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Coordination in arm movements during crawl stroke in elite swimmers with a loco-motor disability

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Abstract

The purpose of this study was to investigate selected kinematics parameters of the arm stroke in crawl swimmers with disabilities and to examine the potential use of an index of arm coordination (IdC) to evaluate the stroking technique of swimmers with diverse functional abilities. The degree of overlap in the propulsive phases (superposition model) and lag time between the propulsive phases (catch-up model) was examined in 18 well-trained swimmers with loco-motor disabilities, 9 females and 9 males, from functional classes S3–S10 with S10 being most functional. Based on the results, correct coordination appears to be fundamental to swimming crawlstroke in both able-bodied swimmers as well as swimmers with a disability. Some swimmers with disabilities examined here exhibited extreme values at both ends of the index scale. This might be essential to maintaining balance while swimming when not all limb activity contributes to the forward movement.

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1. Introduction

According to Costill, Maglischo, and Richardson (1992) and Maglischo (1993), the coordination of arm movements during performance of the front crawlstroke conforms to one of three major models. The model of opposition describes a series of propulsive actions: one arm begins the pull phase when the other is finishing the push phase. The model of catch-up describes a lag time between the propulsive phases of the two arms. Finally, the superposition model describes an overlap, to a greater or lesser degree, in the propulsive phases (Chatard, Collomp, Maglischo, & Maglischo, 1990). Analysis of the stroking parameters and arm coordination has shown that well-trained swimmers with a loco-motor or visual disability usually use the superposition mode of arm coordination during front crawl swimming with a greater degree of two arm overlap in the propulsive phases in comparison to able-bodied swimmers and this despite absolute lower swimming speed (Satkunskiene & Birzinyte, 2003).

Chollet, Chalies, and Chatard (2000) described an index of coordination (IdC) characterizing coordination patterns by measuring the lag time between propulsive phases of each arm movement. Chollet et al. (2000) and Millet, Chollet, Chalies, and Chatard (2002) observed that swimmers modified their arm coordination with increases in velocity (with decreased race distance) and as a function of performance level. They changed from a coordination mode of catch-up in the middle-distance trial to coordination in opposition or superposition in the sprint trial. Better performers also used more opposition and superposition modes. It was demonstrated that these changes reflected changes in the organization of the stroking phases. The relative proportion of the propulsive phases in a stroke cycle increased at higher velocity at the expense of the non-propulsive phases.

In contrast, in swimmers with disabilities the IdC was not related to functional level, swimming velocity, stroke length or stroke rate (Satkunskiene & Birzinyte, 2003). This might be due to the disadvantages in body balance in water of these swimmers (Schega, Pabst, & Witte, 2003). For a number of reasons, swimmers with tetraplegia, high-level paraplegia, and those with spasticity have more difficulties than swimmers with low-level paraplegia and with amputations in maintaining their body in a more horizontal (streamlined) position in water (Chatard et al., 1992). The use of a superposition mode of arm coordination might help to achieve a better body position. This suggestion was supported by the observation that with increasing functional level the IdC slightly decreased (Satkunskiene & Birzinyte, 2003). Other authors showed that with increasing function, the passive drag in water and the projected surface area decreased (Kunze & Schega, 2003).