Study on the Technical Characteristics of Badminton Players in Different Stages through Video Analysis

Jin Qiu

Chongqing Institute of Engineering
Chongqing 400900, China

Abstract—Through video analysis, Tai Tzu Ying, an excellent athlete, and badminton player A from Chongqing Institute of Engineering, were studied in this paper. The videos of the two athletes were organized and recorded, and the use of techniques in different stages were compared. The results found that Tai Tzu Ying's serve technique was flexible, with few errors, while Play A's serve technique was single and had many errors; in terms of serve receive, Tai Tzu Ying was more aggressive, mainly using rush shot and spinning net shot, while A mainly used techniques of spinning net shot and lift shot. The comparison of techniques in front, middle and back courts showed that Tai Tzu Ying's playing style was more aggressive, while A's playing style was more conservative. This paper compared the two athletes to understand the technical characteristics of excellent athletes and gave some suggestions for the training of school badminton players.

Keywords—Women's singles; video analysis; athletes; badminton; technical characteristics

I. INTRODUCTION

Badminton is a small-scale ball sport [1]. With the continuous development of sports, badminton has also been widely loved by people [2], continuously popularized [3], and become an important project in the Olympic Games [4]. With the progress and development of the international badminton world, badminton game system has been reformed [5], the badminton technology has also been continuously innovated and changed, the level of athletes has been improved, and the situation of the badminton world has become more complex. With the development of men's technology, women's singles play and technology have also changed, becoming more comprehensive, faster, and more competitive. Research on badminton has also become more extensive and deeper.

Most of the comparisons of technical characteristics of badminton focus on the world's best athletes, and there is a lack of comparisons between excellent athletes and ordinary athletes. The comparison between excellent athletes and ordinary athletes is of great significance to help ordinary athletes better understand the differences between themselves and excellent athletes, learn, and improve. Therefore, in order to further understand the gap between excellent athletes and ordinary athletes, the technical characteristics of excellent athletes and ordinary athletes were studied in this paper. Chinese Taipei player Tai Tzu Ying is ranked No. 1 in the World Badminton Federation and is a very good player with a well-rounded playing style. This paper compared the technical characteristics of Tai Tzu Ying and an average college athlete through video analysis to better understand the gap between them.

II. LITERATURE REVIEW

At present, research on badminton involves sports injuries [6], neurocognition [7], muscle structure [8], and biomechanics [9], but most studies focus on sports training [10], i.e., how to strengthen skill levels. Ardiantoro et al. [11] used the top Indonesian badminton player Jonathan Christie as a model and analyzed the tactical approach of the player using a frequent pattern (FP) growth algorithm to help the coach to improve the performance of the player. Zhou et al. [12] built a model of the score rate and technical movements of badminton in international tournaments with computers based on the probability theory and quantitatively compared the differences in scoring rates in international tournaments, thus providing a basis for improving training. Huang et al. [13] studied the optimization of training patterns for badminton players using the Apriori algorithm, providing a new idea for studying badminton technical movement rules. Pérez-Turpin et al. [14] conducted a study on men's singles and double outdoor badminton matches, recorded 20 men's single matches using a video camera, and compared the use percentage of different techniques using the Dartfish video analysis package.

III. RESEARCH SUBJECTS AND METHODS

A. Research Subjects

Tai Tzu Ying: An excellent female badminton singles player who holds the racket with her right hand and currently ranks No.1 in the world.

Play A: A badminton player from Chongqing Institute of Engineering who holds the racket with her right hand.

B. Research Methodology

1) Literature method: We collected and read a large amount of literature on badminton and its technical features through search resources such as the library of Chongqing Engineering College, China National Knowledge Infrastructure (CNKI), Duxiu Academic Web, and Google to understand the current research status and trends.

2) Video analysis method: The video data of 20 matches that Tai Tzu Ying participated in between 2016 and 2019 were obtained from the Internet sports video software such as Tecent Sports and Migu Sports, as shown in Fig. 1. The videos of 20 amateur badminton matches that Play A participated in between 2016 and 2019 were obtained from the school for comparison, as shown in Fig. 2. The videos were played by slow playback

and analyzed by pausing frame by frame confirm and record the type of technique and the landing point.

3) Comparison method: The excellent athlete Tai Tzu Ying was compared with the ordinary player A to compare the differences in their technical characteristics in different stages, analyze their characteristics in playing style, and provide data support for research.

4) Data analysis method: After analyzing the video, the data were organized, processed, and analyzed in Excel to motivate the use of different techniques in front, middle and back courts. The usage rate of every technique was calculated. The graphs were drawn in Excel to present the comparison between Tai Tzu Ying and ordinary athlete A and understand their difference.

Fig. 1.   Screenshots of Tai Tzu Ying's Video.

Fig. 2.   Screenshots of Play A's Video.

IV. RESEARCH RESULTS

A. Analysis of the Technical Characteristics of Serve and Receive

A successful serve can gain the initiative of a match and put pressure on the opponent. At the same time, a serve can force the opponent to use the technique expected by the server to return the shuttle; therefore, the study of the serve technique is important for the study of points scored and lost. A comparison of the technical characteristics of the two players when serving is shown in Table I and Fig. 3.

It was seen from Table I and Fig. 3 that Tai Tzu Ying mainly used the forehand clear and forehand low serve, with usage rates of 51.2% and 27.1%, and seldom used the flick serve, with the usage rate of around 3%, and the number of serve errors was 87, accounting for 9.2%; player A mainly used the technique of forehand low serve, for 572 times, with the usage rate of 76.9%, about 50% higher than Tai Tzu Ying, and the rest of several techniques were seldom used, with the usage rates below 5%, and she also made many errors, for 103 times, accounting for 13.8%, 4.6% higher than Tai Tzu Ying.

The forehand clear makes the shuttle hang in the air for a long time, which is good for players to adjust position and make adequate preparation for the next shot, while the forehand low serve can limit the opponent's ability to attack from the back court. In comparison, Tai Tzu Ying's serve was more flexible, with the forehand clear as the main technique, supplemented by the forehand low serve, which is more conducive to mastering the initiative of the match, while Player A's serve was single and had more errors, showing insufficient advantages in serve.

TABLE I.   COMPARISON OF TECHNICAL CHARACTERISTICS OF SERVE

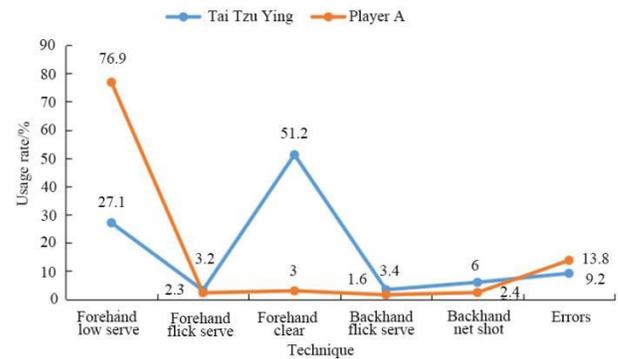| Technique	Tai Tzu Ying		Player A	
	Number of uses	Usage rate	Number of uses	Usage rate
Forehand low serve	257	27.1%	572	76.9%
Forehand flick serve	30	3.2%	17	2.3%
Forehand clear	486	51.2%	22	3.0%
Backhand flick serve	32	3.4%	12	1.6%
Backhand net shot	57	6.0%	18	2.4%
Errors	87	9.2%	103	13.8%

Fig. 3.   Comparison of usage Rate between different Serve Techniques.

The comparison of the technical characteristics of serve showed that attention should be paid to the training of students' serve technique to improve the quality of students' forehand serve and students' awareness of serve, and matches could be simulated to strengthen students' anticipation ability to make them fully consider the way of opponent's return and the way of handling the third shot.

A comparison of the technical characteristics of the receiving serve is shown in Table II and Fig. 4.

It was seen from Table II and Fig. 4 that Tai Tzu Ying and player A had a large difference in the technique of returning the front-court serve and had a small difference in the technique of returning the back-court serve. Tai Tzu Ying used push and spinning net shots frequently to return the front-court serve, with usage rates of 45.25 and 33.4%, and mainly used smash to return the back-court serve, with a usage rate of 49.9%, supplemented by clear and lift shot, with usage rates of 28.4% and 21.7%. Player A used net and lift shots to return the front-court serve, with usage rates of 41.4% and 39.4%. The usage rate of push shot of player A was significantly lower than Tai Tzu Ying, and her usage rate of lift shot was significantly higher

than Tai Tzu Ying. The similarity between Tai Tzu Ying and player A was that the usage rate of rush shorts was the lowest. In the aspects of returning the back-court serve, player A mainly used the smash and clear techniques, with usage rates of 50.2% and 27.5%, and used the drop shot with the lowest probability, 22.3%.

TABLE II.   COMPARISON OF TECHNICAL CHARACTERISTICS OF RECEIVING SERVE

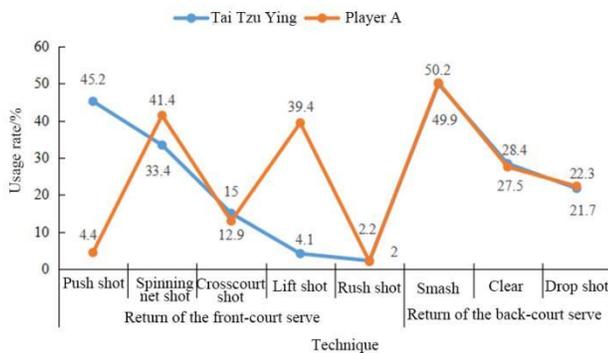|		Tai Tzu Ying		Player A	
		Number of uses	Usage rate	Number of uses	Usage rate
Return of the front-court serve	Push shot	142	45.2%	11	4.4%
	Spinning net shot	105	33.4%	103	41.4%
	Crosscourt shot	47	15.0%	32	12.9%
	Lift shot	13	4.1%	98	39.4%
	Rush shot	7	2.2%	5	2.0%
Return of the back-court serve	Smash	234	49.9%	221	50.2%
	Clear	133	28.4%	121	27.5%
	Drop shot	102	21.7%	98	22.3%

Fig. 4.   Comparison of usage Rate between Serve Receive Techniques.

The video analysis found that Tai Tzu Ying changed the route frequently and was offensive when receiving the service, with the main purpose of consuming the opponent's physical strength. Techniques such as push and spinning net shots are good for limiting the opponent's attack. Smash is featured by fast attack, tricky landing point, and difficult return. Clear can suppress the opponent at the baseline, which is good for her to seize the initiative. The comparison of the technical characteristics of receiving the serve demonstrated that the player could create good conditions for the subsequent attack by taking the initiative through smash and high shots.

B. Analysis of Technical Characteristics of the Front-court Shot

With the advancement of badminton technology, the net technique has also received more and more attention. Although it is relatively difficult to score through net shots, players can create more opportunities to score through the control of the front court. The comparison of the technical characteristics of the front-court shot is shown in Table III and Fig. 5.

TABLE III.   COMPARISON OF TECHNICAL CHARACTERISTICS OF THE FRONT-COURT SHOT

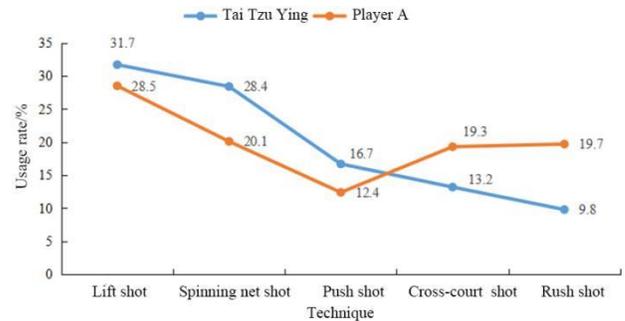| Used technology	Tai Tzu Ying		Player A	
	Number of uses	Usage rate	Number of uses	Usage rate
Lift shot	507	31.7%	464	28.5%
Spinning net shot	453	28.4%	327	20.1%
Push shot	267	16.7%	202	12.4%
Cross-court shot	211	13.2%	315	19.3%
Rush shot	157	9.8%	321	19.7%

Fig. 5.   Comparison of usage Rate between Front-court Shorts.

It was seen from Table III and Fig. 5 that Tai Tzu Ying used lift shots most frequently in the front court, with a usage rate of 31.7%, followed by spinning net shots (28.4%). Player A also had a high usage rate of lift shots, but at the same time, the usage rates of other techniques were even, among which the usage rates of cross-court and rush shots were higher than Tai Tzu Ying. The usage rate of cross-court shots of player A was 19.3%, 6.1% higher than Tai Tzu Ying; her usage rate of rush shots was 19.7%, 9.9% higher than Tai Tzu Ying.

Lift shots can mobilize the opponent by opening the distance and running, and spinning net shots can dominate the attack. Tai Tzu Ying forced the opponent to lift the shuttle through net control to increase the chance of attack. Player A opened the distance with the opponent by lift shots and other techniques and also got rid of the opponent's net control by cross-court and rush shots. The comparison of the technical characteristics of the front-court shots suggested that athletes should strengthen the training of techniques such as lift and net shots and learn to use different techniques to return according to the hitting position, so as to effectively mobilize the opponent.

C. Analysis of Technical Characteristics of the Middle-court Shot

Compared with front-court and back-court shots, the middle-court technique is used relatively less frequently, usually to defend against the attack in passive situations; however, the middle-court technique is also important. Block in the middle court is mainly to return the opponent's aggressive ball to the opponent's net. Drive is aggressive and defensive. Lift shots are mainly used for defending. The number of times the technique was used by both players is

shown in Table IV. A comparison of the usage rate is shown in Fig. 6.

It was seen from Table IV and Fig. 6 that Tai Tzu Ying used the technique of block most frequently, 925 times (63.6%), followed by drive (20.2%) and lift (16.2%) when she was in the middle of the court. Player A used blocks most frequently, but the usage rate (58.6%) was 5% lower than Tai Tzu Ying, but its usage rate of lift shots (22.2%) was 6% higher than Tai Tzu Ying.

Both players mainly used the block technique in the middle court, accounting for more than half of all the techniques, but there were still some differences. Tai Tzu Ying was defensive in the middle court, avoiding the opponent's clear by blocks. She also frequently used blocks to get rid of the passive situation. Player A attacked through the combination of block and drive, hindering the opponent's return to gain the initiative. Through the analysis of the excellent player, it was seen that the training of the block technique should be paid attention to in the daily training to avoid being passive in the game.

D. Analysis of the Technical Characteristics of the Back-court Shot

The back court of badminton is the main scoring place. The main techniques used in the back court are clear, drop shot, and smash. Clear is slow and makes the ball hang in the air for a long time, which is helpful to get rid of the passive state and prepare for the next shot. A high shot can also control the opponent in the back court, which can be used to restrain players who are poor in attacking in the back court. Smash is fast and is an effective active scoring technique. A drop shot is a way to mobilize the opponent, which can disrupt the opponent's rhythm and then score on the follow-up smash. The comparison of the technical characteristics of the two players in the back court is shown in Table V and Fig. 7.

TABLE IV.   COMPARISON OF THE NUMBER OF TIMES THE MIDDLE-COURT TECHNIQUE WAS USED

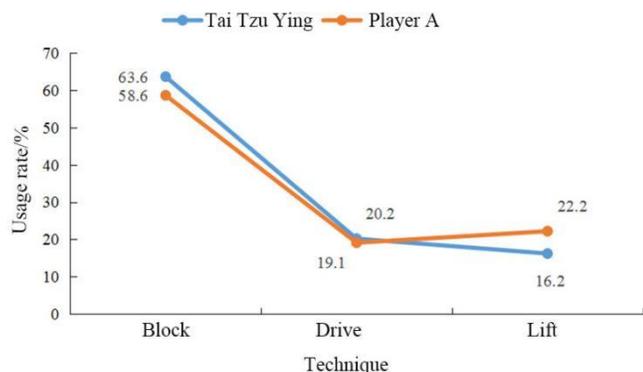| Used technology	Tai Tzu Ying	Player A
Block	925	876
Drive	294	286
Lift	235	332

Fig. 6.   Comparison of usages Rates of Middle-court Techniques.

TABLE V.   COMPARISON OF TECHNICAL CHARACTERISTICS OF THE BACK-COURT SHOT

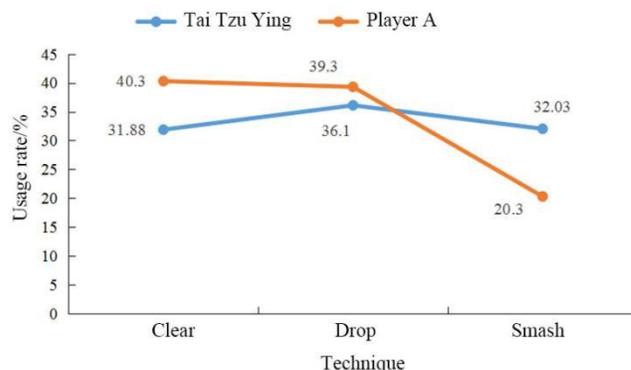| Used technology		Tai Tzu Ying		Player A	
		Number of uses	Usage rate	Number of uses	Usage rate
Clear	Offensive clear	633	22.78%	721	27.5%
	Defensive clear	253	9.10%	336	12.8%
Drop shot	Slice	698	25.12%	712	27.2%
	Drop spike	305	10.98%	318	12.1%
Smash	Cut smash	78	2.81%	52	2.0%
	Spot smash	231	8.31%	168	6.4%
	Heavy smash	581	20.91%	312	11.9%

Fig. 7.   Comparison of the usage Rate between High Shot, Drop Shot, and Smash.

It was seen from Table V and Fig. 7 that Tai Tzu Ying used the drop shot most frequently in the back court, followed by smash and clear, but the overall differences were not significant, about 30%, indicating that she used the back-court techniques with similar frequencies, while Player A was more likely to use clear and drop shots. The usage rate of clear of player A was 40.3%, close to two fifths; her usage rate of drop was 39.3%, also close to two fifths; her usage rate of smash was 20.3 %, 11.73% lower than Tai Tzu Ying. The difference of the usage rate of smash was the largest difference between Tai Tzu Ying and player A in the usage of back-court techniques.

Offensive clear is more aggressive than defensive clear. Tai Tzu Ying used offensive clear more frequently. Offensive clear is used to speed up the rhythm of the back court to find out the opponent's weakness. Defensive clear is usually used for passive defense. In the use of drop shots, the usage rate of the slice was higher. Tai Tzu Ying consumed the opponent's energy with a lot of slices to make him passively defend in most cases. In the use of smash, Tai Tzu Ying used heavy smash most frequently, which is the most aggressive, followed by spot smash. Overall, Tai Tzu Ying used an aggressive style in the back court. Compared to Tai Tzu Ying, Player A used techniques of drop shots and clears more frequently to mobilize

the opponent; her playing style was defensive and used the technique of smash less frequently. The comparison of the technical characteristics in the back court showed that smash, clear, and drop shots were important techniques, especially clear. To enhance the quality of smash, sports training should strengthen students' strength quality and physical stability.

V. Discussion

With the development of science and technology, video analysis methods have also been well applied in the field of sports. Videos can be processed to find the technical characteristics of athletes to help improve the training efficiency of athletes [15]. Those methods have mature applications in various sports, such as basketball and soccer [16] and have excellent performance in athlete detection and classification, athlete or ball tracking and trajectory prediction, team strategy identification, and sports classification [17].

This paper compared the technical characteristics of two badminton players through the method of video analysis. In the current research on badminton and video analysis, Chen et al. [18] investigated badminton trajectories and stroke types and applied video analysis methods to real-time analysis of badminton matches. Liu et al. [19] designed an end-to-end system for racket motion analysis to improve performance in court identification, 2D trajectory estimation, and hitting recognition. Lin et al. [20] achieved tracking and trajectory prediction of moving objects after segmenting video images. Their method can predict badminton serve trajectories accurately. Ongvises et al. [21] recorded the drop shot in badminton with high-speed video and found that the impact velocity of the racket was proportional to the velocity of the badminton when it left the racket. Most of the comparisons of technical characteristics focus on the comparison between the world's best athletes to provide reference for the development of international competition and to improve the competitive level of the best athletes. There are few analyses between excellent athletes and ordinary athletes; therefore, this paper compared the technical characteristics of Tai Tzu Ying, a world excellent badminton player, with an ordinary college student. The results of the video analysis showed significant differences between the two players in the usage of front-, middle-, and back-court techniques. In general, compared to player A, Tai Tzu Ying has the following technical characteristics.

1) She has a stronger sense of active offense, will fully move the opponent's position, and is good at creating offensive opportunities to score.

2) She has a stronger sense of occupying the net in the front court and is more proactive in receiving and serving to wait for opportunities to attack.

3) She counterattacks in the midfield usually through her defensive skills to turn passive into proactive and realize the integration of attack and defense.

4) She used clear, drop, and smash shots in the back court to disrupt the opponent's judgment and take the initiative.

With the help of video analysis and data analysis, the research results of this paper intuitively show the differences in technical characteristics between the excellent athlete and ordinary athlete, which provides a good reference for better understanding the advantages of excellent athletes and the shortcomings of ordinary athletes to guide athletes and narrow the gap between ordinary athletes and the world's best athletes. This work contributes to the improvement of the competitive level of badminton players.

VI. Conclusion

This paper compared and analyzed the technical characteristics of Tai Tzu Ying and a school badminton player through video analysis. It was found that there were some differences between the two players in the use of different techniques. In general, Tai Tzu Ying used lift shots and spinning net shots frequently in the front court, used block frequently in the middle court, and used drop and smash frequently in the back court, which was more flexible and aggressive. The comparison of the technical characteristics between the two players in this paper provides some suggestions for the training of school badminton players through analyzing the difference between excellent athletes and ordinary athletes in technical characteristics, so that they can learn the characteristics of the excellent athletes to improve their technical level. This paper also verified the reliability of video analysis technology in the sports field. In future research, this method can be applied to other sports to help athletes improve their technical ability more effectively. However, this paper also has some shortcomings. The research sample was relatively single, so the study of technical characteristics was relatively limited. In future research, more in-depth work is needed to further understand the differences between outstanding and ordinary athletes.

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