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Technical Characteristics Study of the Sliding Action Based on Biomechanical Analysis

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Abstract: In this study, it studies speed skating in the sliding movement, first analyzes the force condition of the human body in a cycle of the speed skating movement, describes the factors that affect the speed skating results through force analysis and conducts data analysis on knee joint angle, pedal speed and pedal force in the skating. The research results show that the peak of pedal force appears when the knee joint angle is 130° through the force signal; the maximum force is equivalent to 150% of body weight and when the pedal-off speed exceeds its maximum value it will suddenly drop, during speed skating process the adjustment of posture should also be noted, preferably close to streamline, thus it can reduce the resistance of air pressure, the smoothness of the race suits also has a small impact on competition performance.

Key words: Biomechanics, elbow joint angle, hold the rod angle, vertical speed

INTRODUCTION

As an edge science combining biology with mechanics biomechanics have seen a breakthrough in recent years with the development of computer technology which renders the subject make a contribution to the movement research in large part. For gliding biomechanical study many people have made their efforts, it is these people's efforts that makes this type of exercise has a better guiding ideology and means (Zhang, 2013).

For gliding biomechanical study the efforts of many people, it is these people 's efforts to make this type of exercise have a better development guidelines and tools, including: General Mechanics, Dalian University of Technology Chen in his professional PhD thesis "ski Biomechanics simulation analysis" to skiers for the study, from the impact of skiing-related mechanical problems (Li, 2002), we established a biomechanical model of skiing and the development of the corresponding simulation platform, respectively, a 3D multi-body ski model, variable topology ski poles-snow Hill model and the introduction of three-component model containing nerve muscle, muscular system skiing biomechanical model (Liu, 2011), created through the text and ski model software platform to better simulate a variety of skiing for understanding, improve and perfect skiing action technology provides greater convenience (Cui, 2013); Jilin Institute of Physical Education Feng Yurong, etc., in the "Elite Women Short Track speed Skating plantar pressure distribution characteristics of the curve" in the use of plantar pressure distribution measurement system to Elite Women Short Track Speed Skaters as the research object, get a different speed corners taxiing plantar kinetic parameters in order to achieve reveal bend the rules and characteristics glide technique purpose of looking for more advanced, effortless glide technology provides a scientific basis (Feng, 2010); northeast Normal Institute of Physical Education Zhou Dai, etc. in the "freestyle cross-country skiing snowboard pressure distribution research" from the pressure distribution on skis affect athletic performance perspectives on Freestyle skiing affecting performance propulsion factors, the results showed that: Snowboard athletes depend on the relative direction of surfacing and sliding angle, forming a reasonable propulsive force acting on the vertical pressure on the skis can have a greater instantaneous static friction and a very short impulse propulsion (Pan, 1999), different terrain slide in the slide, the top athletes selected pedal power remains almost the same, by adjusting the azimuth snowboard ways to increase propulsion; Jilin Institute of Physical Education Wu Xiaohua, etc. in the "figure skating special physical characteristics and training Methods" in the physical characteristics of figure skating (Gu, 2013), ice watch figure skating national elite athletes training and terrestrial auxiliary training for figure skating outstanding coaches, athletes, the same item conducted focus group interviews with coaches (Wu, 2011), collect the latest training methods and methods, in-depth analysis of figure skating special physical characteristics and laws and summed up the appropriate training methods and means

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to guide the practice of physical training figure skating special purpose improve the level of scientific training of figure skating and the overall strength; Jilin Sports Bureau winter Sports Management Center of Liu Wei (Tong, 2003), etc. in the "power of our study Figure Skating athletes knee" by is kinetic testing state elite figure skaters under the knee flexors and extensors strength of elite figure skaters knee forces to study the conditions, obtained overall power elite figure skaters knees are not significant differences exist on a single elite athletes figure skater knees forces there are some differences, elite figure skater knee flexor strength to be enhanced conclusions (Hao, 2003); northeast Normal University Sports Institute Zhangshao Wei in "excellent speed skater, guiding the movement of glide technique characteristics analysis" in the 12th National Winter Games speed skating short distance athletes grouped straight glide technique comparative analysis (Yan, 2006), summed outstanding sports kinematic features straight glide technique to improve our speed skating short distance project's technical training the scientific level, providing valuable reference (Wang and Shuye, 2013).

On the basis of previous studies, this study uses biomechanics principle to study the force conditions of the human body and the relationship between force and velocity for speed skating, studies the best propulsion of cross-country skiing, conducts data analysis for the vertical velocity formation of the outer jump technique in the figure skating and studies the structure of the ice boots and various jumping techniques. The study contents and conclusions in the text can provide theoretical guidance and leading role on the cause of the sliding movement in our country.

BIOMECHANICAL PRINCIPLES OF SLIDING ACTION

The speed skating is one project belonging to gliding, speed skating for short and it is the most extensive project undertaken with the long-standing history in the skating history.

Most of the case is to obtain the force rely on the use of reaction force (Yang, 2013). In speed skating the skaters use a relatively high speed gliding forward using the ice glide technique; the glide technique is to establish a advancing action on ice at the same time when continuously sliding forward and the skaters in gliding cannot directly generate thrust by backward pedaling, the only possible direction of effective pedaling ice is perpendicular to the direction of the sliding movement. Therefore in the gliding technique it difficult to produce forward velocity by the side kicking, the movement diagram is shown in Fig. 1.

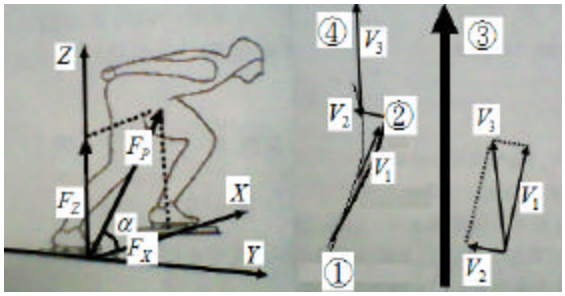

Fig. 1: Power generation schematic of speed skating

As shown on the left in Fig. 1, the component of the pedal force F_P in the X axis is F_X, the component in the Z axis is F_Z, these two components are determined by the size of pedal angle α, the surface XOY is the ground, the Z axis is perpendicular to the ground, F_X is also known as horizontal component force, F_Z is also known as the vertical component force and the three forces and pedal angle satisfies the relationship in Eq. 1:

$$\begin{cases} F_P^2 = F_X^2 + F_Z^2 \\ F_X = F_P \cos\alpha, F_Z = F_P \sin\alpha \end{cases} \quad (1)$$

By the Eq. 1, when the pedal force is certain, the horizontal component force decreases with the increasing of the pedal angle and the vertical component force increases with the increasing of the pedal angle.

As shown on the right in Fig.1, the component F_X in the horizontal plane of the pedal force generates acceleration perpendicular to the sliding direction from right to left; when the other leg pedals, it generates the acceleration perpendicular to the sliding direction from left to right; in the figure V_2 means the lateral velocity, V_1 means the sliding speed, V_3 means the resultant speed of the lateral speed and sliding speed, wherein (1) Means that human centroid route, (2) Means skating route:

$$\vec{V}_1 + \vec{V}_2 = \vec{V}_3 \quad (2)$$

By the Eq. 2 and the speed synthesis figure on the right in Fig. 1, the forward direction is the direction of velocity V_3, wherein the size of the lateral speed and the sliding speed are constantly changing, thus causing changes of V_3; when pedaling ice and sliding in the alternating between left and right legs, the extending trajectory of human centroid along the ice road centerline is substantially shown in Fig. 2.

In a gliding cycle of the human body centroid, the speed skater's torso must lean forward to achieve the smallest facing area to the air and reduce air resistance;

Fig. 2: Movement trajectory of human centroid

Meanwhile in the conventional sliding, we need to avoid force flexor to reach the consequences that the front of the blade cuts in to ice surface, increases friction and reduces balance. In the ice kicking course the lack of torso rotation and foot rotation, makes the pedal force mainly root from the rotation of the thigh and calf. So, in the correct ice kicking technique the pedal force is generated primarily by the extension of knee joint (Zhang, 2012).

In speed skating, ice skater must overcome the resistance of ice and air. The air resistance includes friction resistance and pressure resistance two parts. Friction resistance means the friction generated in the air layer along the body which depends on the smoothness of the racing suite. In speed skating friction resistance and pressure drag is relatively small (Tan, 2013). According to Bernoulli's law the front pressure of skater is bigger than the pressure in the back and it will cause the air flow speed around the body differ. The pressure difference is mainly determined dynamic pressure and the dynamic pressure is calculated as in the Eq. 3 below:

$$F_{dp} = \frac{1}{2\rho V^2} \quad (3)$$

In Eq. 3 F_{dp} represents the dynamic pressure, ρ represents the air density, V means the speed of the air relative to the body; if give the contour area A_p directly facing the front and a correction factor C_d, the total air friction F_f can be obtained and its expression is as Eq. 4:

$$F_f = \frac{F_{dp}}{A_p C_d} \quad (4)$$

The frictional resistance F_{ice} of ice to the ice skate blade is in the Eq. 5:

$$F_{ice} = \mu mg \quad (5)$$

In sports biomechanics analysis of speed skating action, the more commonly used human articular index points are the ankle, knee, greater trochanter and neck, several angles by these points are also the important technical indicators of speed skating motion analysis. Fig. 3 shows the angle condition of the human joint fixed point for skater; typically the angle between the

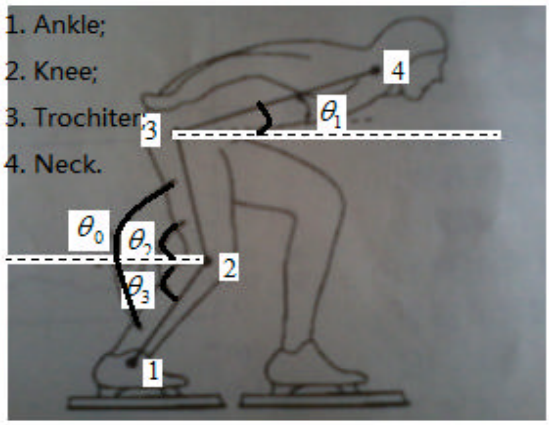

Fig. 3: Angle situation of several technical indicators

connection line of the neck and the greater trochanter and the horizontal plane is form 10 to 30°, the angle between the connection line of greater trochanter and knee and the connection line of knee and ankle is from 100 to 130° and the angle between the connection line of the greater trochanter and knee and the horizontal plane is form 60 to 80°.

BIOMECHANICS DATA ANALYSIS OF SLIDING SPORTS

This study conducts a detailed theoretical analysis for the ice kicking process skating in the speed skating motion; the following is the comparative studies on the data of knee joint angle, pedal speed and pedal force during 0.8s-0s process in the ice kicking process, the change trends of the three variables over time are shown in Table 1.

By Table 1 the changing trends of the three variables over time can be obtained as shown in Fig. 4.

As shown in Fig. 4, during the sliding phase in the speed skating cycle, the knee joint angle is essentially the same; when pedaling the ice, it produces a quick knee extensor movement; when kicking off, through close observation of the knee joint, the knee joint is not fully extended when the leg of the skater lifts from the ground; the pedal off probably occurs in the knee angle of 160°, the early termination of pedal force is due to lack of trunk extensor and flexor. Due to this lack, acceleration of the heavier torso relative to sliding relies mainly on the movement speed of the hip joint away from the ankle joint; the peak of this speed appears far before the knee fully extended, at this time the knee point is 140°; after the instantaneous speed reaches the maximum, the heavier torso and the inertia of side retreat drags the skater until

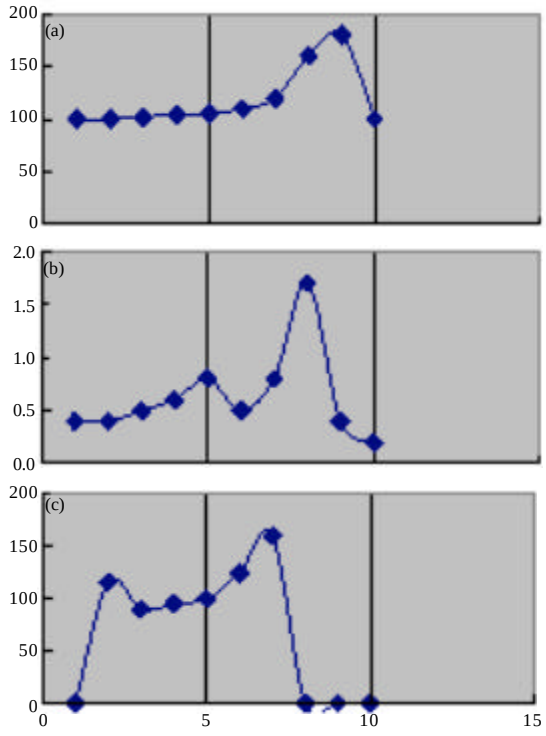

Fig. 4(a-c): Trend figure of speed Skating-knee joint angle A, pedal speed B and pedal force C over time

Table 1: List of knee joint angle, pedal speed and pedal force changing over time

Time	Angle of knee joint (O)	Pedal speed (m sec^{-1})	Pedal force (BW)
-0.7 sec	100	0.4	0
-0.6 sec	100	0.4	116
-0.5 sec	102	0.5	90
-0.4 sec	104	0.6	95
-0.3 sec	105	0.8	100
-0.2 sec	110	0.5	125
-0.1 sec	120	0.8	160
0.0 sec	160	1.7	0
0.1 sec	180	0.4	0
0.2 sec	100	0.2	0

the end of the pedaling ice. As can be seen from Fig. 4, the peak of the pedal force occurs when the joint is 130°, the maximum force is equivalent to 150%of the body weight and when the pedal off is faster than its maximum value, a sudden decline will occur.

CONCLUSION

On the basis of technical indicators analysis for the speed skating, this study analyzes it using biomechanical principles, in order to provide theoretical guidance for these three gliding items; put measuring instruments on normal speed skating athletes, the peak of pedal force appears when the knee joint angle is 130° through the force signal; the maximum force is equivalent to 150% of body weight and when the pedal-off speed exceeds its maximum value it will suddenly drop, during speed skating process the adjustment of posture should also be noted, preferably close to streamline, thus it can reduce the resistance of air pressure, the smoothness of the race suits also has a small impact on competition performance. As an edge science combining biology with mechanics biomechanics have seen a breakthrough in recent years with the development of computer technology which renders the subject make a contribution to the movement research in large part.

REFERENCES

Cui, C., 2013. Application of mathematical model for simulation of 100-meter race. Int. J. Applied Math. Stat., 42: 309-316.

Feng, Y.Y., 2010. Research on the characteristics of plantar pressure distribution in the double-push roller skating technique. J. Jilin Inst. Phys. Educ., 26: 58-59.

Gu, L., 2013. Strength evaluation model of CBA league 2012-2013 season former nba players based on TOPSIS method. Int. J. Applied Math. Stat., 44: 177-184.

Hao, Q.W., 2003. Kinematic study on biff movement of freestyle aerial in poor training by Ji Xiao-Ou. J. Shenyang Inst. Phys. Educ., 22: 18-20.

Li, J.S., 2002. Research technology development and problems of sports biomechanics. Chinese J. Sports Med., 21: 389-391.

Liu, W., 2011. Research on the knee joint strength of chinese excellent figure skaters. China Winter Sports, Vol. 33.

Pan, H.J., 1999. The scientific definition and dialectics of sports biomechanics. J. Beijing Univ. Phys. Educ., 22: 63-68.

Tan, Z., 2013. Fuzzy data envelopment analysis and neural network evaluation mathematical applications model which based on martial arts competition. Int. J. Applied Math. Stat., 44: 37-44.

Tong, Y.D., 2003. Important influential factors of landing stability of the skiers of freestyle skiing aerials. J. Shenyang Inst. Phys. Educ., 22: 15-17.

Wang, H. and S. Yang, 2013. An analysis of hurdle performance prediction based on mechanical analysis and gray prediction model. Int. J. Applied Math. Stat., 39: 243-250.

Wu, X.H., 2011. Research on the special physical power characteristics and training method of figure skating. China Winter Sports, Vol. 33.

Yan, H.G., 2006. Analysis on the Chinese skiing sports ski-flying athlete Chen Shuang's BFDF of freestyle aerial on the water pool. J. Shandong Inst. Phys. Educ. Sports, 22: 85-87.

Yang, H., 2013. Evaluation model of physical fitness of young tennis athletes based on AHP-TOPSIS comprehensive evaluation. Int. J. Applied Math. Stat., 39: 188-195.

Zhang, B., 2013. Dynamics mathematical model and prediction of long jump athletes in Olympics. Int. J. Applied Math. Stat., 44: 422-430.

Zhang, S.W., 2012. Analysis of the straight glide technique of elite athletes from a perspective of kinematic characteristics. J. Northeast Normal Univ. (Nat. Sci. Edn.), 44: 147-149.