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Assessment of the impact of the proprietary Verteko Virtual First Person View Game Analysis Method post-match analysis on the accuracy of self-assessment in beach volleyballers

Abstract: This research is part of the trend of looking for quality improvement without further increasing the duration and intensity of player's training. In this study, an attempt was made to verify one of the many possibilities of increasing the accuracy of self-esteem in players practicing beach volleyball. In that purpose the Verteko Virtual First Person View Game Analysis (VFGA) Method was created. The game was recorded using image recording glasses that players wore. During post-match analysis VR googles was used to show players video recorded by their glasses, and glasses worn by partner. A statistically significant improvement in the assessment of all taken into account elements of their own game was demonstrated in the study group. However, no statistically significant differences were found regarding the partner's game. The effectiveness of the VR goggles use protocol has been confirmed for a small group of amateur volleyball players. It is advisable to conduct further research, also with numerous groups of professional players.

Keywords: post-match analysis; self-assessment; beach volleyball**;** volleyball

1. Introduction

Beach volleyball is an Olympic sport that has been developing very dynamically around the world for many years (Grgantov et al., 2005; Medeiros et al., 2017). Hence there is the need to look for more and more effective methods of training based on reliable scientific research. It is indispensable to use the latest technologies for this purpose, giving the opportunity to improve the training process, without additional burdening their already intensively exploited organisms with further training stimulation (Sands et al., 2017; Hadlow et al., 2018). This research is part of the trend of looking for quality improvement without further increasing the duration and intensity of players' training.

For this purpose, Verteko Virtual First Person View Game Analysis Method (Verteko VFGA Method) was created. A method of training and post-match analysis that can be implemented as a result of the miniaturization of image recording equipment that can fit into the spectacle frames without affecting the player's performance. Beach volleyball is a sport practiced outdoors, so players are used to playing in sunglasses. In addition, the possibility of using virtual reality goggles allows you to experience the match after its completion in an inaccessible way until recently. A player can recreate his play by seeing

everything again from the first-person perspective, thus noticing the elements that his perception missed during a stressful situation during the match. Another aspect of this research is enabling the player to watch the match from the perspective of his partner. Hence, observing your own actions from a third-person perspective, and therefore even greater objectification of the post-match evaluation (Reis et al., 2015; James & Petrone, 2016; (Jones et al., 2017).

The research is aimed at improvement in the post-match analysis of video material. This is a very important element of the player's preparation and development (Tilp et al., 2006; Nicholls & Worsfold, 2016). Competitors often have difficulty in correctly assessing the quality of the actions and activities of the partner (Rudkowska, 2005). For obvious reasons, it is difficult for them to adopt an external, critical position. Even developed on the basis of objective statistical analysis (Brycz, 2003; Michalopoulou et al., 2005).

Hence the proposal to use the Verteko VFGA Method and modern tools for recording and playback of video recordings of sports competitions, in line with global trends of using the latest technologies in improving the training process (Nichols et al., 2019). The research aims to determine whether the Verteko VFGA Method post-match analysis protocol, which includes watching a match using VR goggles from your own perspective and then your partner's perspective, gives better results in the accuracy of your and your partner's quality assessment during a beach volleyball match.

2. Materials and Methods

2.1. Players

The participants were amateur beach volleyball players. Each of them with a training frequency of 2-3 times a week. They were adult men with an average age of 34.42 ± 7.72 years. The youngest of them was 18 years old, the oldest was 49. Their declared state of health enabled them to participate in recreational forms of physical activity and competition during beach volleyball. Based on the informed consent form, 12 people were qualified for the study, forming 6 pairs. The pairs were created randomly. Three pairs were assigned to the study group, the other three constituted the control group. The research was approved by the Bioethics Committee at the Regional Medical Chamber in Koszalin (Poland).

2.2. Verteko VFGA Method

The novel Verteko Virtual First Person View Game Analysis Method (Verteko VFGA Method) was created. In this study, an attempt was made to verify one of the many possibilities of its application - increasing the accuracy of self-esteem in players practicing beach volleyball.

The subjects were randomly assigned to two groups: one analyzed the match only on the basis of an ordinary recording from a camera positioned behind the end line of the court, the other implementing the Verteko VFGA Method protocol (Table 1) - watching the material using VR goggles from the own and partner's perspective.

Using the observational method, video materials were collected. This happened during the usual beach volleyball competition, without any interference by the researcher. His only activity was to equip the players from the examined group before the match with sunglasses with a video recorder, as well as to set the camera behind the court's end line.

The decision was made to analyze the side-out phase of the game, including serving, setting and attacking. Many authors indicate that effectiveness in this phase of the game is the key to achieve success (Palao, 2004; Sánchez-Moreno et al., 2015; Link & Wenninger, 2019). The video recording from the camera positioned behind the end line of the court was used to create objective match statistics including reception, setting and attack performance, to which the subjective ratings of the subjects were compared.

Using the diagnostic survey method, data of the player's assessment of his own game and his partner's game were collected. The survey form (Table 2) on which the respondents indicated their feelings about the analyzed match was distributed twice. Immediately after the end of the match and after analyzing its recording. Then the survey form was distributed again to the players. Their own and partner's game scores were compared with objective statistics and previous scores made immediately after the match. The study group analyzed the match in accordance with the Verteko VFGA Method protocol, the control group watched twice (because the study group also watched the match twice - from their own perspective and then from the partner's perspective) recording from a regular camera positioned behind the end line of the court on the TV screen. Conditions were provided for both groups to watch the material in silence and concentration. Partners from the teams

assigned to the control group watched the recording simultaneously, sitting side by side. In their case, it was also allowed to exchange comments on a given action. When the next one began, attention was required to watch it. Each pair played one set up to 21 points in accordance with FIVB regulations. The peer-to-peer system was chosen. A total of 15 sets in order: 1-6, 2-5, 3-1, 4-2, 3-6, 4-5, 2-6, 3-4, 5-1, 2-3, 6-4, 1-2, 6-5, 1-4, 5-3. The players were put on sunglasses with HD video recorder during the competition (Fig. 1).

The whole match was also recorded with a camera set at a safe distance behind the end line of the court. During the post-match analysis, the players were equipped with virtual reality goggles (Fig. 2), which displayed a recording of glasses illustrating the "first person" view. Initially, the players watched the record from their own glasses. Then recording from the partner's glasses. Thus, having the opportunity to observe their field behaviour from the perspective of the person with whom cooperation is the most important (Künzell et al., 2014). The field of view has been maximally aligned with the physiological values characteristic of each human eye - from 85-90 degrees from the temporal side to 55-60 degrees from the nose, 45-55 degrees from the top and 65-70 degrees from the bottom. The binocular field of view is created by the common area covering this area for the left and right eyes. It is approximately a circle with a diameter of 60 degrees. Both temporal ends of the 30-degree field of view come separately from the right or left eye (Niżankowska, 2007).

This extended visualization allowed them to change the perception of your own behaviour and the quality of the game, and to better understand your partner's behaviour and decisions. It has been shown that this can be problematic even when watching a classic recording from a camera positioned behind the end line of the pitch (Koch et al., 2009).

The study was conducted among amateurs practicing recreational beach volleyball. For this reason, it was necessary to specify less stringent performance criteria for game elements classified as "valid". Before the study, everyone was acquainted with the following definitions of a properly performed task.

2.3. Definitions of good performance

1. Reception - first contact, which allows the partner to perform the set in time comfort, both hand or bump set. Some inaccuracy is allowed, which, however, does not force the partner to perform the set in an unstable position.

2. Set - second contact, that results putting the ball in a in system location, enabling the partner to perform any form of attack (spike or a shot) while maintaining full approach. Some inaccuracy is allowed, which, however, does not exclude any offensive variant.

3. Attack - ended with scoring a point in any form (spike or a shot) or by using opponent's block to be able to play the action again.

Five ranges covering 20% effectiveness were presented in the questionnaire form (Fig. 1). Their task was to estimate in which range the actual effectiveness of the serve reception, set and attack own and partner's was located. The answers were referred to the actual state based on statistics created by the researcher thanks to video material recorded with a camera positioned behind the end line of the court. Therefore, it was possible to estimate the deviation of the respondents' responses from the actual state expressed in the number of 20% ranges. Positive values meant answers that were too high compared to match statistics, negative answers that rated performance too low.

3. Results

A statistically significant improvement in the assessment of all taken into account elements of their own game was demonstrated in the study group. For admission, the average error decreased from 1.37 ± 0.94 interval to 0.27 ± 0.52 interval, for the set from $1.43\ 0.97$ interval to 0.5 ± 0.57 interval, and in the case of an attack from $1, 23 \pm 1.1$ range to 0.47 ± 0.73 range (Table 3). However, no statistically significant differences were found regarding the partner's game. The p value <0.05 occurred in truth when assessing the acceptance of the service by the partner, but it concerned a reduction in the accuracy of the assessment.

In the control group, the most statistically significant improvement was found when assessing the effectiveness of their own attack. Initially, the subjects were mistaken by an average of 1.3 ± 1.23 interval, and after classical analysis of video recordings by an average of 0.53 ± 1.28 interval. There was also a statistically significant small correction of the

level of underestimation of the performance assessment by the partner's serve reception and set (Table 4).

The Table 5 presents the average value of improving the accuracy of rating individual game elements in the side-out phase. It was calculated as the difference between the absolute values of the error of assessment made immediately after the match and after the post-match analysis. Its positive values mean, therefore, how many intervals the respondents improved in their assessment, negative values how many intervals their assessment made after the post-match analysis was less accurate than that made immediately after the meeting.

It was shown that the proposed protocol of the post-match analysis of the Verteko VFGA Method using a recording of glasses equipped with a camera and material analysis on VR goggles was more effective than the traditional model. The average improvement of all the parameters of the own and partner's assessment in the study group was 0.56 ± 0.44 interval, while in the control group only by 0.03 ± 0.21 interval. The difference turned out to be statistically significant (Table 5).

4. Discussion

The purpose of this study was to verify whether the use of widely available, modern technology for post-analysis analysis in accordance with the Verteko VFGA Method will increase the level of self-esteem accuracy for players practicing amateur beach volleyball.

It has been shown that the application of this protocol has significantly improved the ability to assess players of their own level of play. The group performing the post-match analysis according to the Verteko VFGA Method assessed the effectiveness of their game more accurately by 0.53 interval compared to the control group analyzing only the classic video recording from the camera set behind the end line of the **court** (Table 5).

It should be emphasized that classic video analysis proved to be a much less effective method in this case (Table 4). There is a clear tendency that the players focused mainly on observing and assessing their own attack ($p = 0.001$), and the other elements did not undergo such significant statistically significant improvement (Table 4, Table 5).

For both groups a much smaller improvement in the assessment of the partner's performance was noted. Competitors showed a clear tendency to underestimate this effectiveness (Table 3, Table 4). Even after analyzing the video material, their ratings did

not improve significantly (Table 5). This is somewhat consistent with the findings of other authors regarding differences in self-assessment and assessment of others (Pronin et al., 2004; Lai et al., 2011).

5. Conclusions

The conclusions presented in this work should be approached with caution. The study aimed to signal the way to increase the effectiveness of post-beach volleyball game analysis using modern technology together with the Verteko Virtual First Person View Game Analysis Method. Although the differences turned out to be highly statistically significant (Table 4), the effectiveness of the VR goggles use protocol has been confirmed for a small group of amateur volleyball players. It is advisable to conduct further research, also with the participation of numerous groups of professionals.

It should be emphasized that the Verteko VFGA Method, in combination with image recording glasses and VR goggles, has great development potential and can be used not only to increase the self-assessment efficiency of sports activities (thereby increasing internal motivation for self-improvement of players), but also to train concentration of perception on the most important elements during individual actions. However, further research is needed to confirm its effectiveness among professionals and indicate possible further development paths.

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Table 1. Post-match analysis according to the Verteko VFGA Method

Stage	Phase	Description	Customizable by the trainer
	1. Preparation of the position and equipment	- Before conducting the analysis of the match, the person conducting the tests the operation of the equipment (mainly whether the material is played in parallel). - Only players and the person conducting the analysis are in the room - Ensure silence, turn off phones and other communication tools. - Subjects lying down are simultaneously watching a synchronized recording on VR goggles. - The person conducting the analysis looks at the screen of e.g. a computer in parallel with	The position in which players watch the match can be adjusted to their preferences. They have to feel comfortable, so it can also be a semi-lying position, or, for example, a sitting position

Preparation	2. Preparation of participants and leader	- Participants must have time to calm down, mental preparation and focus on analyzing the match. - Leader provides players in Phase 2 and 4 with access to paper and pen.	The research did not pause in the movie, nor did the video rewind, but if the trainer deems it necessary to achieve the training objectives, there are no contraindications to introduce these elements. The condition is, of course, maintaining the synchronism of the images played to two
	3. Reminder of applicable rules	- The analysis reflects the match conditions. During the action, absolute focus is required on observing the course of the game. - After the referee's signal, you can talk to your partner about the previous action. - The referee's signal allowing the next service to be completed ends the	In this study, the person conducting the analysis does not engage in player discussions, however, it is advisable for the trainer to join the conversations between actions. He then has the same rules as players

	Phase 1 watching the recording with your own glasses	- Players should empathize with the atmosphere of the match and try to "play it again" without uncertainty of the result and potentially negative emotions. - It is crucial to adapt to the principle of concentration on action and the free exchange of views and perceptions with the partner (and also with the trainer) between them.	In this study, the entire record of competition has been analyzed, but the trainer can only choose a specific fragment, or several separate, in his opinion key fragments of the meeting.
	Phase 2 Mute and Record your own insights and thoughts	- Players take off their VR glasses - They lie with their eyes closed for 2 minutes summarizing in their thoughts what they saw. - Then they have time to write down the observations obtained in this way. - Under observations are to mention two positive aspects	Depending on the level of maturity of the players, you can expand this phase with in-depth self-reflection, or shorten it only to note two positive and one negative remark. The 2: 1 ratio is important.
	Phase 3 Watching the recording of the partner's glasses	- See Phase 1 - In this phase, players should pay special attention to the partner's perception restrictions regarding their own court behaviour. „If something is obvious for me, it doesn't have to be also for my partner."	- See Phase 1

Phase 4 Mute and Record your own insights and thoughts	- See Phase 2 - It is important that players note new observations about two positive and one negative aspect of their own and partner's play. Acquired thanks to a new perspective - partner	- See Phase 2

Analysis	**Phase 5** Joint discussion	- The person conducting the analysis collects the cards filled in by the players and reads the results aloud. A spontaneous discussion may arise. - The key moment of this phase is to conduct further discussion according to the following four points: 1. Which technical or tactical element of the game was our best? 2. Which technical or tactical element of the game was weakest? 3. What was the main reason for victory / defeat? 4. Therefore, what would you consider as the most important training priorities before the next competition? - The person conducting the analysis takes notes on the answers and thoughts of the players	If the level of maturity of the players allows it, you can ask 1-2 questions regarding yourself and your partner. However, you must ensure that players can accept constructive criticism of the partner.

	Phase 6 Positive final	- The most important phase of building the long-term effectiveness of this method and thus good relationships in the team. - After discussing the positive and negative elements of each player's game together, there must be a "high five" and thanks for playing together, analyzing the match and smile. - The key is to create a positive attitude towards further, joint training work bringing closer to mutual success.	It is important to achieve the effect of clearing the players relations of any mutual grievances against each other, obtaining an appropriate level of self-confidence and internal motivation to continue training, as well as the desire to succeed together. For this reason, this phase will look completely different for each team and requires the person conducting the analysis
Ending	1. Safety and comfort	- After staying in the static position for a long time with the VR goggles on, you should ensure that there are no problems with maintaining balance or spatial orientation. Competitors should be able to calmly learn about their own body reactions. - It is also important to provide participants with comfort, e.g.	

	2. Cleaning activities	- Save note cards and recorded video materials on a computer or external media for comparison and future analysis.	

Table 2. Survey Form The statistical method was used to analyse the significance of differences between variables (Pieter, 1967). From the elements of descriptive statistics, the average value along with standard deviation was used. The normality of the distribution was checked using the Shapiro-Wilk test. The analysis of the significance of differences between the means of parametric variables was made using the Student's T test, for the others its non-parametric equivalent - Wilcoxon test for observation pairs was used.

Own activities					
	0-20 %	*21-40 %*	*41 -60%*	*61-80 %*	*81- 100 %*
Reception					
Set					
Attack					
Partner activities					
Lp	*0-20 %*	*21-40 %*	*41 -60%*	*61-80 %*	*81- 100 %*
Reception					
Set					
Attack					

Table 3. Results of the test group analysing the recording of own and glasses worn by the partner (the Wilcoxon test value was underlined)

Parameter		Average	Standard deviation	T text or Wilcoxon test value	p
Evaluation of own reception	*before*	1.37	0.94	6.81	**< 0.001****
	after	0.27	0.52		
Evaluation of own set	*before*	1.43	0.97	<u>210</u>	**< 0.001****
	after	0.5	0.57		
Evaluation of own	*before*	1.23	1.1	4.17	**< 0.001****
	after	0.47	0.73		
Evaluation of partner's reception	*before*	-0.2	0.89	-2.15	**0.04***
	after	0.23	0.57		
Evaluation of partner's	*before*	-0.4	0.93	-1.88	0.07
	after	0	0.64		
Evaluation of partner's attack	*before*	-0.23	1.17	-1.39	0.17
	after	0.033	0.93		

Table 4. Results of a control group analysing video material only on the basis of a recording from a camera positioned behind the court (the Wilcoxon test value was underlined)

Parameter		Average	Standard deviation	T text or Wilcoxon test value	p
Evaluation of own reception	*before*	1.13	0.78	<u>18</u>	1
	after	1.14	0.79		
Evaluation of own set	*before*	1.17	0.99	<u>20</u>	0.79
	after	1.2	0.89		
Evaluation of own	*before*	1.3	1.23	<u>156</u>	**0.001****
	after	0.53	1.28		
Evaluation of partner's reception	*before*	-0.43	0.97	<u>32</u>	**0.04***
	after	-0.13	0.97		
Evaluation of partner's	*before*	-0.83	1.10	<u>40</u>	**0.42***
	after	-0.73	1.20		
Evaluation of partner's attack	*before*	0.03	1.13	-1.78	0.08
	after	0.40	1.22		

Table 5. The average values of improving the assessment of own and partner's play in the examined and control groups and significance assessment differ between them.

Average improvement [range]		tested group [n=6]	control group [n=6]	jointly – own and partner's play		distinction between own and partner	
				T test	p	T test	p
own play	receptio	1.1	0	2.59	0,05*	7.16	0.02*
	set	0.93	0.03				
	attack	0.77	0.1				
partner's play	receptio	-0.03	0.3			0.13	0.9
	set	0.4	0.1				
	attack	0.2	-0.36				
average improvement of own and partner's		0.56 ± 0,44	0.03 ± 0.21				
average improvement of		0.93 ± 0,17	0.04 ± 0.05				

Fig. 1.

Fig. 2.

Figure captions

Fig. 1. Player with image recording glasses on

Fig. 2. Player with virtual reality goggles on during post-match analysis.