AN ANALYSIS OF 500 M INLINE SKATE STARTING MOTIONS

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The purpose of this study was to examine if there are kinematical variables differences between national representative players (NRP) and non national representative players (NNRP) during 500 m inline skate starting motion. Four NRP and six NNRP were recruited for the study. Each subject executed starting motion five times on a 2x12 m start way in a gymnasium. Kinematical variables were analyzed by the three-dimensional motion analysis system (60Hz). It was hypothesized that there are time and center of mass acceleration differences in starting phase between groups since starting phase has been considered important in sprinting. The results showed that the NRP had significantly shorter starting phase time than that of NNRP.

KEY WORDS: inline skate, start motion, three-dimensional motion analysis

INTRODUCTION:

Inline skating could be divided into 3 phases; the starting phase, the curved phase, and the straight phase. Each phase has different characteristics, thus a good player has to have proper skills specific to each phase. Among them, the starting phase took a great deal of weight in sprinting. It is not easy to outrun other players during the 500 m inline skate racing because the game is held on the 200m track open course. Therefore, start definitely impacts on the outcome in 500 m inline skating. Back, et al. (2002) claimed that Korean female players showed shorter phase time than that of the foreign players while foreign players showed bigger body center of mass (COM) displacement during the starting phase than that of Korean players in world short track speed skating championship. They should be strengthened with start training in 500 m sprint. Slowness during the very first three steps in the short distance inline skating race has been reported as Korean players' weak point. 500 m inline skating records or ranking are determined by a slight difference like short distance running. The starting motions definitely influence records and ranking. The purposes of current study were to examine the kinematical differences between NRP and NNRP in inline skate starting motions.

METHOD:

Data Collection: Four NRP and six NNRP were recruited for the study. NNRP were college grade inline skaters, whose Korean rankings are under 20^{th} and not qualified for the national championship. None had been injured or changed their starting motion in one year. Their physical characteristics have been presented in Table 1.

A 2x12 m start way was prepared in a gymnasium. Anti-slip 3M tapes were attached on the start way to hold back slipping during starting. The gymnasium was big and safe enough to perform inline skate starting motions. A 100x400x200 cm control frame with 59 control points was set on the start way for the three-dimensional motion analysis. The origin of the global positioning was positioned lower left rear of the players. Medio-lateral and anterior-posterior side of the player was set as x-axis and y-axis, respectively. The z-axis was vertical to x-y plane. Subjects wore one-pieced black tight for the easy identification of the reflective land marks on each point of joints. Table 2 shows detail land marks.

Table 1 Physical characteristics of the subjects

Subjects	Age (yrs)	Height (cm)	Weight (kg)	Career (yrs)
NRP*(n=4)	22±2.71	174.0±4.32	71.3±1.50	9.8±3.59
NNRP**(n=6)	22±1.83	172.3±0.96	65.8±4.99	9.3±2.63

*NRP : National Representative Players, **NNRP : Non National Representative Players

Table 2 Land marks for three-dimensional motion analysis

1. r. toe	11. l. toe	21. r. hand	31. r. ant. shoulder
2. r. heel	12. l. heel	22. r. wrist	32. r. pos. shoulder
3. r. lat. malleolus	13. l. lat. malleolus	23. r. lat. elbow	33. PSIS
4. r. med. malleolus	14. l. med. malleolus	24. r. med. elbow	34. forehead
5. r. lat. shank	15. l. lat. shank	25. r. ant. shoulder	35. vertex
6. r. lat. epicondyle	16. l. lat. epicondyle	26. r. pos. shoulder	36. occiput
7. r. med. epicondyle	17. l. med. epicondyle	27. l. hand	-
8. r. lat. thigh	18. l. lat. thigh	28. l. wrist	-
9. r. great trochanter	19. l. great trochanter	29. l. lat. elbow	-
10. r. ASIS	20. l. ASIS	30. l. med. elbow	-

r: right, l: left, lat: lateral, med: medial
ASIS: anterior superior iliac spine, PSIS: posterior superior iliac spine

Six digital video cameras (60 Hz, Sony VX-2100) were positioned at 6 spots which could easily observe body land markers throughout the experiment. The experimental place was shut off with black clothes and used a part light to minimize an impact from the experimental equipments and environment. The video camera was setting up with shutter speed of 1/1,500 second. All subjects were asked to use the same Hiper's 84mm/85a wheel and 13 inch frame for the experimental purpose.
A synchronization system was made with a trigger, TTL(transistor transistor logic) signal generator, and seven LEDs. An operator manually triggered the system with a voice command of 'start'. When an operator triggers the system, all LEDs were lighted on simultaneously by the TTL signal. These LED lights were used as a start signal for the subjects and a synchronization signal for six cameras. The subjects were asked to start with this LED signal and a 'start' command. Each subject repeated start motion five times. The third starting motion was analyzed if there were no special reason.

Data Analysis: Kinematic data were analyzed by Kwon 3D three-dimensional motion analysis system (Visol, City of Kwangmyung, Korea) to examine the differences between NRP and NNRP at the 500m staring phase in inline skating. Three-dimensional positions were reconstructed by the DLT methods and filtered with a second-order Butterworth low pass filter with a cut-off frequency of 6Hz.
In the study, the starting motion, three steps after a starting signal, was divided as phases for the analysis purpose. Phase 1 (P1), the approaching phase with the left foot after a starting signal; Phase 2 (P2), the approaching and landing phase with the preceding foot (the left foot); Phase 3 (P3), the approaching and landing phase with the foot at the rear (the right foot); Phase 4 (P4), the approaching and landing phase with the second left foot. The mean differences of the phases between groups were examined by Kruskal-Wallis test, nonparametric estimation, of SPSS (v12). The differences of mean between groups were examined by Mann-Whitney test which is also nonparametric estimation. Except if otherwise stated, the significance threshold was $p<.05$.

RESULTS:

The phase time between NRP and NNRP are shown in Table 3 and Figure 1.

Table 3 Comparison of the phase time (unit : s)

phase	NRP	NNRP	z
P1	.13±.05	.30±.07	*-2.566***
P2	.30±.04	.35±.08	*-1.706*
P3	.34±.03	.39±.07	*-1.516*
P4	.28±.03	.29±.04	*-.861*
χ^2	*11.505***	*8.065**	

**: p<.05, **: p<.01*

As Table 3 and Figure 1 show, the phase time of each group was P3, P2, P4, and P1 order in NRP group and P3, P2, P1, and P4 order in NNRP group, respectively.

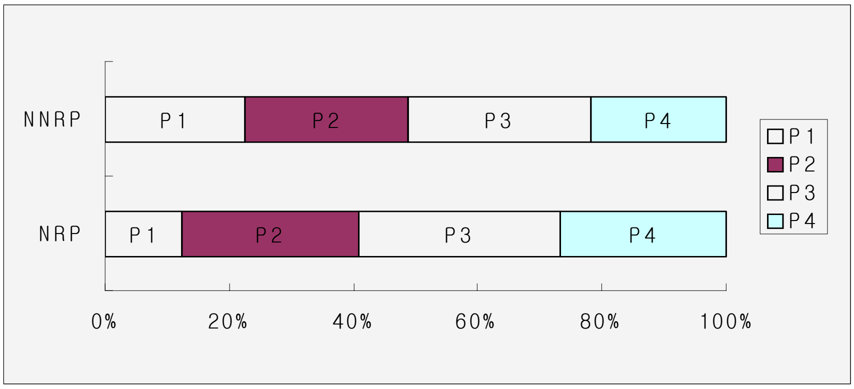

Figure 1: Phase time percentage comparison in the total time.

In comparing phase time in the total time with relative time, NRP were 12,4% in P1, 28.6% in P2, 32.4% in P3 and 26.7% in P4 and NNRP were 22.6% in P1, 26.3% in P2, 29.3% in P3, and 21.8% in P4, respectively. Therefore, the results show that both of them used the most time at the phase P3 <Figure 1 >.

An acceleration of the COM was calculated by $\vec{a}_{com} = \frac{d\,\vec{v}_{com}}{dt} = \frac{d^2\,\vec{r}_{com}}{dt} = \ddot{x}\,\vec{i} + \ddot{y}\,\vec{j} + \ddot{z}\,\vec{k}$, when position vector of the center of mass is $\vec{r}_{com} = x\,\vec{i} + y\,\vec{j} + z\,\vec{k}$.

An acceleration of the COM between NRP and NNRP is shown Table 4 and Figure 2.

Both of them gradually increased up from phase P1 to phase P3 but decreased in phase P4 in the acceleration of COM. And the biggest acceleration was shown in phase P3.

The acceleration of COM of NRP were 85.2% higher than that of NNRP in phase P1, 25.4% higher in phase P2, 14.7% higher in phase P3, and 1.6% higher in phase 4. The ratio decreased from P1 to P4.

Table 4 Acceleration of the COM (unit : cm/s^2)

Phase	NRP	NNRP	Z
P1	314.18±102.02	169.62±32.99	*-2.558**
P2	542.18±120.99	432.53±95.42	*-1.492*
P3	593.06±79.29	517.05±64.98	*-1.706*
P4	500.95±78.17	493.01±139.58	*.000*
χ^2	*8.537**	*14.127***	

**: p<.05, **: p<.01*

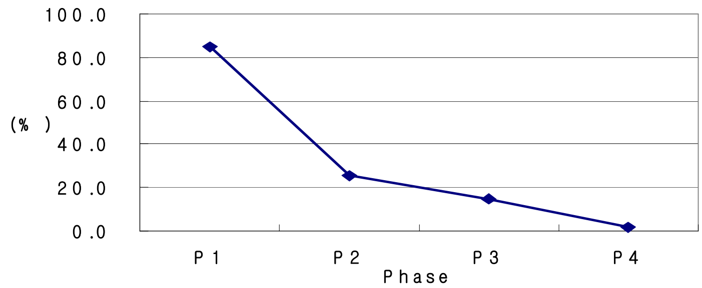

Figure 2: Percentage ratio of the COM acceleration of NNRP compare to COM acceleration of NRP.

DISCUSSION:

The largest time and the rate of change of acceleration differences between NRP group and NNRP group were found in P1. This seems close relation with the reaction time and accordance with the findings of Yoon, et al. (1996) that the first reaction time of excellent players was relatively short. Also, it was similar to the results of research of Shin, et al. (1996) that if the record of starting phase was rapid, the time approaching the first step was also rapid. During the P1, the players should respond to the start signal as quickly as possible. Physically speaking, P1 time represents players' capability of changing the state of the inertia. According to the results, NRP showed shorter P1 time than that of NNRP. This means good players get started quickly the first stroke. Further studies, such as joint angles and ground reaction forces changes and/or differences are expected for the necessary exercise methods recommendations and guidance for a winning race.

CONCLUSION:

This study investigated to reveal the differences between NRP and NNRP during the 500 m inline skate starting motion. The results showed that the biggest difference between two groups happened in P1. NRP showed shorter P1 time than that of NNRP.

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