IN-SHOE PRESSURE DISTRIBUTION DURING FENCING LUNGE

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INTRODUCTION

Fencing is a sport involving sharp backward and forward movements interspersed with several slower gliding steps in which lower limb agility is crucial to good movements and correct body positioning. Thus, while the upper extremity uses the weapon, the legs and feet work to get the fencer in position to use it.

From a biomechanical point of view particularly stressed are the feet. Incidence of foot injury in fencing is high and there have been many cases reported of metatarsal stress fractures, capsulitis, plantar fasciitis and interdigital neuromas.

Although it would be useful to accurately evaluate the high pressure points so that overall lower limb salvage may be improved, to our knowledge, no information about the force and pressure distribution beneath the foot of fencers performing technical actions are available. The purpose of this study was, therefore, to evaluate dynamic in-shoe plantar pressure distribution during fencing lunge.

METHODS

Six right-handed foilists of national level (age: 24 5.5 yr, body mass: 72 6.3 kg) were the subjects of this study. Each athlete was asked to perform the following technical actions: simple lunge; step forward-lunge; step backward-lunge; jump forward-lunge. Data for at least six trials per condition were collected. The Fscan in-shoe pressure measurement system was used to measure plantar pressure during all trials.

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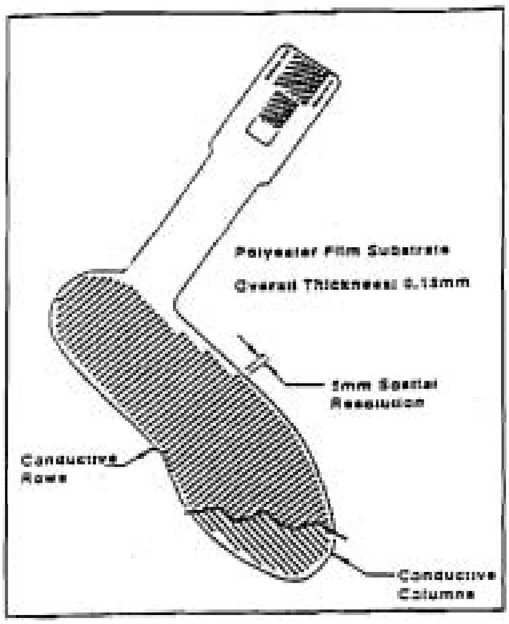

Figure 1. The Fscan insole sensor

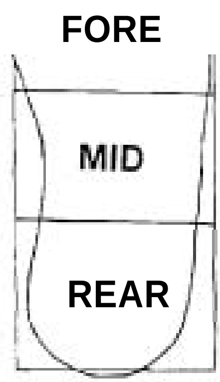

Figure 2. Areas inside of which peak average pressures were measured

RESULTS AND DISCUSSION

Despite the apparent intersubject similarities in performing the actions, clear differences were observed in most of the examined parameters. In contrast to the above finding, the variability within-subject was low indicating a high consistency in movement execution.

As expected, in all the technical actions an asymmetrical load was placed on the lower extremities, with the left foot of the athletes particularly subjected to stress at the landing following a jump forward lunge attacking movement. In this case, the results showed that most of the right foot pressure was localized in the rearfoot. Conversely, in the other technical actions the right was the most stressed foot.

In table 1 the mean peak pressure values of a representative subject of this study performing different technical actions are presented.

The subjects, mean, standard deviation and maximum individual values for peak vertical forces for the right foot, during the lunge ground-contact phase, and the left foot, at landing during the jump forward lunge attacking movements are presented in table 2 and table 3, respectively. In the BW columns values are reported standardized to body weight. The foot-shoe interaction forces recorded indicated the athletes' lower extremities were subjected to relatively high stresses, averaging from 2.0 BW to 3.0 BW according to the different actions selected, with individual values as high as 3.4 BW. Values for the jump forward lunge actions are significantly higher than the values recorded for the other technical actions.

Table 1. Mean peak pressure and standard deviation values (kpa) obtained for a representative subject of this study performing different technical actions

	REARFOOT		MIDFOOT		FOREFOOT	
	left	right	left	right	left	right
simple lunge	95 (7.2)	194.3 (11.3)	29 (3.4)	45 (3.8)	64 (3.7)	115 (5.3)
step forward lunge	103 (8.3)	210.7 (10.7)	23 (2.9)	42 (3.1)	58 (5.1)	116 (4.7)
step backward lunge	92 (7.7)	150.9 (9.2)	40 (2.2)	62 (2.9)	52 (5.5)	111 (5.7)
jump forward lunge	248.5 (14)	117 (5.9)	45 (3.5)	51 (4.2)	45 (3.9)	120 (6.6)

Table 2. Mean peak vertical forces generated beneath the right foot of all the subjects during the lunge contact phase

			maximum values	
	Newtons	BW	Newtons	BW
simple lunge	1451(165)	2.0 (0.21)	1878	2.4
step forward lunge	1660 (194)	2.3 (0.28)	2153	2.8
step backward lunge	1592 (198)	2.2 (0.29)	2101	2.7

Table 3. Mean peak vertical forces generated beneath the left foot of all the subjects at landing after jump forward lunge movements

			maximum values	
	Newtons	**BW**	**Newtons**	**BW**
jump forward lunge	2085 (185)	3.0 (0.25)	2501	3.4

In Figure 3 the typical 3-D pressure maps sequence and foot-shoe vertical forces of a subject performing a classic step backward lunge movement are showed. Note the high pressure levels over the metatarsal region and hallux of the left foot during the push off phase of the lunge move (B), and beneath the right rearfoot and forefoot at the end of the lunge move (C)

CONCLUSIONS

Pressure and force levels, applied regularly and over a long period of time can cause structural damage to the foot. Insufficient attenuation of such forces can result in degeneration of joint surfaces, leading to articular damage.

Shoe and plantar orthotic designers should attempt to reduce such risks designing safer footwear and proper shoe inserts. In addition, administrators should select surfaces that will enable maximization of force attenuation.