THE EFFECTIVENESS OF THE GOGGLES TRAINING SYSTEM AS A COACHING TOOL IN CHANGING PELVIS ANGLE AT THE CATCH DURING ON-WATER ROWING

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The body positions and repetitive action of rowing may predispose a rower to low back injury. This project aimed to identify the immediate, and training, effects of visual feedback on lumbo-pelvic angle during one minute of on-water rowing. Visual feedback was provided through the Goggles Training System (GTS™) for eight NZ national rowers. Pre- and post-training testing consisted of four one minute rowing trials at 28 strokes per minute with: A) No goggles & no instruction; B) Goggles & no instruction; C) No goggles & instruction; and D) Goggles & instruction. Repeated measures ANOVA showed no significant differences for ensembled averages for lumbo-pelvic angle. The GTS™ significantly reduced lumbo-pelvic angle for some rowers. The results support further use of the GTS™ as a tool for improving rowing technique and preventing low back injury.

KEY WORDS: Rowing, low back pain, visual feedback, kinematics, performance.

INTRODUCTION: Approximately 70% of rowers experience low back pain severe enough to require treatment from a health provider (Hickey, Fricker, & McDonald, 1997; Roy et al., 1990). A number of factors have been proposed for this such as the amount of time a rower spends in a flexed position, the number of cycles of the rowing stroke completed, and the forces on the body during the rowing stroke (Reid & McNair, 2000). During rowing an athlete will spend 70% of each stroke cycle in a flexed posture (Hosea, Boland, McCarthy, & Kennedy, 1989). Additionally, within a single 90 min training session, a rower may cover 20-25 kilometres amounting to approximately 1800 cycles of flexion per session (Reid & McNair, 2000). This repetitive cyclic action of rowing may predispose the rower to low back injury. Fatigue of lumbar muscles has also been shown to affect the ability of participants to sense a change in position of the lumbar spine (Tamiela, Kankaapa, & Luoto, 1999). In rowing, this may mean that as the athlete fatigues they may not be aware they are moving into a more flexed posture. Increased flexion may lead to hypermobility of the spine and this has been linked with increases in LBP within rowing populations (Howell, 1984). Howell (1984) stated that 94% of the 17 rowers studied demonstrated hypermobility of the lumbar spine with 82.2% suffering from LBP. In an effort to decrease the forces on the lumbar spine, it has been suggested (Stallard, 1999) that rowers should adopt a less flexed lumbar spine posture, particularly at the catch phase when the oar is placed in the water. In this respect, if the pelvis could be rotated more anteriorly, less motion would be required in the lumbar spine. New Zealand elite rowing coaches are endeavouring to coach athletes to adopt this posture of increased lumbo-pelvic angle (this means less lumbar flexion). Video analysis can be utilised, however, due to the on-water nature of this sport, footage is not viewed for sometime following completion of the movement. Changes to technique most commonly occur as a coach is providing verbal cues to a rower. Trying to modify a pattern of movement (in this case to reduce lumbo-pelvic flexion posture during the drive phase in rowing) once it has been learnt requires the learning of a new movement pattern. There are three phases to skill learning; the cognitive, associative and autonomous phases (Fitts and Posner, 1967). The cognitive phase requires thought and attention as the learner begins to understand the nature of the task and develop strategies to carry out the task. As a skill becomes more refined the learner moves into the associative phase. There is less variability in the skill and improvements are less dramatic. The autonomous phase is characterised by the skill becoming automatic and a lower degree of attention is required for skilled performance. Knowledge of the performance and knowledge of the results are important for the leaner to modify the strategies focussing on the errors and eliminating them (O'Sullivan and Schmitz, 2001). In this phase processing of sensory cues is required. Visual cues are reported to most accurately guide the learning of movements (O'Sullivan & Schmitz, 2001). The equivocal findings regarding the usefulness of visual cues as a training tool may be due to the time delay between practice and viewing (Carr and Shepard, 1998). The use of real time visual feedback may play an important role in enhancing the motor learning required to change from the flexed to the upright posture, especially in the cognitive and associative phases of the learning process. This project aimed to identify if lumbo-pelvic angle could be changed with verbal and/or real time visual feedback during on-water rowing through use of the GTS™. It was hypothesised that while using the GTS™ and receiving verbal instructions the subjects would have a decreased lumbo-pelvic angle (i.e., a more upright rowing position).

METHODS: Visual feedback in real time was provided to eight "rowers" (a "quad crew" of four rowers & a "four crew" of four scullers) whilst rowing on-water via a telemetry GTS™. The goggles are a unique head mounted display unit through which a sagittal view of the rower was projected in real time (see Figure 1). The goggles are of lightweight design and allow the rower to clearly see their rowing action from any direction (dependent upon the placement of the video camera). The eight participants (average age = 23 ± 2.5 years; range 19 – 26 years) from the New Zealand female squad were free from lower back injury at the time of the study. Each participant gave written consent prior to testing as required by the AUT Human Ethics Committee.

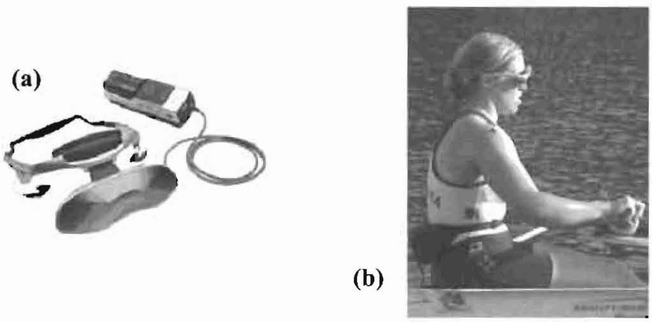

Figure 1. (a) The Glasstron® goggles. (b) The goggles being used during on-water testing. The rower can see this sagittal view through the goggles.

A cross over design was used to test the two crews and is outlined in Figure 2. The rowers completed a 1000m warm-up prior to carrying out four one-minute trials in a set order with a two minute recovery period between each trial. The four conditions were: A) No goggles & no verbal instruction; B) Wearing goggles & no verbal instruction; C) No goggles & verbal instruction; and D) Wearing goggles & verbal instruction. Verbal instructions for achieving a more upright rowing position at the catch and finish positions were given by the same national coach. Instructions were consistent within and between crews. A constant cadence of 28 strokes per minute was maintained throughout each trial. A Sony digital video camera operating at 25 Hz recorded sagittal plane kinematics. Sagittal plane joint markers were placed on the right side of the body at the lateral aspect of the 7^{th} rib, the superior lateral iliac crest and the greater trochanter (see Figure 1). Using manually digitised coordinates from Video Expert II® the lumbo-pelvic angle was calculated using Microsoft Excel® for the drive phase of three strokes. The test-retest reliability error for manual digitising of a rowing stroke using Video Expert II® software was less than two degrees for this study. Descriptive statistics for each variable included ensembled averages, standard deviation, and effect size. Repeated measured ANOVA assessed within session differences ($p < 0.05$) and pre- and post training differences. The paired t-test was used to analyse within subject differences.

RESULTS: Although there were no significant differences in ensembled average lumbo-pelvic angles (rowing in a more upright position and therefore less spine flexion) within or between testing sessions, there was a trend for small increases in lumbo-pelvic angle for six subjects (3 scullers & 3 rowers) when analysing individual data. Figure 3a shows the immediate effects of visual and verbal feedback on subject 1 (sculler). Lumbo-pelvic angle was significantly greater when both verbal and visual cues were provided (GV) compared to no cues (NGNV). Following training with the GTS™ for 20 minutes per day five days a significant increase in lumbo-pelvic angle was observed for subject 2 (sculler). This increase in lumbo-pelvic angle remained present one week following training with the GTS™.

Day	Quad (n = 4)	Four (n = 4)
	BASELINE TESTING	**BASELINE TESTING 1**
1	" NGNV	" NGNV
	" GNV	
	" NGV	
	" GV	
2 - 7	**GTS™ 20 min / day**	**Verbal instruction 20 min / day**
	1st RE-TEST	**BASELINE TESTING 2**
8	" NGNV	" NGNV
	" GNV	" GNV
	" NGV	" NGV
	" GV	" GV
9 / 14	**Verbal instruction 20 min / day**	**GTS™ 20 min / day**
	2nd RE-TEST	**1st RE-TEST**
15	" NGNV	" NGNV
		" GNV
		" NGV
		" GV

Key: NG = No goggles, NV = No verbal instruction, G = Goggles, V = Verbal instruction.

Figure 2. Schematic illustration shows the testing sessions and training requirements over the two weeks for each crew.

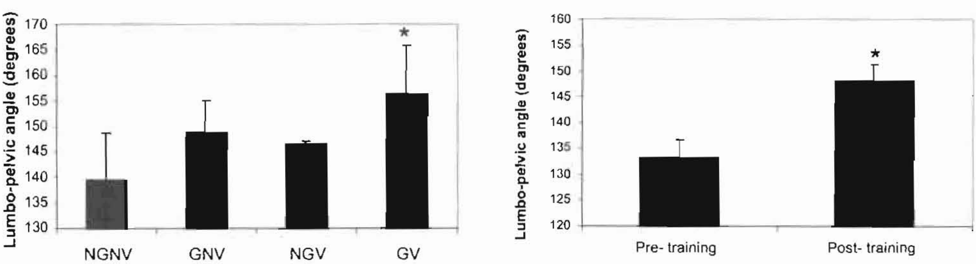

Figure 3. Immediate (a) and training (b) effects of the GTS™ on lumbo-pelvic angle at the catch for individual subjects 1 and 2 respectively (*$p<0.05$).

DISCUSSION: The hypothesis that while using the GTS™ and receiving verbal instructions the rowers would have an increased lumbo-pelvic angle was not supported in the present study by group analysis. It is proposed that the analysis methods were not sensitive enough to detect any consistent change in lumbo-pelvic angle. There was a trend of improved lumbo-pelvic angle at the catch for 75% of the rowers, however this change was at times within the margin of digitising error. There was increased lumbo-pelvic angle following five days of training with the GTS™ (Figure 3b) for four subjects (two subjects showed significant increases). It is possible that due to the experience of the subjects (5 – 10 years), the rate of change of a previously learnt task would be slower than for novice rowers learning the task for the first time. Therefore the allocated training time of five days may not have been adequate to gain significant changes. A limited sample size, on-water video collection, and manual digitising all contributed to the non-significant group findings despite the positive subjective response from the national coach on the ability of the GTS™ to improve body position during the drive phase of rowing. Additionally it is believed that the sample selected, national and elite level rowers were not considered to have poor lumbo-pelvic angles at the catch and during the drive phase and therefore the relative change compared to some novice rowers would be smaller. This proposition is supported by prior pilot work which used nine junior rowers and a Rowperfect® ergometer and showed an increased pelvic angle at the catch (reduced lumbar flexion) and a 20.3 – 29.0% increase ($p = < 0.05$) in power output across the same four testing conditions following one week of training with the goggles. The methodology and technology used in the current study was unique and attempted to ask an applied question in the aim of providing a coaching tool for the improvement of rowing performance and prevention of LBP. This study provides positive initial results on using real-time visual feedback for improving lumbo-pelvic angle and reducing LBP. The researchers believe that with the overriding positive feedback from the coach and rowers the GTS™ will assist in improving all aspects of rowing technique.

CONCLUSION: The results of this study provide some initial support for further use of the GTS™ as a tool for improving rowing technique and injury prevention.

REFERENCES:

Carr, J., & Shepherd, R. (1998). *Neurological Rehabilitation- Optimising Motor Performance*. London: Butterworth- Heinemann.
Fitts, P., & Posner, M. (1967). *Human Performance*. California: Brooks Cole.
Hickey, G., Fricker, P., & McDonald, W. (1997). Injuries to elite rowers over a 10 year period. *Medicine and Science in Sports and Exercise,* **29**(12), 1567-1572.
Hosea, T., Boland, A., McCarthy, K., & Kennedy, T. (1989). Rowing Injuries. *Post Graduate Advances in Sports Medicine- Forum Medicum Inc. University of Pennsylvania, School of Medicine, Pennsylvania.*
Howell, D. (1984). Musculoskeletal profile and incidence of musculosketal injuries in lightweight women rowers. *American Journal of Sports Medicine,* **12**(4), 278-281.
O'Sullivan, S., & Schmitz, T. (2001). *Physical Rehabilitation- Assessment and Treatment* (4th ed.). Philadelphia: F.A. Davis.
Reid, D., & McNair, P. (2000). Factors contributing to low back pain in rowers. *British Journal of Sports Medicine,* (34), 321-325.
Roy, S., DeLuca, C., Snyder-Mackler, L., Emley, M., Crenshaw, R., & Lyons, J. (1990). Fatigue, recovery and low back pain in varsity rowers. *Medicine and Science in Sports and Exercise,* **22**(4), 463-469.
Stallard, M. (1999). The challenge of rowers backache. *Sport and Medicine Today,* 1(2), 53-55.
Tamiela, S., Kankaapa, M., & Luoto, S. (1999). The effect of lumbar fatigue on the ability to sense a change in lumbar position. A controlled study. *Spine,* **24**(13), 1322-1327.

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