The Fractional Utilisation of Maximal Oxygen Consumption during Execution of Ground Strokes and Simulated Match in 14 to 18 years Malaysian Singles Tennis Players

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The purpose of the present study was to determine the fractional utilisation of maximum oxygen uptake capacity (\% VO\textsubscript{2max}) during execution of ground strokes and tennis match play. Ten male Malaysian state-level tennis players participated in this study. Age, height, weight and VO\textsubscript{2max} of the players were 15.3 $\pm$ 1.2 years, 164.0 $\pm$ 7.4 cm, 52.3 $\pm$ 11.5 kg and 51.7 $\pm$ 7.3 ml·kg\textsuperscript{-1}·min\textsuperscript{-1} respectively. This study was conducted in 3 phases: laboratory test (Phase I), on-court test (Phase II) and simulated match (Phase III). Fraction of VO\textsubscript{2max} during execution of forehand and backhand strokes were 71.6 $\pm$ 10.9\% and 72.3 $\pm$ 8.8\% respectively, whereas tennis match play demanded 69.3 $\pm$ 9.8\% of VO\textsubscript{2max}. Execution of forehand and backhand strokes led to a blood lactate concentration of approximately 6 mmol·L\textsuperscript{-1}, indicating the involvement of anaerobic glycolysis. On the other hand, due to the intermittent nature of the game and the work-rest ratio of 1 : 2.2, the post-match blood lactate was found to be 3.21 $\pm$ 0.2 mmol·L\textsuperscript{-1}, reflecting an aerobic dominance in the game. The mean match heart rate (154.3 $\pm$ 15.4 beats·min\textsuperscript{-1}) was lower than mean anaerobic threshold heart rate (164.7 $\pm$ 5.7 beats·min\textsuperscript{-1}), signifying a lower blood lactate level less than 4.0 mmol·L\textsuperscript{-1} in a tennis match. It This might be due to the fact that long rest pauses caused removal of blood lactate as well as recovery of heart rate. Video analysis of the matches revealed that the players executed more forehand strokes (P<0.001) than the backhand strokes. Since similar heart rate and VO\textsubscript{2} responses were observed for forehand and backhand strokes, it is suggested that the players should train themselves equally on both ground strokes. During the longest rally, mean heart rate of the players was 174.9 $\pm$ 3.1 beats·min\textsuperscript{-1}, which corresponded to 84.5 $\pm$ 2.2\% of VO\textsubscript{2max}. In addition, rallies per game, mean rally duration and strokes per rally were found to be 5.7 $\pm$ 2.4, 4.5 $\pm$ 1.5 seconds and 2.8 $\pm$ 0.8 shots, respectively. Hence, it is concluded that the Malaysian state-level tennis players possessed a moderately good aerobic capacity. This can be improved to the international standard through endurance and intermittent type of training. Improvement in VO\textsubscript{2max} may enhance the playing intensity of the match as well a better recovery in the rest pauses and also delay the onset of fatigue during a match. From video match analysis and heart rate VO\textsubscript{2} relationship, it is suggested that the players should also improve the alactic anaerobic component through short bursts of repeated movements of 5-8 seconds durations.

\textit{Key words:} Fractional utilisation of VO\textsubscript{2max}, Ground strokes, Intensity of singles tennis play, Heart rate, Blood lactate, Match analysis.

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Introduction

Tennis is intermittent in nature and the physiological demand of tennis depends largely on the playing surface, equipment, tactical approach, duration of the match and on environmental factors such as temperature and humidity (Christmass et al., 1995; Lees, 2003). Singles tennis demands energy from both the aerobic and anaerobic (alactic and glycolytic) metabolism (USTA, 1998; Fernandez et al., 2006), depending on the intensity and duration of the game.

Exercise intensities during match play have been suggested to be between 60% to 70% of maximum oxygen uptake and the energy requirements are mainly provided by aerobic energy metabolism (Konig et al., 2001). Tennis is a highly physiologically demanding sport (Bergeron et al., 1991; Christmass et al., 1998; Davey et al., 2003; Fernandez et al., 2005). Studies revealed that the VO$_{2_{max}}$ of the players reached 55 ml·kg$^{-1}$·min$^{-1}$ for females and 55 to 65 ml·kg$^{-1}$·min$^{-1}$ for males (Konig et al., 2001; Fernandez et al., 2005). As the tennis play demands an ability to perform short bursts of high-intensity exercise interspersed with several seconds of rest or recovery periods, for a prolonged period of time, tennis players must be sufficiently prepared to meet this physiological challenge to successfully endure the competition. Tennis involves execution of various ground strokes. Studies on O$_2$ oxygen cost of execution of ground strokes (at competition effort) and simulated match play are scanty in the literature, excepting a lone one study by Fernandez et al (2005). Roetert et al. (2009) studied the biomechanics of various ground strokes and recommended a strength and conditioning programme to improve tennis performance. Lafont (2008) revealed that the head position during the stroke execution distinguished significantly elite players from other professional players especially after impact. Elites show a characteristic head fixation in the direction of the contact zone at impact and during the follow-through. This finding suggested significant differences in gaze behaviour (coupled eyes and head movement) among professional players. Kovac (2007) opined that as the game of tennis continues to change, the physiological parameters must be continually investigated to help provide athletes, coaches and trainers with information that will aid in the development of efficient and productive tennis performance and injury prevention programmes.

Hence, the present study was undertaken (i) to investigate the actual on court oxygen consumption during execution of forehand and backhand strokes in tennis drills and (ii) to investigate the intensity of singles tennis match play at junior