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Exploring different technical solutions of the interface between the hand, racket and the rim in wheelchair tennis

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Abstract

Purpose

In wheelchair tennis propulsion of the wheelchair is different for both hands, since the athlete has to hold a tennis racket in one hand. Differences in propulsion technique, i.e. forces and timing, have been found between propelling the wheelchair with and without a racket in the hand [1]. Optimizing the coupling of the hand with the racket to the rim is expected to lead to performance improvement Therefore, the purpose of this study was to explore different technical solutions for the interface between the hand, racket and the rim in order to optimize propulsion technique during wheelchair tennis when holding a racket.

Methods

A limited literature study was done on the interface between the hand, racket and the rim. Qualitative interviews were held with (sub)top Dutch tennis players and trainers to gain insight in their technique. Video analysis of training and tennis matches of (sub)top Dutch tennis players were made to acquire knowledge of the hand and racket positions. A list of requirements and several ideas were developed. Different prototypes of (a part of) a rim were 3d printed and tested in laboratory settings.

Results

The literature study showed an increase of effectivity of propulsive force by creating a larger contact area and increased friction; different textures and/or materials can create an increased friction. The video analysis showed a variety of racket positions between players and within players at different speeds. Five different design components and the connections between them were explored: push rim, wheel, the tire, the hand and the racket. Prototypes with a larger contact area and/or different material showed higher isometric peak forces.

Conclusion

This study shows different technical solutions for the interface between the hand, racket and the rim, which will improve propulsion technique during wheelchair tennis. The technical solutions are; different shape of the rim and/or using textures and/or materials with high friction coefficient on the rim and/or hand.

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Keywords: wheelchair tennis, propulsion technique, interface, hand, racket, rim

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1. Introduction

Since wheelchair tennis was introduced as a Paralympic Sport in Seoul in 1988, the sport has become more popular and professional. In professional wheelchair tennis players, it is important to optimize the performance. That can be done by optimizing the athlete (e.g. tennis skills, fitness) but also by improving the wheelchair and/or the wheelchair-user interface [3]. In wheelchair tennis propulsion of the wheelchair is different for both hands, since the athlete has to hold a tennis racket in one hand. Previous studies showed that the interface between the wheelchair tennis player and the wheelchair is not optimal when having to propel the wheelchair with a racket in the hand [1,2]. Differences in propulsion technique, i.e. forces and timing, have been found between propelling the wheelchair with and without a racket in the hand [1]. The longer time needed to couple the hand with the racket to the rim leads to higher power losses and subsequently higher power output generation during the shorter push phase, this is clearly shown in figure 1. Optimizing the coupling of the hand with the racket to the rim is expected to lead to performance improvement.

Therefore, the purpose of this study was to explore different technical solutions for the interface between the hand, racket and the rim in order to optimize propulsion technique during wheelchair tennis when holding a racket.

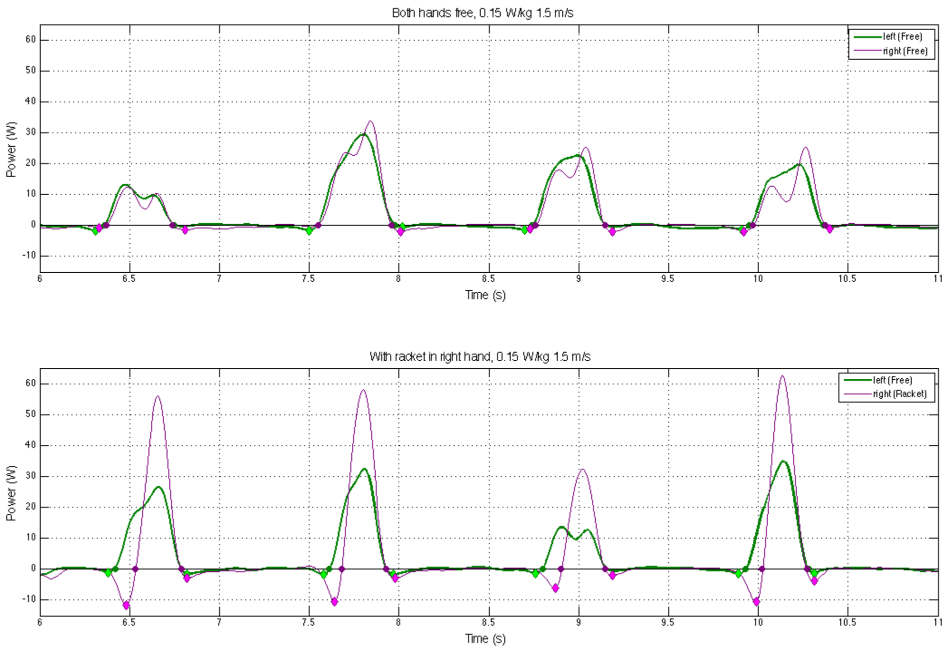

Fig. 1. Typical example of the propulsion technique of the left and right side during a submaximal exercise block on a wheelchair ergometer (upper graph) when propelling without a racket and the second submaximal exercise block (lower graph) when propelling with a racket in the right hand. The longer time needed to couple the hand with the racket to the rim leads to higher power losses and subsequently higher power output generation during the shorter push phase [1].