EFFECTS OF SIX WEEKS OF TRAINING ON INTERSEGMENTAL COORDINATION IN THE ROWING STROKE OF NOVICE INTERCOLLEGIATE ROWERS

Monique Butcher Mokha, Kathryn M. Ludwig, Shawna A. Wood, and Paul S. Mokha
Barry University, Miami Shores, Florida, USA

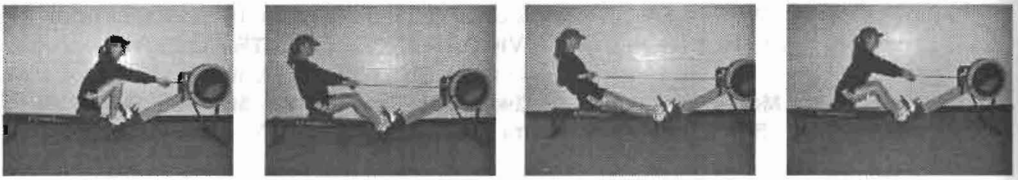
The purpose of the study was to examine changes in coordination during the rowing stroke after 1 and 6 weeks of practice. Initially 11 healthy, females who had elected to join a college rowing program volunteered to participate in both testing sessions: Only 3 participants were still on the novice team at wk 6, thus N=3. Participants were videotaped on a land ergometer in 2D using the Peak Motion Measurement System. SPC was assessed between adjacent 2-segment combinations of the T-S (trunk-shoulder), K-T (knee-trunk), and S-E (shoulder-elbow) to quantify intersegmental coordination. Mean changes in T-S (78.7% v 74.6 %), K-T (66.5% v 102.9%) and S-E (88.2% v 71.3%) showed that the rowing stroke is primarily a simultaneous pattern. However, individual SPC (shared positive contribution) changes varied indicating that 6 wks is not a long enough for coordination to develop in novice rowers.

KEY WORDS: rowing, coordination, shared positive contribution, novice rower.

INTRODUCTION: The development of the timing and sequencing of body segments, or coordination, in sport skills is paramount to the coaching profession, especially in the sport of rowing where the novice team consists of men and women who have never rowed before, and must become proficient in a relatively short period of time. Rowing is a highly technical skill, thus coordination is a key component in achieving the efficiency of the elite rower. However, in the past there have been few biomechanical investigations performed on the mechanical efficiency of rowers, so coaches rely on the appearance of technique (McGregor, Anderton, & Gedroyc, 2002). Nelson and Widule (1983) found that the coordination of trunk and knee extension was of great importance. They showed that the proper body sequence during the drive phase, in order to achieve the most effective rowing, is knee extension in the early part of the drive, then trunk extension. In comparing novice to skilled rowers, they found that peak angular velocities of the knee and the trunk occurred farther apart for the novice rowers than the skilled, resulting in decreased efficiency. Bull and McGregor (2000) found significant differences in femoral, thoraco-lumbar and lumbo-sacral flexion within different styles of rowing. Smith and Spinks (1995) showed that biomechanical performance variables related to rowing capacity; including stroke-to-stroke consistency and stroke smoothness, can be used to accurately discriminate between rowers of different skill levels.

Hudson (1986) introduced a method to quantify intersegmental coordination. She assessed the degree to which adjacent segments operate simultaneously or sequentially by identifying the shared positive contribution (SPC) of the segments during a skill. When a segment is moving in the intended direction with increasing velocity, it is in a state of positive propulsion. SPC was calculated as the time two adjacent segments were simultaneously in positive propulsion divided by the total time either segment was in positive propulsion, and expressed as a percentage. Values close to 0% indicate a primarily sequential pattern with those close to 100% indicating a primarily simultaneous pattern. Others have employed this method of quantifying coordination in striking skills such as the roundhouse middle kick (Kadono, 2003), racketball serving (Smith, Ludwig, Butcher, & Wilkerson, 1996; Smith, McCabe, & Wilkerson, 2001), and badminton (Bird, Hills, & Hudson, 1991). Highly skilled performers of these striking skills generally exhibited a sequential pattern of segmental coordination. Conflict exists as to whether the rowing stroke is a sequential or simultaneous task.

The rowing stroke is divided into four basic parts focusing on the motion of the oar: finish, recovery, catch, and drive phase. This paper will focus on the changes in SPC during the drive phase. The drive phase is the major force producing phase and includes the movement of the oar through the water.



Catch Drive Finish Recovery

Figure 1: Phases of the rowing stroke.

The purpose of this study was to examine changes in coordination in novice female rowers during the rowing stroke after 1 and 6 weeks of practice.

METHODS: Participants were initially 11 adult female volunteers recruited from a larger group who had elected to join the novice rowing team at Barry University in the fall of 2002. All agreed to participate in two sessions (1 = post one week of rowing instruction, and 2 = post six weeks of rowing instruction). Novice was defined as an individual with no prior experience in rowing on-water. In addition, participants had no prior experience on a rowing ergometer. The team was coached by Barry University staff employed by the Department of Intercollegiate Athletics. The coaching staff was responsible for all rowing instruction. As is typical with collegiate novice women's rowing teams, drop out occurred. This left only three of the initial 11 participants available for post-testing. Thus, complete data exist on N = 3. Participants were videotaped during both sessions while rowing on a Concept II© Indoor Rowing ergometer. This brand and style of land ergometer is standard training equipment for all classes of rowers, and is capable of simulating the mechanics of on-water rowing (Lamb, 1989). Resistance was set at three per USA National Team Testing Procedures. A single stationary 120 Hz Pulnix camera wacATCHs placed 4 m from the ergometer perpendicular to the rowing plane. Two points of a known relative distance were placed in the movement space and videotaped for calibration purposes. Upon calibration, the camera remained undisturbed. Reflective markers were placed on the right shoulder, elbow, wrist, pelvis, hip, knee and ankle of each subject. After a standard warm-up of stretching, participants were asked to row continuously for 2-3 mins. building in intensity. As maximum intensity was reached, they were asked to maintain that output for 10 strokes (a Power Ten). After the tenth stroke, the participants were asked to reduce intensity until a resting state was assumed. Resting state was defined a perceived rate of exertion of 8 or lower on the Borg's scale. Videotaping occurred during the Power Ten. A trial from strokes six through nine was randomly selected for analysis. Points were digitized to obtain two-dimensional coordinates. Segments were created between two adjacent points, then relative vector angles (elbow flexion, knee extension) and absolute vector angles (trunk extension, shoulder extension) were created using the Peak Motus software (ver. 7.3.2, Peak Performance Technologies, Inc., Englewood, CO, USA). SPC for the knee-trunk (K-T) trunk-shoulder (T-S), and shoulder-elbow (S-E) were determined in the drive phase of the stroke according to Hudson (1986). Since the novice participants often initiated propulsion of the distal segment before motion of the proximal segment, SPC values could be above 100%. For example, a value of 50% (proximal to distal) was recorded as 50% whereas one of 50% (distal to proximal) was recorded as 150% (Smith et al., 2001). Any value greater than 100% indicated a distal-to-proximal pattern of propulsion initiation.

RESULTS: Data are presented on the three participants who had continuous instruction with the college rowing team for at least the six week period. Mean SPC values from wk 1 and wk 6 for K-T (66.5+55.9% v 102.9+ 24.1%), T-S (78.7+63.7% v 74.6+46.9%), and S-E (88.2+45.0% v 71.3+24.9%). Table 1 depicts a comparison SPC for all subjects for both sessions. Individual data were highly variable, and showed no trends.

Table 1 Shared Positive Contribution.

	Session	
Participant	1 (post 1-wk)	2 (post 6 wks)
Knee-Trunk		
A	91.4	75.8
B	2.4	111.1
C	105.6	121.8
D*		100.0
Trunk-Shoulder		
A	73.1	27.3
B	145.0	121.1
C	17.9	75.6
D*		50.0
Shoulder-Elbow		
A	38.0	58.7
B	124.8	55.3
C	102.2	100.0
D*		80.8

Note. *denotes that participant D is from our data base of elite female rowers and is shown here for comparison only.

Figures 2 and 3 show the timing of the angular velocities for a single novice subject. Figure 4 shows the timing of the angular velocities of a single elite rower from our database.

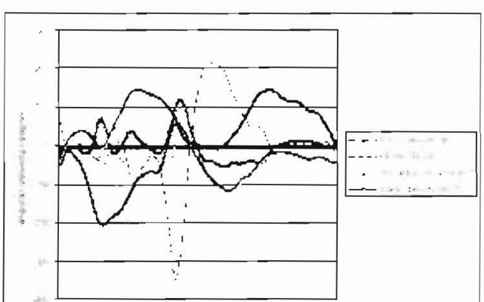


Figure 2: Subject B: Angular velocities 1 6 wk post instruction.

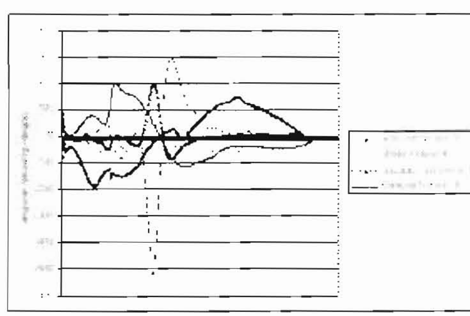


Figure 3: Subject B Angular velocities post instruction.

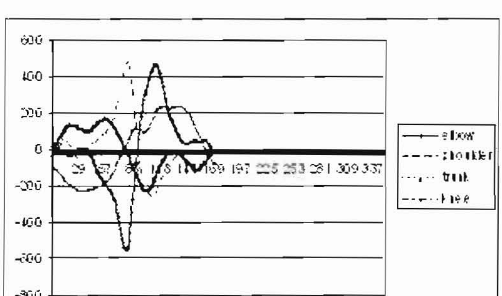


Figure 4: Angular velocities of an elite female rower.

DISCUSSION AND CONCLUSIONS: Elite rowers are better able to synchronize the kinematics of their movements. In this study, this synchronization, or coordination was measured over two different time instances in female novice rowers. Two general conclusions can be made. First, it is apparent six weeks of continuous instruction is not enough time for a novice rower to become coordinated. When SPC of the novices at 6 wks was compared to SPC of an elite rower, K-T, T-S and S-E were different. Of particular note is the SPC of the T-S. The novices demonstrated difficulty in the timing of when to incorporate the shoulder motion into the drive. Many non-rowers consider rowing to be more of an upper body sport than a lower body or trunk sport. Perhaps the findings of T-S variability and lack of matching with our elite rower are due to this notion. All of the novices showed less of a deviation from our elite rower in K-T and S-E, indicating that managing the timing of the propulsion of these segments is less difficult. It is suggested that coaches focus their instruction with novices on the timing of the shoulders and trunk propulsion in order to maximize technique training time. Secondly, it can be concluded that rowing is more of a simultaneous task than a sequential one. In general, all of the novices exhibited a simultaneous pattern, one consistent with a task that is of a closed-kinetic chain nature and requires moving a heavy object (the body) through space (Hudson, 1986). It is possible that developing coordination in simultaneous skills takes longer than 6 wks. Coaches are faced with developing a competitive novice team in a very short period of time, sometimes in only 8-10 wks. Based on our findings, these coaches can expect inconsistent results in ergometer fitness tests, difficulty in establishing training and racing line-ups, and predicting potential of a novice rower. Since novice rowing is known to have a high attrition rate, especially in the beginning, rowers should be encouraged by coaches to be patient with their skill development as it most likely takes longer than 6 wks to develop.

REFERENCES:

Bird. M., Hills, L., & Hudson, J.L. (1991). Intersegmental coordination: an exploration of context. In C. Tant, P. Patterson, & S. York (Eds.), Biomechanics in sports: IX. Proceedings of the 9th International Symposium on Biomechanics in Sports. Ames, IA: Iowa State University.

Hudson, J. L. (1986). Coordination of segments in the vertical jump. Medicine and Science in Sports and Exercise, 18, 242-251.

Kadono, N. (2003). The roundhouse middle kick: a comparison of intersegmental coordination between beginner and advanced performers. Unpublished master's thesis.

Lamb, D. H. (1989). A kinetic comparison of ergometer and on-water rowing. The American Journal of Sports Medicine, 17, 367-373.

McGregor, A., Anderton, L., & Gedroyc, W. (2002). The assessment of intersegmental motion of pelvic tilt in elite oarsman. Medicine and Science in Sports and Exercise, 34, 1143-1149.

Nelson, W.N. & Widule, C.J. (1983). Kinematic analysis of efficiency estimate of intercollegiate female rowers. Medicine and Science in Sports and Exercise, 15, 535-541.

Smith, D.R., Ludwig, K.M., Butcher, G.M., & Wilkerson, J.D. (1996). A comparison of three racket skills executed by novice and experienced performers. In Rodano, (Ed.), Proceedings of the Fourteenth International Symposium of the International Society on Biomechanics in Sport. Lisboa, Portugal: Edicoes FMH.

Smith, D.R., McCabe, D. R., & Wilkerson, J. D. (2001). An analysis of a discrete complex skill using Bernstein's stages of learning. Perceptual and Motor Skills, 93, 181-191.