HEALTHY ADULTS CAN LEARN TO REDUCE HAND IMPACT FORCE IN A FORWARD FALL. A 3-MONTH INTERVENTION STUDY IN YOUNG MALES.

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INTRODUCTION

Minimizing injury during a fall arrest entails substantial challenges. A common fall arrest strategy is to use the upper extremities to protect the head and trunk from impact (O’Neill et al., 1994; Hsiao, 1998). The biomechanics of forward fall arrests using fully extended arms have been studied by Robinovitch and co-workers (1998). The arrest of falls from a standing posture has been studied by Dietz (1981), van den Kroonenberg et al. (1995), and Hsiao (1998). The biomechanics of an active, martial arts-style, fall arrest have been described by Sabick (1999). Finally, a recent study by DeGoede (2000) showed that hand impact forces during a forward fall from an initial shoulder height of 1 m can be volitionally reduced by up to 29%.

The purpose of this study was first to confirm the hypothesis that young males can be taught, in less than 10 minutes, to successfully reduce peak hand impact forces while arresting a standardized forward fall. Then, if the first hypothesis was supported, to test the second hypothesis that, without intervening practice, these subjects could retain the ability to land with reduced impact force at 3 and 12 week’s follow-up.

METHODS

Ten healthy young males participated in this study (mean ± SD age: 23 ± 3 years, body weight: 72 ± 9 kg, and height: 1.743 ± 0.037 m). Subjects were only included if they did not have any previous falls training (e.g. no karate, gymnastics, etc.). The institutional review board approved all test procedures and each subject gave their written informed consent.

Each fall was initiated from a shoulder height of 1 m above padded AMTI force plates on which each hand landed. Body segment kinematics were measured at 300 Hz using an Optotrak system. At the baseline visit each subject performed five falls without instruction (termed “natural falls”), followed by a 10 minute instructional period (intervention) designed to teach them the skill of arresting the forward fall with reduced impact force (termed “reduced-impact falls”). They were taught to try to “catch” the ground (by reducing the hand-ground relative velocity as much as possible prior to impact). They were shown several types of demonstrations so that they could visualize what they had to attempt to do. To be rated as “successful”, a trial not only had to result in a reduced peak hand force, but the subject’s torso had to pass through an imaginary 15 cm-ground clearance threshold with a downward velocity < 0.5 m/s. Following the teaching intervention, subjects performed five ‘reduced-impact’ fall arrests, each time being given verbal feedback on the preceding trial’s peak impact force and torso speed at the 15 cm threshold. At the 3 and 12-week follow-up, subjects performed five additional ‘reduced-impact’ falls without
further practice, instruction or knowledge of results.

The first null hypothesis was tested using a two-sided, paired t-test comparing the average of the ‘natural’ falls to the average of the ‘reduced-impact’ falls during the baseline test session. The second null hypothesis was tested, using a two-sided paired t-test, comparing the average of the baseline ‘reduced-impact’ falls to the initial ‘reduced-impact’ fall at three and twelve weeks. In all cases p<0.05 was considered significant.

RESULTS AND DISCUSSION

During the baseline visit, subjects volitionally reduced their average hand impact force by 11% (p=0.017) over initial values. At 3 and 12 weeks follow-up, the subjects had successfully remembered how to maintain the reduction in hand impact force. Their initial hand impact forces, during the 3 and twelve week follow ups, were not significantly different from the average baseline ‘reduced impact’ arrests, with reductions from the average natural falls of 9% (p=0.725) and 8% (p=0.383).

Across all subjects in the first trial block the average force reduction of 11% is significantly less than the 29% achieved by similar subjects in DeGoede (2000). This discrepancy can be explained by the introduction of the 15 cm-ground clearance criterion in this experiment. This new criterion had the subject attempting to reduce their torso speed to less than 0.5 m/s at the threshold. This caused a diminution of the reduction in peak impact force because the subjects had less time and distance during the post-impact “ride-down” and were not allowed to use the torso itself to arrest any downward momentum.

To our knowledge this may be the first prospective study to demonstrate that fall-related impact forces can be volitionally reduced, in this case by a 10-minute intervention and maintained over a 12-week follow-up period. We acknowledge the limitation of a missing untrained control group, and this is currently being addressed. The most common fall direction at any age is forwards (O’Neill, 1994). The present findings suggest that interventions aimed at training people to fall forward safely may have promise.

SUMMARY

1. Healthy young males could learn in less than 10 minutes how to reduce hand impact forces in a forward fall.
2. They could also retain this skill for a period of up to twelve weeks, without the need for intervening practice sessions.

REFERENCES


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