IMPACT REDUCTION IN JUMPING: ASSESSMENT OF KINEMATIC AND KINETIC INFLUENCE WITH AND WITHOUT SHOES

Adri Hartveld[1] and Nachiappan Chockalingam[2]
[1] North Staffordshire Primary Care NHS Trusts
[2] School of Health, Staffordshire University, Leek Road, Stoke on Trent, England ST4 2DF

INTRODUCTION

Various sports activities involve repetitive application of large amounts of vertical force to the body with high loading rates. These forces are a major factor in the development of overuse injuries. Reducing these forces through training for shock absorption (Novacheck, 1998) and the use of shock absorbing shoes (De Wit et al, 1995) could reduce the rate of injuries and subsequently increase participation in sports. The present study looks at the amount of impact reduction through increasing ankle flexion, knee flexion and the use of running shoes, which are specifically marketed to reduce shock.

METHOD

A 42 year old male subject (height: 180 cm, body mass: 71 kg) with no known musculo-skeletal problems took part in the study. The subject jumped down from a 33 cm high platform on to a strain gauge force platform (AMTI Inc., USA) in a standardized controlled manner, in five different conditions:

1. Barefoot landing with the whole foot striking the floor (little ankle action) but with full knee flexion
2. Barefoot landing with forefoot strike (full ankle action) but with limited knee flexion
3. Barefoot landing with forefoot strike and knee flexion
4. In old running training shoes (Asics Gel used during more than 500 miles of running) with forefoot strike and full knee flexion
5. In new running training shoes (Asics Gel) with forefoot strike and full knee flexion.

Associated software (BioAnalysis) supplied by the force platform manufacturer and Excel were used to analyse the data and calculate the maximum vertical Ground Reaction Force and the loading rate (increase of Fz between footstrike and max Fz).

RESULTS

40 (5 x 8) trials were undertaken, of which 39 produced consistent representation of ground reaction force during the landing phase. The means and standard deviation of each condition are shown in the Table below.

Condition Flexion Ankle Footwear Knee	Max. vertical GRF (N) Mean SD	"Shock" loading rate (N/sec) Mean SD
1: little full barefoot	5406 / 968	446430 / 20468
2: full little barefoot	2687 / 546	48790 / 1464
3: full full barefoot	1718 / 283	33830 / 1343
4: full full old shoes	1549 / 162	29700 / 719
5: full full new shoes	1734 / 250	31380 / 882

Table 1. Vertical ground reaction forces during landing with different landing techniques and footwear

T-tests were performed comparing the various conditions. They showed that:

a. Jumping down with little ankle action produced a highly significantly greater max Fz ($t=10.28$, $p<0.001$) and a highly significantly greater loading rate ($t=5.69$, $p<0.001$).
b. Jumping down with little knee flexion produced a highly significantly greater max Fz ($t=4.39$, $p<0.001$). However the loading rate in this condition was only significantly greater at $p=0.05$, but not at $p=0.01$($t=2.06$).
c. Wearing training shoes did not significantly ($p=0.05$) affect the vertical ground reaction forces for max Fz with old shoes ($t=-1.39$) nor new shoes ($t=0.11$) nor for the loading rate with old shoes ($t=-0.72$) nor with new shoes ($t=-0.41$).
d. The wear of the shoes also did not significantly ($p=0.05$) affect the vertical ground reaction force($t=1.75$) nor the loading rate ($t=0.42$).

CONCLUSION

This single-case experiment confirmed that a healthy person can reduce the maximum vertical forces and the loading rate during the landing phase of jumping down through:

a. landing on the forefoot and optimizing the shock absorption by the calf muscles
b. landing with full knee flexion optimizing the shock absorption by the quadriceps muscles.

These findings are consistent with studies by Hof et al (2002), Kovacs et al (1999) and Gross & Nelson (1988).

Muscles act as powerful and adaptable shock absorbers, which act throughout the landing phase, greatly reducing the shock on the body when jumping down. Shoes might not provide any additional shock absorption when jumping down. Further experiments with more subjects and different shoes are needed to draw more definite conclusions.

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