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STRENGTH AND QUICKNESS TRAINING OF PARALYMPIC ATHLETES PLAYING ICE SLEDGE HOCKEY

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SUMMARY

The Pull in the Ice Sledge Hockey is the upper-limbs pull strategy promoting the sliding of the sledge during the locomotion on ice of the athletes.
In the literature there is a lack of information about the biomechanics of this locomotion strategy.
The first aim of the work was the biomechanical study of the linear displacement in seven national-level athlete in Ice Sledge Hockey. The second was to find the optimal sliding speed of the sledge in condition of maximum power production.
A biomechanical model of the sledge-athlete system during the Pull was designed based on a motion capture system with stereoscopic camera interface.
Kinematics and kinetic parameters of this locomotion task were calculated with a sledge at different level of overload.
The results of this investigation could assist coaches and trainers to design an innovative resistance training able to improve the power of the locomotion on ice performed with the upper-limbs pull strategy.

INTRODUCTION

The Ice Sledge Hockey is a Paralympics sport discipline developed in Sweden and introduced in the Paralympics Game since 1994 [1]. To date this discipline is recognized in the entire world.
The rules of the Ice Sledge Hockey are very similar to the Ice Hockey. Five players are seated on a skated sledge and move themselves around the ice rink to shoot the “puck” (a small black rubber plate) with two sticks, into the “cage” (a small meshed goal) of the opponent team that resists and counterattacks.
The linear locomotion of the sledge on ice is possible using the upper-limbs strategy that consists in three phases: 1) the athlete abducts ahead her/his upper-limbs to drive into the ice two L-shaped harpooned sticks, 2) the athlete pulls her/his sledge forward, and 3) she/he detaches the sticks from the ice to repeat the action.
The horizontal speed of shifting and the force of propulsion allocated during the Pull are two fundamental parameters of this performance. Together these parameters can gather information about the power required to perform the motor task and the level of strength and quickness related to the sport specific requests [2].
Recently were recorded a number of anthropometric data [3] and different match analysis parameters [4] of this team sport game. None scientific references were found about biomechanical parameters of the upper-limbs pull strategy used by this kind of athletes for the locomotion on ice.

The aim of this work was to define some keynotes for training program designers of this discipline through two objects: 1) to design a biomechanical model of the sledge-athlete system during the linear locomotion; 2) to point out the best speed of the shifting on ice derived by the maximum peak power of the performance obtained by an overloading of the sledge weight.

METHODS

Seven international-level male athletes (age 36 ± 10 years, weight 75 ± 8 kg, height 1.8 ± 0.1 m) were recruited from the Ice Sledge Hockey Team of the “Toro Seduti” (Torino, Italy).
Each athlete has executed five trials. The trials were sliding on ice for a 20 m of linear track at the maximum speed and pulling the sledge linked to a chassis whereon some weightlifting plates were loaded. Starting with a 20 kg upon the chassis, other 20 kg was added for each trial until a total of 100 kg was loaded in the last trial.
A marker-based approach was designed with a stereoscopic camera system to obtain a 3D biomechanical model of the motor tasks. A link-model of six segments (stick, forearm, upper-arm, trunk, sledge, and chassis) was designed for this purpose. Eight passive markers were placed on the joints of the left side of the athletes, sledge and chassis. Only a body side was tested because of the symmetry of the task.
The barycenter of the athlete-sledge system was tracked in a virtual space to represent the locomotion on ice.

RESULTS AND DISCUSSION

The relationship between three parameters: 1) the vertical speed of the stick during the impact with the ice (the stick drive phase), 2) the load on the chassis, and 3) the speed of the sledge sliding allow, to obtain the following findings.
When the chassis was overloaded, the athletes increase the vertical speed of the stick drive phase to obtain the necessary power to slide the sledge on the ice. When the chassis was overload, the vertical speed of the stick drive phase and the sledge translocation were dropping down. In Figure 1 a double axes diagram shows this phenomenon.

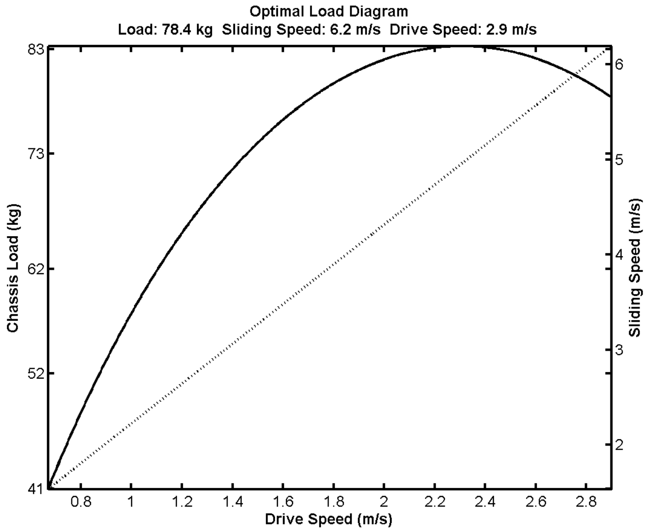

Figure 1: Diagram of the optimal load on the chassis (the solid line) and the related sliding speed of the sledge (the dotted line) at different levels of vertical speed of the stick drive phase. At the top of the diagram the parameters for the best performance were reported.

The relationship between the load of the sledge and the speed of the stick drive phase is a parabolic curve with a maximum peak corresponding to the load whereby it is possible to perform the most effective vertical speed of the stick drive phase. The relationship between the vertical speed of the stick drive phase and the speed of the sledge sliding locomotion is, instead, linear and could gather information about the horizontal speed of the sledge obtained with the optimal vertical speed of the stick drive phase formerly calculated.

CONCLUSIONS

The Pull performed with the upper-limbs strategy is an essential motor task in athletes practicing the Ice Sledge Hockey. The horizontal component of the sledge sliding is related to the vertical component of the drive speed of the stick that impacts on the ice, and this last parameter is related to the mass of the athlete-sledge system. In this work was designed an over-loadable chassis linkable to the sledge to obtain an ideal mass of the athlete-sledge system to develop the optimal value of the horizontal sliding speed of the sledge.

Two innovative considerations could be formulated by this work: 1) the chassis linked to the sledge was presented such as an innovative equipment to develop the power in this typology of athletes, and 2) a test with an incremental load placed on the chassis could provide the optimal load that it is possible to utilize in training session to reach the ideal speed of translation of the sledge on ice.

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