Human Movement Science 45 (2016) 84–95

Contents lists available at ScienceDirect

Human Movement Science

journal homepage: www.elsevier.com/locate/humov

Enhanced retention of drop vertical jump landing technique: A randomized controlled trial

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ARTICLE INFO

Article history:
Received 19 May 2015
Revised 6 November 2015
Accepted 16 November 2015

Keywords:
ACL injury
Attentional focus
Motor learning
Jump landing performance
Technique

ABSTRACT

External focus instructions have been shown to result in superior motor performance compared to internal focus instructions. Using an EF may help to optimize current anterior cruciate ligament (ACL) injury prevention programs. The purpose of the current study was to investigate the effects of instructions on landing technique and performance by comparing an external focus (EF), internal focus (IF), video (VI) and control (CTRL) group. Subjects (age 22.50 ± 1.62 years, height 179.70 ± 10.43 cm, mass 73.98 ± 12.68 kg) were randomly assigned to IF (n = 10), EF (n = 10), VI (n = 10) or CTRL group (n = 10). Landing was assessed from a drop vertical jump (DVJ) in five sessions: pretest, two training blocks (TR1 and TR2) and directly after the training sessions (post test) and retention test 1 week later. Group specific instructions were offered in TR1 and TR2. Landing technique was assessed with the Landing Error Scoring System (LESS) and jump height was taken as performance measure. The results show that males in the VI group and females both in the VI and EF groups significantly improved jump-landing technique. Retention was achieved and jump height was maintained for males in the VI group and females both in the VI and EF groups. It is therefore concluded that EF and VI instructions have great potential in ACL injury prevention.

1. Introduction

Anterior cruciate ligament (ACL) injury prevention programs are effective in the short term, but lack effectiveness in the long term (Benjaminse, Gokeler, et al., 2015). There is a need for optimization of current ACL injury prevention programs considering the relatively large number of subjects needed to treat (Lyman et al., 2009) and associated time investment of training staff (McGlashan & Finch, 2010). Most ACL injury prevention programs use verbal instructions directed towards specific knowledge of body movements (Irmischer et al., 2004; Myklebust et al., 2003; Pfeiffer, Shea, Roberts, Grandstrand, & Bond, 2006). However, a novel approach in ACL injury prevention would be to adopt knowledge of motor learning (Benjaminse, Gokeler, et al., 2015; Gokeler et al., 2013). Motor skills can be learned with attention directed to the movement itself (e.g. "keep your knees over your toes"), which is defined as an internal focus (IF) Wulf, Shea, & Lewthwaite, 2010. Whereas with an external focus (EF), attention is directed towards the effect of the movement (e.g. "point your knee toward an imaginary point in front of you") (Wulf, Shea, et al., 2010).

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http://dx.doi.org/10.1016/j.humov.2015.11.008
0167-9457/

Recent studies showed effectiveness of training to optimize a drop vertical jump (DVJ) assessed with the Landing Error Scoring System (LESS) DiStefano, Padua, DiStefano, & Marshall, 2009; Padua et al., 2012. The subjects were divided in a short-duration (3 months intervention) and extended-duration (9 months intervention) group and received a set of IF instructions and cues (i.e. "keep your toes pointed straight ahead", "keep your knees over your toes" and "land softly on your toes while bending your knees"). Although both groups improved their total LESS scores from pretest to posttest, only the extended-duration training group retained their improvements 3 months after ceasing the injury prevention program. These results suggest that IF instructions result in a better landing technique, but that the high number of repetitions needed when learning movement skills with IF instructions, might require too much time commitment, and therefore potentially decreasing compliance in coaches and athletes (Frank, Register-Mihalik, & Padua, 2014; Hagglund, Atroshi, Wagner, & Walden, 2013; Lindblom, Waldén, Carlfjord, & Hägglund, 2014; McGlashan & Finch, 2010; Sugimoto, Myer, McKeon, & Hewett, 2012). Furthermore, paying attention to motor skills can work counterproductive for automatization of movement skills (Beek, 2000; Benjaminse, Welling, Otten, & Gokeler, 2015; Farrow & Abernethy, 2002). On the other side, adopting EF instructions and feedback are less attention demanding. They also improve skill retention and transfer to sport and optimize program efficiency, making the effect of these programs less transient (Benjaminse & Otten, 2011; Wulf, Shea, et al., 2010). Furthermore, in a recent systematic review it has been shown that an EF enhances motor performance and technique and improves neuromuscular coordination (Benjaminse, Welling, et al., 2015). For example, greater jumping distances (Porter, Anton, Wikoff, & Ostrowski, 2013), greater knee flexion angles (Makaruk, Porter, Czaplicki, Sadowski, & Sacewicz, 2012), more center of mass (CoM) displacement Wulf, Dufek, Lozano, & Pettigrew, 2010 and lower peak vertical ground reaction forces (vGRF) McNair, Prapavessis, & Callender, 2000; Wu, Porter, & Brown, 2012 were observed in jump landing activities. These results all suggest to be beneficial in reducing the risk of ACL injury. Hence, adoption of knowledge from the motor learning domain seems promising to enhance ACL injury prevention (Benjaminse, Gokeler, et al., 2015; Benjaminse, Welling, et al., 2015; Gokeler et al., 2015). It is also imperative to better understand and expand the generalizations how word changes in verbal instructions influence focus of attention and task execution when performing a motor skill. Limited research to date showed if subjects followed the prescribed focus instructions during motor activities (Porter, Nolan, Ostrowski, & Wulf, 2010).

In addition, visual instructions have shown to be effective in ACL injury prevention programs (Benjaminse, Otten, Gokeler, Diercks, & Lemmink, 2015; Dai et al., 2015; Munro & Herrington, 2014; Myer et al., 2013; Onate, Guskiewicz, & Sullivan, 2001; Onate et al., 2005; Parsons & Alexander, 2012). ACL injury prevention programs (Hebert, 1999; Janelle, Barba, Frehlich, Tennant, & Cauraugh, 1997; Kirkendall & Garrett, 2000) have used videotapes of an expert model for jump-landing instruction as a key component in the intervention programs to instruct individuals on the proper jump-landing techniques to reduce potentially injurious forces. The concept of an "expert model" using proper technique when landing from a jump, in addition to verbal information regarding proper technique, is thought to positively influence an individual's motor learning capabilities. Therefore, ACL injury prevention programs could be expanded to include modern technology such as video with expert learning to investigate the effects of video feedback in motor learning and retention (Benjaminse, Gokeler, et al., 2015).

This study was conducted considering the room for improvement in terms of retention of learned motor skills and time investment required from training staff. The primary purpose of the present study was to investigate the effects of instruction on landing technique and performance comparing an EF, IF, video (VI) and a control (CTRL) group. Additionally, it was examined whether possible beneficial results still existed at a retention test one-week after the testing session. The secondary purpose was to measure the consistency by which participants followed the prescribed attentional focus instructions (Porter et al., 2010). It was hypothesized that the EF and VI groups would show a better landing technique (i.e. lower LESS score) compared to the IF and CTRL groups, while maintaining performance (i.e. jump height).

2. Materials and methods

2.1. Subjects

A randomized controlled design was conducted in a laboratory setting. Forty (twenty males, twenty females) subjects were recruited from local sports clubs (Table 1). For inclusion, subjects had to be: (1) $\geqslant$18 years old and (2) physically active in (recreational) ball team sports for a minimum of 4 h per week. Subjects were excluded if they had lower extremity injury

Table 1
Descriptive of subjects per group (mean ± SD).

	EF	IF	VI	CTRL
N	10	10	10	10
Sex (m/f)	5/5	5/5	5/5	5/5
Age (years)	22.60 ± 1.35	22.10 ± 2.64	22.90 ± 0.57	22.40 ± 1.35
Height (m)	1.80 ± 0.14	1.77 ± 0.08	1.78 ± 0.10	1.83 ± 0.11
Mass (kg)	72.40 ± 10.38	71.10 ± 6.92	74.40 ± 17.10	78.00 ± 14.79

EF = external focus; IF = internal focus; VI = video instruction; CTRL = control group. Data are expressed as mean values ± SD.