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Comparison of bar trajectory analysis between senior Algerian weightlifters and world-class athletes.

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Abstract

The aim of our study is to analyze the bar trajectory of Algerian internationals using myDartfish pro software, and to compare its data with the analysis results of world-class athletes. We have chosen the snatch as our exercise, given its technical demands and explosiveness, and our interest is in calculating the spatial parameters (horizontal and vertical) of the bar trajectory.

Comparing the data from the two populations will answer our question: is the trajectory of the bar of Algerian athletes similar to that of world athletes? We assume that these data are not similar, and that we can detect and correct technical faults through the use of this software, whether in beginners or the most experienced athletes.

We used myDartfish pro as a study tool, as well as HD video cameras and weightlifting equipment, which enabled us to put our research into practice.

Keywords: elite athletes, bar trajectory, spatial parameters, fault correction

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1. INTRODUCTION

The use of Mydartfish pro technology has enabled us to detect several technical faults in our athletes, as well as to make a comparison between the data, more particularly the spatial parameters (vertical and horizontal) of our athletes and those of world-class athletes. Several researchers have looked into this question (Akkus H. 2012). Our concern being to situate the level of our athletes with the world elite and to correct certain technical faults that the human eye won't be able to detect, as the snatch is a fast and explosive exercise (lasting less than three seconds) we are ultimately interested in knowing whether the spatial data (horizontal and vertical) of our athletes are compatible with those of world-class athletes. (horizontal and vertical) comparable to that of the world's best athletes?

the morphological characteristics and physical capacities of athletes can influence, in both directions, the technique of weightlifters, whether in the snatch or the clean & jerk, analysis by technological means can prove highly effective, (Cunanan AJ, Hornsby et al, 2020).

Biomechanical analysis has entered the field of personalized coaching, with several bibliographical references giving particular interest to this pedagogical approach in order to make the most of it for better sporting results (Korkmaz S. 2015).

The use of technology by top-level weightlifters has been a constant for decades, as weightlifting is such a complex practice that the human eye cannot observe every detail (Harbili E, Alptekin A.J ; 2014). video videos,cameras and the various software programs available in this field have made it easier for researchers and trainers to set up the most technically advanced execution models. (Hideyuki Nagao 1, Zhong Huang 2, Yasuyuki Kubo , 2020), in order to provide coaches with scientific tools to improve the efficiency of the technical gesture.

We have chosen the snatch exercise because of its technical complexity. In a single movement, the athlete must lift the bar from the plate with both arms outstretched without stopping.

Our problem is based on the following question: are the results of mydartfish pro bar trajectory analysis of world-class athletes identical to those of our elite athletes?

firstly, we assume that the horizontal parameters of the bar trajectory of our athletes are different from those of world-class athletes. Secondly, we assume that

the vertical parameters of our athletes' bar movements are not different from those of the world's elite.

2. Methods

Our study was carried out on a sample of international-level male athletes, we performed anthropometric measurements, standing height (cm) and body weight (kg), we also performed technical tests of the classic snatch with loads exceeding 90% of each athlete's individual maximum, the performance was recorded by high-definition video cameras. L'experimentation a été réalisée au GYM 06 de l'ES STS Dely Brahim durant le mois d'avril de l'an 2022.

2.1 Sample

Fifteen (15) international athletes voluntarily took part in our study, whose characteristics are shown in the following table:

Table N°1: Anthropometric characteristics of the sample

N	Age (years)	Height (cm)	Weight (kg)
15	25.53 ± 3.62	173.93 ± 7.62	84.87 ± 10.14

2.2 Equipment

For our study we used the following material:

2.2.1 Anthropometric parameters:

- An anthropometer for measuring standing height;
- an electronic scale for weighing body weight;

2.2.2. Physical tests :

- twenty (20) kilogram "Eleiko" Olympic bars;
- 0.5 to 25 kg weightlifting discs;
- Eleiko" brand training trays.

2.2.3 Video analysis of bar trajectory:

- two high-definition (HD) video cameras;
- myDartfish Pros software;
- Portable pc.

2.2.4 Statistic method

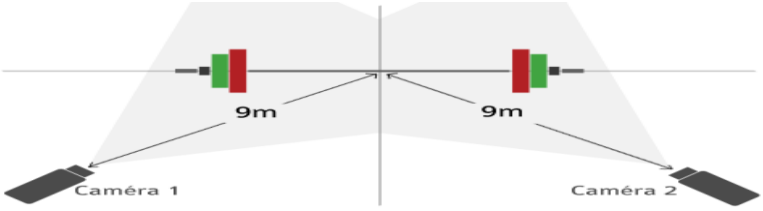
Our analysis was based on software such as XLSTAT 2014, STATISTIKA 10 (Starsoft, France) and the Excel analysis utility.

2.3. Protocol

This study was carried out on several gatherings of Algerian elite athletes, through which we took anthropometric measurements and performed technical tests of the classic snatch at the weightlifting hall (Gym 06) of the Ecole Supérieure en Sciences et Technologie du Sport (ES.STS de Dely Brahim, Algiers).

We installed two (02) video cameras connected to a PC, which thanks to myDartfish Pros software, we were able to produce a 2D bar trace on our videos.
Each athlete performed several trials in the intensity zone exceeding 90% of personal snatch performance, with successful achievements analyzed through the software data.
Each athlete was allowed three (03) attempts at intensities exceeding 90% of their maximum load.

Figure N°1: Camera layout for recording the technical exercise.



(https://www.sci-sport.com/articles/Description-cinematique-de-l-arrache-chez-des-athletes-feminines-de-haut-niveau-044.php, P. Debraux , 2012)

Figure 2: Position of the athlete during experimentation.

(https://www.dartfish.com/fr/pros).

After recording the video, we were able to calculate the characteristics of the bar trajectory for each trial of our entire sample, thus determining the following parameters :

A/ The maximum height of the bar trajectory (as a percentage of the athlete's height) (Hmax);

B/ The minimum height (as a percentage of the athlete's height) of the bar's landing (Hmin);

C/ The difference (%) between Hmax and Hmin (ΔH);

D/ Initial forward horizontal displacement (in cm) of the bar (DHI);

E/ Final horizontal backward displacement (in cm) (DHF).

Figure N°3: Spatial parameters of the bar trajectory.

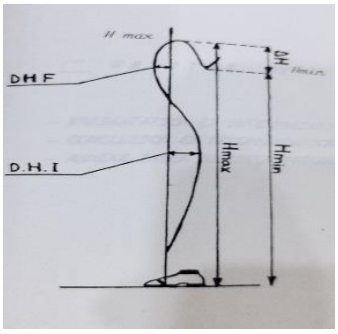


Table N°2: The different movements of the bar during the classic snatch of world-class athletes

Displacements	Average data
Hmax	74 ± 3%
Hmin	67.3.± 33.3%
ΔH	7±3%
DHF	4 à 7 cm
DHI	2 à 3 cm

(Roman. Charkyzianof, 2017).

3. Presentation of results.

3.1 Vertical bar displacements :

3.1.1 Maximum height (Hmax) of the bar.

Table 3: Comparison with data from world-class athletes (Hmax)

Sample	Overage (%)
Algerian	79 ± 5.34
Worldwide	74 ± 3
Comparaison T	1.25
P	> 0.05

3.1.2 Minimum height (Hmin) of the bar.

Table 4 : Comparison with data from world-class athletes (Hmin)

Sample	Average (%)
Algerian	67 ± 2.18
Worldwide	67 ± 3.3
Comparaison T	0
P	> 0.05

3.1.3 differences (ΔH) between maximum (Hmax) and minimum (Hmin) heights

Table N°5: Comparison with data from world-class athletes (ΔH)

Sample	Average (%)
Algerian	12.2 ± 1.21
Worldwide	7 ± 3
Comparaison T	1.61
P	> 0.05

3.1.4 Horizontal bar displacements.

Table N° 6: Comparison with the initial horizontal displacements (IHD) of world-class athletes.

Sample	Average (cm)
Algerian	9.25 ±1.25
World wide	5.5 ± 1.6
Comparaison T	2.09
P	<0.05

Table N°7: Comparison with the final horizontal displacements (DHF) of world-class athletes

Sample	Average (cm)
Algerian	7.77 ± 1.25
World wide	2.7 ±1.3
Comparaison T	3.5
P	<0.05

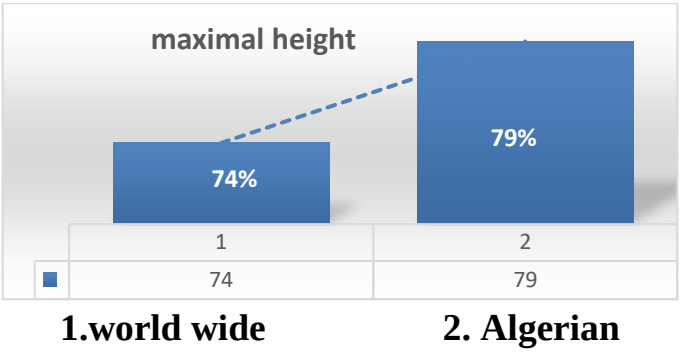
4. Analysis and discussion of results.

4.1 Maximum bar trajectory height (Hmax).

The maximum height of the bar trajectory is a revealing index of the power of the technical gesture. Analysis of the maximum heights of the bar trajectory enabled us to observe that our sample achieved higher trajectories than those of world-class athletes. Our sample reached a height of 79% ± 5.39%, where as world-

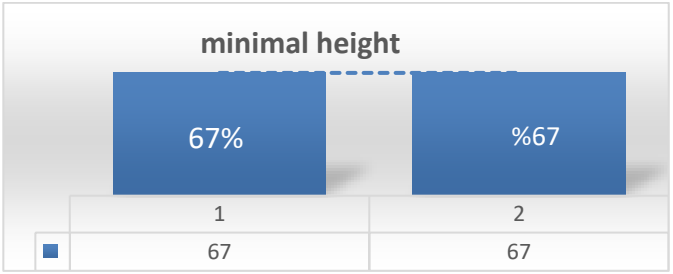
class athletes only 74% ± 3%. This indicates that our athletes make much greater efforts than the world elite, and we believe that this is due to a lack of technique, and that their movements are not as economical and perfected as those of world-class athletes, despite which the comparative study of these data did not reveal significant values **(P > 0.05).**

Figure 4: Comparison of maximum trajectory heights.



4.2. Minimum bar path height (Hmin).

Figure N°5: comparison of minimum trajectory heights.



1. World wide **2. Algerian**

The bar trajetory (bar landing point) enabled us to observe that ours sample achieved similar bar landing trajectorry. Thus, our sample reached a height of 67% ± %2.18% of their height, the same as those achieved by world-class athletes 67%±3.3%. The data for the two populations are almost identical, so the difference is not significant **(> 0.05).**

The minimum height of the bar tractory represents the lowest distance from the bar landing to the end of the movement.This similarity between the data of the two samples is due to the morphological parametrs of the weighlifters, wich have no direct interference on the result of the Snatch.

4.3. Difference (ΔH) between the two vertical parameters (Hmax et Hmin).

The difference beween the two vertical parameters of the bar trajectoryi is an indicator of technical mastery, the samller the index, the greater the mastery of the motor gesture.

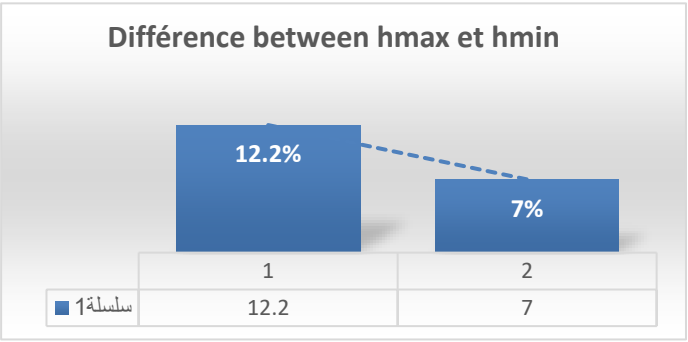
In our experiment, we recorded a difference of 12.2% ± 1.21% in ours sample, where as in world group it was only 7% ± 3%, the statistics revealed a significant difference of the order of **(P<0.05)**.

The mastery of purley technical gesture requires years of practice and constant correction throught training and competition.

Our sample shows a loss of efficiency of the order five per cent (12% - 7% = 5%) compared to the world data. With less than pulled, the world's elite achieve higher performances than our sample.

Our coahes would do well to control this vertical parameter using this sofware (Mydartfish pro) to reduce this difference between the two heights of the bar trajectory in the snatch for better performance in the execution of this highly technical exercise.

Figure N°6 : Différences in vertical trajectory displacements (%).



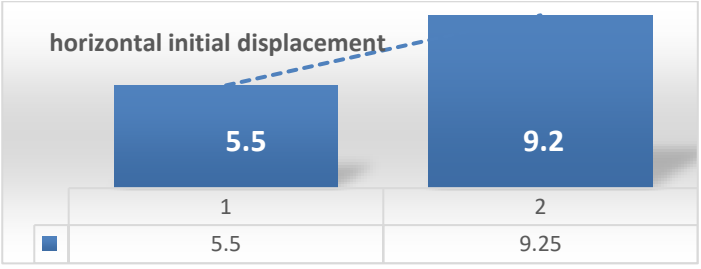
2. Algerian **1. World wide**

4.4. Initial horizontal displacement.

Horizontal displacement of the bar trajectory are often synonymous with mastery of the snatch technique. We often tend to understand that the bar follows a purley vertical trajectory, but the study and analysis of this trajetory using technological control and observation tools reveal that it is not strictly vertical, but lakes horizontal displacements in relation to the starting point of the movement.

In our experiment , we found that our sample had an average initial displacement (DH) of 9.2 cm±1.25cm , while studies of the bar trajectory of world –class athletes reveal average displacements of 5.5 cm ± 1.6 cm . we can therefore affirm that, for good control of the bar's movements , our athletes need to master, even more, the lateral displacemnts of the bar's trajectory, as our experiement revealed significant differences on this parameter **(P<0.05)**.

Figure N°7 : Horizontal initial displacement (DHI cm).



1.Worl wide **2. Algerian**

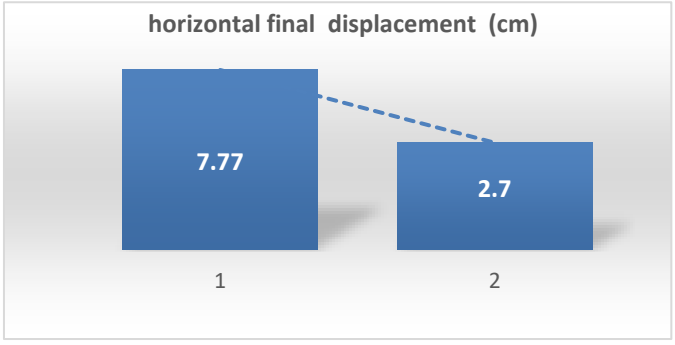
4.5. Final horizontal displacement (DHF, cm).

The final horizontal displacement of the bar's trajectory expresses an economical execution of the technical gesture. The circular nature of the articular parts of the human body physically prevents us from making strictly vertical passages, but the use of technological tools brings out this trajectory in the shape of an « S » stretched upwards.

These final horizontal displacements observed in relation to the start phase of the snatch are indicative of the athlete's level practice. In our experiment, we found that our sample had average final displacement (DHF) of 7.77 cm ± 1.25cm , where as studies on the bar tajectory of world-class athletes reveal average final horizontal displacements of 2.7 cm ± 1.3 cm.

On this basis, we can affirm that, for the good conrol of bar movement, our athletes need to master, even more so, the lateral displacement of the bar trajectory as our experiment confirmed significant difference of the athlet's level of practice Also, on the parameter **(P<0.05)**.

Figure N°8 : horizontal final displacement (DHF, cm)



1.Algerian **2. World wide**

5-Conclusion:

The comparative study of the spatial kinematic parameters of the bar trajectory (vertical and horizontal displacements of the bar) during the snatch-flexion of our sample with the data of world athletes in the maximum and sub-maximum zones (90 to 100%) allowed us to conclude that the trajectories of our sample are not quite identical to those of the world level, so we arrived at the following conclusions:

The maximum vertical height (Hmax) of the bar trajectory of our population is slightly greater than that of world athletes, but the difference was not statistically confirmed ($P > 0.05$). Our sample shows a slight lack of mastery in managing the height of the maximum pull-up in the snatch, and our coaches are obliged to readjust this parameter for greater efficiency and performance, since the higher the height of the pull-up than the norm, the more inefficient the exercise becomes.

This study confirmed our first hypothesis, namely that the minimum vertical height (Hmin) of the bar reception is almost identical to that of the world level, as this parameter is not indicative of physical ability but rather depends on the morphological characteristics of the athletes.

Our second hypothesis, concerning the difference between the two heights (ΔH), was invalidated by our experiment, as this parameter marked the greatest difference between the two samples ($P<0.05$). This difference reveals the degree of technical mastery of this competitive exercise, so our athletes need to reduce this difference to a strict minimum for better technical stability and a better sporting result.

As for the horizontal displacements (DHI and DHF) of the bar trajectory of our sample, they enabled us to observe differences compared to the vertical displacements (Hmax, Hmin) ($P<0.05$). Our athletes lack the mastery of the world's elite, and horizontal displacements are at the root of imbalances. These displacements, whether forwards or backwards, can be the cause of missed bars in competition and training. Gesture control with this software can guide coaches and athletes to correct these faults with great precision.

Our analysis of the trajectory of the weightlifting bar in the snatch has revealed a number of statistically confirmed differences between the technique of our elite and that of the world's elite, and we have also recorded certain similarities in a number of parameters; from this we can conclude that our coaches need to use new technologies to analyse the technical movements of their athletes, in order to draw maximum pedagogical information from these modern technological instruments.

In conclusion, we can confirm that access to the world level depends on several parameters, and high performance is assured by staff who master the smallest details.

We recommend the use of modern technologies for the analysis of technical gestures, so "Mydartfish pro" could be a considerable benefit to coaches at all levels of practice.

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