

NOTATIONAL ANALYSIS ON GAME STRATEGY PERFORMED BY FEMALE SQUASH PLAYERS IN INTERNATIONAL COMPETITION

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Abstract

Recently, the general performance standards of women's squash have progressed to very high levels as demonstrated by several 'spectacular' world championships final matches. Our aim was to identify successful game strategies of female squash players at the international level via notational analysis. 25 matches were obtained for analysis from several international competitions, including the Women's World Championship 2014, the Women's World Team Squash Championship 2014 and the Malaysia Circuit Squash 2015. Analysis was based on observation of the type of stroke performed and the rally outcome. The mean total number of shots performed per game was 337 (SD=189.6) shots. The most preferred strokes performed were drive (47.1%), followed by cross-court (19.9%), volley (12.7%), drop (11.1%), boast (5.8%), with the lob (3.4%) as least frequently occurring shot. Meanwhile, rally outcomes were categorized as winners, errors, stroke, and let. There were more winners produced (58.5%) than errors (24.8%) or lets (16.69%). The findings indicate that defensive long rallies together with offensive endings (such as well-timed drop shots) are characteristic of points played in elite women's squash. The practical implications of this analysis may help coaches and female players enhance both tactical strategy and performance.

Keywords: High performance sport, playing styles, tactics and women

Introduction

In competitive sport, data related to tactical strategies provide an important reference base, representing athletes' playing styles. This data can help athletes and coaches understand and prepare strategic game plans before encountering their opposition. Indeed, athletes often use notational analysis before high performance squash matches to inform their tactical playing strategies and improve their chances of success.

Several tactical strategies in elite squash have been identified as the defensive or offensive styles. According to Vučković, Dezman, Kovacic, and Pers (2006), the defensive game strategy is also known as 'basic play' which is largely comprised of drive shots, which limit the opponent's chances to play winners when the ball is at the back of the court. A defensive strategy is assumed to be most likely to achieve success in elite male squash, as stated by McKenzie (2002), who argued that playing defensively is the key to winning. However, in contrast, Tong and Hong (2000) argue that the pressure and attacking game strategy (offensive) by using killing shots such as smash, net, and hit shots is the most effective playing strategy that contributes to winning. Notably, both studies analysed male elite squash matches, and to our knowledge there is no published data concerning the tactical playing strategies present in women's squash.

Prior to 2009, former international squash scoring rules specified a 'hand-in-hand-out' (HIHO) policy, in which only the server can win a point and games were played up to 9 points. Partly to improve squash as a spectator sport, the World Squash Federation (WSF) changed the rules in 2009 to allow a 'point a rally' in which every rally is a point regardless of who served and the scoring of games up to 11 points. It is possible that these significant rule changes have had a large impact upon the game strategy and playing styles of elite players.

In recent times, several women's squash championships have involved spectacular matches indicative of a high level of tactical awareness of the players. Previous notational analysis studies have only considered elite male squash players. We set out to analyse playing strategies used by elite female squash players based on their performance in international competitions.

Methods

Participants

Matches were recorded at the Malaysia Circuit Squash 2015 ($n = 15$), the Women's World Team Championships 2014 ($n = 5$), and the Women's World Championship 2014 ($n = 5$). Participants included Malaysia's female top five players (age = 22.4 ± 6.15 , height = $1.61 \pm 4.15\text{m}$, weight = $53.2 \pm 2.28\text{ kg}$), and selected based upon their involvement in tournaments especially in finals and their high ranking (Professional Squash Association average world ranking = 36.6 ± 25.7). For consistency, only right-handed players were. The participating University's ethics committee granted ethical approval for the study and all participants were aware at the time of competing that the game was being recorded and observed. Prior authorization to record and analyse the games was obtained from the head coaches of the Squash Racquet Association of Malaysia (SRAM).

Procedure

This study involved a notational analysis of squash matches based on observation and video recordings on the type of stroke and the outcomes of the rally. Recordings were typically obtained using video camera, Sony Digital Video Camera Recorder, model DCR-PC350E (lens Carl Zeiss Vario-Sonnar T, 720 x 576 pixels, 25 frames per seconds) positioned at the frontal view at the back of the court with an overall view of the court ensured being captured and recorded. However, to improve the sample size of matches, several games (10 of 25 videos) obtained online (posted on YouTube.com) were deemed to be appropriate quality for video analysis. The video recording started when players initiated the first serve of the game and ended when the referee announced the winner for the set.

Notational Analysis

The notational analysis tool used for this study was Focus X2 elite sport analysis software (www.performanceinnovation.net, UK). The analysis template was developed according to the specific details on the type of stroke and outcomes involved. The following variables were coded for each event:

Type of stroke performed (drive, drop, cross-court, volley, lob and boast)

Outcomes: Winners (unconditional winner (UW) and conditional winner (CW)), Errors (unforced error (UE) and forced error (FE)), stroke (conditional winner (stroke)(CW(S)) and unforced error(stroke)(UE(S)) and Let (L).

An experienced notational analyst categorised a shot as a drive stroke when the player hit the return ball straight to the back of the court. The drop stroke code was used when a player hits a return ball to the front area of the court. The cross-court stroke was coded when the return ball landed at the opposite area of the court. The lob stroke code was when the return ball was hit higher and curved to the back of the court. Lastly, the boast stroke code was applied when a player hit the return ball to the side wall first before the front wall.

For outcomes, the unconditional winner code was used when a player had hit an outright winning shot that rewarded them point without any other circumstances, while a conditional winner was coded when the opponent made a mistake in attempting to play their shot. The unforced error code was used when a player was deemed to make an unnecessary mistake without pressure from their opponent, while a forced error was when a player committed an error under pressure of their opponent's return ball. A conditional winner by stroke occurred when a player gained the point awarded by the umpire due to an opponent's mistake while an unforced error by stroke occurred when opponent gain point awarded to them due to player's own

mistake. A let occurred when the umpire determined to restart the rally due to certain circumstances as set forth in the official rules of squash.

Each event described above was coded. The frequency of shot performed and rally outcomes were then recorded in a spreadsheet via Microsoft Excel 2010 for statistical analysis.

Reliability

The notational analyst had playing experience of squash for more than 10 years and also data analysis experience in elite squash for 5 years. Any errors that appear in the data result either from the analyst pushing the wrong button to record an event or incorrectly categorising an event (James, Jones and Hollely, 2002). Therefore, to quantify intra-rater error, the analyst viewed half of the total matches twice for reliability testing. All second viewed data gathered were recorded and compared to the first observed events using Cohen's Kappa reliability test.

The intra-rater reliability analysis resulted in an overall Kappa value of 0.794 for both types of stroke and outcomes. For type of stroke, kappa values for each stroke were as follows: drive, drop and boast with 0.762; cross-court and volley with 1.00 (no error); and lob with 0.667. The kappa value of outcomes were as follows: CW with 0.750, UW with 0.762, FE with 0.643, UE with 0.750, L with 1.00 (no error occur), CW(S) with 0.762 and UE(S) with 0.706. Consequently, overall reliability results for the type of shot and outcomes were accepted as good and reliable for further analysis (Sim & Wright, 2005).

Results

Analysis of Type of Stroke

Notational findings resulting in total number of shots performed for all 25 matches were 8,441. Therefore, the average total number of shots performed per game was 337.6 shots (SD=189.6).

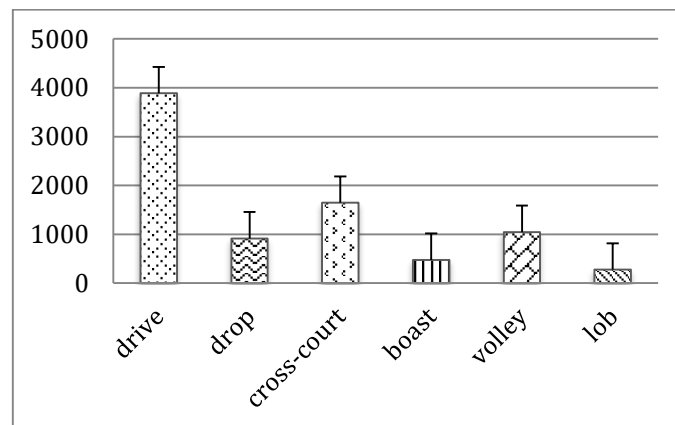


Figure 1: Average number of shots. Error bars indicate SEM across games.

Figure 1 shows that the most frequently occurring type of stroke performed was the drive stroke with 3,889 of 8,441 total shots (47.1%), followed by cross-court [1,646 of 8,441 (19.9%)], volley [1,047 of 8,441 (12.7%)], drop [917 of 8,441 (11.1%)], boast [478 of 8,441 (5.8%)] and the least preferable stroke, lob, with only 278 of 8,441 (3.4%).

Hence, players prefer to play drive strokes, which is a general indication of the pattern of long rallies from the back of the court.

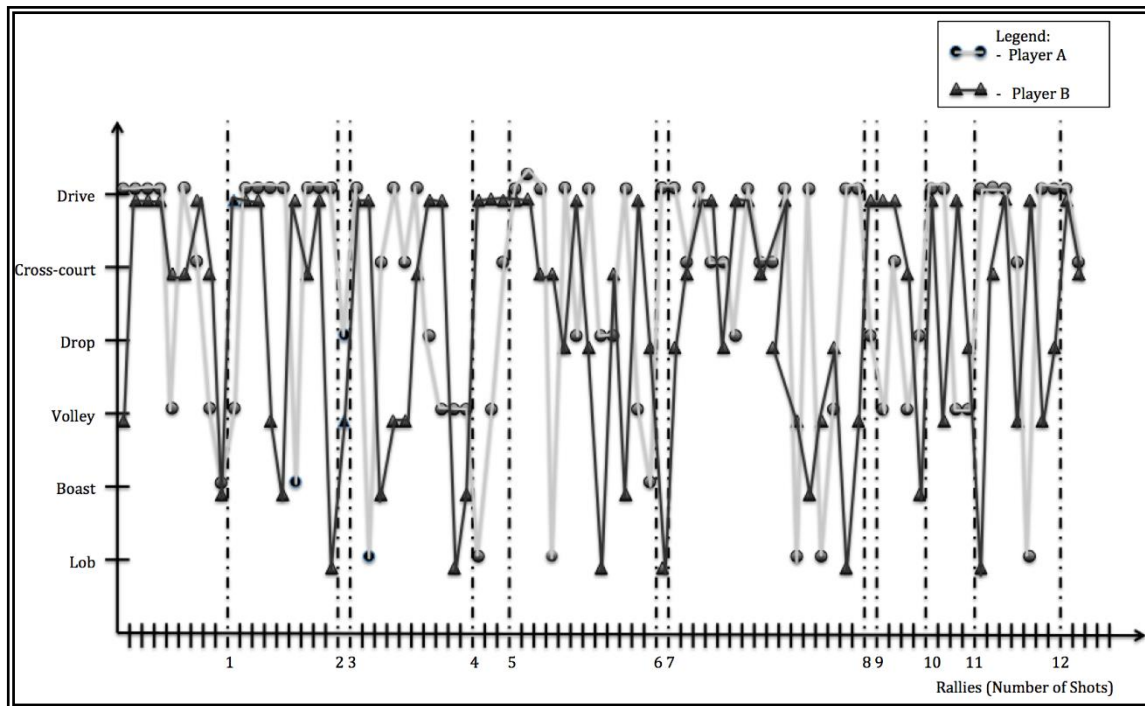


Figure 2: A representative fragment of game play from two players based on type of stroke performed. The vertical dotted lines signify the beginning and end points of rallies.

Figure 2 is a visual aid depicting the playing pattern implemented by players during 13 consecutive rallies. Although the illustration only represents a small part of the total shots performed per game (106 shots of 977), it clarifies the fluctuation between defensive rallies using drive, cross-court, or volley strokes, and offensive rallies using drop or boast strokes. Most rallies begin with a series of drive strokes which indicates a basic playing pattern (i.e., exchanges of drives to the back of the court). Then, rallies typically ended with either drop or boast shots, which indicates an attacking playing pattern intended to create a disturbance in the opponent’s playing rhythm to end the rally.

Analysis of Outcomes

Winners occurred more often compared to errors and lets. The frequency of winners was 58% or 757 out of 1,294 total outcomes. Errors were next most frequent at 25% (321 of 1,294), followed by lets with 17% (216 of 1,294)

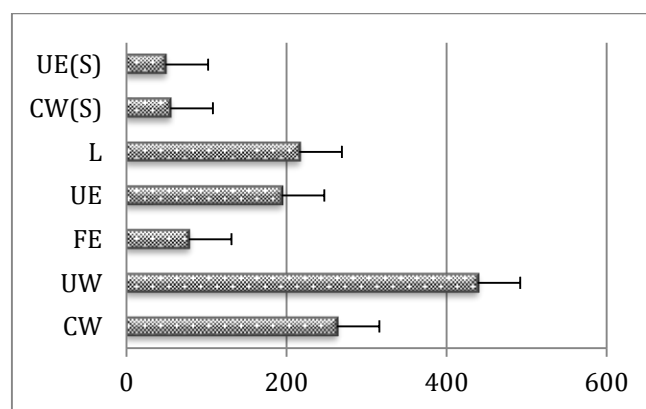


Figure 3: Number of outcomes. Error bars indicate SEM

Figure 3 demonstrates that the ‘unconditional winner’ was the most frequent winning outcome, with a total of 439 occurrences out of 1,294 outcomes. Moreover, the source was most often due to the drop stroke (Figure 4). The least frequent outcome was ‘unforced error by stroke’, in which players made a mistake

during the rally and lost the point due to the umpire decision. Such errors were due to mistakes, such as poor execution of a drive stroke to the back of the court (Figure 5).

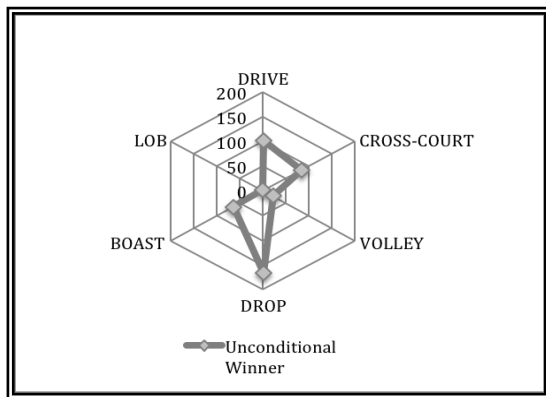


Figure 4: Type of stroke obtained unconditional winner

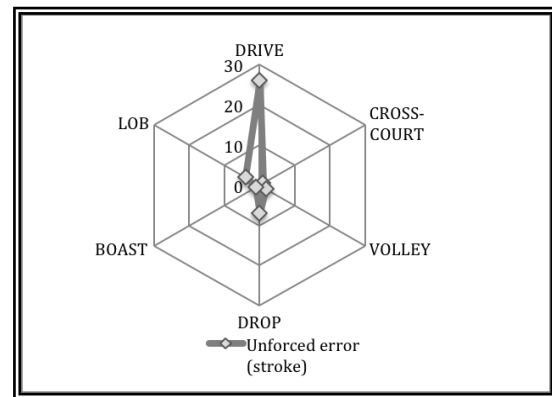


Figure 5: Type of stroke leading to unforced error

The overall results in outcomes indicate that players tend to hit more winners using attacking strokes (e.g., using a drop shot) rather than waiting for their opponent to make a mistake (conditional winner). However, there were also more unforced errors occurred compared to forced errors. A drop stroke most often resulted in unforced errors during a rally (Figure 6).

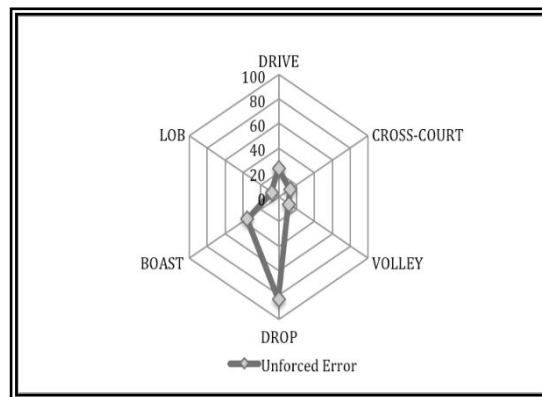


Figure 6: Type of stroke leading to unforced error

Discussion

This study found that the drive stroke was the most frequent type of shot performed during elite women's squash rallies. From a tactical perspective, the drive stroke is an indication of a defensive game strategy. Previous studies also report a similar finding with drive stroke as the most preferred stroke performed during rallies (Murray & Hughes, 2001; Vučković et al., 2006; Vucković et al., 2013). By playing a drive stroke to the back of the court, a player can move their opponent away from the optimum position (i.e., at the centre of court) and plan their next shot. This playing style has been called the defensive game plan as it is associated with the lowest percentage of winner shots (Vučković et al., 2006). A good drive stroke is played when the ball is performed tight to the side and end walls of the court. Players then have time to regain control on rally and plan other shots to win point, while their opponent's opportunity to respond with a winning or offensive shot is limited.

Furthermore, the defensive game strategy resulted in long rallies using the drive stroke. The total mean number of shots performed per game (337.6 shots) was slightly higher compared with 252.1 shots reported by Hong, Robinson, Chan, Clark, and Choi (1996b) in elite men's squash. Elite female players tend to play longer rallies than their male counterparts and seem to prefer to wait for clear chances to hit winners. The purpose of longer rallies could also be to assess opponent's fitness levels and ability. Hong et al. (1996b) suggest a 'pressure and attack' game style is common in male squash which leads to shorter rallies. In the present study, female players typically started games with defensive rallies predominantly using the drive

stroke and then begun playing pressure and attack style later in the games which led to an overall greater number of rallies involved.

However, the defensive game strategy was not the only game strategy leading to successful performance. In fact, this study identified the drop stroke as the most common shot which created unconditional winners in elite female squash matches. When players perform drop strokes it is indicative of an attacking game strategy (Murray & Hughes, 2001). A drop stroke often forces the opponent to suddenly move to the front court and it can interrupt playing rhythm usually after a long rally using drive strokes. By playing a drop stroke, it is possible to increase the pressure on an opponent by shortening the time available to hit a return shot moreover when they were out of position away from front court. Thus, when this shot is executed well it can lead to winning situations (Vucković et al., 2013).

While the drive stroke was the most common stroke performed and the drop stroke was associated with the highest percentage in delivering winners, there were also some apparently contradictory findings. This study also showed that both strokes were the primary cause of errors. Unforced errors by stroke were often caused by drive strokes while unforced errors in general were often associated with drop shots. These results lead us to suggest that in order to implement a mixed playing style (i.e., combining defensive and offensive styles of playing during a rally), occasionally it can lead to errors, possibly due to poor timing and over-eagerness to attack.

Players often made mistakes through poor technical execution (i.e., hitting returns half court, loose away from the side wall, or the ball bounced straight towards themselves). Such mistakes explained a high number of occurrences for unforced errors where their opponent was awarded stroke points. Unforced errors by drop often occurred when players were eager to strike an attacking shot to end the rally, possibly without taking into consideration whether the situation was benefitted or they were forced to do so.

A principal finding of this study was to confirm the existence of a fluctuating pattern between defensive and offensive playing strategy along the course of rallies. This 'mixed tactical style' is supported by McGarry and Franks (1995), who suggest that the evolution of rallies in squash depends on shots responses from both players and the tactical strategy often changes mid-rally. A previous study by Hughes, Well, and Matthews (2000) stated that elite players employed an overall all-court game which consists of defensive and offensive strategies. Players tend to play a basic pattern with a predominantly defensive style at the beginning and in the middle, they attempt to attack using attacking shots.

This study provides some empirical evidence that female players and coaches might use. Whether adopting a defensive, offensive, or mixed playing strategy, they should be prepared to encounter any circumstances triggered by their opponent during rally. However, playing long rallies using the drive stroke and ending with offensive drop strokes (i.e., a mixed style) seemed most applicable and the optimal game strategy. Our analysis has shown that this kind of playing strategy can lead to winners, though it may also produce a number of errors. Previous studies (Hong, Chang, & Chan, 1996a; Hong et al., 1996b) concluded that playing attacking strategy at the end of rally could contribute to the winning performance. It is important for players to practice a style of playing in which defensive and offensive strategies fluctuate and thereby learn to recognize the best moments to attempt to end rallies. Identifying the sources of information that players use to identify such moments in a game would be a useful topic in future research.

Conclusion

Although the information gathered from this study is clear and well-defined regarding the type of stroke performed and the outcomes in elite women's squash, it remains challenging to verify the exact playing strategy that could lead to the ultimate winning performance due to the individual differences and dynamical transition between individuals and the surroundings. Arguably, notational analysis is most valuable when providing player-specific information about their performance during tournaments, how they should execute their strategy against certain players and whether or not it was successful. Instead, the purpose of this study was to identify generic styles of play amongst elite players rather than to tease apart individual players' strengths and weaknesses. The most common strategy implemented by elite female squash players in international tournaments was found to be playing a rally defensively using the basic drive stroke and

finishing the rally using an offensive drop stroke. However, it was not to be assumed that this strategy was the only strategy that lead to winning performance due to the many other sources might influence the playing strategy that have not been discussed in this paper. Further recommendation for future research could include psychological aspects in terms of an individual's perception of performance.

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