THE INFLUENCE OF NEW AND DEGRADED INSOLES ON HEEL IMPACTS WHEN RUNNING IN MILITARY BOOTS

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INTRODUCTION

In the present study the ability of new and degraded insoles to reduce peak heel forces and pressures when running in military boots is assessed. The aim of the study is to identify the most appropriate insole for use by Royal Marine recruits during their 30-week training period.

REVIEW AND THEORY

A previous study has highlighted the ability of new shock-absorbing insoles to cushion impacts when running in military boots, with the identification of the most effective insoles at reducing peak pressures (Windle et al., 1999). However, it has been demonstrated that repeated impacts cause an increase in material stiffness, indicating a reduction in cushioning ability (Foto et al., 1999). Therefore, in order to provide recommendations for the most appropriate insoles, a study of the influence of degraded insoles on cushioning ability during running is required.

The purpose of the present study was to assess the ability of insoles to maintain their cushioning ability in running following controlled degradation of the insole material. It was hypothesised that a controlled degradation would reduce the ability of insoles to cushion impacts when running in military boots.

PROCEDURES

Three insole types were assessed. Insole A was a moulded polyurethane foam footbed of approximate thickness 6 mm, with a 1 mm layer of viscoelastic polymer inserted in the heel and forefoot. Insole B was a viscoelastic polymer of approximate thickness 3 mm. Insole C was composed of a 6 mm thick polyurethane foam shaped into a footbed. Samples of each of the insoles were subjected to controlled degradation by the application of a repeated pulse of total length 100 ms, to provide a nominal peak pressure of 500 kPa over the heel area of the insole, (Instron model 1125). Insoles were subjected to 40,000 impacts with a period of one second between each pulse, simulating a running distance of approximately 100 km. Insole stiffness was calculated for new and degraded insoles.

16 Royal Marine recruits were used as subjects. The influence of new (n) and degraded (d) insoles on peak heel pressures and on peak impact force was assessed when running in combat boots. Ground reaction force data (1000Hz, AMTI) were collected for 10 running trials (3.6 $m.s^{-1}$ ±5%) for each subject under each of the insole conditions and a boot only condition (control). GRF data were used to identify peak magnitude and rate of loading of impact force, and the time of peak impact force. For nine subjects, in-boot pressure data were also collected (250 Hz, Parotec). Heel pressures were analysed for twelve sets of pressure data for each subject-footwear combination. Mean values of peak heel pressure during impact over the twelve trials were obtained for both feet.

Significant differences were tested for using a one-way ANOVA with repeated measures followed by a post-hoc Tukey test ($p<0.05$).

RESULTS

All insole materials experienced an increase in mechanical stiffness following 100 km of simulated running impacts (Insole A: 133%; Insole B: 65%; Insole C: 267%). Significant differences in impact force and pressure variables compared with the no insole condition are highlighted in Table 1 ($p<0.05$). For insoles A and B no significant differences in peak impact force variables were detected compared with the control condition. Compared with the control condition, the use of insole C (new and degraded) resulted in a significant increase in the time of occurrence of peak impact force. Insole C (new) also resulted in a significant reduction in the peak loading rate. Significant reductions in peak heel pressures were detected for insole A and insole C (new and degraded) compared with the no insole condition. For each insole type, no significant differences in force or pressure variables were detected between the new and degraded insoles.

	No insole	Insole A (n)	Insole B (n)	Insole C (n)	Insole A (d)	Insole B (d)	Insole C (d)
Peak Heel Pressure ($N.cm^{-2}$)	42.3 (8.0)	33.0* (7.7)	41.7 (6.5)	26.9* (8.6)	33.8* (9.2)	41.2 (13.4)	26.1* (8.2)
Peak Impact Force (BW)	1.99 (0.40)	1.99 (0.42)	1.95 (0.43)	1.90 (0.37)	2.01 (0.41)	1.91 (0.42)	1.89 (0.31)
Time of Peak Impact Force (ms)	26.7 (5.1)	27.3 (4.6)	26.1 (4.3)	30.4* (6.3)	29.3 (4.4)	26.7 (5.9)	29.8* (5.6)
Peak Loading Rate ($BW.s^{-1}$)	183.3 (59.6)	174.0 (61.4)	167.3 (57.4)	152.3* (47.9)	170.1 (60.9)	169.1 (62.3)	157.0 (54.7)

Table 1: Mean values for peak pressures (n=18) and impact force variables (n=16) (SD).
* indicates a significant difference compared with the no insole condition ($p<0.05$).

DISCUSSION

The finding that peak heel pressures can be reduced when running with insoles in military boots supports previous findings (Windle et al, 1999). Insole C has been found to provide the most impact absorption, with a mean reduction in peak heel pressure of 36% compared with the no insole condition. The observed reduction in peak loading rate observed for insole C also indicates that this insole provides the highest impact-absorbing ability of the test insoles. Although increased insole stiffness has been detected following 100 km of simulated running impacts, the hypothesis that this increased insole stiffness will result in a reduction in impact-absorbing ability during running has not been supported. This suggests that insole A and insole C are suitable for at least 100 km of wear. In contrast, the inability of insole B to reduce peak pressures or impact force variables indicates that this insole cannot be recommended.

REFERENCES

Foto et al. Proceedings of 4th Symposium on Footwear Biomechanics, 40-41, 1999.
Windle et al.. *Gait and Posture*, **9**, 31-37, 1999.