IMPACT FORCES DURING SKATEBOARDING LANDINGS

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INTRODUCTION

Skateboarding has several million regular participants in the US alone and a relatively high incidence of injury (Kyle *et al*., 2002). Many of these injuries are the result of un-controlled landings. One of the most popular maneuvers practiced by skateboarders is the *rail slide*, i.e., sliding down a sloping handrail on a skateboard and then landing on a flat surface. When performing rail slides skateboarders land on their skateboards or become separated from their boards in midair and land on their feet. We were curious about how high the vertical ground reaction forces (VGRF) are when landing on the skateboard versus on the feet. Our results indicate that the sprung elements of the skateboard provide significant shock attenuation and offer the skateboarder some protection from the inevitable effects of gravity.

METHODS

VGRF data were collected on 10 healthy top-amateur and professional male skateboarders (BM = 69 ± 9 kg) landing on a large force plate (AMTI model BP12001200). Subjects slid down a sloping handrail on their skateboards, eventually leaving the rail and landing on the force plate at the base of the rail. We recorded data on all cases of landing whether a *land (L)*, i.e., a successful landing on the skateboard, or, a *bail-out (BO)*, i.e., separating from the skateboard in mid-air and landing on their feet. During the L trials, subjects landed with all four wheels completely hitting the force plate. During the BO trials, the subjects landed feet first and fully on the force plate. Each subject performed only 3 trials for the BO and L conditions due to the violent nature of these landings. VGRF data were collected for 8 seconds at 1000 Hz for each condition. A low pass Butterworth filter was applied to the data in both conditions with a cutoff frequency of 100 Hz. All subjects wore the same model of skate shoes. However, each subject used his own skateboard for reasons of safety.

RESULTS

Figure 1 shows typical VGRF curves for L and BO for a single subject. These data show early, rapidly rising impact forces when the subjects first make contact with the force plate and at least one later peak in VGRF. This second peak corresponded with reaching full compliance of the body and equipment system. When BO, 3 of the 10 subjects consistently landed with both feet simultaneously (BO-Spike), while 5 consistently landed one foot before the other (BO-Step).

Two of the subjects, exhibited both types of BO landings. The mean VGRF results for the *L* versus the *BO* conditions for all ten subjects are compared in Table 1. The mean peak VGRF during the impact phase was significantly lower ($p < 0.05$) when our subjects landed on the skateboard. The mean peak VGRF was significantly lower ($p < 0.05$) when our subjects exhibited BO-Step landings.

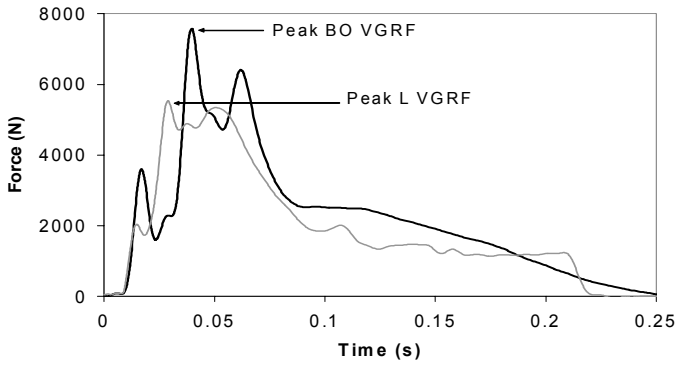

Figure 1: Representative VGRF curves for BO-Step (black) and L (grey).

DISCUSSION AND CONCLUSION

The magnitudes of the landing forces in skateboarding are among the highest reported for sports and other activities. (Nigg, 1985). This supports clinical observations of a relatively high incidence of acute injury among the skateboarding population. The skateboard is a sprung element in the system of skateboarder and skateboard. The board itself flexes and the trucks that support the wheels as well as the wheels themselves are compliant. The skateboard appears to provide significant shock attenuation lessening the peak impact forces experienced by the skateboarder when landing a rail slide. When a bail-out is required and subjects land on their feet, significantly higher forces are experienced. Landing technique and the shock attenuation properties of their footwear become critically important in these circumstances. Further investigations on the shock attenuation properties of skateboarding-specific footwear and landing techniques are needed.

REFERENCES

Nigg, BM. (1985). *Biomechanics IX-B*, Champaign, IL Human Kinetics. 91-96.
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Table 1 Peak VGRF's for L, BO, BO-Step, and BO-Spike Impacts. Force = Newtons; n = Trials. Mean (SD).

L	BO	BO-Step	BO-Spike
n = 30	n = 30	n = 19	n = 11
5347 (800)	8282 (1913)	7724 (1063)	9246 (2639)