KINEMATIC ANALYSIS OF A SPORTS EQUIPMENT DEVICE, THE HANGO

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Out of the scooter family a new and innovative model arises "The Hango". The present study lies in an analysis of the movement pattern during the manipulation of the Hango. The Hango is a light weighted, three-wheeled vehicle, whose displacement is produced through a symmetric and co-ordinated movement of alternating load, similar to the one of other sports, like skiing or skating. The analysis was done with the made possible help of a kinematic 3D study of a sample of 4 subjects, using the KINESCAN/IBV 2001®. The results have the kinematical description of the movement. The latter was divided in phases, which allow a better comprehension of what happens in the course of the movement. These phases are defined by the acceleration in the direction of the movement. From the analysis emerges that the movement made by the user of the Hango can be catalogued as a sort of cyclic task. Besides, it is an activity characterised by the absence of impacts and by the symmetry of its movement pattern; so it is beneficial for the organism. The data obtained present the Hango as a vehicle suitable for the practice of physical sports activity.

KEY WORDS: hango, kinematic analysis, biomechanics, sport device.

INTRODUCTION: In the last years, the physical activity practice aiming the health improvement has favored the apparition of several activities and equipments. The current study presents the consequences of the physical activity practice of the Hango (figure 1). The Hango is a scooter, which has two rear wheels and one front wheel. Over the rear wheels, two platforms are placed to support the player´s feet. The handle is raised over the front wheel. A tube is raised from each rear wheel to the base of the handle; this joining point is articulated, so that the peculiar movement of the apparatus is permitted. This new equipment could be classified in the field of the physical activity as a medium for improving health; It could be included in the large family of the equipments of urban sports. The activity developed with the Hango presents several doubts regarding physiological and biomecanical effects produced in the subject using the Hango (hanger). A kinetic three-dimensional analysis of the activity realized with the Hango is presented next. It tries to describe the movement pattern of the Hango and is a previous step for further studies. The results obtained show that the Hango permits the realization of a healthy physical activity that is suitable for different fields: therapeutic treatments, muscular tonification, physical preparation and initial periods of training in several sports.

METHODS: The present work consists of a kinetic tridimensional study, in which four subjects with experience in driving the apparatus participated. They carried out four passings at the same velocity (+- 10%). The process was filmed with four synchronized cameras in a frequency of 25 frames per second (50 Hz) and digitized afterwards by means of the software KINESCAN/IBV 2001. A system of reference of 2x8x1.95 m (x, y, z) and an anatomic wired model of 26 real markers and two virtual ones, calculated markers, which included the Hango and the hanger, were used (figure 2). The following variables were took account for the study:

- Knee angle, used in comparison to other sports.
- Shoulder velocity, hip velocity, knee velocity and ankle velocity, used to study the kinematic chain.
- Trajectory of the Hango in the X-axis, used to study the movement
- Ankle position in the Z-axis, used to ensure that impacts do not exist during the activity.
- The acceleration of the Hango in the Y-axis, which has been the criterium followed in order to divide the complete movement in different phases.

The range of motion (ROM) of the knee was calculated using these variables. This permitted the division of the technique movement into various phases based on acceleration in the axis Y. The temporal relationship between the peaks of velocity of the shoulder, hip, ankle and

knee during the movement was obtained; the symmetry of the movement, as well as the absence of impacts in the activity were tested.
The definition and extraction of the studied variables was possible through the equipment KINESCAN/IBV 2001, and the analysis of the mentioned variables was resolved by descriptive statistics with SPSS 10.0 for Windows.

Figure 1. Hango.

Figure 2. Anatomic model.

RESULTS AND DISCUSION: The handling of this device presents remarkable characteristics. It is shown with a waved trajectory in the horizontal plane. The trajectory was symmetrical and cyclical, as long as the translation speed was kept constant (figure 3).

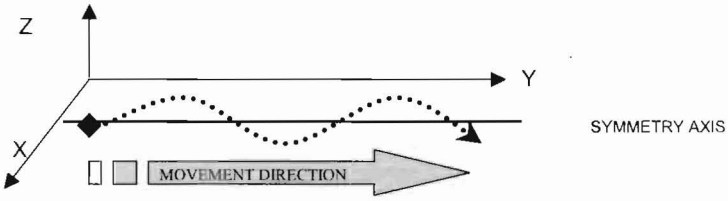

Figure 3. Hango´s trayectory.

The sequence that follows the acceleration determines the phases of the movement: starting of the neutral position, where the knees show the same angle, followed by a phase of acceleration, and a phase of deceleration that coincides with the turn, afterwards, an acceleration stage starts again and leads to the neutral position. At this moment a new sequence starts as a cyclical movement is being described. The cycle's duration was of 0.89 seconds.
Phases of movement:
1. Neutral position.
2. Impulse before turning.
3.Turn, which is divided into:
    3.1. Entrance.
    3.2. Maximum.
    3.3. Exit.
4. Impulse after turning.
The results show that the average of the module of the highest velocity of the shoulder is 2.6 m/s, and was obtained 0,2 seconds after the neutral position. The average of the module of the highest velocity of the ankle is 3,91 m/s, and was obtained 0,41 seconds after the neutral position. This fact shows that the movement follows the dynamics of a closed kinetic chain. On the other hand, the average of the highest angle of the knee is 161° and the lowest angle is 119°. This means that the knee shows a ROM of 42°.It is important to point out that during the activity of the normal handling of the Hango, impacts of the locomotive apparatus against the ground do not occur. Figure 4 shows a graphic about the position of the ankle in the vertical axis. We can see that the resulting curve does not present abrupt changes. Moreover the said figure shows that the ankle practically moves mainly in the same plane during the whole cycle.

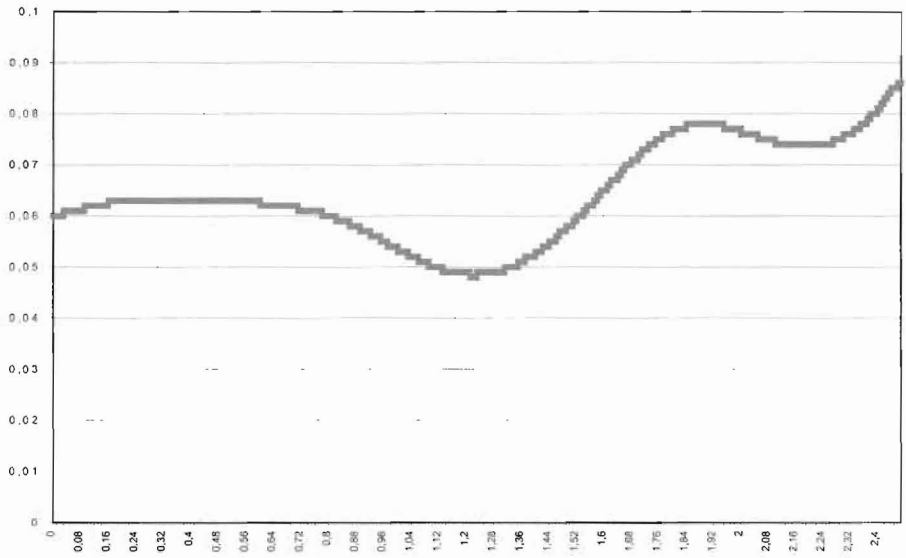

Figure 4. Position of the ankle in the vertical axis.

CONCLUSIONS: The results of the study show some positive characteristics of the Hango compared to other activities of similar mechanical structure or aim. One of these advantages is its symmetrical character. Another important aspect that the Hango presents is similar to other sports like alpine ski or cross country ski, regarding the joint ranks in both sports (Boer et al 1987; Smith, Brian 1994;Koning *et al* 1991).The Hango technique follows the structure of a kinetic chain, in which the ankle (as the most proximal segment of the apparatus) acquires the greatest velocity of the other segments in a retarded way, as Hochmuth (Hochmuth 1984) described. Considering the characteristics mentioned before, the Hango is a healthy activity as long as it is practised in plain areas and the driving is smooth and cyclic. It may be recommended as a therapeutic activity and suitable for muscular toning, especially for the lower limb. Moreover, it could be a useful support for the physical preparation in the initial periods of training in some sports. Further studies involving more volunteers should be carried out to support these conclusions.

REFERENCES:

Boer, R..W. Vos, E. Huntter, W. Groot, G. Ingen Schenau, G. J.(1987). Physiological and biomechanical comparison of roller skating and speed skating on ice. *Eur J appl phyiol.* 56. 562-569.

Hochmuth,D. (1984).Biomechanics Of Athletic Movement. Berlin: Sportverlag.

Koning, J. Groot, G. Ingen Schenau,G. J. (1989). Mechanical aspects of the start in Olympic speed skating. *Human kinetics.* **5**(2), 151-168.

Koning, J. Groot, G. Ingen Schenau,G. J. (1991). Coordination legs during speed skating. *J biomechanics.* **24**.(2), 137-146.

Smith, G.A. Heagy, B.S. (1994). Kinematic analysis of skating technique of olympic skiers in the men's 50-km race. *J appl biomechanics*, **10**, 79-88.