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THE DISTANCE COVERED BY WINNING AND LOSING PLAYERS IN ELITE SQUASH MATCHES

RAZLIKE V OBSEGU GIBANJA MED ZMAGOVALCI IN PORAŽENCI AKTIVNIH FAZ V VRHUNSKEM SQUASHU

Abstract

The aim of this research was to analyse players' motions in elite squash matches and to establish whether or not there were differences in the distance covered between winners and losers of individual rallies. An automated player-tracking system, with operator supervision and intervention, captured players' movements during matches at the World Team Championships (N=11). All rallies (n = 1429) were analyzed, except when a 'let' decision was made by the referee (n = 307). All rallies were sorted into four different time-related categories: very short, short, medium and long rallies. On average, the winners of rallies covered 0.71m less than the losers. However, in 41.4% of cases, the loser of the rally covered less distance than the winner of the rally. This result suggests that a player who forces an opponent to cover a greater distance is not guaranteed to win the rally. A general explanation for this finding is that whilst a player may dominate a rally and cause the opponent to cover a greater distance, an error by the dominant player, or a good move by the player under pressure, would result in the rally winner having covered a greater distance. Consequently, further analyses are needed to examine whether any link exists between shot selection and their outcome and the distance covered.

Keywords: squash, motion analysis, rally, winners, losers, differences

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Izvleček

Namen raziskave je bil preučiti gibanje najboljših svetovnih igralcev squasha in ugotoviti ali obstajajo razlike v poti gibanja zmagovalcev in poražencev posameznih aktivnih faz. S pomočjo avtomatičnega sledilnega sistema in nadzorom operaterja je potekalo sledenje igralcev, ki so nastopili na Svetovnem ekipnem prvenstvu (N=11). V raziskavi so bile zajete vse aktivne faze (n = 1429), razen tistih pri katerih se je aktivna faza končala s sodniško odločitvijo 'let' (n = 307). Vse aktivne faze so bile razdeljene v štiri časovne kategorije in sicer v zelo kratke, kratke, srednje in dolge aktivne faze. V povprečju so zmagovalci opravili za 0.71 m krajšo pot gibanja kot poraženci. Vendar so v 41.4% primerih poraženci opravili krajšo pot gibanja od zmagovalcev. Ti rezultati kažejo, da igralec, ki prisili nasprotnika opraviti daljšo pot gibanja, ni nujno tudi zmagovalec aktivne faze. Do tega lahko pride, ko dominanten igralec v posamezni fazi stori napako oziroma igralec v podrejenem položaju izvede zmagoviti udarec. Zaradi tega je v nadaljnjih raziskavah smiselno preučiti interakcijo med posameznimi udarci in njihovo učinkovitostjo ter potjo gibanja obeh igralcev.

Ključne besede: squash, analiza gibanja, aktivna faza, zmagovalci, poraženci, razlike

INTRODUCTION

In squash, each player tries to force their opponent to move as much as possible over the playing area in order to make their opponent's ability to make a successful shot as difficult as possible. This strategy results in different types of shots that can be made. Sometimes, it is advantageous to play a shot which is defensive in nature; for example, when under pressure a desirable shot would be aimed towards the back of the court to try to maximise the time available to get back to the central part of the court (known as the T area). In a more aggressive mode, a player could try to play an outright winning shot or try to hit the ball to an area that maximises the speed needed and minimises the time available for the opponent. These different types of shots can result in greater distances being covered, and a consequent higher work load for one player, in comparison to their opponent. However, the difficulty in measuring the distance covered by squash players has resulted in very little published information on the subject.

The first motion analysis of squash players was conducted by Hughes, Franks, and Nagelkerke (1989) who used video images of the matches and mixed them with co-ordinates obtained from a touch sensitive pad. By using this methodological approach, Hughes and Franks (1994) established significant differences between the winning and losing player in terms of the distance covered during lateral and longitudinal movements. Although this confirmed the theoretical presumption that winners move less than losers, the results were confined to simple longitudinal (front-back) and lateral (left-right) analyses.

Recent advances in computer vision techniques have enabled a new method of motion analysis in sport. Two-dimensional video images are processed automatically under operator supervision in basketball (Barris, 2008; Vučković & Dežman, 2001), soccer (Barros et al., 2006) and handball (Perš, Bon, Kovačič, Šibila, & Dežman, 2002). In squash Vučković, Dežman, Erčulj, Kovačič, and Perš (2003) found that the average distance covered in a match by the best Slovenian squash players was 3,650 meters (915 meters per game). Vučković et al. (Vučković, Dežman, Erčulj, Kovačič, & Perš, 2004) went on to analyse a larger sample of the same players, finding no significant difference in the overall distance covered between winning and losing players. However, when only the time the ball was in play was analysed, it was found that game winners covered a significantly greater distance than game losers. The authors suggested that this may have been due to the extra number of movements to the T area following a serve made by the winners, which is a consequence of them serving more often than the losers. The authors also concluded that individual game analysis might not be the most appropriate measure for determining differences in performance between winners and losers, because it is often the case, particularly in close matches, that the losing player wins a high proportion (nearly 50%) of the rallies. This implies that analysis at the game level may not be sufficiently specific as to determine differences between winner and losers and that it is analysis at the rally level that is required to determine any significant differences. A recent study that corroborates this view was undertaken by Vučković et al. (Vučković, Perš, James, & Hughes, 2008) who showed that the movement patterns exhibited by winners and losers of elite squash games were not significantly different in terms of where they played their shots from and their court location at the moment their opponent was playing their shot.

When considering squash matches at the rally level, it should be noted that rally durations can last for very short periods of time (the serve or return of serve could end the rally) or, particularly at the elite level, for very long periods (five-minute rallies have been known). Clearly, as the rally durations increase so will the distance covered by both players, although this is dependent on the accuracy of the shots played, since poor shots that travel through the T area can result in little movement. Consequently, this study will assess differences in distance covered between the winners and losers of rallies in which the duration of the rally will be used as an independent variable.

METHODS

Design

Matches (n = 11) were recorded at the World Team Championships in 2003 containing sixteen of the world's top squash players (age 26.7 ± 3.5). Approval for the study was granted by a university ethics committee and informed written consent was obtained from all participants. All matches were divided into individual games (n = 42) and then to individual rallies (n = 1429). All rallies were analyzed, except when assessing the differences between winners and losers of rallies. In these analyses, rallies in which a 'let' decision was made by the referee (n = 307) were excluded, because no player won that particular rally. Hence, 1,122 rallies were analyzed for the distance covered by rally winners and losers and sorted into four different time-related categories, which were agreed upon by two national level squash coaches: very short rallies (0 to 4 seconds in duration),

– short rallies (4 to 12 seconds in duration),

– medium rallies (12 to 25 seconds in duration) and

– long rallies (25 and over in duration).

Procedure

All matches were recorded with a fixed SVHS video camera (JBL UTC – A6000H, South Korea) capturing images at 25 Hz. The camera was fastened to the ceiling in the centre of the squash court, so that its wide-angled lens (2.3 mm–6.0 mm, Kenko, Japan) covered the entire court. The camera did not interfere with the play and could not be hit by the ball. The video-recordings were digitized using the Video DC30+ video digitizer hardware (Miro, Germany) with a resolution of 384×576 at 2 $MB.s^{-1}$ data rate, whilst the processing was carried out at a resolution of 384×288 pixels. Digital images were processed by the SAGIT/SQUASH tracking system (Vučković et al. 2010). Final data were stored using Microsoft Access software (Perš, Kovačič, & Vučković, 2005).

Statistical analyses

Data analyses were performed using the SPSS statistical package . The data were assessed for normality (P-P and Q-Q plots) before analysis. Mean and standard deviation (SD) were calculated when the data were normally distributed; the median and inter-quartile range were corrected (IQR) for skewed data. A paired sample t-test was used for the first three time categories and a non parametric Wilcoxon signed ranks test for the last time category (due to positive skewness in the data) to compare rally winners and losers in terms of distance covered. Statistical significance was accepted at $P < 0.05$.

RESULTS

The elite squash games in this sample lasted an average of 1,005s (SD = 401s) with 547s (SD = 214s) of the ball-in-play time (mean = 55%). Players travelled on average 1,119m (SD = 426m) per game with 795m (SD = 305m) of this activity during the ball-in-play time (mean = 71%). Since matches can take place over three to five games, this suggests that elite players are likely to travel between 2,385m and 3,975m during ball in play time.

Rallies lasted for an average duration of 16.55s (SD = 16.22s) and resulted in average distances of 23.74m (SD = 23.25m) per player. To assess the differences between winners and losers at the rally level, only ball-in-play time was assessed (recovery distances between rallies would be similar) and all rallies that ended in a 'let' were excluded. Furthermore, because of the large variation in rally durations, evident in the relatively large standard deviation (16.22s), rallies were classified according to their duration. This meant that 15.15% of all rallies that were won by one of the players were classified as very short (n = 170) with a mean distance covered during ball in play time of 3.40m. (Table 1).

Table 1: Mean distance a player covers during a rally (ball in play time only, rallies ending in a 'Let' excluded).

Rally classification	Frequency (N)	Mean duration (s)	Mean distance covered (m)
Very short rallies (<4 seconds)	170 (15.15%)	2.68 (±0.87)	3.40 (±1.48)
Short rallies (4–12 seconds)	451 (40.20%)	7.67 (±2.24)	11.16 (±3.98)
Medium rallies (12–25 seconds)	304 (27.09%)	17.85 (±3.75)	26.58 (±6.37)
Long rallies (>25 seconds)	197 (17.56%)	40.78 (±18.67)	60.25 (±26.15)
Average		15.48 (±15.18)	22.78 (±22.35)

Winners of very short rallies (mean = 3.24m, SD = 1.39m) covered significantly less distance ($t = 4.01$, $df = 169$, $p < .001$) than the losers (mean = 3.56m, SD = 1.55m). Similarly, winners of short rallies (mean = 10.82m, SD = 3.96m) covered significantly less distance ($t = 5.37$, $df = 450$, $p < .001$) than the losers (mean = 11.50m, SD = 3.97m). Winners of medium rallies (mean = 26.17m, SD = 6.35m) covered significantly less distance ($t = 3.20$, $df = 303$, $p < .01$) than the losers (mean = 26.99m, SD = 6.37m). Finally, winners of long rallies (median = 51.28m, IQR = 25.20m) covered significantly less distance ($z = 2.00$, $p < .05$) than the losers (mean = 53.24m, IQR = 26.40m). On average, winners of rallies covered 0.71m less than the losers (SD = 3.90m) although there were 464 (41.4%) occasions in which the loser of the rally covered less distance than the winner of the rally (Figure 1).

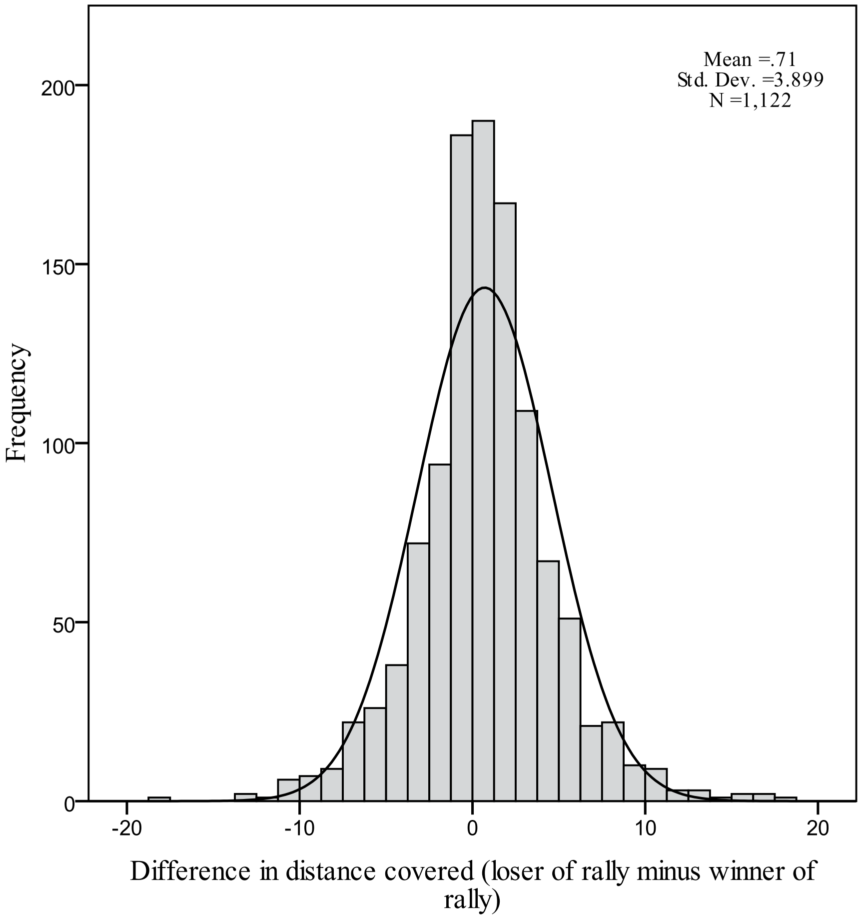

Figure 1: Frequency histogram of the difference in the distance covered between the winners and losers of rallies (negative values signify that the rally winner covered more distance than the rally loser).

DISCUSSION

Vučković et al. (2008) suggested it may be more pertinent to conduct future analyses of squash matches at the rally level, because game winners also tend to lose some rallies. Thus, differences between winners and losers may not be apparent at the game level, as was found by Vučković et al. (2008). This study tends to support this assertion, given that rally winners covered significantly less distance than rally losers for all durations of rally. However, the actual difference in the distance covered between the winners and losers of rallies was shown to include many instances in which the loser of the rally covered less ground (41.4%) than the winner of the rally. This shows how closely contested rallies tend to be in elite squash matches, although maximum differences in distance covered were 17.78m for the winner of rally covering a greater distance and 18.03m when the loser of the rally covered the greater distance. A general explanation for this finding is that whilst a player may dominate a rally and cause the opponent to cover a greater distance, an error by the dominant player or a winning move by player the under pressure would result in the rally winner having covered a greater distance. This may explain why Vučković et al. (2004) found that game winners covered a significantly greater distance than game losers. It may be the case that their data sample included an unusually high number of rallies won as a result of errors made in positions of dominance or winners playing when under pressure. Alternatively, it may be the case that the level of squash they analysed is characterised by a limited ability to win rallies when dominating, i.e. the players were unable to make their advantage count and thus enabled their opponents to win rallies from inferior positions. It may also be the case that different causal factors for distance covered are present in the rallies of different durations. Very short rallies do not have time to develop into an equally balanced situation; thus differences in distance covered are likely to be a consequence of a single attacking shot, with the winner or loser of the rally covering more distance on the basis of whether the shot was successful or not. Short rallies allow some pressure to be built up and thus more than one consecutive shot could account for differences in distance covered. In the medium and long rallies, only very small differences in distance covered were found, suggesting that these rallies are either characterised by relatively long periods in which both players are covering the same distance or the rally fluctuates between which player is covering the greater.

This study has shown that rally winners cover less distance on average in comparison to rally losers, but this is not always the case. This suggests that a player who forces an opponent to cover a greater distance is not guaranteed to win the rally. Research into perturbations (e.g. McGarry et al., 1999), i.e. shots that cause the transition between a stable state (neither player dominating the rally) to an unstable state (one player dominates) suggests that rallies can contain multiple perturbations. This would suggest that at different points in a rally one player will cover more distance than the other (defined as an unstable state), but the rally can return to a situation in which both players cover a similar distance (stable state). Evidence of multiple perturbations in a rally was also found by Murray et al. (2008) who suggested that the boast, drop and volley drop were the main shots that could be called perturbations, indicating that playing short potentially causes the opponent to come under pressure and hence cover more distance. This explanation seems to hold true for the results relating to medium and long rallies in this paper. Future research should try to ascertain whether this is the case, as well as whether shots played to the front of the court the most likely to put the opponent at a disadvantage and so cover more distance? If this is true, is there a risk associated with this type of shot, so that advantages for one player can become an advantage for the other? This may explain why rallies seemingly can fluctuate between being advantageous for one player to being disadvantageous for that player. This type of analysis would need to examine whether any link exists between shot selection and distance covered by an opponent. By undertaking this analysis, it may be possible to determine periods of dominance and explanations both for its emergence and disappearance.

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