A COMPARATIVE BIO-KINEMATIC ANALYSIS OF LUNGE INITIATION BEFORE AND AFTER FRONT FOOT CONTACT IN FOIL FENCING

Ali Abdallah Essa
University of Basra
IRAQ

Sameer Khalaf Gary
University of Basra
IRAQ

Yarob Abdul Baqi Daikh
University of Basra
IRAQ

Corresponding Author: ali_abdullah@uobasrah.edu.iq

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ABSTRACT

Background. Biomechanics played a major role in these contributions, as it details and explains the function of each part of the body and studies each technique, its effectiveness, and what a particular technique can achieve in fulfilling the purpose of the movement. **Objectives.** This study aimed to identify differences in selected bio-kinematic variables between initiating a lunge prior to versus following front foot ground contact in foil fencing. **Method**. The researchers used the descriptive method with a comparative analytical approach as the optimal method for solving the research problem. The descriptive method is defined as the accurate description of a phenomenon or problem and studying the phenomenon as it is in reality, The research community was identified as four players of the Iraqi national foil team. In order to obtain a result that is close to reality, the research sample consisted of 24 attempts made by the players for both cases. The sample was chosen purposively, as only the two cases of stabbing were studied, and for more than one match, as the total number of matches reached (3) National team players are chosen because they have a high level of physical and technical capabilities due to the need to study for this level. The research sample consisted of four fencers from the Iraqi National Foil Team. **Results.** There is a significant difference between the thrust before and after the anchorage in the variable of knee joint angle, as the value of T was equal to (-5.383). The significant difference between the lunge before and after landing in the shoulder joint angle variable, where the T value was (-3.590). T value for the dueling distance variable was (2.509), as the T value was (3.444). And there is a significant difference in the step distance variable and in favor of stabbing after fulcrum, as the value of T was (-2.933). **Conclusion.** The study reached several conclusions; primarily, the results revealed significant differences in certain bio kinematic variables between the pre-contact and post-contact lunge techniques, while other variables showed no significant differences between the two styles. Based on the findings, the researchers recommended that coaches train athletes in both lunge techniques due to their significant impact on match outcomes.

Keywords; fencing, biomechanics, kinematic variables, lunge skill, foil.

A. INTRODUCTION

The world has recently witnessed great development on all levels, whether technological, scientific, health, or sports. This comes from the diligence of researchers and scientists in studying the minute details that would affect the phenomenon completely. In the sports field, advanced technologies have emerged that seek to analyze the movement performance into small parts in order to enhance the good ones and correct the weak ones, and thus this benefits the overall form of the movement.

Biomechanics played a major role in these contributions, as it details and explains the function of each part of the body and studies each technique, its effectiveness, and what a particular technique can achieve in fulfilling the purpose of the movement. It also determines when this technique or that can be used, especially in a sport like fencing, which is considered one of the most important individual sports that can achieve important medals and titles if its practitioners are properly trained. The skill of thrusting is one of the most important skills, indeed it is the foundation of the game, as points cannot be scored without it (Sabah Nouri Hafez et al., 2014). Therefore, thrusting techniques vary in one way or another, and each athlete performs them according to the external influences imposed on him or the appearance of a reaction from the opponent that provides an opportunity to get a touch.

From the above, the importance of the research is evident in subjecting two methods of progressive jabbing in order to identify the most important biomechanical differences between them and providing this information to coaches and fencing athletes so that it becomes a flexible tool in their hands, thus achieving good levels and at the same time giving the athlete the opportunity to distinguish the method of jabbing that the competitor performs in succession of cases in order to exploit those variables to his advantage in defense and jabbing after defense. And enriching the sports library with important information about the differences and variations in the methods of performing a single skill provides greater development opportunities for athletes.

It may be very difficult for an inexperienced or even an expert viewer to follow the nature of a fast-moving performance, given the inability of the human eye to see fast-moving

motion. Even if it is able to do so, the focus is usually on certain parts and some parts of the movement that determine the type of style are overlooked.

From the practical observations resulting from the analysis of the grappling skill in previous studies by researchers, it became clear that there are two different grappling styles according to certain requirements. This may not be subject to scientific scrutiny, and thus there is an unintentional oversight of these two cases. The lack of information that contributes to achieving a high athletic level for our players is an indication of a lack of attention to this skill in a precise scientific manner. Therefore, such a case was studied in order to identify its most important variables and benefit from this information as much as possible. Moreover, knowledge of these differences gives the opportunity to discover the weaknesses of the attacking fencer and thus exploit those points when defending.

This study aimed to identifying the differences in the values of some biomechanical variables between starting the thrust before and after landing with the front foot on the ground in foil fencing. There are differences in the values of some biomechanical variables between starting the thrust before and after landing the front foot on the ground in foil fencing.

B. METHOD

The researchers used the descriptive method with a comparative analytical approach as the optimal method for solving the research problem. The descriptive method is defined as the accurate description of a phenomenon or problem and studying the phenomenon as it is in reality (Al-Assaf, 2000).

Research community and sample

The research community was identified as four players of the Iraqi national foil team. In order to obtain a result that is close to reality, the research sample consisted of 24 attempts made by the players for both cases. The sample was chosen purposively, as only the two cases of stabbing were studied, and for more than one match, as the total number of matches reached (3) National team players are chosen because they have a high level of physical and technical capabilities due to the need to study for this level.

To control for variables that could affect the study results, the researcher performed homogeneity testing on the sample. The researchers used the coefficient of variation, a statistical measure that indicates the homogeneity of the sample. A coefficient of variation below 30% indicates greater homogeneity among the sample members (Wadie Yassin Al-Tikriti & Mohammed Hassan Al-Obaidi, 1999)

Table 1. Shows The Homogeneity of of the sample group is evident.

Variables	Player 1	Player 2	Player 3	Player 4	Mean	Standard deviation	Coefficient of variation %
Age (years)	20	21	22	19	20.50	1.12	5.46
Mass (kg)	71.8	74.6	73.5	70.2	72.53	1.67	2.30
Height (cm)	175.4	178.9	177.3	174.3	176.48	1.76	1.00

Tools, equipment, and methods for collecting research data

Sample data registration form – Bio-kinematic analysis form – Internet.

Tools and Equipment Used:

1. Camera (Sony HDD 520).
2. Computer (Lenovo Yoga).
3. Fencing equipment.
4. A measuring tape.
5. A drawing scale.
6. A medical scale.

Exploratory Experiment

The exploratory experiment was conducted on Wednesday, 15/10/2025, on one player in order to check the equipment and tools, as well as to identify problems and obstacles that may hinder the progress of the main experiment and to find solutions to them before implementing the main experiment.

Main Experiment

Video Imaging and Bio-kinematic Analysis

Photography process was carried out using a (SONY HDD 520) camera, where the height of the lens from the ground was taken into account. As its height was (1.43 m) and at a distance of (5) m from the duel platform, as well as the photography angle to be appropriate for the field of movement and perpendicular to it to show the player completely and clearly,

after which the Bio-kinematic analysis process was carried out. The DARTFISH V4.5 program installed on a laptop (LENOVO YOGA) was used. As in picture (1).

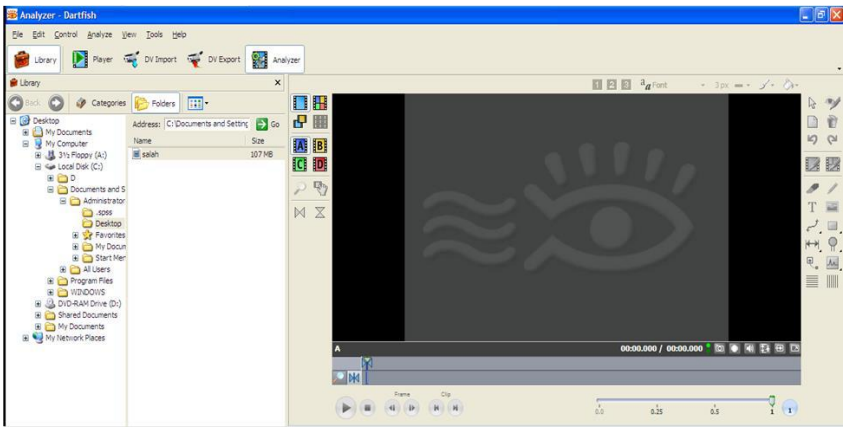

Figure 1. software interface is shown Dartfish.

The main experiment was conducted on November 5, 2025, with a sample of four players. The camera was set up according to the measurements obtained during the pilot study to analyze the video and identify the biomechanical variables under investigation. After the players warmed up, three matches were filmed between the players, and those matches were filmed in a scientific manner, as two cameras were placed on the right sides of the competitors. The players were observed performing the lunge technique in two ways: lunging before landing with the front foot on the ground, and lunging after landing, according to the requirements of the game. A total of 24 instances of lunging before landing were recorded. To ensure accurate statistical analysis, 24 instances of lunging after landing were also studied to achieve an equal number. What posed a challenge in the work was that the use of the lunge before landing appears in specific situations, so it is necessary to follow the movement of both competing players. That is, the instances in which the lunge before landing appeared were not many, and some of them were unclear, which necessitated continuing the filming until the end of the three matches, which were structured as two matches followed by a final match for the winners of those two matches. *Bio-kinematic variables*: Knee joint angle, Shoulder joint angle, Drag distance, Torso tilt angle at the moment of thrust, Hip joint height, Lancing stride length and Elbow joint angle

Statistical Methods

The analysis in this study went through the stages of Arithmetic mean, Standard deviation, Coefficient of variation and T-test for uncorrelated samples which were assisted using the SPSS 26 application.

C. RESULTS

Table 2. means and standard deviations of the biomechanical variables of the appeal before anchorage are shown.

No.	Biomechanical variables	Number of attempts	Mean	Standard deviation

		Measurement unit			
1	Knee joint angle	Degree	24	117.9500	21.04249
2	Shoulder joint angle	Degree	24	77.5083	6.55209
3	Duel distance	Meter	24	0.8125	0.16756
4	Angle of inclination of the trunk at the moment of stabbing	Degree	24	79.7667	6.24999
5	Hip joint elevation	Meter	24	0.7350	0.04189
6	Length of the stabbing step	Meter	24	0.3142	0.11843
7	Elbow joint angle	Degree	24	128.7333	9.06214

Table 3. Means and standard deviations of the biomechanical variables of the tug after anchorage are shown.

No.	Biomechanical variables	Measurement unit	Number of attempts	Mean	Standard deviation
1	Knee joint angle	Degree	24	157.0642	12.6381
2	Shoulder joint angle	Degree	24	97.6333	19.333
3	Duel distance	Meter	24	0.6267	0.290
4	Angle of inclination of the trunk at the moment of stabbing	Degree	24	86.491	11.419
5	Hip joint elevation	Meter	24	0.7692	0.0516
6	Length of the stabbing step	Meter	24	0.5583	0.223
7	Elbow joint angle	Degree	24	140.2667	14.934

Table 4. Presentation And Discussion Of The Results Of The T-Test For Biomechanical Variables Before And After Landing

No.	Bio-kinematic Variables	Value T	Sig.	Level of Sig.
1	Knee joint angle	-5.383	.000	Sig.
2	Shoulder joint angle	-3.590	.004	Sig.
3	Duel distance	2.509	.029	Sig.
4	Angle of inclination of the trunk at the moment of stabbing	3.444	.000	Sig.
5	Hip joint elevation	-2.164	.053	Insig.
6	Length of the stabbing step	-2.933	.014	Sig.
7	Elbow joint angle	-2.656	.022	Sig.

At a significance level of (0.05) and under 23 degrees of freedom

From Table No. (4), it is clear to us that there is a significant difference between the thrust before and after the anchorage in the variable of knee joint angle, as the value of T was equal to (-5.383). The angle of the knee joint after landing is greater than before. Researchers attribute this to the fact that the front foot lands first, before the weapon reaches the opponent. This means the front leg is almost extended at this moment, allowing the fighter to take a greater distance forward, especially if the distance between the fighters is significant. This makes it easier for the weapon to access the competitor's body effectively.

Furthermore, increasing the distance between the front and back legs increases the base of support, enhancing body balance during the strike and contributing to the transfer of power from the back leg and torso to the armed arm and then the weapon, ultimately reaching the opponent (Roi & Bianchedi, 2008) Performing the lunge skill effectively and efficiently requires mechanical coordination of the lower limb and torso up to the weapon, while the bending at the knee joint is less in the case of lunging before the stabilization. Since the angle was measured after contact with the ground, which is after the end of the lunge operation, this means that performing the lunge and the end of the action causes the center of gravity to move out more, which generates pressure on the knee joint. Therefore, the large bending appears, especially since the advancement of the torso and arm preceded the stabilization operation. This is confirmed (Hall, 2012) by the fact that the torso moving out of the base of support during the movement exerts muscular torques around the joint in order to maintain balance and control the movement more.

As shown in the table above, there is a significant difference between the lunge before and after landing in the shoulder joint angle variable, where the T value was (-3.590) The mean value of this variable after landing was also greater than before. Researchers attribute this to the large range of motion at the shoulder joint angle, which is due to the large base of support created by the player extending the front leg towards the opponent. This base of support allows the player to effectively control the torso, enabling them to extend the arm and propel forward, increasing the shoulder angle without losing balance or falling forward. This is confirmed by (Chen et al., 2017) the fact that players exhibit large shoulder angles because of high dynamic balance. The lunge before landing indicates that the torso is advanced before the foot touches the ground. Since the shoulder joint angle is measured between the torso and the arm, the values of this angle must decrease in proportion to the anatomical position. In other words, the push before landing indicates a rapid action that surprises the opponent before the movement is completed in its three phase. (Khayoon, 2010) believes that performing the preparatory section faster than the comprehension of the opposing player makes the opponent unable to know the next move, thus preventing him from preparing to respond and react.

T value for the dueling distance variable was (2.509), as the dueling distance when lunging before landing was greater than when lunging after landing. This is considered one of the important factors in building an effective attack, as the shorter the dueling distance, the greater the chance of achieving the touch. Also, lunging before the front foot lands on the ground allows the player to reduce the dueling distance further, thus allowing him to increase his chance of achieving the touch against the opponent (Badawi, 2021). Moreover, the short dueling distance is what drives the fencer to perform the lunge before landing, as completing the movement to reach the full lunge, i.e., after landing, allows a great opportunity for the opponent to launch a counterattack. This is confirmed by (Ali et al., 2025) the fact that increasing the dueling distance gives the opponent more time to observe and prepare to launch a counterattack.

It was found that there is a significant difference in the hip joint angle values between the lunge before and after landing, as the T value was (3.444) This is because the fencer rushes and performs the stabbing process before landing, and consequently the forward advance of the torso, are greater. This occurs through forward flexion of the torso, rapid torso advancement requires high synchronization and the ability to maintain balance, which is a crucial factor in successful performance without loss of balance. Maintaining a good

height of the body's center of gravity helps to increase balance. (Husam Al-Din 1994) defines balance as the player's ability to maintain the body's center of gravity within the limits of the pivot base and indicates that the height of the center of gravity and the area of the pivot base are the two factors affecting the maintenance of balance and stability.

As shown in Table (4) That there is a significant difference in the step distance variable and in favor of stabbing after fulcrum, as the value of T was (-2.933). Researchers attribute this to the significant forward extension of the front leg, allowing the player to take a larger stride and thus reach the opponent more effectively, especially if the sparring distance between the players is considerable. Furthermore, increasing the base of support necessitates a larger stride (Essa & Abdul Baqi, 2020). In addition, the short duel distance in the stab before fulcrum will lead to the stabbing step being short compared to what happens in the stab after fulcrum, especially since measuring this distance occurs after the stab ends and the foot comes into contact with the ground. Therefore, the shorter stride is due to the shorter sparring distance. Additionally, quickly regaining balance after the lunge is crucial to prevent the lunge from failing and thus adopting a defensive stance. (Czajkowski, 2005) believes that in the event of a failed attack, the player must quickly return to a defensive position (En Garde), which helps them regain balance and distance, enabling them to prepare for the expected counter attack from the opponent.

From the table above, we can see that there is a significant difference in the variable of the angle of the elbow joint in favor of stabbing after landing. This is because the front foot's landing on the ground before the lunge is completed forces the player to cover the distance between hemself and the opponent by extending the armed arm almost fully to reach the opponent and achieve the touch. landing also provides the player with the necessary balance to extend the armed arm significantly, thus reducing the distance. The unarmed arm also plays a crucial role in maintaining balance, as extending it backward acts as a counter weight to the armed arm, helping to maintain equilibrium and prevent the body from tilting forward and falling (Sabah Nouri Hafez et al., 2014). Furthermore, the shorter landing distance and the initiation of the lunge before landing mean that the arm is not fully extended from the elbow joint, hence the observed differences.

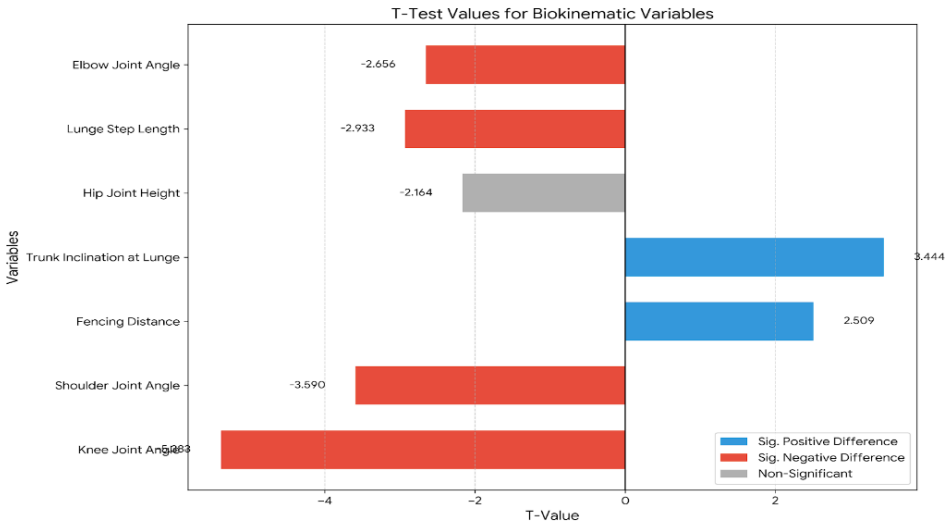

Figure 2. It shows the results of the t-test for related samples.

JOR ReKat (Rekreasi Masyarakat)
Prodi Olahraga Rekreasi
Fakultas Ilmu Olahraga
Universitas Negeri Jakarta

D. CONCLUSION AND RECOMMENDATIONS

The results showed significant differences in some biokinmatical variables during the stabbing before and after landing. The variable (and hip joint height) did not show a significant difference between the two methods. It turns out that the lunge before landing is usually performed when the distance of the duel is short and there is a need to surprise the opponent, i.e., according to the requirements of the game and according to the capabilities available to the opponent, as performing the lunge before landing requires high physical and mental abilities. Researchers recommend that coaches train their players to tackle using both styles, as they have an impact on match results. Giving special exercises to focus on the lunge technique after the foothold, due to its effect on a large range of biokinmatical changes. The need to focus on timing and synchronization between the movement of the legs and feet during the stabbing, in a way that serves the skill and the current situation. The study should also consider other variables such as speed (linear and angular), force applied to the ground, attack time, and others.

E. ACKNOWLEDGMENT

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F. AUTHOR CONTRIBUTION STATEMENT

Ali Abdallah Essa was responsible for all content of the manuscript, drafting the idea, and drafting the article. Sameer Khalaf Gary and Yarob Abdul Baqi Daikh assisted in data analysis and finalization.

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