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Shoulder and hip roll differences between breathing and non-breathing conditions in front crawl swimming

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ABSTRACT

The effects of breathing on body roll have been previously investigated for the roll of the whole trunk only. The purposes of this study were: to calculate separately the shoulder roll (SR) and hip roll (HR) of swimmers during front crawl for non-breathing and preferred-side breathing conditions; to assess the differences in the magnitude and temporal characteristics of these variables between non-breathing and preferred-side breathing conditions; and to examine their association with swimming performance (indicated by swimming speed). Twelve male swimmers who competed at national and international level performed two maximum 25 m front crawl trials: one non-breathing and one with breathing to their preferred side. Performance was recorded with four below and two above water synchronised cameras. SR and HR in both trials were calculated for the breathing and non-breathing sides. The timings of SR and HR peaks to each side and at the positions of neutral roll were also calculated. Swimming speed was significantly slower in the breathing trial ($p<0.01$). Swimmers rolled their shoulders and hips to the breathing side significantly more in the breathing than in the non-breathing trial (SR: $p<0.01$; HR: $p=0.03$). Nevertheless, there were no significant differences in the overall SR or HR between these trials. In the breathing trial, SR was higher in the breathing than in the non-breathing side ($p<0.01$) but HR was not significantly different ($p=0.07$). There was no evidence to suggest that temporal characteristics of SR or HR were associated with swimming performance.

1. Introduction

The alternation between left and right arm strokes in front crawl swimming is accompanied by rotations of the trunk around its longitudinal axis. These rotations are commonly known as body roll (BR). BR has important functions in front crawl swimming, such as facilitating the breathing action (Yanai, 2001) and the recovery of the arm (Counsilman, 1968), as well as affecting the underwater hand path, therefore contributing to hand velocity (Payton et al., 2002). It has been suggested that BR is linked to swimming performance; Psycharakis and Sanders (2008) indicated that faster swimmers rolled their shoulders less than slower swimmers during a 200 m front crawl test, while Yanai (2003) reported that swimmers rolled their shoulders 9° less when they increased speed from 1.3 to 1.6 m s^{-1}. Other authors have stated that BR might assist in increasing propulsion or decreasing drag forces (Cappaert et al., 1995; Castro et al., 2003), and in reducing the risk of developing shoulder injuries (Weldon and Richardson, 2001).

The breathing actions in front crawl swimming might cause alterations on stroke mechanics, for example an increase in hydrodynamic drag and BR (Pendergast et al., 1977), and a decrease in horizontal velocity (Castro et al., 2006; Payton et al., 1999). Despite the potential links between BR, breathing actions and front crawl swimming performance, this area has been the topic of only a few studies (Beekman and Hay, 1988; Castro et al., 2006; Payton et al., 1999). In the latter studies, researchers calculated BR for the whole trunk, based on the assumption that the trunk rotates longitudinally as a rigid segment. For the calculation of trunk roll, a wooden fin was attached on each swimmer's back and swimmers swam towards a poolside camera. Using this camera, trunk roll was calculated with two-dimensional methods as the angle between the fin and the vertical axis (Fig. 1).

The findings from the above studies were inconclusive. Greater trunk roll in the breathing trial was reported by Payton et al. (1999), Castro et al. (2006) for swimmers swimming at moderate and fast intensities and Beekman and Hay (1988) for swimmers with a shoulder injury. On the contrary, no differences in trunk roll between breathing and non-breathing trials were reported by Castro et al. (2006) for swimmers swimming at low intensities

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