BIOMECHANICS OF SKATEBOARDING: KINETICS OF THE OLLIE

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INTRODUCTION

Epidemiological studies characterise skateboarding as an activity with a relatively high injury incidence (Kyle, et al 2002; Osberg, et al, 1998). Given these clinical concerns and the fact that this sport has an estimated participation level of 13 million in the US alone, it is surprising that so little is known about the biomechanics of this growing sport. We sought to help fill this information void by undertaking descriptive biomechanical studies of some of the basic manoeuvres of skateboarding. In this paper we report on the first phase of this study – an analysis of the kinetics of the "Ollie".

An Ollie is a common manoeuvre used by skateboarders to hop onto, off of, and over things. The manoeuvre is complex and precisely coordinated, but essentially is a jumping movement intended to bring both skater and skateboard to a new position, vertically and horizontally. Because the skateboard is not tethered to the skater in any way, a precise sequence of movements is needed to keep the skater and board together. To execute the Ollie, the skater rapidly rotates the board about the rear axle, causing the tip to pitch upward. This bounces the tail of the board off the ground causing the board to rise. At the same time the skater jumps up and usually forward while using the lateral forefoot of the lead foot to control and direct the trajectory and orientation of the board. The board and skater move in unison and, in the end the skater lands on top of the board. Skaters practiced in the subtleties of the Ollie can hop over obstacles of a meter or more, but we have chosen to study more modest challenges.

METHODS

Four male, top-amateur or professional skateboarders visited the University of Massachusetts Biomechanics Laboratory to take part in this study. Each subject performed two movements: Ollie Up (OU); and Ollie Down (OD). The OU movement required the subject to ride his board onto the force plate, mounted at floor level, and to Ollie up onto a flat plywood platform 18 inches (45.7 cm) above floor level and about 80 cm beyond the end of the force plate. The OD manoeuvre involved rolling toward the edge of the platform (18 inches [45.7 cm] above the floor level), and, at the last moment, using an Ollie manoeuvre to hop off the wooden platform and down onto the floor-level force plate.

A large AMTI model BP6001200 force plate was used to measure ground reaction forces. In addition, in-shoe RSscan *footscan* insole pressure sensors were placed in both shoes to provide data on the distribution of forces under the plantar surface of each foot. We collected ground reaction force and pressure data for three trials of each movement for each subject.

All subjects were required to wear the same model of skate shoe, in their size, during the study. However, they were allowed to use their own skateboards.

RESULTS AND DISCUSSION

Ollie Up: The resulting vertical ground reaction forces (VGRF) observed during the OU have a characteristic two-humped shape. The first VGRF peak, occurring after both wheels were on the force plate is usually lower in magnitude than the second. A force minimum, or, at least a cessation of the rise in force, is reached in between the two peaks. This appears to be the result of an un-weighting of the board as the center of mass is lowered just prior to the jump. The second and higher magnitude peak is the result of the force rapidly applied to cause the board and skater to leave the ground. The magnitude of these second, propulsive, peaks has a mean of 1614.7 N ± 118.6 SD. Expressed as a proportion of body weight the results for this propulsive peak VGRF are 2.254 ± 0.133 SD.

These results are lower than expected given the fact that the board and the mass of the body must be raised by 45.7 cm. These propulsive peak values are similar in magnitude to those observed in runners who raise the center of mass to a much lesser extent in each step (Frederick, Hagy, 1986). This suggests that the mass center is raised by less than the height of the platform. This is consistent with our observation of the crouched position of the body at the time the board and body first land on the platform.

Medial-Lateral forces are more variable and do not show a consistent pattern, however, the anterior-posterior (A-P) shear forces are more regular. Most prominent in the A-P force curve is a pronounced peak observed to correspond with the propulsive peak in VGRF. This is consistent with the rapid upward pitch in the board, produced by shifting the weight onto the back foot. This movement forces the tail of the board to contact the surface. It is off the tail of the board that the body and board are launched upwards in the Ollie. The mean peak in this anterior shear force is 23.25 N ± 3.86 SD for all subjects and all trials.

Ollie Down: The initial phase of landing consistently shows a rapidly rising impact curve reaching a peak magnitude in VGRF concomitant with the initial landing of the skater and board on the force plate. Shortly after that initial impact peak VGRF drops as the ankles, knees, hips and trunk flex as the skaters absorb the shock of landing. One secondary and one or two tertiary peaks, much lower in magnitude than the impact peak, are observed in most landings as the body oscillates while absorbing the landing forces. It is the initial impact peaks that we are most interested in.

The impact peak rises to a magnitude ranging from about 4.0 to 5.0 times Body Weight and reaches this peak 40 to 50 ms after initial contact. The mean value for this impact peak for all subjects including all trials is 3250.5 N ± 530 SD (4.519 BW ± 0.582 SD). These impact peaks are of a higher magnitude than would be expected given the relatively short drop of 45.7 cm. But a closer examination of the pattern of movement of the subjects helps explain these relatively high forces.

When our subjects landed their skateboards on the force plate they seemed to intentionally effect a firm, forceful landing to stabilize their position and balance. This appears similar to “spiking” a landing in gymnastics. This results in higher vertical ground reaction forces than we would expect just based on the height of the drop. We also observed that the skaters do not just roll off the end of the platform, but Ollie off the end. This is done to put both the body and board in position for a controlled landing. This Ollie off the end of the platform raises the center of mass above the level it maintains while rolling across the platform. This observation also helps explain the higher than expected impact forces.

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