ANALYSIS OF THE HANDS SUPPORT IN EXTRA-PLUMMET CLIMBING SKILL

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INTRODUCTION

Climbing is a sport that requires a high level of skill for top performance. In the last decade there has been a development of technical devices to improve the climbing performance. The design of those climbing devices try to give exceptional light sensitivity, flexibility and great gripping power. An example of this evolution is the modern rock climbing shoes and rock slippers (Smith, 1996). In the same way that the gripping power of climbing devices develops, the climber's are also looking for ways to get more profit from hand grips power in each climbing skill. The teachings of the extra-plummet climbing skills (as performed in climbing walls with horizontal angles below 90º), in different world climbing schools, suggest that hand's actions behave in different ways in both skills. They believe that when we try to put the climber's projected weight very close to the feet surface the hand grip becomes more precarious. The present study's purpose is comparing the hand grip behaviour in two different extra-plummet climbing skills. In the first skill the direction of the climber's weight is a short distance away from the pressure centre of the feet and in the second skill the direction of the climber's weight is a short distance away from the pressure centre of the hands support.

METHODS

These two extra-plummet climbing skills can be distinguished by basic body positions: in skill A the basic body position is "body arc" and in skill B the basic body position is "body suspense" (figure 1). In both skills the upper limbs are completely extended. Skill A and skill B do not differ only in body position but also in weight distribution. In skill A the aim is to put the weight, as much as possible, close to the wall and a short distance away from the pressure centre of the feet's support. An indication that the execution of this skill is correct can be had by looking at the knees: if they are almost in contact with the wall, the execution of skill A is correct. Unlike this, skill B's aim is to execute the larger part of the effort through the hand's supports; If the subjects have the hip joint flexed more than 90º the execution is considered correct.

Taking the pressure centre of hands support as reference the body balance is considered a stable balance because the hands have a higher position than the feet (Jodar, 1993). Therefore the level of body stability in these two skills, depends, basically, on the performer's capacity of maintaining body contact with the wall by means of the hand grip (Verbier, 1991). The capacity to maintain the hand's grip is the result of the relationship between friction force and the tangential forces applied by the climber on contact surface.

Taking the mathematical expression of friction force into account, the access to the behaviour of the friction force can be achieved through normal force (Hammil & Knutzen, 1995). Thus, the hand's support stability is accomplished by the quotient of each tangential (Fx is the force acting in parallel direction to the sagital plan, Fy is the force acting in parallel direction to the frontal plan) and normal force (Fz is the normal force) applied by the climber on contact with the surface.

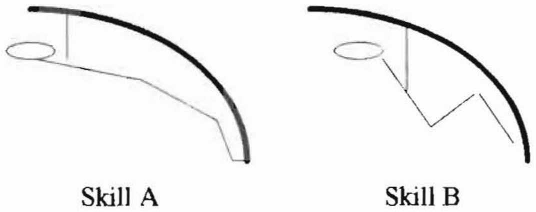

Figure 1- Side view of both extra-plummet climbing skills: skill A denominated "Body Arc" and skill B denominated "Body Suspense"

Measurement of forces values included mounting and calibrating a multicomponent measuring Kistler platform fixed horizontally on an artificial climbing wall. The data collection was achieved, by means of a Kistler platform model 9281B, through Kistler 8-channel charge amplifier type 9865b, analogue/ digital conversion Biopac System (MP100 acquisition unit and Universal Interface Module 100) and appropriate software to wave form data analysis (Acqknowledge®), using a personal computer Macintosh II VX. The sample was composed of eight experimented climbers, with the capacity to control the critical components in both extra-plummet climbing skills, ages ranging from twenty-two to forty years old. Each performance was a simulation of a real situation (figure 2): the hand is gripped to the force platform and the feet are supported on an artificial climbing wall. In both performances the body positions are similar to the ones effected in the real situation. The duration of each performance was 15 seconds with 15 Hz sampling frequency. Every subject accomplished five valid performances in each skill.

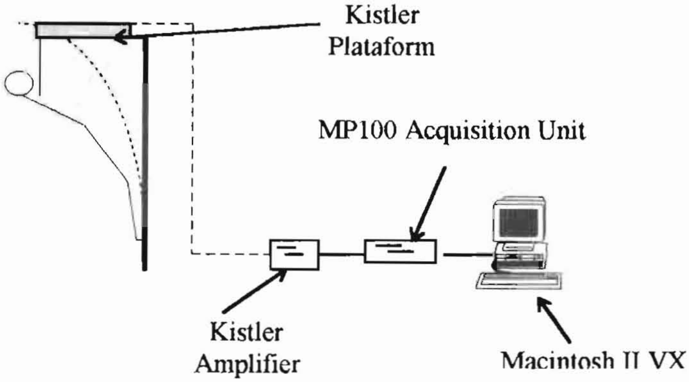

Figure 2- Experimental design

RESULTS

The values of force were determinate with a Kistler platform (15 seconds of performance at 15Hz sampling frequency, 225 samples collected). The ratio values of Fx/Fz and Fy/Fz were computed. The ratio Fx/Fz is the relation between the sagital force component and the vertical force component. The ratio Fy/Fz is the relation between the frontal force component and the vertical force component. The ratio average-curve Fx/Fz was computed with all data of all performers and is shown on figure 3a. This average-curve ratio shows a greater value for skill A than for skill B. The ratio average-curve Fy/Fz was computed with all data of all performers and is shown on figure 3b. This ratio shows a greater value for skill B than for skill A.. The *t of pairs* ($P < 0,05$) have been applied and a no significant relationship was find.

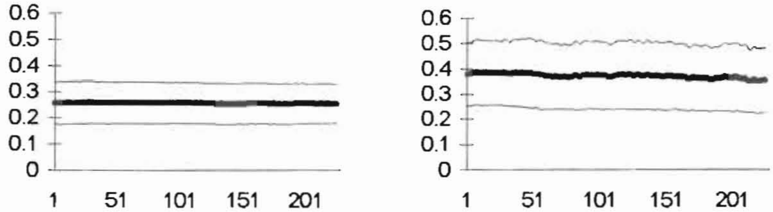

Figure 3a- Both skills ratio average-curve ($X_i \pm \sigma_i$) Fx/Fz *vs.* sample order.

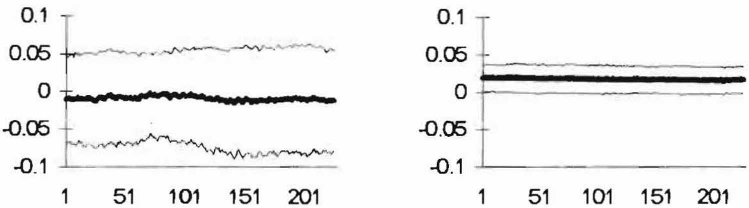

Figure 3b- Both skills ratio average-curve ($X_i \pm \sigma_i$) Fy/Fz *vs.* sample order.

The coefficient of variation of each ratio have been computed:

	Fx/Fz	Fy/Fz
Skill A	0,372 $\wedge$ CV= 0,352	0,009 $\wedge$ CV= 6,830
Skill B	0,250 $\wedge$ CV= 0,311	0,017 $\wedge$ CV= 1,089

CONCLUSIONS

The results give evidence that the values of Fy/Fz do not differ between the studied skills, but the absolute value of Fx/Fz ratio in skill B was significantly different from skill A. Therefore skill B has a greater potential to be used in further climbing skills, because it uses a smaller percentage (≈25%) of normal force than skill A (≈37,2%). The results show that skill B is the best one to be used in the first approach in the learning process of extra-plummet climbing skills, chiefly when the wall allows for little friction. Considering that the climber needs a stable motor control in order to achieve a stable result, the enormous variability of Fy/Fz at both skills suggests that the key point of the success of these extra-plummet climbing skills is in the sagital plane of performance.

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