EFFECT OF DIFFERENT TYPES OF SARGENT JUMP ON MAXIMUM VERTICAL VELOCITY IN MEN

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INTRODUCTION

The most frequently used measure in characterising the explosive power of the leg extensors is the result of the vertical jump. There are several methods applied during this century to measure or calculate the jumping height or vertical velocity. Recently researcher mostly calculate the height of the jump or vertical velocity by applying force or capacitive plate (Bosco 1982). Unfortunately, these methods are not appropriate to track the whole progression of the vertical jump.

It is generally believed that the knee extension is the major factor in development of vertical velocity because high significant correlation was found between fiber distribution of vastus lateralis muscle and the height of jump (Komi and Bosco 1978, Bosco and Komi 1979, Bosco et al. 1983).

The potentiation of muscular performance, observed after an active muscle has been stretched, and which has been attributed to the storage and utilisation of elastic energy has been investigated not only in studies of isolated muscle preparation but also in man (Cavagna et al. 1971, Asmussen and Bonde-Petersen 1974, Komi and Bosco 1978). However, active state of the isolated muscle can partly be compared to the state of the knee extensors during vertical jump.

Considering the problems listed above an experiment was designed which aimed

i to learn if the maximum vertical velocity is reached at the and of the take off or earlier;

ii to investigate if the knee extensors play the major role to increase the vertical velocity;

iii to re-investigate the effect of pre-stretch of the muscles on the vertical velocity.

MATERIAL and METHODS

Ten well-trained students took part in the experiment. They were trained to be familiar with the methods used then tested.

The subjects performed 3-3 so called deep, half and high squatting jump (SQ), respectively. The deepest knee angle position was 86 (SQ86), 106 (SQ106) and 129 (SQ129) degrees at the respective squatting jump in average calculated on the basis of motion analysis.

Then subjects were asked to carry out 3-3 counter movement jumps (CMJ) with trying to perform those with the same extreme knee angle position measured at the respective squatting jumps (CMJ82 and CMJ101). The subjects carried out the jumps on a Kistler force plate

and the displacement of the selected part of the body was recorded by a Selspot motion analyser system simultaneously. Infra LED diodes were placed to the ankle, knee, hip joints and a short and light wooden bar kept tightly on the shoulder by the hands (Fig.1).

Vertical velocity and knee angular displacement were plotted against the time of the concentric phase (Fig 2). Maximum vertical velocity and velocity at the end of the take off was determined in a function of knee angle position. Also, vertical velocity was calculated from the flying time obtained from the force-time curve of force plate (Fig 1).

Means, standard deviation of means and Student t-test were applied to compare means.

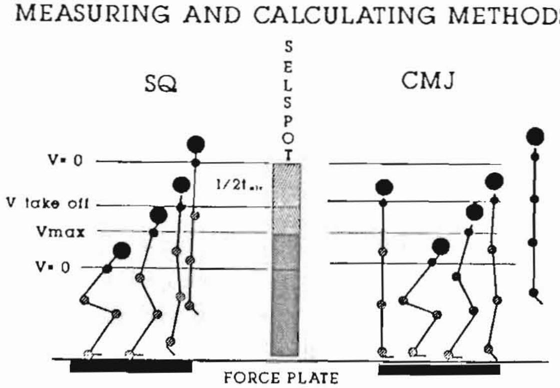


Figure 1. V from t_{air} = 1/2 t_{air} g

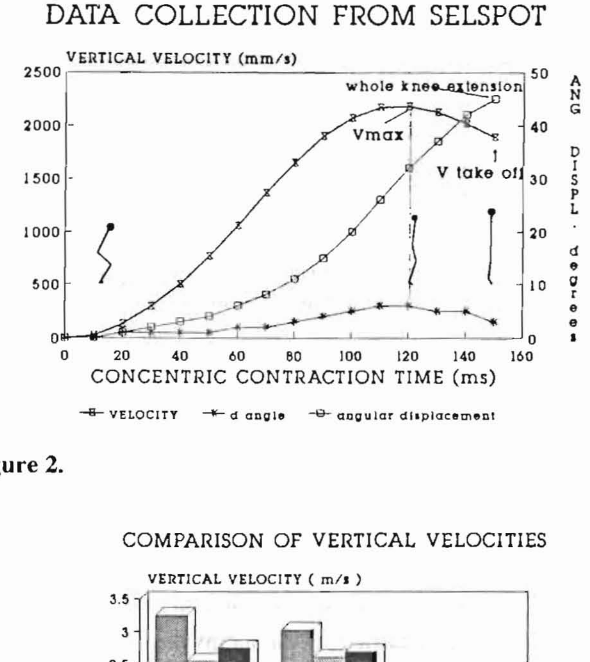
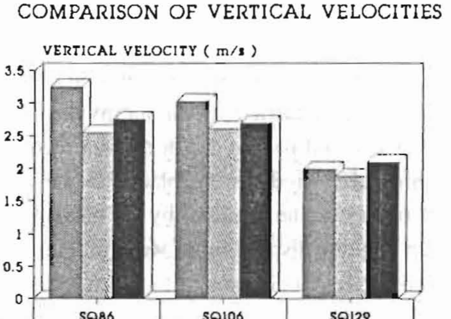


Figure 2.



	SQ86	SQ106	SQ129
Vmax	3.25	3.03	1.99
V take off	2.55	2.61	1.88
V from t air	2.76	2.7	2.1

Figure 3.

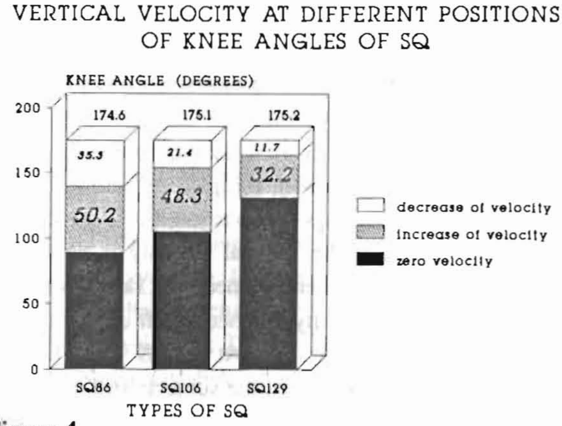


Figure 4.

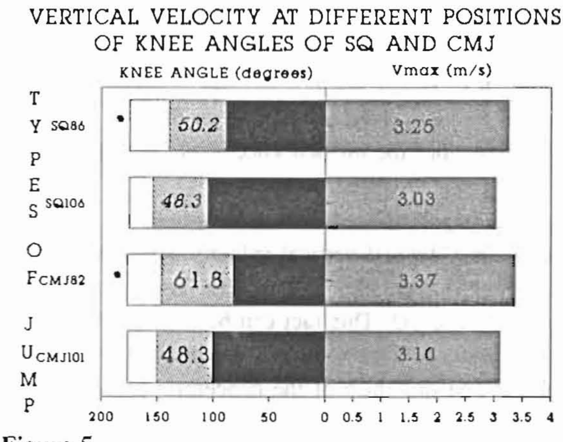


Figure 5.

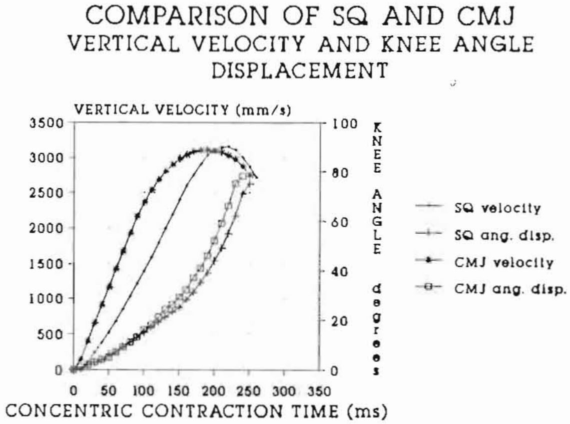


Figure 6.

RESULTS

Maximum vertical velocity was found significantly higher as comparing to the velocity at the end of the take off calculated from either Selspot data or flying time at the deep and half squatting types. At high squatting differences were not significant (Fig 3).

Subjects could produce lower vertical velocity at SQ129 as compared to SQ86 and SQ106. Interestingly, differences between M86 and SQ106 squatting types were not significant (Fig 3).

This result may be explained by the findings demonstrated in Fig. 4. It is visible that the knee angle range while the subjects increase the vertical velocity is almost identical at SQ86 and SQ106. It seems that subjects cannot use the entire knee joint range available to increase the vertical velocity. Moreover, the maximum velocity reached much earlier than the whole knee extension decreases till the subjects leave the ground. At SQ129 there is knee angle displacement enough as far as whole knee extension. However, the subjects still cannot use up the whole. That is the reason why the range of increasing velocity is significantly less than that of M86 and SQ106.

It was assumed that the previous stretch of the extensors of the lower extremities change the kinetics of the vertical jump. In Fig. 5 the comparison of SQ and CMJ can be seen for deep and half squatting. The knee angle range during the vertical velocity is increased significantly larger for CMJ82 than for SQ86. However, it did not influenced significantly the maximum vertical velocity since the difference in vertical velocity between SQ and CMJ is not significant. Considering SQ106 and CMJ101 neither the utilised knee joint range nor the vertical velocity differ significantly.

The question arises why the larger utilised knee joint range did not result in higher vertical velocity. Fig. 6 which represents typical vertical velocity and angular displacement curves in a function of concentric contraction time may explain this discrepancy. During CMJ the velocity increases more sharply than during SQ. This fact can be attributed to the previous stretch of the muscles, but not for the knee extensors since the angular displacement changes almost identically for both SQ and CMJ at the first one-third of the concentric phase. The reason of the identical maximum vertical velocity at SQ and CMJ is that the initial higher acceleration for CMJ could not be maintained by the subject. As the velocity-time curve of CMJ indicates after 100 ms which is only half of time during which the vertical velocity is increased. This means that there is deceleration of the body. Surprisingly, from this moment the knee angular displacement for SQ and CMJ starts to diverge so that the vertical velocity for CMJ increases more than for SQ. From this fact one can conclude that the knee extensors cannot contribute to the increase of vertical velocity effectively.

FINDINGS AND CONCLUSION

The maximum vertical velocity was reached before the whole knee extension because the athletes cannot use up the whole knee angular displacement to increase of the vertical velocity, in both case of the SQ and CMJ. It seems that the knee extensors influence the vertical velocity during both SQ and CMJ less than it has been thought.

Probably the hip extensors and even the back muscles can play more significant role in increasing of vertical velocity than knee extensors, especially at the beginning of the concentric phase of the jumps.

In our study we cannot conclude that the previous stretch of the leg extensors influences the vertical velocity positively in spite of the fact that the initial velocity of the concentric phase increased more markedly at CMJ as compared to SQ.

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