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Original Article

Kinematics characteristics of Seoi-Nage and reverse skill in judo

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Abstract:
Biomechanics is considered to be the leading science that helps to increase and reach the highest level of sports performance. Biomechanics studies and analyses motor performance within the factors that affect performance and aims to reach the most suitable biomechanical solution. Kinematics is one of the branches of biomechanics that provides a precise description of movement; kinematics is used to understand techniques of judo, which is a highly technical sport. This study aims to identify the kinematic characteristics of performing traditional Seoi-Nage and developed Seoi-Nage (reverse skill). To compare both methods, 10 athletes with a high-performance level of both skill were chosen from the Egyptian youth national team to performed both method. The data were collected using a three-dimensional coordinate setup with 4 cameras recording at the speed of 250 frames/s; motion analysis, using a semi-motion system, was used to analyse the attacking athletes performance. The obtained results allowed to identify the kinematic characteristics of both methods and differences between them (e.g., motion phase time, motion phase displacement, motion phase velocity, motion phase acceleration) that were in favour of reverse Seoi-Nage in most kinematic variables during the three phases of performance. The obtained results suggest that trainers should teach the traditional skill to young athletes first and then teach the reverse skill based on the principle of gradual transition from easy to difficult in the process of education and training. Training of high level athletes in judo on the reverse skill is performed owing to its great effectiveness during matches compared to the traditional skill.
Key Words Kinematic, Seoi-Nage, Reverse skill, judo.

Introduction

Judo is a combat sport whose goal is to throw the opponent on his back, by applying explosive throwing techniques and require high muscle power both in upper- and lower-body muscle groups, Judo is an Olympic combat sport with a competitive weight class system. Bonitch-Domínguez, et al (2010), Vacca, L. et al (2020), Murayama, et al (2020), Franchini, E., et al(2011), Ciaccioni., et al(2019), Le Panse, et al (2020).

The skills of throwing in judo is one of the most important skills in which the player can win the matches and the skills in judo is a vary according to the classification of the Kodukan and through the games noted the spread of a number of skills, including Seoi-nage (hand technique)is accomplished by making your opponent off balance by pulling in a straight forward motion, or a right or a left forward motion, then pick up your opponent's body on your back and throw over the shoulder.(Kodokan,2019), Melo,et al (2013)

Seoi-nage in judo is categorized in group one of the Gokyo no waza (five groups for teaching judo). Seoi-nage is also frequently used by many judo athletes during practice and competition. Ishii, et al (2012), Shan-Shan, M. A. O. (2017)

According to statistical analysis done on the Rio de Janeiro Olympics Games in 2016 and the world judo championships in Baku, the Republic of Azerbaijan in 2018, judo athletes were most likely to acquire points with seoi-nage techniques in the matches. Ishii, et al (2019).

Therefore seoi-nage techniques is one of the most common skills and spread in games globally and in recent years became international players distinguished in the performance of the skills of throwing them a great credit in the development of the performance of the skills of throwing especially Seoi-Nage. (**Figure 1**)

Figure 1. Illustration of traditional Seoi-Nage

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Reverse seoi-Nage is one of the skills developed by the South Korean player "choi- Min-Ho" He was the first to use this skill in early 2000 and the Korean Seoi-nage was named after the first player he used. He was a Korean player and later became known as Reverse Seoi-nage. The beginning was an unknown skill, and the referees did not count any points and then spread internationally on a large scale later and were used by many players other than the Koreans. ("Choi Min-Ho.2019).

Until now there is no studies on the Reverse seoi nagi (development skill) although it is widely spread in international competition

Kinematics is one of the branches of biomechanics that is concerned with describing how the body moves in space and does not attempt to explain why this movement, Kinematics measurements have a fundamental importance in evaluating sports performance because it is the basic stone from which other mechanical measurements are extracted, it gives a precise description of the movement without addressing the causes of movement. Knudson, D. (2007), GLEADHILL, et. Al (2020), Coppola, et. Al (2020), Starzak, et. Al (2020), Saračević, et. Al (2018),

There are many studies that have used the Biomechanical analysis of traditional Seoi-nage with using various motor analysis systems such as.(Ae, M., Koshida, S., & Fujii, N. ,2016; Gutiérrez-Santiago, A., Prieto, I., Camerino, O., & Anguera, M. T. ,2013; Ishii, T., Ae, M., Suzuki, Y., & Kobayashi, Y. ,2018 ; Ishii, T., Ae, M., Kobayashi, Y., & Suzuki, Y. , 2012; Sacripanti, A.,2008), Imamura, R. T., Hreljac, A., Escamilla, R. F., & Edwards, W. B. (2006).

The Kinematics variables were used to describe the skill performance more accurately and then compare the performance of the traditional Seoi-nage and the reverse Seoi-nage, Thus, the hypothesis of research is to determine the kinematics characteristics of the traditional Seoi-nage and the reverse Seoi-nage to compare them to extract information that can be utilized in the process of education and training, Kinematic variables are involved in the description of the movement, inde-pendent of forces that cause that movement, They include linear and angular,displacements, velocities, and accelerations.

To achieve high sport performance, athletes, coaches, and teams first have to identify limiting factors of performance and design effective training programs. Ishii, et al (2015).

Coaches need a thorough understanding of the kinematics of seoi-nage and biomechanical characteristics that differentiate the skill levels using the standard motion model so that coaches will be able to improve their observation skills to evaluate its performance properly. Ishii, et al (2019).

Therefore, the aims of this study were to know the Kinematic characteristics of performing the traditional Seoi-Nage and the developed Seoi-Nage(Reverse skill) to compare between both methods to identify factors of effectives performance to understanding performance to identify the differences through comparison.

Material & methods

The participants were 10 players from the Egyptian national team of youth, players who won local and continental tournaments and have a high-performance level of traditional skill or reverse skill, the players' data were collected weight, length, age, belt degree and training age (Table 1)

Table 1. The players' data

Participations	Age	Weight/ kg.	Height/M	Belt degree	Training age
1	18	72	1.65	Black/Shodan (1st)	9 YEAS
2	19	81	1.8	Black/Shodan (1st)	7 YEAS
3	18	69	1.67	Black/Shodan (1st)	6 YEAS
4	17	65	1.69	Black/Shodan (1st)	7 YEAS
5	19	77	1.7	Black/Shodan (1st)	9 YEAS
6	19	75	1.77	Black/Shodan (1st)	9 YEAS
7	18	72	1.74	Black/Shodan (1st)	9 YEAS
8	17	79	1.75	Black/Shodan (1st)	7YEAS
9	20	79	1.8	Black/Shodan (1st)	10 YEAS
10	18	80	1.75	Black/Shodan (1st)	9 YEAS
	18.3	**74.9**	**1.732**		**8.2**

After receiving the approval of the players to participate in the study was explained the nature of performance required during the process of Three-dimensional coordinate data and were trained on the performance required on the Judo mat, uke (the person being thrown by the tori) wore the judo jacket while the tori (the person throwing an opponent) wore short shorts so that the researcher and the assistant team could mark the anatomical points on the body.

Figure 2. Participants during Three-dimensional coordinate data

Three-dimensional coordinate data of the tori with 4 cameras at a speed of 250 / s, the distance between the cameras 6m, the distance between the cameras and the starting area of 6m. A number of judo mattresses were used to carry out experience. The players performed 50 Times for the traditional Seoi-nage and the reverse Seoi-nage, Five judo experts were used to determine the best four of the traditional Seoi-nage and the reverse Seoi-nage way to analyze them, The start of the performance was determined from the moment the tori catching of the uke and the end of performance from the moment the Dropp off the tori on the back, the end of the first phase was determined by putting the tori to the right foot in front of the uky's right foot during the imbalance process, and the end of the second phase at the moment of rotation of the tori and put his left foot front the left foot of the uky, And the end of the third phase in the moment the Droop off the tori on the back on mat, Data were captured with 4 cameras of a Simi motion system for the tori (the person throwing an opponent)**(figure 2)**

The researcher used the statistical program spss to conduct statistical processing using the Mann-Whitney U test, non-parametric statistics test to find differences between The Kinematics parameters between traditional skill and developed skill. Cohen, J. (1988).

Results

The results of the statistical analysis, as shown in Table (2), showed statistically significant differences in The Kinematics variables during the traditional Seoi-nage performance phases and the reverse Seoi-nage performance phases as follows:

- There were statistically significant differences between the two groups in the (total performance time), (the performance time of the third phase) of the second group (reverse Seoi-nage).
- There were statistically significant differences between the two groups in the (The performance time of the first stage), (the performance time of the second stage) of the first group (traditional Seoi-nage).
- There were statistically significant differences between the two groups in the (Displacement during the first phase), (displacement during the third phase) of the second group (reverse Seoi-nage).
- There were no statistically significant differences between the two groups in (displacement during the second phase).
- There were statistically significant differences between the two groups in the (velocity in the first phase), (velocity in the second phase), (velocity in the third phase) of the second group (reverse Seoi-nage).
- There were statistically significant differences between the two groups in the (acceleration in the first phase) of the first group (traditional Seoi-nage).
- There were statistically significant differences between the two groups in the (acceleration in the second phase) of the second group (reverse Seoi-nage).
- There were no statistically significant differences between the two groups in (acceleration in the third phase).

Table 2. Kinematic variables and the statistical significance of the differences between the traditional Seoi-Nage and the reverse Seoi-Nage

	Seoi-Nage (traditional)		Seoi-Nage (reverse)		Significance	ES
	Mean Rank	Sum of Ranks	Mean Rank	Sum of Ranks		
Time	2.750	11.000	6.250	25.000	R>T * 0.043	0.057
Time 1	6.380	25.500	2.630	10.500	T>R * 0.028	0.029
Time 2	6.500	26.000	2.500	10.000	T>R * 0.020	0.029
Time 3	2.500	10.000	6.500	26.000	R>T * 0.021	0.029
Displacement 1	4.250	17.000	4.750	19.000	R>T * 0.766	0.886
Displacement 2	4.500	18.000	4.500	18.000	N.S. 1.000	1.000
Displacement 3	3.500	14.000	5.500	22.000	R>T * 0.245	0.343
Velocity 1	3.000	12.000	6.000	24.000	R>T * 0.083	0.114
Velocity 2	3.500	14.000	5.500	22.000	R>T * 0.248	0.343
velocity 3	3.250	13.000	5.750	23.000	R>T * 0.149	0.200
Acceleration 1	5.250	21.000	3.750	15.000	T>R * 0.386	0.486
Acceleration 2	3.250	13.000	5.750	23.000	R>T * 0.149	0.200
Acceleration 3	4.500	18.000	4.500	18.000	N.S. 1.000	1.000

*, significant; N.S., not significant; T, traditional seoi-nage; R, reverse seoi-nage

Numbering 1,2,3 means the three-motion phase.

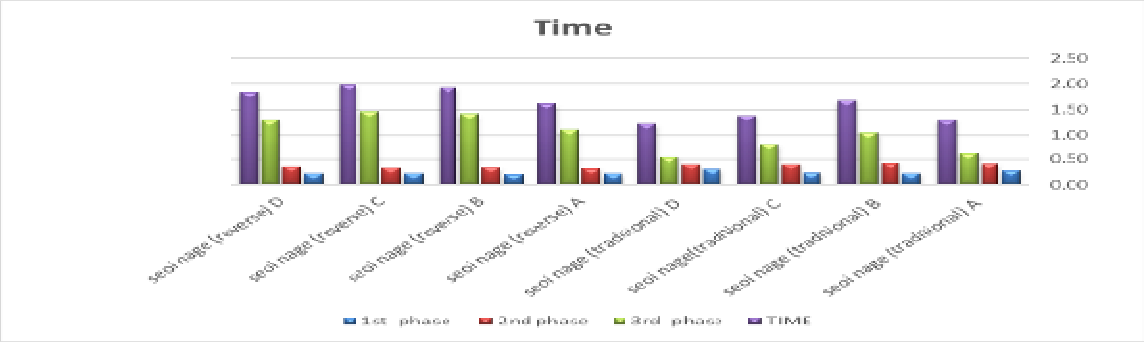

Figure 3. motion phase time

Figure (3) shows the difference between the time of the phases and the time of the full performance of the traditional Seoi-nage and the reverse Seoi-nage. The figure shows an increase in the total performance time and the time of the third phase of the reverse seoi-nage compared to the traditional seoi-nage, However, there is no significant variation in the time of the different phases of both methods. And increasing time during the third phase through which the implementation of the process of throwing and follow shows the difference between the traditional Seoi-nage and the reverse Seoi-nage in the form of performance and the requirements of this important phase.

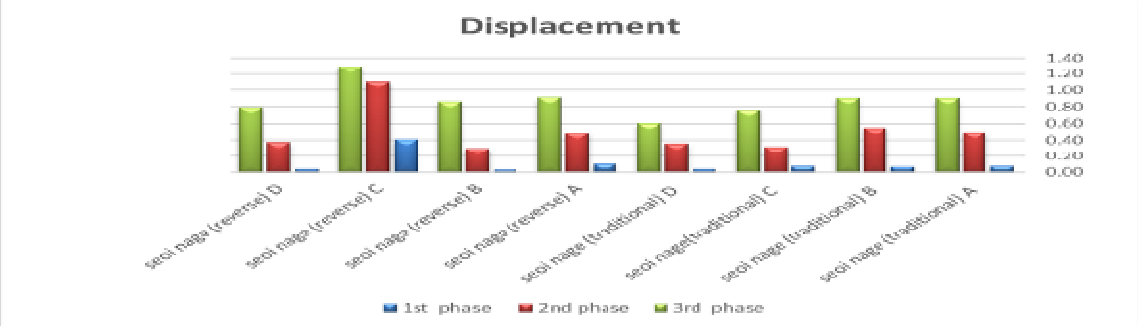

Figure 4. motion phase displacement.

Figure (4) showed slight differences in displacement during the three phases of performance between the two methods and clearly during the third phase and in favor of the reverse Seoi-nage.

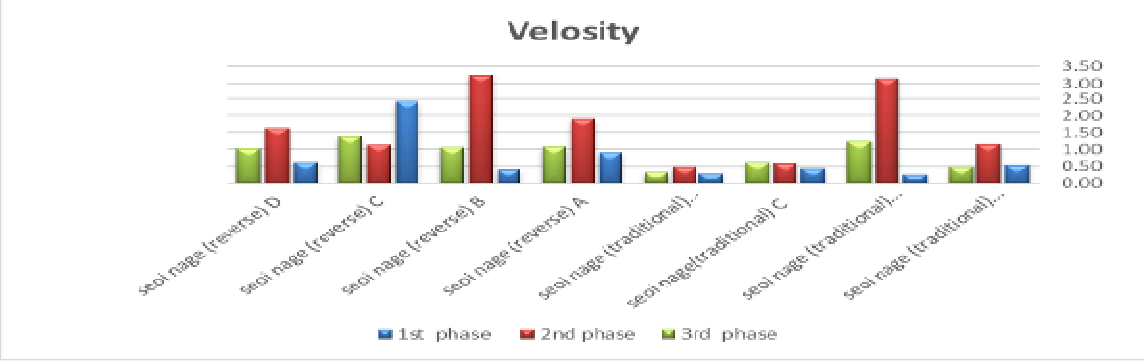

Figure 5. motion phase velocity

Figure (5) shows the high velocity values significantly during the performance of the three phases of the reverse reverse seoi-nage compared to the traditional seoi-nage.

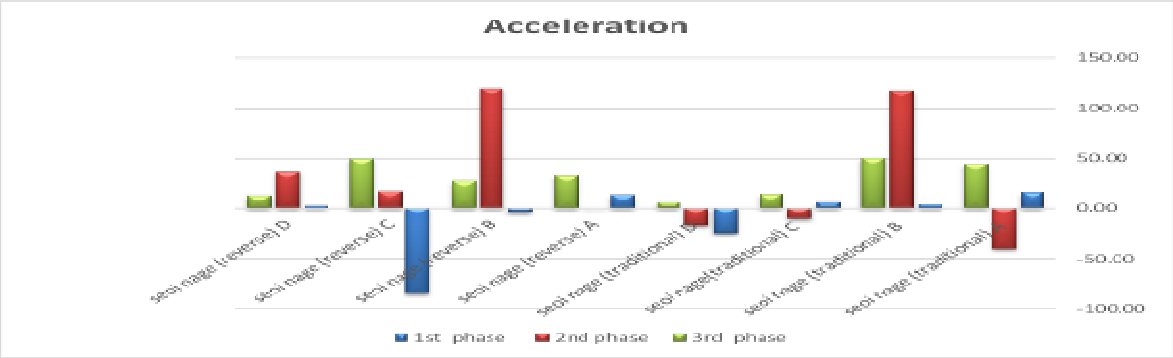

Figure 6. motion phase acceleration

Figure (6) shows the acceleration values of the center of body mass during the traditional performance and reverse performance where there is no difference except the emergence of some negative values in the first and second phases.

Dicussion

The main objective of the study is to find a comparison between both the traditional performance and the Reverse performance, the results of the Statistical analyses showed that there are statistically significant differences in favor of the reverse Seoi-nage performance in the time of total performance and the performance time of the third phase (throwing phase). This superiority can be traced back to the reverse Seoi-nage performance for the nature of the technical performance of the reverse method, in particular the throwing process which depends on the rapid rotation and the exploitation of the trunk significantly in the throwing process which leads to a stronger impact in the throwing process compared to the traditional performance which needs a relatively longer time. There were statistically significant differences in favor of the developed performance in the displacement of the center of body mass during the first phase and the third phase, the difference in foot movement in the first phase in the developed performance greatly helps in better access to the uke from the back to complete the throwing compared to traditional performance. The use of the trunk significantly as an assistant with the arms during the process of throwing in the developed performance has a significant role in the superiority of the developed performance. The statistically significant differences in favor of the developed performance in the velocity of the center of the body mass during the three phases of performance and the acceleration of the center of the body mass during the second phase, there were the velocity of the center of the body mass during the developed performance contributed significantly to its superiority over traditional performance, especially during the first phase and the second phase.

The Statistical analyses that showed the differences between the traditional seoi-nage and the reverse seoi-nage in the Kinematics variables, which showed the superiority of the reverse seoi-nage in most kinematics variables, can be attributed to the fact that the reverse seoi-nage depends heavily on a number of technical aspects that give preference and can be identified as follows:

- The use of the trunk significantly during the imbalance to help with the hands as an additional force to support the process of imbalance, which greatly helps the following tasks up to the throwing phase.
- The process of rotation in the second phase of performance after the imbalance to enter the position of throwing or the beginning of the stage of throwing is very fast compared to the traditional seoi-nage, which makes the body reach the position of throwing fast.
- The position and location of the trunk and the location of the throwing allows the use of arms and trunk to the maximum, which increases the speed and strength of the process of throwing in the reverse seoi-nage.

Conclusions

The objective of the study is to find out the fundamental differences in the way the performance of each of the two skills, the results showed a clear superiority of the reverse skill in the performance of the three stages Kinematics Characteristics. Through the results of this research, Training beginners on the traditional seoi-nage first and then the reverse seoi-nage in accordance with the principle of gradual easy to difficult, Training of high level players in judo on the reverse skill because of their great effectiveness during matches compared to traditional skill, design the special physical exercises that increase the efficiency of movement of body members that have a key role during performance, especially for high levels, More scientific research on the skills of throwing developed from the creations of high levels players, the results of this research can help coaches to training program development and achieve greater results in competitions.

Conflicts of interest No potential conflict of interest was reported by the author.

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