configuration

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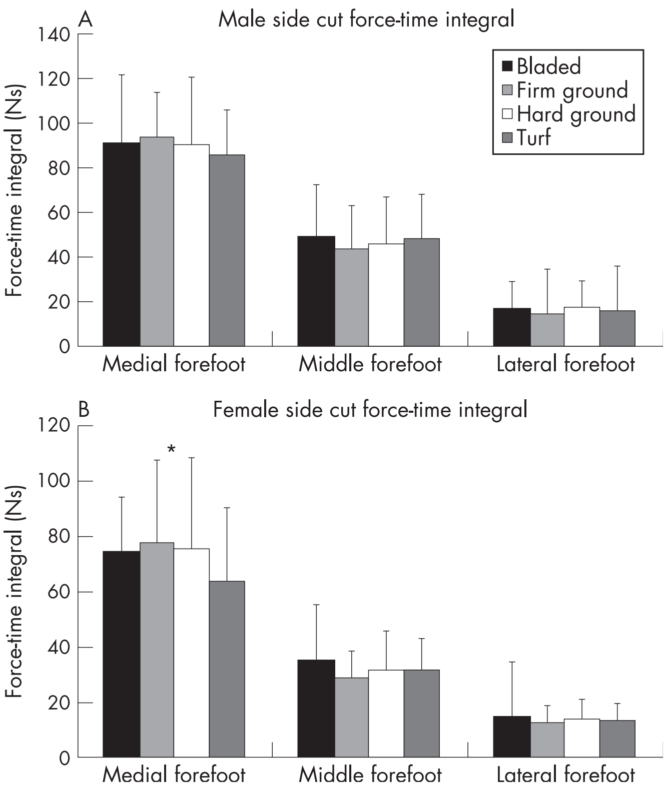

Figure 6 Side cut force-time integral in the three forefoot regions. (A) Male subjects, no significant differences. (B) Female subjects, *indicates a significant difference in the medial forefoot between the turf cleat and the other three cleat configurations ($p<0.002$).

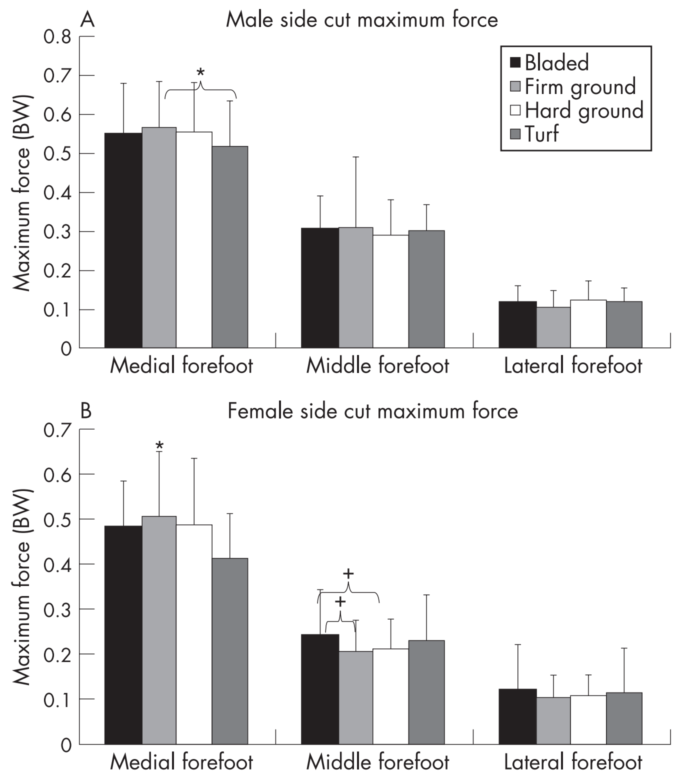

Figure 7 Side cut maximum force in the three forefoot regions. (A) Male subjects, *indicates a significant difference in the medial forefoot ($p<0.001$). (B) Female subjects, *indicates a significant difference in the medial forefoot between the turf cleat and the other three cleat configurations ($p<0.002$) and † indicates a significant difference in the middle forefoot ($p = 0.004$)

might make the turf shoe more suitable for preventing metatarsal stress fractures. Also, for athletes returning to play after a metatarsal injury, it might be beneficial to wear a turf shoe in order to minimise the forces experienced during functional cutting tasks. It might not be feasible, however, for athletes to compete in turf shoes due to loss of traction. Studies have found that a decrease in shoe surface friction leads to slipping, but decreases the number of complaints of knee pain from athletes.[17 18] A decrease in shoe surface friction may also reduce the incidence of knee injuries.[19] Conversely, an increase in shoe surface friction (such as that provided by the other three cleat types) can potentially increase player performance, however, it increases the risk of injury due to increased speed and the resulting contact forces.[17 20] These findings imply that although the turf shoe minimises forces in the forefoot during ground contact, it might not be the best choice of footwear in all circumstances.

Previous studies have been conducted to examine the effect of changing the cleat configurations and the effect of these configurations on injury risk. Torg and Quedenfield[10] first investigated the relationship between cleat configurations and injury occurrence. They found that both the number and size of cleats correlated with the occurrence of knee and ankle injuries in American football.[10] They also found that less aggressive cleats reduced the number of injuries in these athletes.[10 21] Another study found that cleats placed on the peripheral margin of the sole with pointed, smaller cleats interiorly are likely to be associated with a major knee injury on a natural grass surface.[19 21] This risk of knee injuries may have been due to the increased shoe-surface resistance in athletes wearing the cleats discussed above.[19 22 23] Other studies have claimed that the construction of the sole material is more important than the pattern of the cleats on the sole of the shoe in determining the traction of the cleat.[24 25] These studies proposed that the sole of cleats be constructed of synthetically moulded material, have a minimum of 14 cleats per shoe, a minimum cleat diameter of 12.5 mm and a maximum cleat length of 9.5 mm.[10 24] Another proposed a method to lower injury incidence related to the shoe–surface interaction by reducing individual cleat friction by increasing the total number of cleats.[8 17] While each of these previous studies has focused on changing the relationship between the cleat and the ground, it is important to try and balance the benefits of injury prevention while maintaining performance. Although studies have focused on the knee and ankle with respect to cleat design, there is no previous study examining the effect of cleat design on metatarsal injuries.

In the current study, significant differences between the hard ground, firm ground and bladed cleat types existed only in females. The firm ground cleat and the hard ground cleat were significantly different in the FTI in the lateral forefoot during the cross cut task. This is most likely due to the increased number of cleats in the hard ground cleat compared to the firm ground cleat, which may disperse the forces during impact. Also, the bladed cleat and the firm ground cleat demonstrated significant differences in maximum force and the FTI in the middle forefoot during the side cut task. This might be due to the fact that there are effectively two ‘‘shoe width’’ studs spanning the forefoot region in the bladed cleat, whereas in the firm ground cleat, there is a cleat under each of the three forefoot regions. The two ‘‘shoe width’’ studs may transfer force from the medial forefoot to the middle forefoot during a

What is already known on this topic

- Football is one of the most popular sports in the world with approximately 270 million players worldwide.
- Significant plantar loading differences exist between movement tasks and between playing surfaces when performing football-specific tasks.

What this study adds

This study examines the effect of four different cleat plate configurations on plantar loading during football-specific movements to aid in the understanding of injury risk while playing on FieldTurf.

female side cut; however, this difference did not exist in men. The results of this study do not support the hypothesis that competing in the bladed cleat would result in a significant increase in force and pressure in the forefoot when compared to the other three cleat types. While a significant increase in force and pressure existed between the bladed cleat and the turf shoe, the bladed cleat did not demonstrate a significant increase in force and pressure when compared to the firm ground and hard ground cleats. The lack of difference between the bladed cleat and the firm ground and hard ground cleats may be the result of similar construction in these three cleats. Each of these cleats was designed with a rigid cleat plate and the same upper material. Therefore, potentially the construction of the sole of the shoe and not the placement of the studs could be a larger contributing factor in altering plantar loading.

The turf shoe appears to be the only cleat that decreases the force and pressure beneath the metatarsal heads and therefore could potentially minimise metatarsal injury risk. Thus, there seems to be no conclusive evidence that athletes should choose one cleat type over another for the purpose of minimising injury risk. It might, however, be beneficial to add forefoot cushioning to existing cleat types. This would allow athletes to both retain traction provided by the longer sparser cleat types while also minimising impact forces in the forefoot.

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Commentary 1

Stress fractures of the metatarsals in football players have become recognised as a significant injury issue at higher levels of play. Football involves a substantial number of cutting manoeuvres with rapid changes in direction during running. These motions appear to load the plantar surface of the forefoot to a high degree. Shoe design may play an important role in reducing loading rates applied to the forefoot and the underlying metatarsal bones. Although traction has been a key design goal in cleat placement and shoe design, it now appears that additional emphasis should be placed upon improving cushioning in the forefoot region in football boots.

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Commentary 2

This study compared the interactions of cleat types on FieldTurf for two common football tasks: side and cross cut manoeuvres. Given the increase in prevalence of artificial/synthetic playing field surfaces, attention to complementary footwear, in particular to cleat design, is warranted to potentially augment performance and reduce foot injuries. Using in-shoe pressure sensor soles, differences in foot loading patterns were shown among cleat designs and between male and female subjects. These mechanical differences should be considered by players, coaches and athletic trainers, and studied further to identify possible links to foot injuries.

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A comparison of cleat types during two football-specific tasks on FieldTurf

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