STUDIES REGARDING THE DIFFERENCE BETWEEN NORMAL SPRINTING AND RUNNING OVER FLAT MARKERS

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The purpose of this study was to clarify the difference between normal sprinting (NS) and running over flat markers (FMR). Eleven male collegiate sprinters participated in this study as subjects. The subjects initially ran 50m normally, then over some markers set up on the runway, and finally they ran 50m normally again. The leg motion of the three runs were compared by two-dimensional motion analysis. FMR showed a significant increase in stride frequency, but leg motion showed no significant differences. However, there were subjects whose leg motion showed smaller hip and knee angle and angular velocity during contact phase. The results suggested that the second sprint was influenced by FMR. FMR may be a good tool for sprinting improvement to obtain a higher stride frequency.

KEY WORDS: sprint, running over flat marker, stride frequency, leg motion

INTRODUCTION: In sprinting, maximum running velocity is a key determinant of race time (Matsuo et al.,2008). Maximum running velocity is determined by stride frequency and stride length. Tsuchie (2009) reported that the increase in stride frequency leads to the increase in maximum running velocity. Mori et al. (2005) showed the mini-hurdle interval stride length was set up at 95% in the averaged 100m stride length, and stride frequency increased during the acceleration phase. Ito et al. (1998) examined the relationship between running motion and running velocity, and faster sprinters showed less change in knee joint angle during the contact phase. Although there are many studies about the characteristics of excellent running motion, there are few studies regarding the training in order to attain it. According to kinematic comparison of sprinting and running over mini-hurdles (Suematsu et al., 2004), there are some differences, such as faster recovery of the leg, and larger extension of the ankle joint. From these factors, there are advantages and disadvantage in running over mini-hurdles. Recently, FMR has been used in training (Nakamura, 2011), with. Suematsu et al. (2009) showing that the effects of this training increase stride frequency and swing speed. In that particular study, the subjects were elementary school students, and there was no comparison between normal running and running over flat markers. Therefore, the purpose of this study was to clarify the difference of normal running and FMR using motion analysis, and to determine how FMR can affect performance.

METHODS: Eleven male collegiate sprinters (Height 171.6±5.54cm, body mass 63.0±5.89kg, 100m time 11.23±0,48sec) participated as subjects. Subjects ran a 50m dash three times. At first, they ran normally (Pre). Secondly, they were instructed to run over flat markers and target foot placements over interval markers (FMR) and lastly, they ran normally again (Post). Figure1 shows the setup of the runway for FMR. Markers were set from 20m to 40m. The interval of the marker was 1.1 times the subject's height. A high speed camera (EXILIM EX-F1, CASIO, JAPAN) was used to record the running motion at 300Hz. This camera was located 30m from the left side of the runway and panned to record the running. Frame DiasⅣ(DKH, JAPAN) was used to digitize 23 body segment points and 4 reference marks, and reconstruct two-dimensional coordinates (from left foot contact to the next left foot contact) . Running motion was divided into phases by 5 events: ①Left foot on (L-on, 0%) – ②Left foot off (L-off, 50%) – ③Right foot on(R-on, 100%) – ④Right foot off (R-off, 150%) – ⑤Left foot on(L-on, 200%). Data was calculated for 50m running time, running velocity during the 30-40m section, stride frequency, stride length, hip, knee and ankle angle and angular velocity. The data of all subjects were normalized by the time of each phase and averaged. To test the differences among the three conditions, one-way analysis of variance was used, with the significance level set at p<0.05.

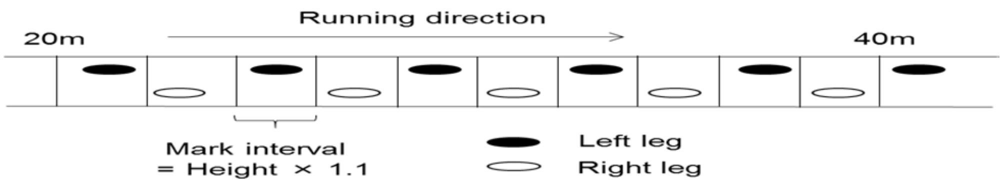

Fig.1 Set up of the runway for running over flat markers

RESULT: Fig.2 shows the 50m average time. Fig.3 presents data from the 30-40m section for stride frequency, stride length, and running velocity. The 50m time, stride length, and running velocity showed no significant difference. Stride frequency showed a significant difference between Pre-FMR and Pre-Post. Hip, knee, and ankle angle and angular velocity had no significant difference.

*:p<0.05

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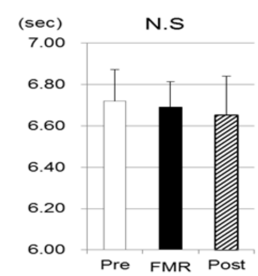

Fig.2 Result of 50m time

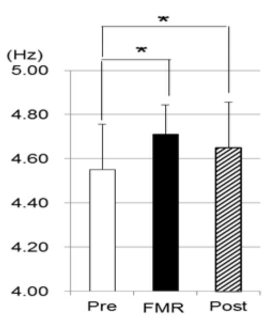

Fig.3 Stride frequency (30-40m)

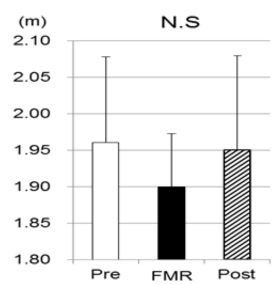

Fig.4 Stride length (30-40m)

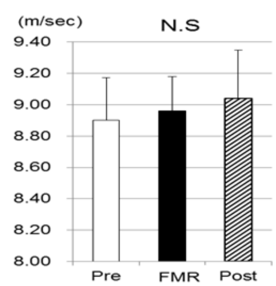

Fig.5 Running velocity (30-40m)

Discussion: Suematsu et al. (2009) showed stride frequency increase as an effect of FMR for elementary school students. Mori et al. (2005) showed that when the interval of the mini-hurdle was set up shorter than the average stride length of a 100m race, stride frequency increased during the acceleration phase. Therefore, it is likely that FMR increases stride frequency when the interval of markers is shorter than usual race or during running. Angle and angular velocity showed no significant differences. Conversely, there were some subjects that showed a typical change of running motion. Therefore, the results of these two subjects are discussed individually in the following paragraphs that show the effect of running over flat makers.

According to Fig.5 ID6 decreased hip and knee joint extension angular velocity from L-on (0%) to L-off (50%) (Fig.5 left). This means that ID6 inhibited extension of the subject's hip and knee joint during FMR more than Pre and Post. ID6 increased stride frequency, and leg motion was inhibited by backward rotation. As a result stride length was shorter than usual, and running velocity was decreased (Table1).

ID9 increased stride length during FMR (Fig.5 right), but stride frequency decreased. ID9 increased stride frequency, decreased stride length, and increased running velocity at the Post stage. ID9 showed that the flexion angle of hip and knee joint of FMR were smaller than that of Pre and Post, during the contact phase. It was considered that a longer stride length increased the propulsive force. From these results, FMR has some potential to improve the motion of hip and knee joint motion during the contact phase, and it will be a good tool for sprinting training.

Table1 Result of stride parameters, running velocity and 50m time of ID6 (left) and ID9 (right)

ID6	Pre		FMR		Post
Stride frequency	4.41	↑	4.72	↓	4.44
Stride length	2.02	↓	1.87	↑	1.99
Running velocity	8.93	↓	8.85	→	8.85
50m Time	6.69	↓	6.76	→	6.76

ID9	Pre		FMR		Post
Stride frequency	4.80	↓	4.65	↑	4.84
Stride length	1.88	↑	1.97	↓	1.91
Running velocity	9.01	↑	9.17	↑	9.26
50m Time	6.70	↑	6.63	↑	6.57

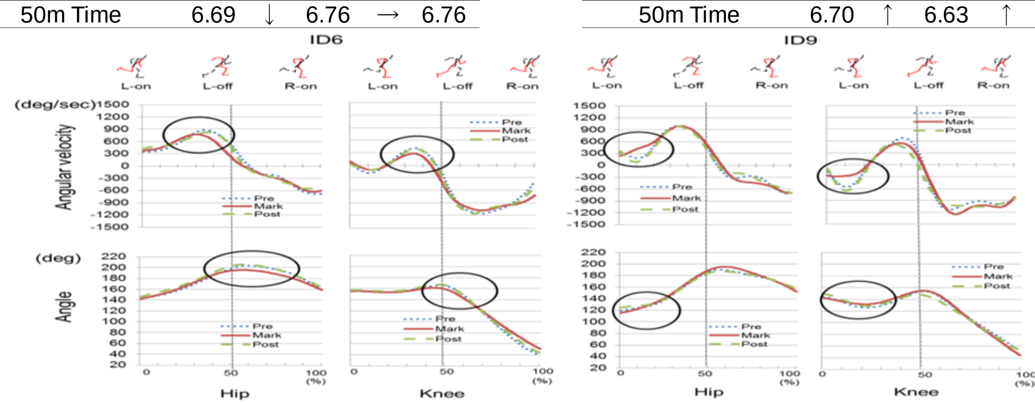

Fig.5 Kinematic parameters during 30-40m (left: ID6 right: ID9)

CONCULUSION: The purpose of this study was to clarify the difference between NS and FMR. Across the entire study population, FMR typically increased stride frequency with no significant difference in leg motion. However in two individual case studies, hip and knee joints did not over extend and over flex during contact phase. FMR did not have an immediate effect on running velocity, but it has the possibility of improving leg motion by long-term training.

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