KINEMATICS ANALYSIS OF A NEW STRAIGHT LINE SKATING TECHNIQUE

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Great changes have taken place in the area of international speed skating in the past few years. With the manufacture and application of the new spring skate, the performance of speed skating has changed considerably. The purpose of this study was to summarize the features of new speed skating technique. The performance of eight Chinese elite athletes at the 9th National Sports Meeting was videotaped by a high-speed camera. Skating time, posture and speed were analyzed and subsequently compared with the old technique. The results of the study have suggested that the increased duration of double support treading prolonged the effective treading duration and thus increased the average speed. A wider angle of the ankle joint in the final stage enhanced the stretching and treading phase. It can be concluded that the application of new style skate has improved straight-line skating performance.

KEY WORDS: skating, kinematics

INTRODUCTION: Great changes have taken place in the area of international speed skating in the past few years. With the manufacture and application of the new spring skate (new -style skates), speed skating has changed considerably. Currently, the positive effect of the new technique in improving speed skating results has received universal recognition. There is an appreciable difference between the general level of Chinese speed skating and that of other international high performance teams. Undoubtedly, the low level of sports technique training is one of the main reasons. There is reason to believe that in order to increase the level of technique training, it is necessary to improve physique training. This is considered to be the most significant way to improve the standard of Chinese speed skating competition. Therefore, research into new techniques for speed skating is critical and provides an important project for athletic researchers. The purpose of this article is to compare the athletic features of new speed skating technique, using new style skates and old technique, using old-style skates. The results will be obtained through kinematics target comparative analysis. By focussing on the new skating techniques of Chinese speed skating athletes, this research hopes to provide a system for improving Chinese speed skating results and recommendations for training method for the new techniques.

METHODS: The subjects of this study were elite athletes from the Chinese national team. The data, including 50 trials, performed by male subjects, and 52 trials performed by female subjects was collected at the 9th National Sports Meeting of People's Republic of China. For the analysis, compound step actions were shot with a SX-16 high-speed movie camera (China) at the frequency of 72 and a Panasonic M-9000 camcorder (Japan) at the frequency of 50Hz from sides. Films and videotapes were analyzed by a ST-87 film analyzer (China) and NP-64 video analyzing system. Data was analyzed and processed by IBM 686 computer.

RESULTS AND DISCUSSION: The athletics analysis of skating duration. Speed skating is a cyclic sport. In straight line skating, skating duration differs due to different postures and speeds. For this study, a single step is divided into three stages: free sliding, single support treading and double support treading stage. Because of the new style of skate, there is an additional action of stretching the ankle joint and treading ice in the final stage. The whole treading duration is prolonged, and therefore the proportion of different stages and the rhythm of skating has been changed.

Table 1 The Duration Variation of New Technique Straight Line Skating [Unit. s]

Gender	Skating distance	A single step	Single support treading	Double support treading	Free sliding
male (n=50)	500m	0.52 (0.07)	0.120 (0.032)	0.200 (0.082)	0.200 (0.045)
female (n=52)	500m	0.56 (0.06)	0.168 (0.041)	0.196 (0.063)	0.196 (0.036)

Values enclosed in parentheses represent standard deviation.

Table 2 The Duration Variation of Old Technique Straight Line Skating [Unit. s]

Gender	Skating distance	A single step	Single support treading	Double support treading	Free sliding
male (n=46)	500m	0.59 (0.06)	0.22 (0.02)	0.16 (0.02)	0.21 (0.04)
female (n=43)	500m	0.75 (0.04)	0.30 (0.03)	0.19 (0.04)	0.26 (0.05)

Values enclosed in parentheses represent standard deviation.

Table 1 and 2 indicated that the duration of a single step in the new technique was 0.52±0.07s for male and 0.56±0.06s for female, while for old technique, the duration of a single step is 0.59±0.04s for male and 0.75±0.04s for female. The application of new-style skate prolonged the double support treading stage and shortened the single support stage and free sliding stage.

Table 3 Time Proportion of Different Stages in the New Technique Straight Line Skating

Gender	Skating Distance	The whole treading (%)	Single support treading (%)	Double support treading (%)	Free sliding (%)
male	500m	61.55	23.10	38.45	38.45
female	500m	65.00	30.00	35.00	35.00

Table 4 Time proportion of different stages in the old technique straight line skating

Gender	Skating distance	A single step	Single support treading	Double support treading	Free sliding
male	500m	63.88	36.75	27.13	36.12
female	500m	65.61	39.95	25.66	34.27

Table 3 and 4 showed that the time proportion of different treading stages has not changed the application of new technique. This also means that there is no obvious change in the time division between free sliding and treading. However, the time proportions of single support treading and double support treading are different. With the new technique, male athletes double support treading takes 38.45% of the time, and with female athletes double support treading takes 35%; male's single support treading takes 23.10% and female's takes 30%. With the old technique the figures are respectively 27.13%, 25. 66% 36. 75% and 39. 95%. After the application of the new technique, male's treading duration is prolonged by

11.32%and female’s duration by 9.34%. These results showed that the application of new technique prolonged the function period of double support treading.

Table 5 Time Proportion of Different Stages in Straight Line Speed Skating

Gender	Single support: free sliding	Double support: Free sliding	Single support: double support
Chinese male athletes (new technique)	1:1.25	1:1	1:1.25
Chinese female athletes (new technique)	1:1.16	1:1	1:1.16
Chinese male athletes (old technique)	1:0.96	1:1.3	1:0.73
Chinese female athletes (old technique)	1:0.87	1:1.34	1:0.63

The application of new technique changed the speed skating treading technique of Chinese athletes considerably. The proportion of male’s double support treading and free sliding became 1:1, which is regarded as ideal by coaches and athletes prior to the application of new technique.

The athletics analysis of skating posture. In this article, three key technique action periods were analyzed: the beginning of single support trading after free sliding, the beginning of double support treading and the end period of double support treading. Joint angles that can reflect skating posture and show technique action structure are chosen as athletics parameters.

Table 6 Variation of Joint Parameters in Different Action Stages [Unit. Degree]

Gender	Item	Action stages					
		Beginning of single support treading		Beginning of double support treading		Ending of double support treading	
		Treading leg	Supporting leg	treading leg	Supporting leg	treading leg	supporting leg
male (n=50)	ankle joint angle	85.49 (5.23)	81.18 (7.86)	84.70 (3.26)	87.34 (9.20)	112.56 (10.03)	85.31 (9.12)
	knee joint angle	112.10 (6.02)	85.64 (4.78)	127.83 (7.63)	101.53 (6.72)	170.17 (9.21)	108.86 (8.73)
	hip joint angle	62.81 (4.02)	109.55 (5.32)	77.70 (4.78)	78.30 (5.04)	147.51 (8.29)	49.79 (6.21)
	body angle	27.42 (3.21)		27.55 (3.67)		26.79 (2.96)	
female (n=50)	ankle joint angle	87.29 (4.08)	86.75 (5.02)	87.67 (4.67)	89.43 (4.21)	133.53 (8.72)	84.01 (5.34)
	knee joint angle	113.23 (7.21)	76.80 (4.03)	145.54 (11.02)	102.55 (7.86)	164.31 (10.24)	100.24 (6.21)
	hip joint angle	91.45 (6.72)	101.14 (7.08)	78.51 (5.96)	69.38 (4.82)	123.49 (9.34)	52.98 3.87
	body angle	20.60 (2.71)		22.50 (2.69)		18.11 (1.98)	

Values enclosed in parentheses represent standard deviation.

Based on Table 6, the angle of the treading ankle using new technique were wider in the final stage: male 112.56±10.03° female 133.53±8.29°, which is favorable to stretching ankle and treading ice in the final stage. However, the ankle joint angle is so wide that in free sliding and beginning of single support trading, there is a small stretching of knee in the beginning of single support stage. As a result, the torso angle was too wide and the centre of gravity was too high, which is unfavorable for the gravity on the skate.

The athletics analysis of skating speed. Speed is the most important factor that determines the results. According to Table 7, results showed that speed keeps increasing during free sliding and double support treading stages. Both male and female athletes accomplished their highest speed in double support treading stage: 13.24±1.102 m/s for male and 12.653±0.9878m/s for female. The application of the new technique prolonged the function duration in double support treading, so the athlete is able to maintain high speed during the whole action stage. During the final stretching ankle and treading period, the speed of the gravity centre reduces instead of increasing. It is interesting to note that the stretching ankle and treading stage prolonged the function duration and the duration with highest speed. Increase of speed is the result of technique structure change caused by the application of new technique.

Table 7 The Average Speed of Gravity Centre in Different Stages [Unit. m/s]

	Average speed of gravity centre			
	Free sliding	Single support treading	Double support treading	The whole single step
	12.699	13.111	13.245	12.018
Male n=50	1.232	1.178	1.102	0.782
Female n=52	11.159	12.444	12.653	12.189
	1.021	1.034	0.987	1.124

CONCLUSION: Through interpretation of the preceding analysis, the application of the new technique has been able to improve the straight-line skating technique of Chinese athletes considerably. From a kinematic perspective, the results can be summarized in the following:

1. Skating action structure changed significantly. In terms of rhythm, the stretching of the joint ankle and treading in the find treading stage prolonged the duration of double support treading in a single step and prolonged the effective treading duration.
2. The angle of the ankle became wider in the final stage, which is favorable to the stretching ankle and treading. However, the center of gravity remains high.
3. The skating speed is increased mainly because the highest speed is sustained during the double support stage and so the average speed is increased, though not because the stretching ankle and treading increased the speed in the final treading stage.

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