EVALUATION OF KINEMATIC PARAMETERS OF JAVELIN THROWERS IN RELATION TO PERFORMANCE.THE USE OF THREE-DIMENSIONAL DATA OF THE MOVEMENT.

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The technical level of the athletes is considered to be a clear determinant of performance.The evaluation of the elements which define a technical pattern of athletes is a fundamental step in sport training.This paper tries to find out if there are significant statistical relations between a certain given kinematic parameters and performance.

The factors which determine the performance in javelin throw are the following:

1 - technical execution.

2 - behavior of the javelin in flight phase.

3 - level of specific physical condition of the thrower.

This study focuses in the first group of determinants: That's to say the technical execution and considering given kinematic parameters.The technical pattern of the thrower is basically defined by the order in which those parameters are ordered and at the same time,represent a given degree of mechanical efficiency.

In sport training,coaches tend to evaluate the technique of the athletes in relation to isolated factors.Considering that reality,we have designed an investigation among given technical parameters that in greater measure are used in the training of javelin throwing.Also,we'll try to untherstand the influences that each of them have in respect to performance.

Purposes of the study were:

1.- to find out significant relations between given technical parameters.

2.- try to know the influence that each of them have respect to performance.

METHODOLOGY

The experimental technique of cinematography has been used in 3D with high speed cameras(200 frames/sec.).The algoritm DLT(Direct linear transformation) was used to calculate the 3D marker coordinates.The coordinates were smoothed through Spline functions of the 5th order.The two best spanish javelin throwers were the subjects of the study and 36 throws were analized.The kinematic parameters obtained on the marker coordinates(x,y,z) were transformed as variables of the study (times; hip, shoulders and left knee angles during the final throwing phase).

The variables are the following:

1. - Mechanical variables.
   - position and velocity of the markers.
   - left knee angle.
   - Shoulder and hip lines in the horizontal plane.

2. - Statistics variables.:discrete sets of data to the value of the variable in different throws.These variables are those which are submitted to statistical treatment.

Main times that define the intervals.

- tl: amval of the left foot at the ground.This moment corresponds to the beginning of the final throwing phase.
- t2: maximum external rotation of the right arm respect to his longitudinal axis and corresponds to the typical position of "tense arch".

- t5: moment of takeoff of the javelin.

Statistic treatment of data.

Descriptive statistics, ANOVA and correlation analysis were performed on the announced variables.For ANOVA,distance of throwing was considered like factor with two levels:

- Level 1: throws with result above the median.
- Level 2: throws under the median.

RESULTS AND DISCUSSION.

According at the speed of the points:hip,shoulder, elbow and wrist throughout the final throwing phase,we can observe that the principle of speed transmission from the proximal to distant points are clearly stated.Relationships among values of the speeds and times defined the personal mechanical pattern of the thrower and offers a clear scheme of his technical execution.

In relation to the hip,shoulder and knee angles, conclussions for athlete R.F. are:

1.- the angle of the hip in t1 is greater than shoulder angle for this time.That reveals an adequate organization of the kinetic chain at beginning of the final throwing phase.

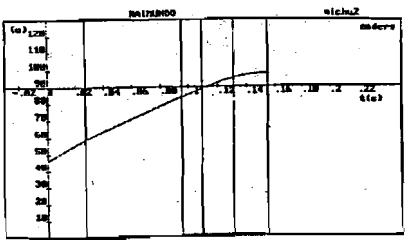

Fig.1:Angle of the hip line during final throwing phase.

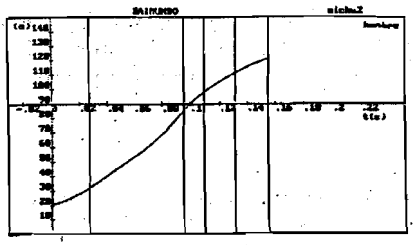

Fig.2:Angle of the shoulder line during final throwing phase.

2. Knee angle shows a range in flexion-extension movement between 160 and 170 degrees that confirms which ones are the limits advisable from the technical point of view.

Correlation analysis.

The correlation study accomplished on the statistical variables, demonstrates that there is no significant relationship ($p<0.05$) except in isolated cases that will be interpreted below.

In table 1 we can see results of correlation analysis for variables in case of athlete named R.F.It can be observed,that the correlation index between time variables and throwing distance are very low and without statistic significance.The only significant value corresponds to the negative index between variables t1-2 and t2-5($r=-0.67;p=0.004$).If we compare these variables with throwing distance,we could say that in case of this athlete,the improvement of performance is associated mainly to the shortering of phase t1-2 rather than to the increase in t2-5.Which means that in order to improve performance the athlete should:on the one hand,try to get the position of "tense arch as soon as possible and on the other hand to make the last phase of the movement as long as possible.

Table 1:Correlation analysis between tiem variables and throwing distance.

Table 2 represents data corresponding to correlation index of the statistical variables from the knee in case of athlete R.F.It is interesting to underline that there is no

relationship between knee angle and throwing distance.That conclusion minimizes the participation of this factor in the performance and leads us to think that movement of knee could be a basic element in personal technical pattern of this athlete.

Table 2:Correlation analysis between knee angle and throwing distance.

Variance analysis.
The most significant values of the variance analysis are presented for athlete

J.S.:Hip in t5

Values indicate that the greater the angle of hip line in takeoff of the javelin,the better the results are.That implies throws in which the hip line is kept more opened to the left side of the thrower in this time (table 3).

Table 3:Analysis of variance in case of athlete J.S.

R.F.:Hip in t l

In this case values indicate that when the angle of the hip line in the moment of the amval of left foot at the ground(pressure foot)is smallest ,the better the results are.And also that the greater the alignment of the hips as regard throwing direction at the beginning of the final throwing phase,the better the results are.

Table 4: Analysis of variance in case of athlete R.F.

CONCLUSSIONS

According to results it seems evident that it is difficult to evaluate the javelin technique through isolated kinematic parameters.That's why we must be careful in making modifications to isolated parameters in the training process because of the negative interference that can affect the stable factors in mechanical patterns of the athletes.

Consequently it would be necessary to complete studies which could take into account kinetic variables wich may help to consider the movement in a more global way.Such studies would have to be directed to kinetic energies of segments using multivariant statistical procedures.

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