





The effect of a laser device on some biomechanical variables of the rotational phase in the achievement of 100 m freestyle swimming for the Iraqi team (16-18 years old)

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ABSTRACT

The researchers have discovered weaknesses in the rotational phase of the 100-meter freestyle event, including a lack of proper movement direction and control of biomechanical variables necessary for swimmers to achieve high rotational accuracy, which leads to outperforming competitors. The objective of this study was to investigate the effect of using a laser device on improving the performance of the rotational phase among swimmers on the Iraqi national team. The experimental approach was conducted on a sample of 6 swimmers, representing 100% of the target population. The researchers concluded that the utilization of a proposed laser device in the rotational phase resulted in positive differences in biomechanical variables, contributing to the enhancement of swimmers' performance and increasing the horizontal distance achieved. Consequently, the researchers recommend the implementation of a laser device during the rotational phase to detect weaknesses and enhance strengths, thereby facilitating coaches in the development of swimmers. **Keywords:** Analytical study, Biomechanical variables, Laser device, Rotational phase, Freestyle, 100-meter freestyle.

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INTRODUCTION

Swimming is one of the water sports and its main nerve, as it is characterized in its performance from the rest of the other games as continuity and permanent fluidity that appears in the continuous mutual work between the movements of the arms and legs, as it is in a medium characterized by continuous resistance, whether from the density of water or its pressure on the body or the ripples resulting from the movements inside the water (Salman, 2015), as the movements must be according to a motor rhythm appropriate to the method of swimming. The scientific and technical development witnessed by the world today has a great role in the application of scientific and technological foundations that contribute to raising the scientific level in general, and sports in particular, and accordingly, it can be said that reaching the best sports achievement or the highest level of skill performance is closely related to the development of science and technological progress (al-Samarrai & albayati, 2005). Biomechanics is considered the first of the sciences that advanced the sports field, as biomechanics is one of the sciences that take care of the development of sports movements through study (Alwan & Al-Fadhli, 2012), analysis and biomechanical evaluation, clarifying differences and finding relationships observed through kinematic representation to identify the strengths and weaknesses of swimmers and thus provide sufficient information for the coach to have a solid base and accurate information in order to work to enhance strengths and work to develop them and avoid weaknesses and thus develop the digital achievement of swimmers. As for the 100m freestyle event, the rotation stage is one of the most important stages in this event, which gives it great importance in reducing the achievement time, as the swimmer must look at a wall before the last hand stroke that will lead to rotation while not losing speed. It is necessary to change the momentum before and after the turn at the lowest value to sustain the momentum of the race speed on the approach and after the push, because of the possibility of gaining advantage and outperforming the rest of the competitors. The speed of rotation depends on controlling how fast the swimmer rotates his head around the horizontal axis by avoiding the moments of inertia of the line during the rotation to increase the speed of the body around the horizontal axis for this reason he must move his head at a high speed during a rotation in the direction of speed as much as possible. The research aimed to identify:

- Identify the effect of using a proposed laser device according to some biomechanical variables for the rotation phase and the achievement of 100 m freestyle.
 - To determine the values of some biomechanical variables for the rotation, swimming, and achievement phase of the 100 m freestyle.
1. Human domain: National team swimmers in the youth category (16-18 years old).
 2. Temporal field: From 2/24/2024 to 4/18/2024.
 3. Spatial field: Al-Shaab Stadium swimming pool, Army Sports Club swimming pool.

MATERIAL AND METHODS

The researchers defined the research community, the research sample represented by the players of the Iraqi national team (16-18 years old) and the number of (6) swimmers, they were selected by the random method, representing 100% of the original community of players and those who continue to train.

The first exploratory experiment

To ascertain and locate the correct place and locating the cameras and to avoid the obstacles that may appear during the pre-test and for training on the test procedures, the researcher will conduct the exploratory experiment on (Sunday) 14/2/2023 at (6:00 pm) at the Army Sports Club swimming pool, and the procedures

of the exploratory experiment will be very similar to the procedures of the pre-test in terms of using the same cameras and the rest of the equipment and the presence of the same assistant work team.

Second reconnaissance trial

To ensure the accuracy of the work during the procedures of the main experiment in the research and its validity and for the purpose of avoiding obstacles, the researcher will conduct the second exploratory experiment on (Wednesday), 16/2/2023 at 6:00 pm at the Army Sports Club swimming pool and the sample will include swimmers from the research sample and the procedures of the experiment will be very similar to the procedures of the main experiment where the laser device (for the rotation phase) will be used during it to identify the accuracy and validity of its work and not causing any damage to the players (Hameed, Al-Shamaa, & Haider, 2024).

Biomechanical variables of the swimmer's rotation phase

Some of them were extracted by the Kenova kinetic analysis program, which is one of the kinetic analysis devices in the sports field.

1. 1.Momentum: It deals with the force Momentum = mass * velocity (Al-Fadhli, 2020)
2. Velocity: It is the relationship between distance and time (Omar & Abdul Rahman, 2011)
3. Thrust: It is the exertion of a force during a unit of time based on its law (thrust = force * time).
4. and is measured from the Foot Scanner
5. Thrust force: The value of the force variable extracted through the law of thrust (thrust = force x time). (Al-Fadhli, 2020) and measured from the Foot Scanner.
6. Push time: The period of time required to perform the thrust according to the law of thrust (thrust = force x time) (Al-Fadhli, 2020) and measured from the Foot Scanner.

The researcher used a device (laser in some biomechanical variables of the rotation phase) as a means of approximating the angle of the rotation phase for each swimmer according to the need for the development of assistance within the training units of the group, specifically in swimming exercises (100 m freestyle). The experiment was from 24/2/2024 to 14/4/2024 with (24) training units of (3) training units per week.

The statistical package (SPSS) was used to process the results statistically.

RESULTS

Table 1. Mean (μ), standard deviation (σ), and differences of the mean (μ difference) and standard deviation (σ difference) of the pre and post-test of the biomechanical variables of the Rotational phase in (100m freestyle) swimming.

Kinematic variables	Pre-test		Post-test		μ . Difference	σ . Difference	T-test value	Sig Value	Sig
	μ	+ σ	μ	+ σ					
Momentum (Kg*m/s)	78.180	11.821	83.831	14.826	-5.651	3.158	-4.384	.007	Sig.
Velocity (m/s)	1.175	0.128	1.258	0.166	-0.043	0.043	-4.725	.005	Sig.
Thrust (N*s)	528.719	29.203	533.792	26.726	-5.072	3.652	-3.488	.018	Sig.
Thrust force (N)	654.304	33.051	677.626	35.987	-23.322	6.268	-9.114	.000	Sig.
Thrust time (s)	0.8100	0.0642	0.7900	0.064	-532982	26.678	-48.935	.000	Sig.

Note. df = 5, significant when sig value is smaller than (.05). Sig. = Significant.

Table 2. Pre-test, and post-test differences for the achievement of (100) meter freestyle swimming.

Kinematic variables	Pre-test		Post-test		μ . Difference	σ . Difference	T-test value	Sig Value	Sig
	μ	+ σ	μ	+ σ					
Achievement (s)	58.703	0.370	58.516	0.359	0.186	0.095	4.770	.005	Sig.

Note. $df = 5$, significant when sig value is smaller than (.05). Sig. = Significant.

DISCUSSION

We notice from the above table that there are statistically significant differences and therefore we notice that the device used has significantly affected the results of the swimmers and therefore the process is reversed whenever the training is done using the device. We notice from Table 1 the values of the differences for the arithmetic means of the biomechanical variables for all stages of the performance of the rotation phase of the 100 m freestyle swimming, as it was found that the differences between the arithmetic means of the variables under study for the pre and post tests were significant in favour of the post-test, and the reason for the significance of the differences between the arithmetic means of the variables of momentum and speed in favour of the post test is due to the adaptation of the swimmers to the change in the performance of the rotation phase as a result of the special training (Tariq, Qasim, & Hamid, 2020) (Abdulkareem et al., 2017) for the rotation that they were exposed to the analysis according to Newton's third law (action and reaction), as the player needs a large momentum in order to transfer the direction of kinetic energy after performing the rotation movement to the other side represented by the reaction force (Shalash, 2013) of the force exerted by the swimmer on the pool wall to shed a thrust force that results in an increase in the swimmer's speed while flowing (Shalash, 2013). As a result of increasing the value of momentum as mentioned above, we find that significant differences appeared between the values of the arithmetic means of the speed variable between the pre and post-tests in favour of the post-test, as a result of increasing speed in the direction of the horizontal vehicle during swimming before performing the rotation movement, which helped the swimmer to transfer the kinetic energy from the horizontal vehicle to the vertical vehicle more quickly, which increased the value of the angular velocity of the rotation of the body centre of gravity, which led to a reduction in the time required to perform this phase (Hill, al-Zayadi, & Abdulrahman, 2014).

This is clearly shown by referring to Table 1, where we find that the differences appeared significant for the force variables in the direction of increase and decrease for the time variable, which resulted in an increase in the value of thrust in the direction of increasing the value of the force and according to the law of thrust: (Omar & Abdul Rahman, 2011)

$$\text{Thrust} = \text{force} * \text{time}$$

Based on the above law, we find the inverse proportionality between the two variables of force and time (Abdul-gani et al., 2024), and this is what appeared through the results of the research, as an increase in the value of force appeared at the expense of a decrease in the variable of time, and this is what is required and in the interest of the swimmer, as the reduction of the propulsion time (Al-Fadhli, 2020) is reflected to reduce the total completion time of the 100 m freestyle.

Referring to the variable of completion time and referring to the values of the arithmetic means shown in Table 2, we find that the significant differences between the values of the arithmetic means of the pre and post-tests in favour of the post-test due to the reduction of time that occurred due to the increase in the value of speed to increase the value of momentum before performing the rotation, as well as the increase in the value of angular velocity to rotate the centre of gravity of the body, in addition to the increase in the value of

the knee angle from the maximum flexion, which also reduced the time required to perform the propulsion. the value of the knee angle from the maximum flexion, which also reduced the time required to perform the push, as well as the change in the direction angle, which increased the underwater flow distance with less resistance imposed on the swimmer's body during progression, which also reduced the time required to perform this stage, and the aforementioned changes were reflected in reducing the overall completion time of the 100 m freestyle (Abdulhussein et al., 2024).

CONCLUSIONS

1. The change in the biomechanical variables of the rotation mode that showed significant differences contributed to the development and increase of the horizontal distance achieved by using a proposed laser device for the rotation phase.
2. Reduction of the 100m freestyle time as a result of changes in the biomechanical variables affecting the rotation phase, as these changes contributed to reducing the time required to cover this distance.

Recommendations

1. The use of devices (proposed laser device for the rotational phase) in subsequent studies because it helps to reveal weaknesses and enhance strengths, which facilitates the coach's task in the development of swimmers.
2. Increase the emphasis on the rotational phase of swimming during training and include it in the training modules due to its effective role in improving the level of achievement.

AUTHOR CONTRIBUTIONS

In a recent field study on the biomechanics of the 100-meter freestyle turning phase, three leading researchers have made a significant contribution to the advancement of the field by using laser technology to analyse performance. Sema Zaher Yahya was the lead researcher on this project, designing the study and selecting the necessary equipment. She was responsible for calibrating the laser and ensuring the accuracy of the data collected. She also performed the initial experiments and analysed the raw data to extract the vital parameters related to rotation. Bushra Kazem Abdul Rida was responsible for collecting data from the swimmers participating in the study. She supervised the experimental sessions and ensured that they were carried out according to the protocol. Bushra also analysed the movement data and identified the main differences between the swimmers in terms of rotational efficiency and speed of performance. Omar Waleed Abdulkareem was responsible for analysing the data using mathematical models and advanced software. He translated the collected data into interpretable reports and results and contributed to the final research paper. He also contributed to identifying the key biomechanical factors that affect performance in the rotational phase and translated the research paper from Arabic to scientific English. The results of the study emphasized the importance of using laser technology to analyse biomechanics in swimming, which will help improve training techniques and the performance of swimmers in general.

SUPPORTING AGENCIES

Iraqi Aquatics Federation.

DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

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