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Wheelchair tennis player movement speed: Differences in movement, with and without a racket

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ABSTRACT

This study attempted to measure the capacity of wheelchair tennis players to accelerate and change directions, as well as investigate the differences with regard to the level of the athlete, either using the racket or not using the racket, when moving. 9 international players participated in this study. We measured the time they took to cover 5, 10 and 20 metres and the time to make an agility test (T court test), with and without a racket. The results showed that the use of the racket negatively impacts the movement ability of the players. Higher level players seem to make specific displacement movements more efficiently with or without the racket, as compared to lower lever players. Results of our findings, apart from being reference values for trainers, inform about the use of the racket for specific mobility in the physical training of WT players.

Key words: speed, agility, racket, wheelchair
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INTRODUCTION

The duration of a wheelchair tennis match ranges between 60 and 80 minutes (Ponzano & Gollin, 2017; Roy, Menear, Schmid, Hunter, & Malone, 2006; Sánchez-Pay, Sanz-Rivas, & Torres-Luque, 2015). During this time, players cover between 2,000 and 4,000 m. on the chair, with an average speed of 1m/s and a max. of 2,9 m/s (Ponzano & Gollin, 2017; Sindall et al., 2013). The great number of accelerations and decelerations of WT players is a consequence of the specific movements of the players in their chairs: starting, sprinting, stopping and turning (pivots) (Sanz, 2003). This sequence, which must be done while holding the racket, makes mobility an important success factor in WT (Bullock & Pluim, 2003). Correct displacement lets the player prepare properly to hit a stroke (Filipcic& Filipcic, 2009). Propelling the chair while holding the racket has negative effect on the production of power and displacement speed (de Groot, Bos, Koopman, Hoekstra, & Vegter, 2017), mainly during the first three pushes of the chair (Goosey-Tolfrey & Moss, 2005). These studies show the difference when displacement takes place exclusively on a straight line, apart from not knowing if there are differences depending on the level of the group. Therefore, this study will target the analysis of the influence of using the racket in the different speed and agility tests and setting the differences depending on the level of the athletes.

METHOD

Participants

The participants in the investigation were the best 9 WT players in the national ranking. Out of these 9 players, the best 4 in the international ranking were in the National Selection (Group 1) and the remaining best 5 in the second group (Group 2). Table 1 shows the characteristics of the sample.

Participants	National ranking	International ranking	Group	Injury	Weekly training (hours)	Tennis experience (years)
1	1	Top 20	1	AF	20	12
2	2	Top 20	1	AT	15	8
3	3	Top 50	1	L2	8	5
4	7	Top 50	1	OI	3	24
5	5	Top 100	2	AF	6	9
6	6	Top 100	2	D11	10	2
7	8	Top 100	2	AF	8	17
8	9	Top 150	2	D9	6	8
9	10	Top 150	2	D4	8	7

AT: Amputation at tibia level. AF: Amputation at femoral level. L: Spinal cord injury at the lumbar level. D: Spinal cord injury at the dorsal level. OI: Imperfect osteogenesis

Table 1. Characteristics of the National Selection players (group 1) and the second team (group 2).

Measurements and instruments

Three measurements per participant were recorded by means of the field tests used in different studies to evaluate the speed and agility of wheelchair athletes. After a standard 5 minute displacement warm-up, with changes of direction, and 3 minute controlled sprints, players did the following tests:

- Displacement speed test: Displacement speed was measured through Chronojump Photecell® (Chronojump, Barcelona, Spain) and Cronojump software version 1.7.1.8 for MAC. Four gates were used, they were placed at 0, 5, 10, and 20 metres. The subjects started from a line at 0.5 m. behind the first gate (Figure 1a). Each participant took the test 3 times without a racket, and three times with the racket and a resting time between each 2 minute repetition. Average values of 5, 10 and 20 m. of the three repetitions were recorded. The time was recorded in seconds and milliseconds with an error of ± 0.001 seconds.

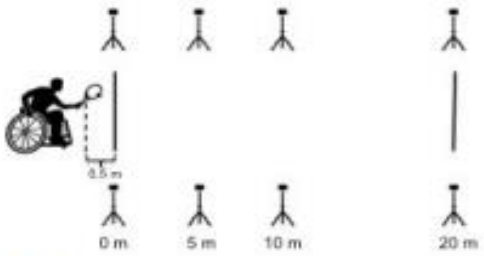

Figure 1a. Displacement speed test.

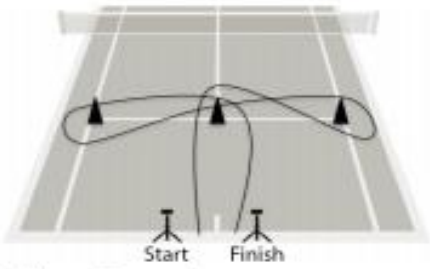

Figure 1b. Agility test (T court test).

- Agility test (T court test): The participant is positioned in the centre of the court, behind the baseline, and must go to the intersections of the singles and service lines, always crossing the central area (T) and returning to the starting point (Figure 1b). Each participant took the test 3 times without a racket, and three times with the racket with a resting time between each 2 minute repetition. Average values of the three repetitions were recorded. The times were measured with Chronojump Photecell® (Chronojump, Barcelona, Spain) and a Cronojump software version 1.7.1.8 for MAC with a gate placed at the baseline to record the beginning and the end of the test.

Data analysis

The descriptive analysis of the data included the mean and standard deviation (M ± SD) of the variables in question. The Shapiro-Wilk test was used due to the size of the sample to contrast the normality of the data registered for each variable. A Student's t-test was used to compare the mean between the level groups (Group 1-National Team, and group 2) and for the tests with and without a racket, setting the significance level at $p<0.05$. Finally, the correlations between the 20 m. variables, with and without a racket, were studied in relation to the rankings through the Pearson r coefficient. Analysis was performed with SPSS software for Windows (Version 20.0. Armonk, NY:IBM Corp.).

RESULTS

	Without a racket				With a racket			
	5m	10m	20m	T-Test	5m	10m	20m	T-Test
	M±SD	M±SD	M±SD	M±SD	M±SD	M±SD	M±SD	M±SD
Group 1	1.47 ± 0.7^	2.61 ± 0.16***^	5.06 ± 0.34**^	11.91 ± 0.87	1.55 ± 0.06^	3.00 ± 0.32	5.32 ± 0.38**^	11.96 ± 0.86^
Group 2	1.66 ± 0.15^	3.09 ± 0.18^	6.06 ± 0.43	13.13 ± 0.79^	1.84 ± 0.18	3.36 ± 0.30	6.33 ± 0.39	13.56 ± 1.05
Total	1.57 ± 0.14	2.88 ± 0.30	5.62 ± 0.64	12.59 ± 1.01	1.71 ± 0.20	3.20 ± 0.35	5.88 ± 0.64	12.85 ± 1.24

*: Differences between Group 1 and Group 2. * = p<.05; ** = p<0.01; *** = p<0.001
^: Differences between with and without a racket ^= p<.05; ^^ p<0.01; ^^^ = p<0.001

Table 2. Mean values (M) and standard deviation (SD) of speed and agility tests with and without racket in both level groups.

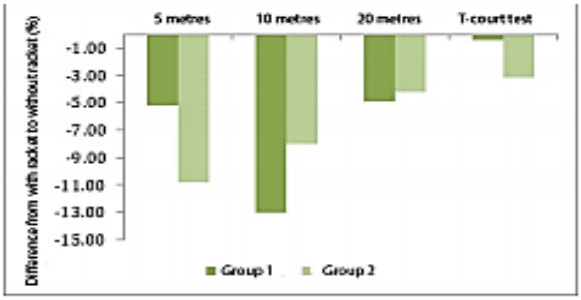

Figure 2. Percentage of time lost in movement from with a racket to without a racket in high (group 1) and lower (group 2) level players.

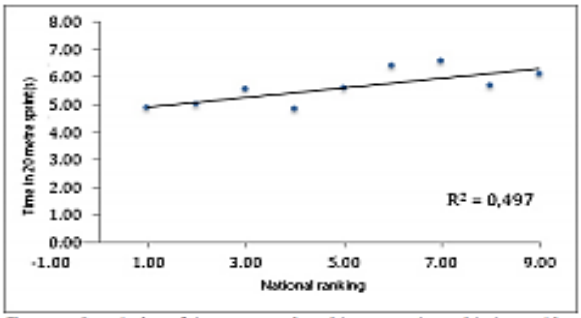

Figure 3. Correlation of the 20 m. sprint without a racket, with the ranking position of the player.

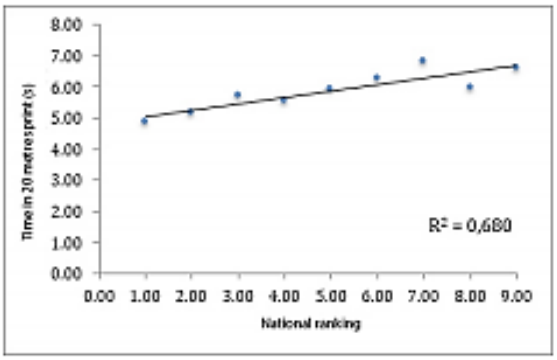

Figure 4. Correlation of the 20 m. sprint with a racket, with the ranking position of the player.

COMMENTS AND CONCLUSIONS

The target of this study was to analyze the influence of the racket when accelerating and changing direction in WT players, and to discover possible differences in relation to player levels.

The findings of this study show how the use of the racket in WT player displacement impacts negatively on the time of this displacement (Table 2). High and low level players take statistically longer to cover 5 and 10 metre distances when using the racket, but this is not so in 20 m. Data seem to indicate that the acceleration capacity from a static position is affected by the use of the racket in the first metres; however, maintaining high speed levels does not seem to be significantly affected when using the racket. This may be due to the fact that once the initial inertia of the chair in a static position is overcome, the chair itself facilitates the displacement when in movement. Higher level players waste 5% on their time in the first 5 m. and 13% up to 10 m. (Figure 2). Lower level players waste 11% in the first 5 m. and 8% up to 10 m. This loss of speed in the use of the racket in the impulse on the wheels translates in reaching the ball later and not being able to hit it correctly (Filipcic & Filipcic, 2009).

WT players do not move exclusively in a straight line, they start, sprint, stop and turn (pivot) (Sanz, 2003), and these are more specific movements in this sport specialization. In this sense, higher level players show no differences in the agility T court test with or without the racket (table 2), with a time waste of 0.5% (figure 2), this occurring among lower level players. This seems to indicate that specific mobility in WT (when using the racket) is more efficient among higher level players. Graphs 4 and 5 show the correlation between the time of displacement in 20 m. (with and without a racket) with the ranking of the player. The use of the racket shows a greater correlation with the ranking of the player (R2 = 0,680) when compared with the displacement without the racket (R2 = 0,497). This greater correlation may indicate that apart from the fact that better ranked players move more quickly than lower ranked players, they are more efficient when moving with the racket. All this may be due to the fact that, among other things, higher level players have a better technique to impulse the chair both with and without the racket. On the other hand, we could consider that they provide more strength in the first impulses due to a possible difference in their physical fitness, an aspect which has not been studied.

As a conclusion, higher level players move more quickly than lower level players. Furthermore, the use of the racket impacts negatively in the time of displacement, although not in the same way in its different sections, nor depending on the players level.

Higher level players, who are supposed to have a better and more efficient displacement technique, because of their physical fitness, and the way they use strength, are better than lower level players. Therefore, the differences are greater in short (5 m.) and long displacements (20 m.) as well as in displacements with change of direction (T court test). This is a very important issue and as WT displacements during a match are less than 10 m., the large number of small movements of around 5 m. makes it a very specific task, particularly when starting the first 2 or 3 impulses, which means that they must be practiced in a specific way and with the racket, so as to improve these actions. This fact can be seen in the first 5 m. and in the agility test where higher level players waste less time (%) than lower level players (Figure 2). The results shown here, as well as from being useful as reference values for WT coaches, encourage the practice of specific mobility physical exercises in WT, as much as possible, and always, with the racket

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