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Effects of leg extensors on kinematic parameters of suspension shooting in high-performance Algerian handball players.

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Abstract

Since the integration of science into the field of sport, performance has continued to improve. This can be explained by the effectiveness of training methods based on scientific principles, and by the significant advances in evaluation tools and techniques. With the recent development of computers and electronics, a new dimension has been added to techniques for analyzing the sporting movement. Handball, as a competitive discipline, has also undergone a remarkable transformation in recent years, with more attention being paid to the physical aspect by developing training methods adapted to the demands of top-level performance. Today's handball player tends to become more powerful, enduring and stronger in order to achieve optimum sporting performance [(1)]. A number of studies have shown that increasing the maximum strength of handball players can not only improve their shooting speed but also increase their power [(2)]. It is therefore essential to understand the impact of lower limb power as a means of increasing muscular strength in order to apply it to a motor skill (suspension shooting) and thus aim for maximum sporting performance. Our approach is to set up a well-structured training programme to develop the power of the extensors of the legs in handball players and to predict the effectiveness of suspension shooting by determining the kinematic parameters (positions, angles, speeds, ….etc.), using the bio-kinematic method.

I. Introduction

Handball as a competitive sport has undergone a remarkable transformation in recent years. More attention is now being paid to competitions, with the development of training methods that meet the demands of modern handball ever more closely. These days, handball demands intensive physical preparation from its players if they are to succeed in competition. Technical and tactical mastery alone is no longer enough to compensate for a shortfall at this level. Several studies have shown that the real time of a handball match is made up of a series of intense muscular efforts and dynamic contractions of all the major muscle chains required to attack, defend and carry out decisive actions. In this study, we focused our analysis on the suspension shot performed by Algerian handball players, following a specific training programme aimed at developing the leg extensors. Using digital video sequences recorded during the shooting sessions, we measured and analysed the kinematic parameters of the technique (distance, speed, acceleration and changes in the centre of gravity). The contribution to this problem is the subject of this research work.

II. Formulation of the problem

. The high muscular strength of the leg extensors observed in elite Algerian handball players could potentially lead to significant improvements in the gestural speed of the jump shot. The main objective was to develop a specific programme for improving lower limb muscle power in handball players and to highlight the kinematic parameters during suspension shooting. Our experiment was carried out on a sample of 20 handball players in the U21 age group playing for the El Biar club (HBCEB), representing the experimental group. The control group was made up of 20 handball players from the GSP club. Table 1 shows the morphological characteristics of the population.

Table 1: Morphological characteristics of the population

	Age (year)	Height (cm)	Weight (cm)
G. Expérimental	19± 0,78	181± 0,01	73,75 ± 7,93
G. Control	20± 0,36	186,6 ± 0,06	76,62 ± 7,85

III. Research methodology

When assessing kinematic parameters, we opted to use the video analysis technique, which consists of using a digital system composed of :

- A camera.
- Markers.
- An interface between the camcorder and the computer.
- Software for processing video sequences.
- Animation software.
- A computer.

For the two-dimensional (2D) analysis, it is necessary to position the camera in a plane parallel (sagittal) to the handball players (Figure 1). We recorded the suspension shooting technique performed by indoor handball players using a consumer digital camcorder capturing 25 frames per second.

Figure 1: Conditions during the video recording session

We used cinematographic analysis to follow the evolution of the different body segments of the handball players during the execution of suspension shots (Plate 1). This analysis method is based on winer modelling, which treats the human body as a polyarticulated system in the form of rigid, articulated rods with 14 segments (Figure 2). In this study, we limited ourselves to the analysis of the suspended shot on the (o,x,y) plane.

Figure 2 : : "Wireframe" modelling of Winter [1]

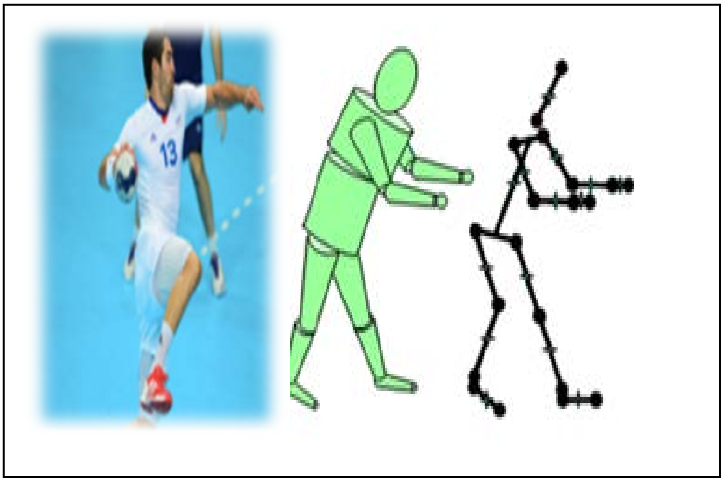
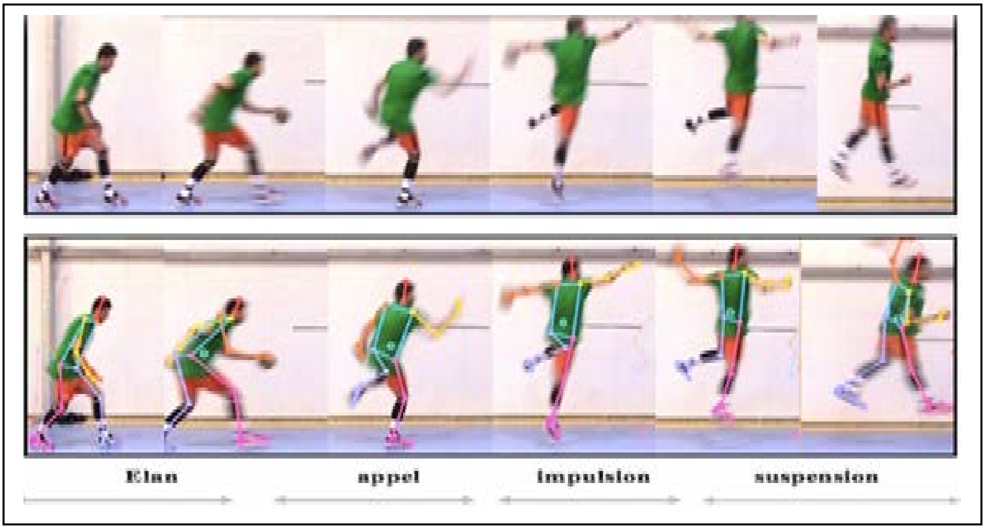


Plate 1: Chronophotography of the suspension shot



IV. Results and discussion

4.1 Experimental results for kinematic parameters

In this part of the research we will present some experimental results of the kinematic parameters obtained during the performance of our kinematic analysis of suspension shooting for the two experimental and control groups, namely:

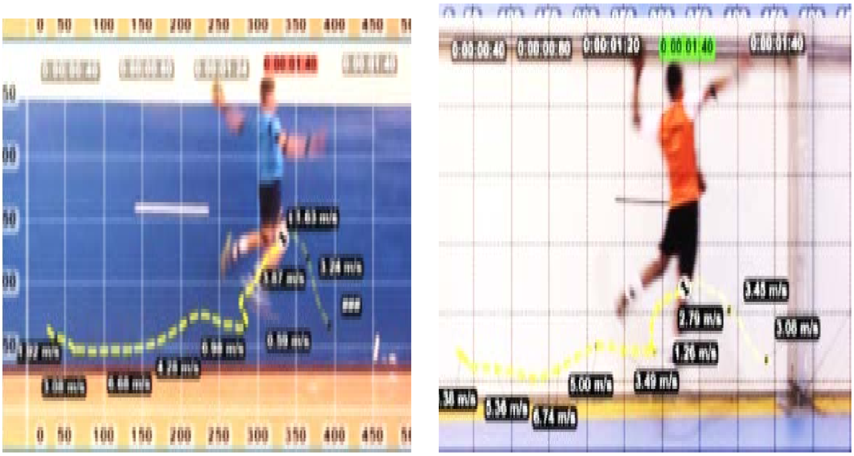
- The variation in the instantaneous speed of the take-off leg and the average speed of the trajectory covered during a suspension shot for the two groups.
- The variation in the instantaneous position of the centre of gravity (CDG) of the handball players during a suspension shot for the two groups.

The representation of the results was the subject of a comparison between each test before and after the programme carried out for the two groups, Experimental (Exp), and Control (Tm), thereafter justifying the intra-group evolution for each sample by the statistical tool.

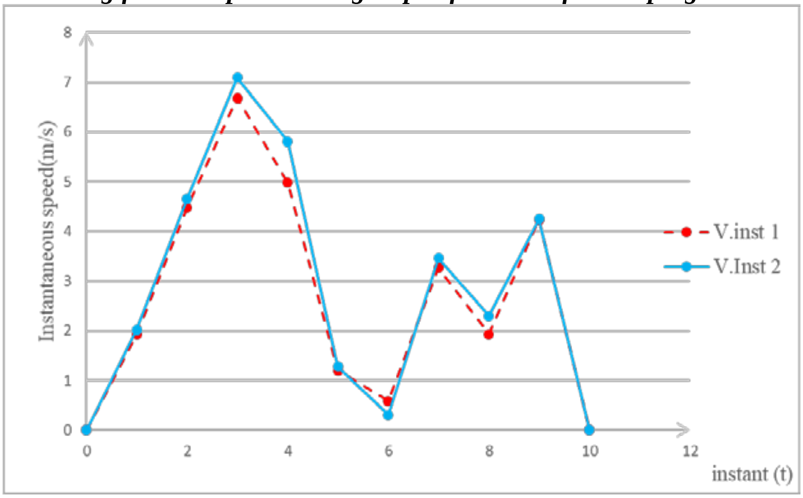
4.1.1 Variation in the instantaneous speed of the take-off leg and the average speed of the trajectory travelled during a suspension shot

In this section we will present the evolution of the average instantaneous speed over each phase of the execution of the jump shot in the two groups. We assimilated the athlete's body to a single material point at the knee joint of the take-off leg, as shown in Plate 2. We located several instants for the two groups in the trajectory covered by the players in order to determine the speed of the take-off leg in each instant, with each value of the instantaneous speeds corresponding to the average of the set of instantaneous speeds of the whole group at this instant, then we will calculate the average speed during the execution of the technique before and after the programme.

Plate 2 : Changes in the instantaneous speed of the take-off leg during suspension shooting for the two groups before and after the programme

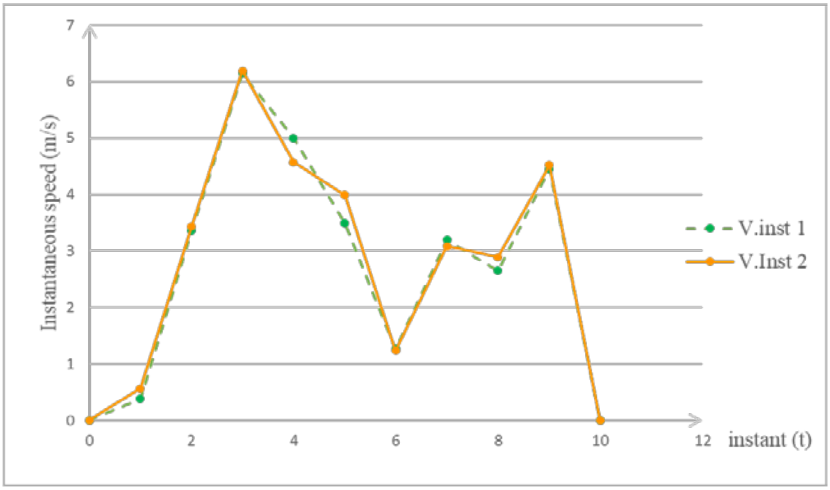


Graph 1: Changes in the instantaneous speed of the take-off leg during suspension shooting for the experimental group before and after the programme.



Graphs 1 and 2 illustrate the variation in the change in instantaneous speed of the take-off leg during suspension shooting in the two groups. In each graph we present two curves, the first curve (Vinst1) represents the change in instantaneous speeds before the programme was carried out. The second curve (Vinst2) represents the evolution of instantaneous speeds after the programme was implemented. The results in graph 1 show a significant improvement in the evolution of the instantaneous speed in the experimental group, the significant differences can be seen especially during the run-up phase (instant 3), the peak speed increases from (6.68 m/s) in the first test to (7. 09 m/s) in the second test. In particular, during the take-off phase (instant 6), the value went from (0.59 m/s) in the first test to (0.31 m/s) in the second test; this slowdown can be explained by the maximum bending of the take-off leg, to finish with the suspension phase (instant 8), the peak speed went from (1.93 m/s) in the first test to (2.3 m/s) in the second test. During the other phases we observed a slight improvement, so the impact of the programme we carried out had a positive effect on the three key phases of suspension shooting1 (the run-up, the take-off and the suspension). In contrast, the results in graph 2 show a stagnation in the values of the instantaneous speed of the take-off leg in the control group.

Graph 2: Changes in the instantaneous speed of the take-off leg during suspension shooting for the control group before and after the programme.



4.1.2 Variation in the height of the centre of gravity (HCG) during the jump in both groups before and after the programme

In this part of the biokinematic analysis of the suspension shot, we will present the variation in the position of the centre of gravity (CDG) during the three phases of the jump (take-off, impulse and suspension) for the two groups (Experimental) and (Control) before and after carrying out the programme, as shown in Plate 4. See below the effect of the programme on the handballers' GDC height during take-off. As a second step, we statistically process the numerical data in order to justify the progression observed in the experimental group.

Plate 4: variation in the height of the (CDG) during the jump in the experimental group before and after the programme

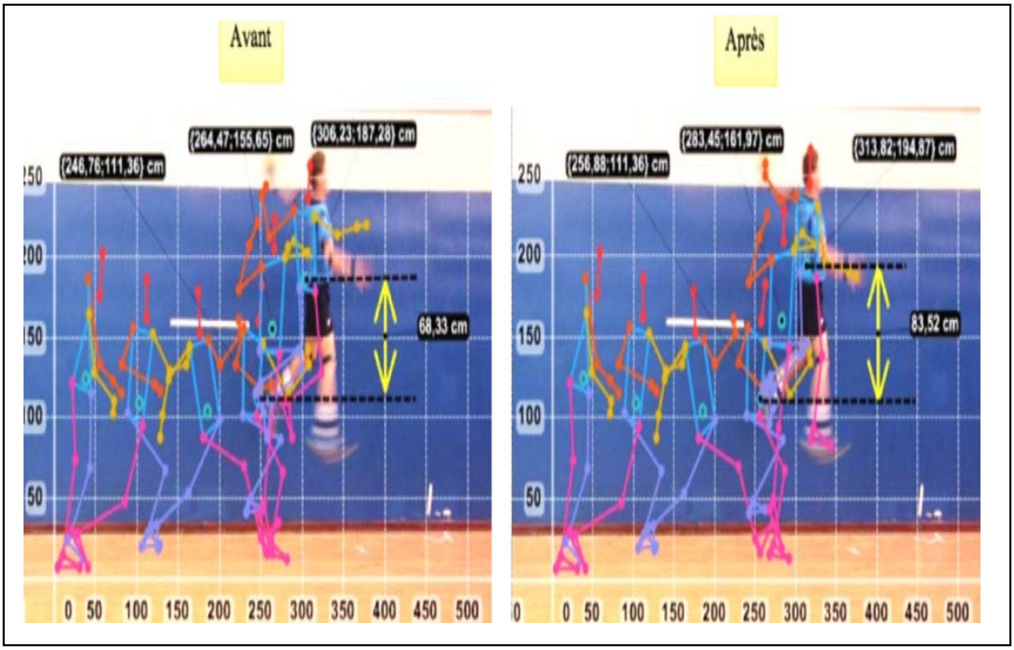


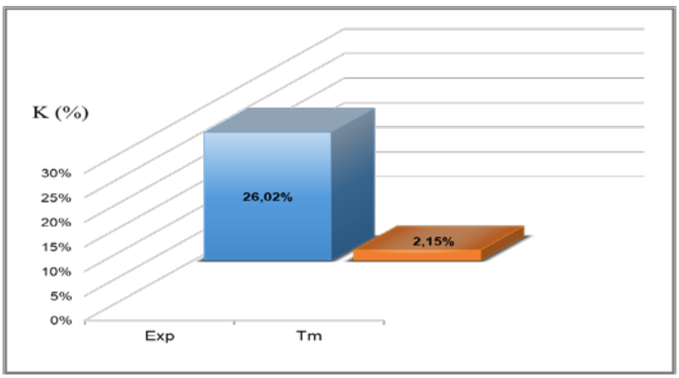
Table 2 : Variation in the height of the (CDG) in the two groups before and after the programme

	G .Expérimental		G. Controù	
	Ts1	Ts2	Ts1	Ts2
Height (cm)	60.26±8.44	75.94±11.79	63.06±5.25	64.42±4.83
p	P= 0.0001 ***		P=0.05 *	
K (%)	26.02%		2.15%	

Ts1/ Ts2 : test 1/ test 2 p : Significant level K : Rate of progression
*** : Hithly significant * : Significatificant

Table (2) shows the variation in the arithmetic means of the height of the CDG during the jump between the initial and final phases for the two groups. The results between the two tests show a very significant difference in the experimental group, with an average (60.268±.44 cm) in the first test, while in the second test there was a clear improvement in the height of the CDG, with a value of (75.9411±.79 cm). In the control group, on the other hand, we observed stagnation, with an average value of (63.065.25± cm) in the first test and (64.424±.83 cm) in the second test. Statistical analyses applied to comparisons of the test before and after the programme for the experimental group reveal significant differences with a Student's T calculated (P= 0.0001) at the threshold of (0.05). For the control group, the statistical results reveal a significant difference with a calculated Student's T (P=0.05) at the threshold of (0.05), so the control group does not show a significant difference.

Histogram 1: Rate of increase in the height of the (CDG) in the two groups



Histogram (1) represents the coefficient of progression which confirms the results of the T student that we calculated, we note a progression of the height of the CDG with a rate of (26.02%), for the experimental group, the control group presents a very weak progression with a rate of (2.15%).

V. Conclusion

The introduction of specific physical training must play an important role in the preparatory process of high-performance handball players. To improve strength and power, handball players use specific weight training methods with additional loads. In fact, the results of our experimentation constitute a positive argument for introducing a strength training programme aimed at developing all muscular qualities into the preparation of handball players. Through kinematic analysis, it is possible to see directly the impact of a strength training programme on motor skills and therefore on sporting performance in handball. Our aim was to show the importance of a well-conducted strength training programme on the dynamic nature of the technical aspect and to propose a rational teaching tool to better appreciate and optimise the technical gesture in handball. The experimental approach we have adopted is frequently used in sports technology, enabling not only a detailed analysis of sports movements but also the prediction of sports performance. The results obtained open up new horizons for the bio-dynamic analysis of the problem. To guarantee greater reliability of the results, it would be interesting to take into account both the forces of resistance and the force of gravity. This study will open up new perspectives for future research.

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