

ECCENTRIC TRAINING ON ROWING PERFORMANCE: A CONCEPT PAPER

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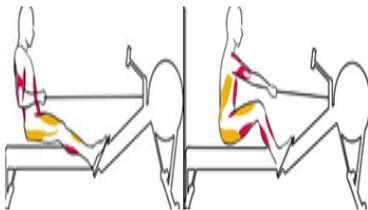
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Graphical abstract



Abstract

Physical injuries are almost a norm among athletes. In a sport such as rowing, the common injuries among rowers concentrated on the lower back, knee and wrist regions. Henceforth, rowers participate in various training regimes such as aerobic training, resistance training, concurrent training and interval training in order to minimize the occurrence of injuries. Nevertheless, since injuries among rowers are still reported despite this efforts, experts raised questions on the effectiveness on a number of the training regimes. This study gives a special focus on eccentric training. Eccentric training is proven to improve musculoskeletal function in human body such as strength, endurance and physical power. However, with respect to the science among rowers; there are inconclusive results gathered from literature on the benefits given by eccentric training especially at core body section. The objective of this concept paper is to determine the effects of eccentric training in delaying muscle fatigue, changing in physical characteristic and improving physical related fitness performance among rowers. The objective will be achieved by measuring the muscle activation and muscle fatigue of a number of selected muscles among rowers by using surface electromyography (sEMG). This sEMG measurement will be performed during rowing performance 2000m maximal effort. It is hypothesized that eccentric training may appear to demonstrate greater improvement on physical development among rowers in comparison to other training regimes. There are need of studies on benefits of eccentric to confirm the controvert finding especially on rowing population regarding delaying muscle fatigue. This is crucial to reduce the risk of injuries among rowers. The findings from this study such as the type of exercises, intensity and intensity for eccentric training will contribute new knowledge upon prescribing eccentric training regime to rowers.

Keywords: Eccentric training exercise, rowing, muscle fatigue, electromyography (EMG)

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1.0 INTRODUCTION

The nature of rowing sport involve separate groups of athletes' racing against each other in boats that are propelled by the rowing motions of oars. Rowing movements involves cyclically synchronous motion of both the upper and lower body limbs [1]. It engages over 70% of body muscle mass, numerous muscle groups of the lower limbs, abdomen (core), buttocks, shoulders and arms, and it increases metabolic changes in the rower's body [1]. In order to

effectively participate in this rigorous sport, rowers require muscular strength to give speed to the boat at the beginning of the race while high efficiency of muscular endurance is needed to maintain speed throughout the race [2]. As other types of sports, the goal of this sporting event is to win. Hence, various scientific studies have been performed to acquire the extra edge in the sport.

Sports results in rowing depend on various factors such as morphological traits (anthropometric characteristics), excellent fitness level, high technical

level, tactical, technological development of rowing shells and oars, weather conditions and optimization of the training programme as a successful preparation before joining the event [3, 4]. Interesting, it was found that senior elite rowers are stronger than their less successful peers, whether through genetic endowment, successive years of rowing or the diligent pursuit of weight- training as a normal basis [5]. Henceforth, rowers participate in various types of exercise or training regime to maintain and elevate their personal fitness level. Other than to increase the chances of victory, the training regimes are also essential in minimizing the possibility of injuries while participating in the sport.

Rowers frequently experiences injuries especially during competition. Study conducted among British senior rowers stated that, injuries constantly occur at the lower back, knees and wrists [6]. It stated that, the statistic of lower back injury consist of 32.3% of all injuries among elite level junior rowers and these findings are in line with published reports in older rowers of 25% to 50% [2, 7]. The frequencies of low back injuries among elite male junior rowers were greater when compared to female (34.4% vs. 29.9%) and sustained during cross-training programme. These problems occur due to a number of factors, such as muscle fatigue during performing the repetitive movement, miss-performing, the correct posture during stroke and overuse of force towards catching stroke length [8]. As noted earlier, by participating in various training regimes, rowers could minimize the possibility of suffering from injuries in relation to the sport. Examples of the common training regimes usually practiced are aerobic training, resistance training, concurrent training and interval training.

In contrary, some doubt had been raised with respect to the benefits given by these training regimes. For example, the effectiveness in integrating resistance (or weight) training as part of the training plans of amateur and professional rowers [9, 10] has been questioned. This is because even upon implementing this form of training regime, studies found that injuries still occur among rowers [11]. Thus, there is the need to further investigate the effectiveness of various training regimes in reducing musculoskeletal injuries to the rowers.

This study gives a special focus on eccentric training. This study aims to determine the effects of eccentric training in delaying muscle fatigue, changing in physical characteristic and improve physical related fitness performance among rowers. It is hypothesized that eccentric training may appear to demonstrate greater improvement on physical development among rowers compared to concentric training. The findings from this study such as the type of exercise, intensity and dose for eccentric training will contribute new knowledge

when prescribe eccentric exercise to rowing population.

2.0 METHODS

2.1 Eccentric Training

Eccentric training is a training regime which focuses on muscle contraction that occurs as the muscle fibres lengthen, such as when a weight is lowered through a range of motion with the tempo of 4-6 seconds to maximize strength gain. The contractile force generated by the muscle is weaker than an opposing force, which causes the muscle to stretch [12].

Eccentric training comes in a package with tons of benefit. It is also known as "negative" contraction, eccentric muscle work provides unique responses and benefits compared to conventional exercise such as muscles resist force rather than produce it, requiring 80% less oxygen compared to concentric work. This sort of training regime shows low perceived exertion in order to comfortably produce higher force output than in traditional concentric exercise. Furthermore, eccentric exercise can help the body to resist 30-40% more weight eccentrically than it can push concentrically, thus, helping to enhance the concentric abilities and promotes muscle growth and strength [5, 12]. In addition, faster responses and greater workloads are also achieved via eccentric training. Apart from that, specificity of exercise, from activity daily life's (ADL's) to sports performance, eccentric training offers a mean to train for functional activities, including descending stairs, lowering loads, jumping and deceleration. Eccentric training also helps to build up type II (fast twitch) muscle fibres, to enhance the overall athletic performance especially power, reaction and agility. Lengthening (eccentric) contractions result in the greatest muscle forces at the lowest relative energetic costs. Thus, eccentric training is actually made favourable to the elders, body builders and those who were recovering from injury and development of muscle hypertrophy.

2.2 Exercise Intervention

As this study focus on trained population, the exercise prescriptions followed the guidelines from position stand published by the American College of Sports Medicine (ACSM) [14] as the main reference in prescribing exercise guideline for resistance training among trained population especially rowers in this present study. In resistance training regime, the selection of exercise should be considered on rowers. The training intensity (resistance training) will set in table 1.

Table 1 Eccentric and concentric training programme

Training	sets	Repetitions	Tempo	Intensity	Rest interval
Eccentric	2-3 sets	8-12 reps	1:4	60-80% 1repetition maximum	1-2minutes
Concentric	2-3 sets	8-12 reps	3:1	60-80% 1repetition maximum	1-2minutes

3.0 RESULTS AND DISCUSSION

3.1 Experimental Research Design

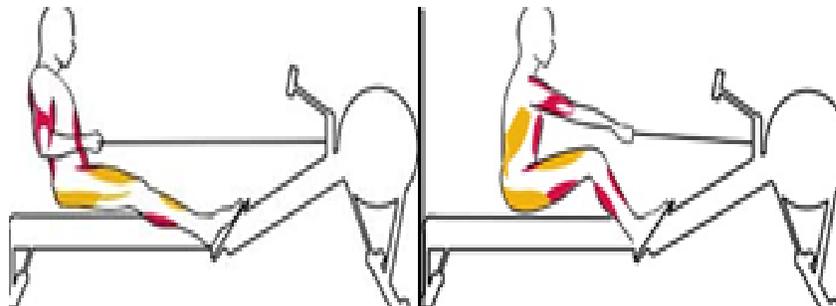
Demographic data will conduct due to see the homogeneity of among participants. All the instruments and testing procedures are reliable and valid to be used in measuring the selected outcome measures.

Muscular fatigue shall be measured using surface electromyography (MYON 320S, Switzerland). Targeted muscle fatigue includes muscle located at lower back, upper and lower body. The surface electrodes will used in this study will placement on targeted sites based upon the muscle following the Surface EMG for non-invasive assessment of muscles (SENIAM) [15]. The electrode sites will be prepared by shaving and then cleaning the area with alcohol. The electrodes are orientated approximately parallel to the direction of the fibres of the muscles of interest. The muscles of interest are in parallel with the ones

suggested by a previous study. The previous study [13] recorded the reading from 23 muscles in two separate sessions interspaced by 4 days in 1 week. The muscles tested by [13] were tibialis Anterior (TA), soleus (Sol), gastrocnemius lateralis (GL), gastrocnemius medialis (GM), vastus lateralis (VL), vastus medialis (VM), rectus femoris (RF), biceps femoris (BF), semitendinosus (ST), gluteus maximus (GMax), latissimus dorsi (LD), erector spinae multifidus (ES), trapezius medius (TraM), biceps brachii (BB) and brachioradialis (Br). The muscles recorded in the first (lower body part) and second (upper body part) session as shown as below in Figure 1. Subsequently, in the second session, the following muscles were recorded by [13]: longissimus (Long), iliocostallis (Ilio), multifidus (ES), latissimus dorsi (LD), deltoideus posterior (Delt), trapezius upper (TraU), trapezius medius (TraM), trapezius lower (TraL), triceps brachii (long head—TriL), triceps brachii (short head—TriS), biceps brachii (BB), brachioradialis (Br) and flexor digitorum superficialis (FD)

Table 2 Subject information gathered from participants

Detail	Description	Standard followed
Demographic	Age	-
Anthropometry	Weight	SECA, weight scale, USA
	Height	to International Society for the Advance
	Body length	Kinanthropometry (ISAK), 2004
	Breadth	
	Girth	

**Figure 1** Point of targeted muscle involve during rowing

During the Surface EMG measurement, the data were tested at 500 Hz, amplified 1000 times, band-pass filtered (20–450 Hz) and relayed to a computer based data acquisition and analysis system (ProEMG Lite software v2.1.10.1, Switzerland) with the common mode rejection ratio at 60 Hz is >80 dB for the DE 02.3

electrodes [13]. The study further noted that the subjects were asked to perform with maximal effort and to hold their position as manual resistance was applied for 6–8 s. Suggestively, this was vital in ensuring that consistence data was obtain throughout the experiment.

Following this, further information on data analysis was provided. The EMG activity collected during the rowing trial was normalized to EMG activity recorded during a maximum voluntary isometric contraction (MVC) [13]. The study noted that the root mean square values from 2s epochs were calculated for each muscle during these maximum muscle tests and later the highest value recorded for each muscle was used in the subsequent analysis. With respect to muscle fatigue, [13] enlightens that muscle fatigue was assessed by examining changes in the frequency content of the power spectrum of the EMG signal obtained from the maximal effort isometric contraction before and immediately after the rowing trial. The study also explained that the raw EMG data collected during the MVC was sampled at 1024 Hz from the surface electrodes, preamplifier (1000), band-pass filtered (20–450 Hz) and relayed to above mentioned computer based analysis software for processing. The ample information provided by [13] is essential in acquiring vital data with the use of Surface EMG, thus, suitable to be replicated in other studies.

3.2 Statistical Analysis

ProEMG will be utilized to determine point of muscle fatigue by measuring at root means square (RMS) and mean power frequency (MPF) epochs. A mixed within-between subjects analysis of variance (ANOVA) will be utilized to determine significant changes within time, main effect, and interaction effect between eccentric and concentric interventions on the selected outcome measures. The statistical significant is set at an alpha level $p < .05$.

3.3 Expected Results

It is hypothesized that eccentric training may appear to demonstrate greater improvement on physical development among rowers in comparison to other training regimes. This study on eccentric training will contribute as a new finding on training regime which able to increase strength, hypertrophy, power and in directly can help in delaying point of muscle fatigue as well as reducing risk of common injury among rowers.

4.0 CONCLUSION

Conclusively, it is hypothesized that by participating in eccentric training regime, rowers will show greater improvement with respect to physical development in comparison to other training regimes. This study fills the research gaps in studying the effects of eccentric training on total body training regime – especially at the core body region. Suggestively, eccentric

training will gives a lot of benefits to the practitioner and this is especially critical to high performance athlete such as rowers

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