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COMPARISON OF LUGERS' START ELEMENTS ON A SLIDING TRACK AND AN ICED START RAMP

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The aim of this study was to determine whether there are significant differences in timing of start elements that lugers perform on a sliding track and an iced start ramp built for training purposes. Male and female lugers with different competitive experience performed starts on the start ramp and on the luge track. Timing of start elements was measured from high-speed video records and compared between start facilities. Most of the athletes showed different timing of start phases at the track and the ramp. These differences partially arise from a necessity to assume a riding position in-time on the track. Though training on the start ramp does not represent exactly start performance on a luge track, it is a convenient way for practicing technical elements of the start.

KEY WORDS: timing analysis, high-speed video recording, start phases, winter sports.

INTRODUCTION: The sport of luge is one of the fastest winter sports – athletes slide on iced tube-like tracks with speeds reaching values of 150 km/h, and thousandth of a second often determine a winner. It had been shown in previous research that a fast start time is a prerequisite for an excellent overall performance in the sport of luge (Bruggemann et al., 1997); start records for each sliding track are even officially registered during major competitions. Athletes spend a lot of time mastering their start technique; the starts are practiced not only on the sliding tracks, but also at different other facilities, including specially constructed start ramps, both iced and for roller-sleds (Rogowsky & Wala, 1978). Although the start is considered an important technical element in the sport of luge, it has not been thoroughly studied to date. The purpose of this study was to compare duration of start elements typical to male and female lugers on an iced start ramp and on a luge track. This is done in order to evaluate correspondence of athletes' technique elements at training facilities to those shown at competition facilities.

METHODS: Timing data of seven athletes were collected for the purpose of this study: two elite level female athletes – athletes A1 and A2 – (weight 86.6 and 73.1 kg, height 174 and 173 cm, competitive experience 19 and 11 years), two junior level female athletes – athletes B1 and B2 – (weight 73.7 and 69.1 kg, height 175 and 169 cm, competitive experience 5 and 2 years), one junior male athlete – athlete C – (weight 86.8 kg, height 191 cm, competitive experience 3 years) and two elite level male athletes – athletes D1 and D2 – (weight 81.9 and 89.3 kg, height 184 and 176 cm, competitive experience 19 and 24 years). The athletes performed four starts daily on the luge track for two consecutive days; timing data from the start ramp were collected previously during training camps (partially reported for female and junior athletes by Fedotova & Pilipiv (2010a)). On the track male athletes started from men's start and female athletes from ladies' start that is located lower.

In the sport of luge athletes begin in a sitting position; first they perform a rocking motion forth and back, then a forceful start jerk follows, and after that athletes continue accelerating the sled pushing-off the ice surface with their fingers or palms before assuming the riding position on the sled. Kempe and Thorhauer (1995) had divided lugers' start into five phases:

1. Pushing the sled forward whilst holding the start handles;
2. Movement of the sled backwards or "compression" phase;
3. Push-off from the start handles;
4. Several paddling arm strokes and thrusting off the ice surface;
5. Assuming a supine race position on the sled.

Duration of phases 2, 3 and 4 was measured in the study; number of arm strokes in phase 4 varies among athletes and is also dependent on the technical specifics of the start facilities – the track or start ramp – since the starting portion of the tracks is designed differently. Duration of each arm stroke phase was measured from touchdown of the fingers (ice-contact) to the next touchdown – intervals PO_1, PO_2, etc., depending on an athlete; duration of the last push-off with hands that is followed by phase 5 was not included into the study. Three other time intervals were measured: time from beginning of sled's backward motion until the sled reaches its maximal backward position – time interval t(a) – this is phase 2 described by Platzer et al. (2009) as an eccentric pre-phase in lugers' start. Time interval t(b), measured from the beginning of the sled's forward motion till the moment athlete releases the start handles – it describes the start jerk itself. Time interval t(c) from releasing the start handles till the first fingers touchdown.
Only successful attempts were analysed; an attempt was considered unsuccessful if an athlete hit the wall, unexpectedly lost the hold of the start handles or otherwise lost control of the situation. Due to this consideration and technical limitations in data collection, a sufficient amount of data on the sliding track (five to seven starts) was obtained from four athletes only (B1, C, D1 and D2). Other athletes had three and less valid starts at the track; their data are discussed in this paper for illustrative purposes.
Duration of time intervals was calculated from high-speed video records using SIMI Motion (SIMI Reality Motion Systems GmbH) motion analysis software. Video records were collected with one Casio EX-FH20 digital camera (Casio Computer Co., Ltd.) at 210 fps frequency, and two Basler A602fc video cameras (Basler AG) at 100 fps.
Statistical analysis was done in Matlab environment (The MathWorks, Inc.), since data did not follow the normal distribution, the non-parametric Mann-Whitney U-test was applied; α=0.05 level of statistical significance was used throughout the study.

RESULTS and DISCUSSION: Duration of start phases at the luge track and the start ramp for athletes B1, C, D1 and D2 is presented in Table 1 as mean (SD), measured in seconds.
The only athlete who did not show significant differences in timing of the start elements at different facilities was elite level male athlete D2. For all other athletes there existed a difference in duration of several phases with a trend of decrease relative to results at the start ramp. The stability of athlete's D2 results might be partially explained by competitive experience exceeding that of any other athlete participated in this study; however, it might also indicate certain inflexibility of the technique of this athlete. From Table 1 it can be also noted that athlete D2 has the shortest phases' time among all athletes, except for phase t(c) that does not differ from other athletes, and phase t(b), which has almost the same duration as for other male athletes. It is most probable that reduced duration of phases arises from anthropometric features of athlete D2 who has a relatively small body height for a luger.
A typical feature for male athletes was stability of number of push-offs from the ice performed on the start ramp and the track; athlete B1 had reduced that number from 5 at the ramp to 4 at the track. She had also a decrease in duration of t(c), PO_1 and PO_2 phases at the track relative to the ramp, and a trend to decrease duration of PO_3 phase. Athlete D1 had a similar tendency, but shifted two phases further: he had decrease in phases PO_2 to PO_4. A possible explanation to this tendency of shortening the acceleration time lays in the fact that a failure to assume the riding position in-time on the track leads to much more severe consequences than on the ramp, this puts an additional psychological pressure on the athletes and they try to get into supine position faster. Construction of the track does not allow performing a large number of arm strokes at the ladies start as a straight path before the first curve is short, so female athletes not included into Table 1 had also showed a trend to reduce the number of arm strokes to 4. It was possible to define some differences in duration of start phases at the ramp and the track for athletes A1, A2 and B2, though without a pronounced decrease trend.
The difference in number of arm strokes among female athletes does not indicate inconsistency of trainings at the start ramp, since athletes have to vary the number of their arm strokes at competitions due to environmental conditions and construction of tracks.

Table 1
Duration of start phases on the luge track and the start ramp

Time interval	Athletes B1		C		D1		D2	
	track	ramp[+]	track	ramp[+]	track	ramp	track	ramp
t(a)	0.77* (0.02)	0.81* (0.07)	0.76* (0.02)	0.79* (0.02)	0.89* (0.04)	0.94* (0.03)	0.62 (0.01)	0.65 (0.02)
t(b)	0.60 (0.01)	0.60 (0.02)	0.56 (0.01)	0.56 (0.01)	0.56 (0.01)	0.56 (0.01)	0.54 (0.01)	0.55 (0.01)
t(c)	0.28* (0.01)	0.30* (0.02)	0.30 (0.01)	0.28 (0.01)	0.30 (0.01)	0.31 (0.01)	0.29 (0.01)	0.29 (0.01)
PO_1	0.48* (0.01)	0.52* (0.02)	0.51 (0.01)	0.51 (0.03)	0.53 (0.01)	0.53 (0.01)	0.44 (0.01)	0.43 (0.01)
PO_2	0.46* (0.01)	0.48* (0.02)	0.49 (0.01)	0.49 (0.02)	0.48* (0.01)	0.50* (0.01)	0.41 (0.01)	0.41 (0.01)
PO_3	0.46 (0.01)	0.47 (0.02)	0.49 (0.02)	0.49 (0.02)	0.47* (0.01)	0.49* (0.02)	0.40 (0.01)	0.40 (0.01)
PO_4	n/a	0. 46 (0.02)	n/a	n/a	0.48* (0.01)	0.50* (0.01)	0.40 (0.01)	0.39 (0.01)
PO_5	n/a	n/a	n/a	n/a	n/a	n/a	0.38 (0.01)	0.38 (0.01)

*Significant differences between start facilities for a given athlete.
[+]Reported by Fedotova & Pilipiv (2010b)

Data in Table 1 show that for all athletes except athlete D2 it is typical to have a phase t(a) shorter on the track than on the start ramp. For athlete D2 the difference in this phase is not statistically significant, though the mean value at the track appears shorter than on the ramp. Figure 1 illustrates the tendency for decreased duration of “compression” phase at the track among athletes whose data are not presented in the table (SD is not indicated since the data have only illustrative purpose).

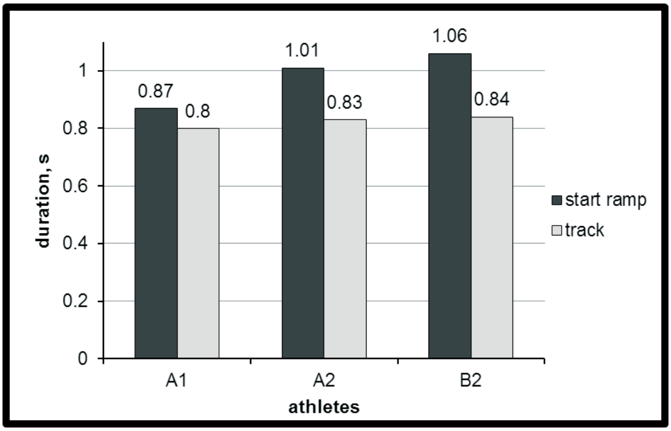

Figure 1: Duration of phase t(a) for athletes A1, A2 and B2.

The main reason for shortened “compression” phase quite probably is the design of the start platform – its length from the beginning to the start handles is considerably shorter on the start ramp than on the track. As a result athletes do not have a necessary freedom of motion (however, it is probably a psychological effect only) and slide more carefully and therefore slower on the ramp. Even though our studies did not reveal a correlation between phase t(a) duration and the start time (Fedotova & Pilipiv, 2010b), Platzer et al. (2009) indicate that the eccentric pre-phase is a major contributor to the starting performance, and the speed in this phase correlates with the speed at the exit from start handles (end of t(b) phase). We believe that influence of the “compression” phase on the training process, and performance in this phase at the start ramp should be further investigated.
On the other hand, time for the start jerk – phase t(b) – is the same on the start ramp and the sliding track for all athletes. The start jerk is an important start element as it gives an initial acceleration to the sled; it requires a considerable physical strength. The ability of athletes to transfer their start jerk timing from one facility to another indicates suitability of the start ramp for training this concentric movement.

CONCLUSION: This study had shown that generally there exist a difference in duration of lugers’ start phases between the sliding track and the iced start ramp; however, some individuals are able to transfer their typical timing patterns from the training to competitive facility. It had been shown that some athletes tend to decrease duration of arm strokes when starting on the luge track, probably due to necessity to assume the riding position in-time. It is typical to maintain the same duration of the start jerk on both starting facilities, therefore the start ramp can be considered a convenient method for training the concentric movement in the lugers’ start. On the other hand, decrease of the eccentric pre-phase duration on the track relatively to the start ramp requires further investigation in order to evaluate the consequences for the training process.

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