Research article

EFFECTS OF AUGMENTED FEEDBACK ON LANDING FORCE FROM JUMPS

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Abstrak

Journal of Sports Science and Physical Education 6(2): 1-9, 2017 - Improper landing techniques from jumps are usually associated with knee injuries. Such incidence could be alleviated through augmented instructions and feedback on performing the landing movement. The purpose of this study was to investigate the effect of augmented feedback on landing force from jumps. Twenty-eight participants, divided into three groups (visual, n=10, verbal, n=10, control, n=8) performed jumps from a box and their ground reaction force (GRF) measured using force platform analyzer before and after treatment. The visual group received visual feedback from video playback of their landing action, the verbal group received verbal feedback based on the Landing Error Scoring System (LESS) criteria, and no feedback was provided for the control group. Both visual and verbal groups underwent interventions for two weeks, consisted of three sessions per week. Factorial mixed-design ANOVA with repeated measures on the tests results showed no significant interaction between groups and test, $F_{(2.00, 25.80)} = 841$, $p > .05$. In conclusion, feedback could be effective in reducing GRF, but may require extended duration of practice with feedback to assess its effectiveness in modifying behaviors.

Keywords: Ground Reaction Force, Landing, Augmented Feedback

INTRODUCTION

Occurrence of lower extremity musculoskeletal injury and its debilitating effects is a concern among physically active people (Onate, Guskiewic, Marshall, Giuliani & Garrett, 2005). Many types of lower extremities musculoskeletal injuries have been reported and one of the most common knee injuries is the anterior cruciate ligament (ACL). This injury is detrimental to individuals, especially athletes because of long duration and high cost of rehabilitation measures and the injured athlete may not be able to recover fully to his or her former level of performance. Related studies have shown knee injuries often occurred among athletes, and most of the injuries were not because of physical contact, but due to high loading athletic movements (Boden, Dean, Feagin, & Garrett, 2000).

Many sports movements required jumping and landing actions. Many researchers (Piasecki, Spindler, Warren, Andrish, & Parker, 2003; Powell & Barber-Foss, 2000) stated ground reaction force generated from landing has relationship with lower extremity injuries. According to Benjaminse et al., (2015), excessive force generated from landing can cause high impact on joints like ankle and knee and subsequently leads to injuries. Landing force is associated with the technique of landing (Myer et al., 2013). Dallinga et al., (2017) stated that proper landing techniques of landing can absorb the excessive force and reduce ground reaction force, thus lessen the risk on lower extremity injuries.

Landing force can be determined by ground reaction force (GRF), using force platform (Ericksen, Gribble, Pfile, & Pietrosimone, 2013). The technique of landing from an elevated position could be evaluated by the Landing Error Scoring System (LESS) where this instrument evaluates all the movement in order to complete the action of landing (Bell, Smith, Pennuto, Stiffler, & Olson, 2014; Padua et al., 2015). Dolan, Cortes, and Onate, (2013) used LESS in clinical tests to assess performance of jumping in patients with ACL. Based from their studies (Bell et al., 2014; Dolan et al., 2013), LESS can be used as a screening tool to assess the landing movement. However, just as in performing any motoric skill, individuals need to undergo a learning process with sufficient practice and feedback.

Feedback is an essential part of process in learning motor skills. Feedback is information about the previous action that determined by observation and evaluation by self or others to allow correction process (Junqueira, Ferracioli, & Ferracioli, 2012). Some researchers investigated the importance of proper landing in sports. For example, Hewett et al., (1996) used female volley ball players to evaluate the effects of six weeks of plyometric training on impact forces and hamstring torque. The impact force and muscles torque were measured by force plate and muscles dynamometer. The study showed that the plyometric training program reduced ground reaction forces in the landing phase. But these studies did not clearly show what elements that truly contributed to reduce landing forces. The reason was due to the complexity of the program which utilized many protocols, consisted of a variety of components, namely strength, power, flexibility, instruction, and feedback.

Another study examined feedback in order to learn or maximize performances. Wälchli, Ruffieux, Bourquin, Keller, and Taube, (2016) examined augmented feedback as one of their instrument for their study. This study used flight time detected by force plate and projected to screen as feedback in order to maximize jumping performance. A study by Szczepan, Zatoń, and Klarowicz, (2016) used LED tube device along the track in swimming pool that showed the light as concurrent feedback. The light responded to the speed of swimming and act as an indicator to control swimming speed in order to improve economical of energy used. It showed that this feedback gave significant effect better on controlling speed of swimming as compared to no feedback.

Feedback is divided by two categories that are intrinsic or sensory feedback and augmented feedback. Augmented feedback can improve motor performances by providing external sources of information that included of either knowledge of result (KR) or knowledge of performance (KP) (Lauber & Keller, 2014; Schmidt & Wrisberg, 2004). Augmented feedback provides additional information for intrinsic feedback (Magill, Chamberlin, & Hall, 1991). Verbal feedback, in the form of quantitative and qualitative analysis of performance, complements the effectiveness of instruction because it gives positive guideline, encouragement, and motivation (Knudson & Morrison, 2002). Study by Staub et al., (2013) provided the quantitative result for every jump performance in counter movement jump (CMJ) as verbal feedback and the intervention yielded significance positive effect. Visual feedback is another form of augmented feedback since performance in sports can be recorded using video cameras and other devises. Visual aids such as video to provide visual feedback about the performance of the motor skills (Zetou, Kourtesis, Getsiou, Michalopoulou, & Kioumourtzoglou, 2008).

Based on the previous studies (Davies, Adamson, Button, Roos, & Deursen, 2016; Keller, Lauber, Gottschalk, & Taube, 2014; Lauber & Keller, 2012; Staub et al., 2013; Szczepan et al., 2016; Wälchli et al., 2016; Weng, 2014), augmented feedback has shown to improve sports performance. However, there seems to be limited studies on the use of augmented feedback, specifically on verbal and visual on injury prevention. Hence, this study intended to investigate the effect of visual and verbal feedback on reducing landing force. It was hypothesized that there was no significant difference effect of visual and verbal feedback on reducing landing force.

METHODOLOGY

This experimental study was designed with pre-test and post-test to determine and compare the effects of video and verbal feedback on reducing landing force. All participants in this study underwent the pre-test, intervention and post-test sessions.

Participants

Twenty-eight sport science undergraduates from Sultan Idris Education University were chosen as participants through random sampling. They were aged between 18-24 years old They were

randomly divided into three groups which consisted of visual group, verbal group and control group

Visual group

This group received delayed augmented feedback by watching video recordings of their actions in landing after they have performed the activity.

Verbal group

This group received verbal feedback of how to land from the box based on the Landing Error Scoring System (LESS). Video recordings were evaluated by the main researcher to determine the performance of the action in order to give verbal feedback to them. The video recordings were not shown to this group. The evaluation consisted of stand width, foot rotation, initial foot contact, knee valgus angle, trunk lateral flexion, initial landing feet, knee flexion displacement and total joint displacement (Bell et al., 2014; Padua et al., 2015). The feedback given in the overall performance using simple words (e.g. bend your knee more, land softly, bend your hips).

Control group

This group received no feedback when they jumped from the box. They performed the pre-test, acquisition phase, and post-test without receiving any feedback.

Procedure

The participants' weight was measured to utilize ground reaction force reading into unit of body weight (BW). On the first week, the participants undergo a pre-test, where they were instructed to step off from 300mm box and land with both legs as soft as possible for three times. Peak vertical ground reaction force was measured using Gen5 AMTI (Advanced Mechanical Technology, Inc., Waltham, Watertown, USA) force and motion analyzer. After the pre - test, they had an acquisition phase of two weeks, where the visual and the verbal group received specific feedback. Each session consisted of five trials each. In the five trials of practice sessions, they received feedback only after the first and fourth trial of each exercise in order to avoid dependence on this information (Magill, 2007). In this phase, participants in the visual group watched video playback of their performance in the step off action. The video was recorded using a camera and projected to the LCD screen. Participants in the verbal group received verbal feedback on how they land from the box based on Landing Error Scoring System (LESS), while the control group was not involved with any treatments during the acquisition phase. After the end of the acquisition phase, all participants performed post-test without any feedback.

Data Analysis

All data analyzed using 'Statistical Package for Science Social' (SPSS) version 16.0. All findings recorded and included in the table. Factorial 3 groups (visual, verbal, control) x 2 tests (pre, post) ANOVA with repeated measures on the second factor was used to examine differences between the groups and interactions. Significant level for all statistical tests were set at $p < .05$

RESULTS

A three groups x two tests ANOVA with repeated measures on the second factor performed on the data collected. The descriptive data shown in *Table 1.0* and *Figure 1.0*. Descriptive data, significance level between groups and result of interaction shown in this section.

Table 1 Descriptive Statistics

	Group	Mean	Std. Deviation
Pre test	Visual	4.40	.88
	Verbal	3.42	.61
	Control	3.71	1.62
	Total	3.86	1.12
Post test	Visual	3.12	.37
	Verbal	2.63	.80
	Control	2.77	.84
	Total	2.84	.70

Mean of ground reaction force (GRF) of visual group in pre-test (M=4.4 BW, SD=.88), verbal (M=3.42, SD=.61), and control group (M=3.71, SD=1.62). While, in the post-test mean of ground reaction force (GRF) of visual group in pre-test (M=3.12, SD=.37), verbal (M=2.63, SD=.80), and control group (M=2.77, SD=.70). The results showed that although there were reduction in GRF between pre-test and post-test, no statistically significant differences was found.
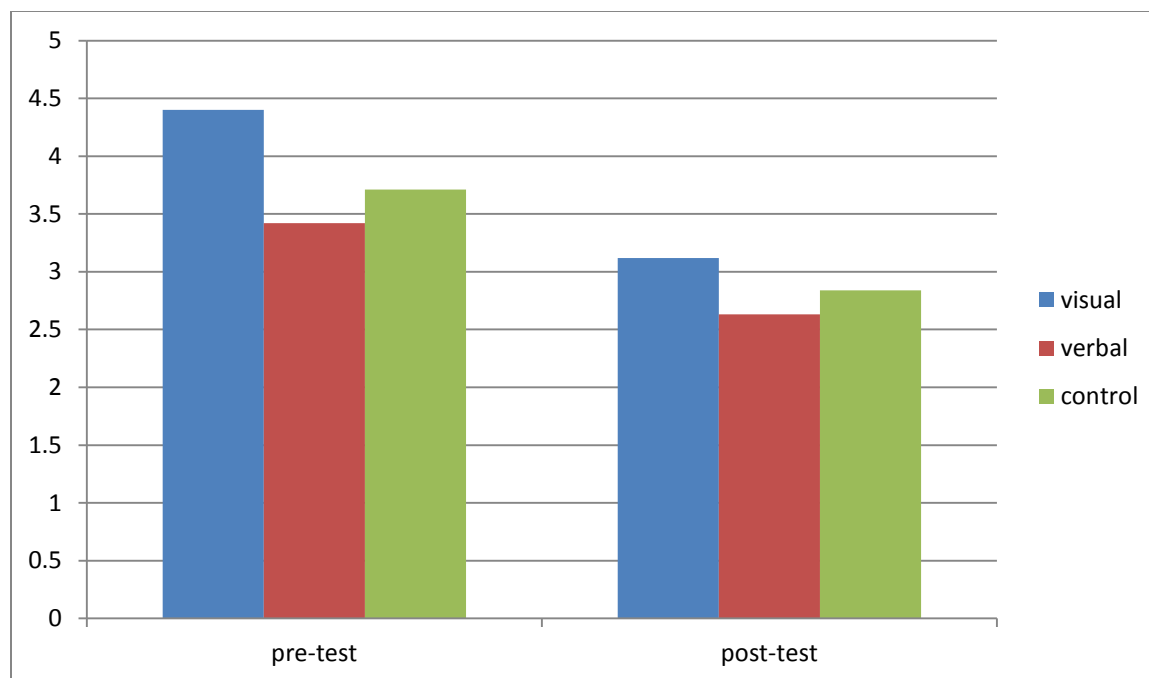
Figure 1 Mean for pre-test and post-test

Repeated measure ANOVA involving the groups were tested with two (pre-test and post-test) with repeated measures in the second factor. Based on the result $F_{(2.00, 25.80)} = 841$, $p > .05$, there were no interaction between groups and tests. As a result, the null hypothesis was accepted that there were no significant difference effect of visual, verbal feedback and no feedback on reducing the landing force**.**

DISCUSSION AND RECOMMENDATIONS

The main purpose of this study was to investigate the effects of visual and verbal feedback on reducing landing force. Based on the findings, no significant difference was displayed between groups in the post-test and there were no interactions observed between group and test as well. Feedback supposedly showed significance effect compared than no feedback group (Keller et al., 2014; Lauber & Keller, 2012; Onate, Guskiewicz, & Sullivan, 2001; Szczepan et al., 2016; Zetou et al., 2008). However, in this study, the result contradicted previous studies. This finding could be resulted due to the fact that participants that involved are from the sports science faculty and most of them are athletes and physically active. Hence, it was reasonable to conclude that the participants have already familiarized with jumping technique and effect of the treatment cannot be accurately projected. Besides, the number of sessions (six) within 2 weeks in the intervention phase may not be enough to elicit any modification of behavior (i.e., learning process). In addition, the number of repetitions for each training session which was five times per session may not be enough to elicit significant modifications of behavior. Augmented feedback was

provided once after first and fourth trials. It probably did not provide sufficient information for that skill.

Future studies could utilize motion analysis with motion capture technology to evaluate proper technique of landing mechanism with detail precision and accuracy. Other than that, the intervention period could also be extended to elicit the long term effects of learning.

REFERENCES

Bell, D. R., Smith, M. D., Pennuto, A. P., Stiffler, M. R., & Olson, M. E. (2014). Jump-landing mechanics after anterior cruciate ligament reconstruction: A landing error scoring system study. *Journal of Athletic Training*, *49*(4), 435–441. https://doi.org/10.4085/1062-6050-49.3.21

Benjaminse, A., Gokeler, A., Dowling, A. V, Faigenbaum, A., Ford, K. R., Hewett, T. E., … Myer, G. D. (2015). Optimization of the anterior cruciate ligament injury prevention paradigm: novel feedback techniques to enhance motor learning and reduce injury risk. *Journal of Orthopaedic & Sports Physical Therapy*, *45*(3), 170–182.

Boden, B. P., Dean, G. S., Feagin, J. A., & Garrett, W. E. (2000). Mechanisms of anterior cruciate ligament injury. *Orthopedics*, *23*(6), 573–578.

Dallinga, J., Benjaminse, A., Gokeler, A., Cortes, N., Otten, E., & Lemmink, K. (2017). Innovative video feedback on jump landing improves landing technique in males. *International Journal of Sports Medicine*, *38*(2), 150–158.

Davies, J. L., Adamson, P., Button, K., Roos, P., & Deursen, R. Van. (2016). Augmented feedback approach to double-leg squat training for patients with knee osteoarthritis : a preliminary study, 20–22.

Dolan, M. G., Cortes, N., & Onate, J. (2013). Clinical assessment of drop-jump landing for determination of risk for knee injury. *International Journal of Athletic Therapy and Training*, *18*(3), 10–13.

Ericksen, H. M., Gribble, P. A., Pfile, K. R., & Pietrosimone, B. G. (2013). Different modes of feedback and peak vertical ground reaction force during jump landing: a systematic review. *Journal of Athletic Training*, *48*(5), 685–695.

Hewett, T. E., Stroupe, A. L., Nance, T. A., & Noyes, F. R. (1996). Plyometric training in female athletes: decreased impact forces and increased hamstring torques. *The American Journal of Sports Medicine*, *24*(6), 765–773.

Junqueira, I., Ferracioli, D. C., & Ferracioli, M. D. C. (2012). RBCDH videotape feedback, (November), 204–214.

Keller, M., Lauber, B., Gottschalk, M., & Taube, W. (2014). Enhanced jump performance when providing augmented feedback compared to an external or internal focus of attention. *Journal of Sports Sciences*, (December 2014), 1–9. https://doi.org/10.1080/02640414.2014.984241

Knudson, D. V, & Morrison, C. S. (2002). *Qualitative Diagnosis of Human Movement With Web*

Resource. Human kinetics.

Lauber, B., & Keller, M. (2012). Improving motor performance: Selected aspects of augmented feedback in exercise and health. *European Journal of Sport Science*, *14*(July 2015), 1–8. https://doi.org/10.1080/17461391.2012.725104

Magill, R. A., Chamberlin, C. J., & Hall, K. G. (1991). Verbal knowledge of results as redundant information for learning an anticipation timing skill. *Human Movement Science*, *10*(4), 485–507.

Myer, G. D., Stroube, B. W., DiCesare, C. A., Brent, J. L., Ford, K. R., Heidt Jr, R. S., & Hewett, T. E. (2013). Augmented feedback supports skill transfer and reduces high-risk injury landing mechanics: a double-blind, randomized controlled laboratory study. *The American Journal of Sports Medicine*, *41*(3), 669–677.

Onate, J. A., Guskiewic, K. M., Marshall, S. W., Giuliani, C., Yu, B., & Garrett, W. E. (2005). Instruction of Jump-Landing Technique Using Videotape Feedback Altering Lower Extremity Motion Patterns. *American Journal of Sports Medicine*, *33*(6), 831–842. https://doi.org/10.1177/0363546504271499

Onate, J. A., Guskiewicz, K. M., & Sullivan, R. J. (2001). Augmented feedback reduces jump landing forces. *The Journal of Orthopaedic and Sports Physical Therapy*, *31*(9), 511–517. https://doi.org/10.2519/jospt.2001.31.9.511

Padua, D. A., DiStefano, L. J., Beutler, A. I., De La Motte, S. J., DiStefano, M. J., & Marshall, S. W. (2015). The landing error scoring system as a screening tool for an anterior cruciate ligament injury-prevention program in elite-youth soccer athletes. *Journal of Athletic Training*, *50*(6), 589–595. https://doi.org/10.4085/1062-6050-50.1.10

Piasecki, D. P., Spindler, K. P., Warren, T. A., Andrish, J. T., & Parker, R. D. (2003). Intraarticular injuries associated with anterior cruciate ligament tear: findings at ligament reconstruction in high school and recreational athletes An analysis of sex-based differences. *The American Journal of Sports Medicine*, *31*(4), 601–605.

Powell, J. W., & Barber-Foss, K. D. (2000). Sex-related injury patterns among selected high school sports. *The American Journal of Sports Medicine*, *28*(3), 385–391.

Schmidt, R. A., & Wrisberg, C. A. (2004). Motor learning and performance.

Staub, J. N., Kraemer, W. J., Pandit, A. L., Haug, W. B., Comstock, B. A., Dunn-Lewis, C., … Häkkinen, K. (2013). Positive effects of augmented verbal feedback on power production in NCAA Division I collegiate athletes. *The Journal of Strength & Conditioning Research*, *27*(8), 2067–2072.

Szczepan, S., Zatoń, K., & Klarowicz, A. (2016). the effeCt of ConCurrent Visual feedBaCk on ControllinG sWimminG sPeed. *Pol. J. Sport Tourism*, *23*, 3–6. https://doi.org/10.1515/pjst-2016-0001

Wälchli, M., Ruffieux, J., Bourquin, Y., Keller, M., & Taube, W. (2016). Maximizing performance: Augmented feedback, focus of attention, and/or reward? *Medicine and Science in Sports and Exercise*, *48*(4), 714–719. https://doi.org/10.1249/MSS.0000000000000818

Weng, C. (2014). The Effect of Different Feedback Methods Impact the Learning of Novice Badminton Forehand Serve in Fifth Grade Students, *4*(2), 130–138.

Zetou, E., Kourtesis, T., Getsiou, K., Michalopoulou, M., & Kioumourtzoglou, E. (2008). The effect of self-modeling on skill learning and self efficacy of novice female beach-volleyball players. *Athletic Insight: The Online Journal of Sport Psychology*, *10*(3).

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