B10-3 ID102

THE EFFECTS OF A UNILATERAL GLUTEAL ACTIVATION PROTOCOL ON SINGLE LEG DROP JUMP PERFORMANCE

Robin Healy, Andrew J Harrison

Biomechanics Research Unit, University of Limerick, Limerick, Ireland

This study examined the effects of a gluteal activation protocol (GA) on the performance of drop jumps performed on a force sledge apparatus. Fifteen sprinters performed 10 single-leg drop jumps on three days with a unilateral GA performed within the warm up on day 2. Ground contact time (CT), height jumped (HJ), maximum vertical ground reaction force (GRFmax) and vertical leg-spring stiffness (K_{vert}) were calculated on all three days. A repeated measures ANOVA was used to examine mean differences on all variables across days. The results show significant differences on all variables between days 1 and 2 and on HJ and K_{vert} between days 1 and 3 but no differences in any varables between days 2 and 3. This suggests that the improvements in day 2 were due to a practice/learning effect rather than the GA protocol.

KEY WORDS: Potentiation, Warm-up.

INTRODUCTION: This paper examines the use of low-load unilateral gluteal exercises on subsequent single leg drop jump performance to assess whether a post activation potentiation effect occurs. Postactivation potentiation (PAP) is the “transient increase in muscle contractile performance after previous contractile activity” (Sale, 2002). Previous research in complex training has examined whether the performance of heavy resistance exercise prior to explosive type movements such as plyometrics invokes a PAP effect. Comyns *et* al, (2011) reported acute improvements in ground contact time and leg stiffness following complex training. Recently, Crow *et al* (2012) examined the effect of low load gluteal exercises on countermovement jump performance and found an acute enhancement of peak power output. This enhancement has been attributed to PAP. According to the fitness-fatigue paradim (Plisk and Stone, 2003) a typical PAP effect should involve a reduction in performance immediately after the exercise stimulus followed by an enhancement some time later. Various research designs involving skills such as countermovement jumps and drop jumps to examine PAP, have failed to account for improvements in performance due to learning or practice effects that may occur in participants that are unaccustomed to performing these skills. The use of simple pre-test post-test designs may not be entirely suitable and therefore a 3 day design where participants complete a third bout of testing which mirrors that of the pre-test may allow researchers to identify whether improvements in performance occur due to learning or whether they can be attributed solely to PAP. It would be expected that learning effects would present as sustained improvement in performance on the 3rd test day or a score similar to the 2nd test day. The aim of this study was to determine the effects of a low load unilateral gluteal activation protocol on single leg drop jump performance parameters including HJ, CT, GRFmax and K_{vert} and determine, through the use of a 3 day design, if these effects can be attributed solely PAP or simply due to a learning effect.

METHODS: Subjects: Fifteen participants were recruited for this study. All participants were sprint trained males (n=8) and females (n=7); age: 19.9 ±1.6 years; height: 173.9 ±11.7 cm; body mass: 67.5 ±11.1 kg (mean ±SD) and were injury free at the time of testing. Ethical approval was granted by the local University Research Ethics Committee and all participants completed an informed consent form before testing.

Equipment: Force time data were collected using a force sledge angled at 30° to horizontal as described by Comyns et al, (2011). Force data were sampled at 1000 Hz and filtered using a Butterworth filter with a cut-off frequency of 50 Hz. Participants were secured in the sledge chair with their arms crossed to constrain potential involvement of the upper body in the performance of the drop jump.

Protocols: A 3-day testing design was used over a seven day period as illustrated in Table 1. Participants performed a standardised dynamic warm up of 3 minutes of cycling at a self-selected pace followed by four repetitions of high knees, walking hamstring sweeps and walking lunges over 10 m on all 3 days using a procedure adapted from Esformes *et al*, (2010) which examined PAP in sprint trained males. The participants performed single leg drop jumps from a standardised drop height of 30 cm on their dominant leg with a rest interval of 1 minute between trials which allowed for full recovery. Following the procedures used in Comyns *et al*, (2011), the participants were instructed to minimise their contact time on the force plate while maximising the height of the jump and during all three testing days participants were given the following cue after their third, sixth and ninth jump to ensure consistency of technique “Minimimize your contact time, get off the plate as quick as you can”. On day 1, following warm up, 3 familiarisation jumps and 10 single leg drop jumps were perfomed. On day 2, 10 drop jumps were performed after a warm up and a gluteal activation (GA) protocol as described in Table 2, with each exercise being performed for 10 reps and contractions held for 5 seconds.

Data Analysis: The dependent variables were contact time (CT), maximum vertical ground reaction force (GRFmax), height jumped (HJ) and vertical leg-spring stiffness (K_{vert}). CT and GRFmax were obtained directly from the force platform data; HJ was found using an adaptation of the equation of Bosco *et al,* (1983): $HJ= (9.81 * (FT)^2)/16$ where FT represented the flight time and the equation was adjusted for the 30° incline of the force sledge. K_{vert} was derived by the equation $K_{vert} = [m. \pi(FT + CT)] / \{CT^2[FT + CT] / \pi – CT/4]\}$ where m is mass of participant and force sledge, FT is flight time and CT is contact time.. Statistical analyses were conducted using a repeated measures analysis of variance (ANOVA) with the alpha level set at $p \leq 0.05$.

Table 1: Layout of Three-Day Design

Standardized Dynamic Warm up ↓ **3 Familiarisation Single Leg Drop Jumps** ↓ **Single Leg Drop Jump performed every minute for 10 minutes**	**Standardized Dynamic Warm up** ↓ **Gluteal Activation Protocol** ↓ **1 Single Leg Drop Jump every minute for 10 minutes**	**Standardized dynamic Warm up** ↓ **Single Leg Drop Jump performed every minute for 10 minutes**
Day 1 Pre-test/Control	**Day 3 Intervention**	**Day 7 Control**

Table 2: Gluteal activation exercises in order of performance adapted from Crow *et al*, (2012)

Unilateral bridge	Quadruped lower extremity lift	Quadruped hip abduction	Side lying clam in 60 degree hip flexion	Side lying hip abduction	Prone single leg hip extension	Single limb squat

RESULTS: The mean results for all variables are shown in figure1 below. Repeated measures ANOVA found significant differences for CT, FT, GRFmax and K_{vert} between days

1 and 2. CT and FT reduced by 0.036 s (8.93%, *p*=0.005) and 0.026 m (9.25%, *p*=0.008) respectively whereas GRFmax and K_{vert} increased by 57.0 N (7.23%, *p*=0.011) and 707.8 N.m^{-1} (19.06%, *p*=0.004) respectively. Significant differences were also found between days. 1 and 3 for HJ and K_{vert}. HJ decreased by 0.023 m (8.19%, *p*=0.033) and K_{vert} increased by 481.6 N.m^{-1} (12.97%, *p*=0.041). No difference was found between days 2 and 3 for all variables.

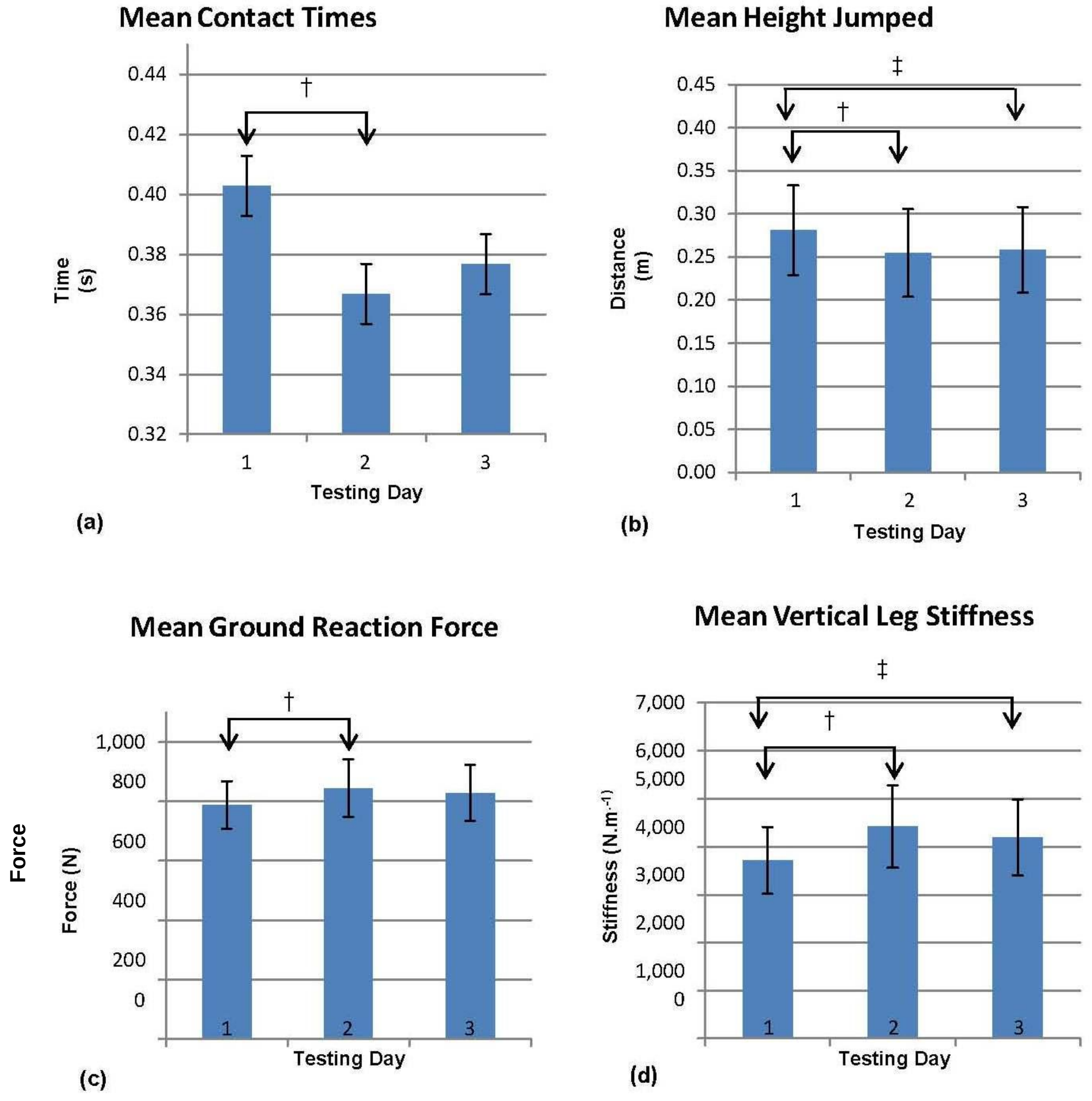

Figure 1: Mean results for contact time (a), height jumped (b), maximum ground reaction force (c) and vertical leg spring stiffness (d). † Denotes statistically significant difference between days 1 and 2 ($p \leq 0.05$). ‡ Denotes statistically significant difference between days 1 and 3 ($p \leq 0.05$).

DISCUSSION: The results in Figure 1, show significant differences in all variables between days 1 and 2. This suggests that improvements were due to PAP however the 3 day design used showed no significant differences between days 2 and 3. This combined with the significant differences in HJ and K_{vert} between days 1 and 3 suggest that a learning effect had occurred and improvements between days 1 and 2 were more likely due to practise. If PAP were to truly occur then acute improvements in performance should be evident in day 2 of testing with no differences between days 1 and 3. These results appear to contradict those of Crow *et al,* (2012) since no performance enhancing effect was found as a result of a GA protocol. A simple pre-test post- design on day 1 and day 2 data would have resulted in statistically significant reductions in CT and HJ and improvements in GRFmax and K_{vert} which would have incorrectly indicated a PAP related effect. The results showed that the GA protocol caused neither an improvement or impairment in performance and this suggests that GA exercises can be combined with explosive and dynamic exercises in a very practical and safe manner. This should improve session efficiency compared to performing these exercise seperately. A potential limitation may exist in the use of conventional statistical hypothesis tests such as Student-t or ANOVA to detect PAP related differences because the variations in the timelines of recovery between subjects may increase sample variability at each time point and thereby mask true differences in the group. The typical error method (Hopkins, 2000) may be a more suitable method for detecting PAP related changes in individuals as it compares individual post test changes in performance against the biological variability of each subjects baseline (i.e. pre-test) performance. From a practical standpoint, GA exercises can be combined with explosive type exercises in order to improve training session efficiency. Due to the complex relationship of factors required to elicit a PAP response, further research on GA should endeavour to assess whether differences in variables such as volume and intensityof the pre load stimulus results in acute improvements.

CONCLUSION: The GA protocol performed following a dynamic warm up had no acute performance enhancing or impairing effect on subsequent drop performance compared to a dynamic warm up alone in sprint trained individuals. These results appear to contradict those of Crow *et al,* (2012) It is concluded that the significant differences observed in this study can be attributed to a learning/practise effect. A 3 day research design is recommended to control for improvements occuring due to learning.

REFERENCES:

Bosco, C. Luhtanen, P., & Komi, P.V. (1983). A simple method for measurement of mechanical power in jumping. *European Journal of Applied Physiology and Occupational Physiology*, 50 (2), 273-282.

Comyns, T.M., Harrison, A.J. & Hennessy, L.K. (2011). An investigation into the recovery process of a maximum stretch-shortening cycle fatigue protocol on drop and rebound jumps. *Journal of Strength and Conditioning*, 25(8), 2177-2184.

Crow, J.F., Buttifant, D., Kearny, S.G. & Hrysomallis, C. (2012). Low load exercises targeting the gluteal muscle group acutely enhance explosive power output in elite athletes. *Journal of Strength and Conditioning Research*, 26(2), 438-42.

Dalleau, G., Belli, A., Viale, F., Lacour, J.R. & Bourdin, M. (2004). A simple method for field measurements of leg stiffness in hopping. *International Journal of Sports Medicine* 25, 170-176.

Esformes, J.J., Cameron, N. & Bampouras, T.M. (2010) Postactivation potentiation following different modes of exercise. *Journal of Strength and Conditioning Research* 24, 1911-1916.

Hopkins, W.G. (2000). Measures of Reliability in Sports Medicine and Science, *Sports Medicine*, 30(1), 1-15.

Plisk, S.S. & Stone, M.H. (2003). Periodization Strategies. *Strength Conditioning Journal*, *25*, 19-37.

Sale, D.G. (2002). Postactivation potentiation: Role in human performance, *Exercise & Sport Sciences Reviews*, 30(3), 138-143.

Acknowledgement

The author would like to thank the ISBS for financial assistance for the completion of this study.