

## IMMEDIATE EFFECT OF RUNNING OVER FLAT MARKERS TO IMPROVE STRIDE FREQUENCY

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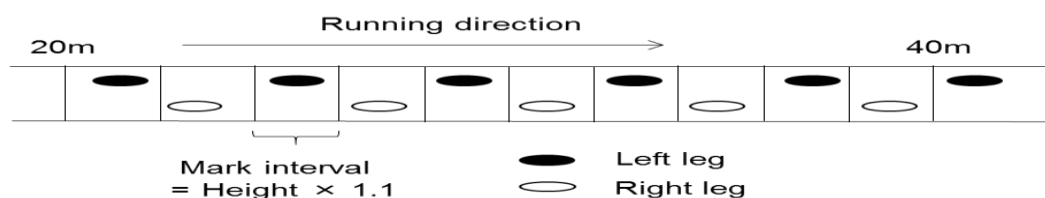
The purpose of this study was to clarify the difference between normal sprinting (NS) and running over flat markers (FMR). Seven male collegiate sprinters participated in this study. The subjects initially ran 50 m normally, then over some markers set up on the runway, and finally they ran 50m normally. The leg motion of the three runs was compared by two-dimensional motion analysis. FMR showed a significant increase in stride frequency and running velocity. There was no significant difference in leg motion between NS and FMR. However, knee torque and torque power showed a significant increase between FMR-Pre and FMR-Post. 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 markers (FMR), sprint 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. In order to increase the running velocity, it is necessary to improve both stride frequency and stride length or improve either one and maintain the other. There is a trade-off between stride frequency and stride length (Hunter et al 2004), whereby the optimum combination of the stride frequency and stride length for obtaining the running velocity depends on running velocity and differs depending on the sprinter (Kunz and Kaufman, 1981; Schiffer, 2009). A 100m sprinter can be divided into either a stride frequency type or a stride length type (Ae et al, 1994). As a result of examining individuals in a 100m race (Salo et al, 2011), and due to the difference in sprinter type, the training of each is considered to be different. To alter the stride frequency and stride length, using a stick or mark to regulate the stride length is thought to be a good method (Korchemny, 1994). Comparison of the kinematics sprinting and running over mini-hurdles has identified some differences, such as faster recovery of the leg, and larger extension of the ankle joint have been reported (Suematsu et al., 2004). From these factors, there are advantages and disadvantage in running over mini-hurdles. Recently, running over flat markers (FMR) has been used in training (Nakamura, 2011), with Suematsu et al. (2009) showing that the effects of this training increased 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:** Seven male sprinters (Mean  $\pm$  SD; 1.69  $\pm$  0.04 m, 62.5  $\pm$  6.12 kg, 100 m time 11.22  $\pm$  0.30 s) participated as subjects. Subjects ran a 50 m dash three times. At first, they ran normally (Pre). Secondly, they were instructed to run over flat interval markers and target foot placements over the interval markers (FMR). Lastly, they ran

normally again (Post). Figure 1 shows the setup of the runway for FMR. Markers were set from 20 m to 40 m. The interval of the marker was 1.1 times the subject's height. This setting was decided based on previous research (Fukuda et al., 2008). A highspeed 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 to reconstruct two-dimensional coordinates (from left foot contact to the next left foot contact). Running motion was divided into phases by 5 events: ① Left foot on (L-on, 0%) – ② Left foot off (L-off, 50%) – ③ Right foot on (R-on, 100%) – ④ Right foot off (R-off, 150%) – ⑤ Left foot on (L-on, 200%). Data was calculated for 50 m running time, running velocity during the 30-40 m section, stride frequency, stride length, hip, knee and ankle angle, aular velocity, torque, and torque power. 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  $p < 0.05$ .



**Figure 1. Set up of the runway for running over flat**

**RESULTS:** Figure 2 shows the 50 m time. Figures 3 to 5 represent data from the 30-40 m section for running velocity, stride frequency and stride length. The 50 m time showed no significant difference between NS and FMR time. However, running velocity showed a significant difference in Post compared to Pre and FMR. Stride frequency showed a significant difference between FMR-Pre and FMR-Post, and stride length showed a significant difference between FMR-Pre and FMR-Post.

Hip joint angle, angular velocity, torque and torque power had no significant difference between NS and FMR. Knee and ankle joint angle and angular velocity had no significant difference between NS and FMR. But, knee joint torque showed a significant difference between Pre-Post (Figure 6). Knee joint torque power showed the negative torque power of Pre-Post 54-60% section (Figure 6).

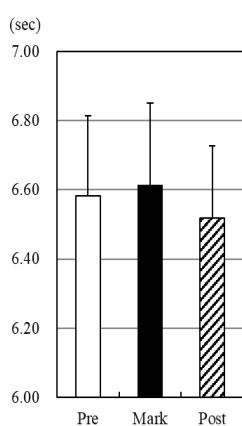


Fig.2 50m Time

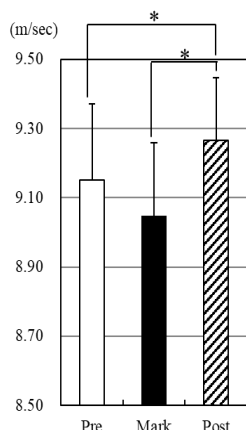


Fig.3 Running velocity

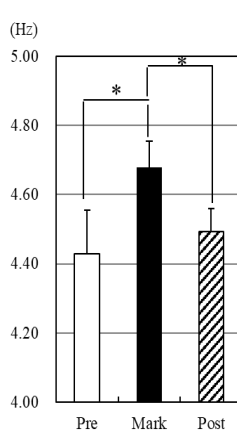


Fig.4 Stride frequency

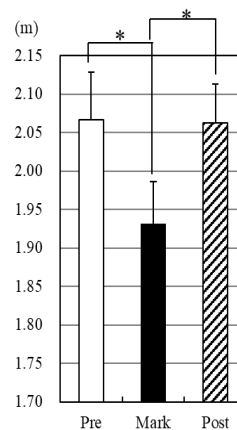


Fig.5 Stride length  
\* :  $p < 0.05$

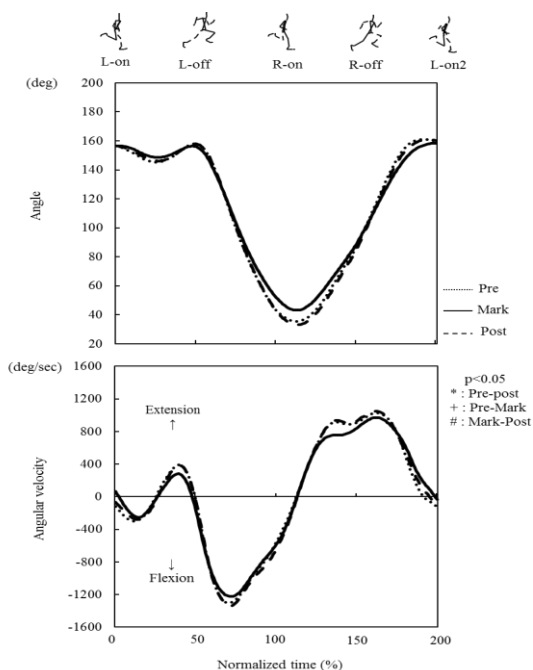


Figure 6. Knee joint angle and angular velocity of each sprinting.

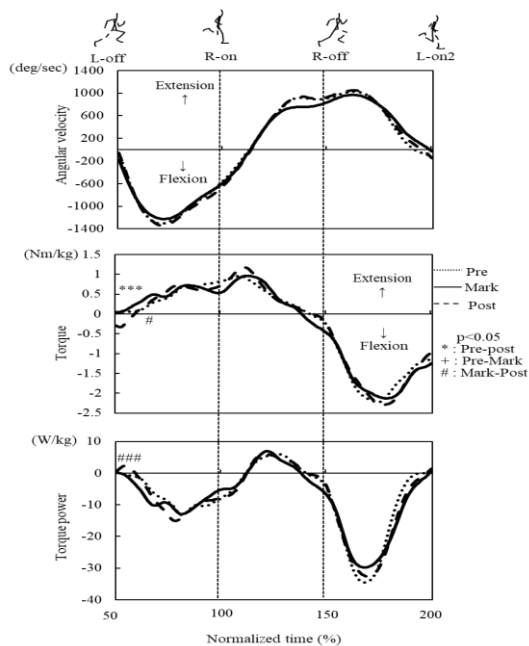


Figure 7. Knee joint angular velocity, joint torque, and torque power of each sprinting.

**DISCUSSION:** In this study stride frequency significantly increased between Mark-Pre and Post-Pre. Suematsu et al. (2009) showed a 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 in a usual race or during running.

Hip, knee and ankle joint angle and angular velocity were not significantly different between NS and FMR. However, in the recovery period, knee joint torque increased between FMR-Pre and FMR-Post. Ito et al (1998) reported that sprinters with a high running velocity tend to have large flexion angle of knee joint, and it is reported the extension torque opposite to bending motion of the knee joint is exhibited (Ito et al., 1997). In this study, similar results for FMR occurred, whereby the knee joint torque increased as the timing became faster, the flexion angle became larger. As a result, the recovery operation is performed in a short time, stride frequency increased. From the above, this study suggested that for subjects with large stride length, it is possible to have an immediate effect of increased stride frequency and running velocity after FMR.

**CONCLUSION:** The purpose of this research was to verify the effect of a mark run set at the inter-mark distance of 1.1 times the height. Seven male collegiate sprinters performed 50 meter sprints three times. There was no significant difference in the time of 50 m, but the running speed and the stride frequency improved. In addition, the timing of exhibiting the knee joint extension torque became faster and the flexion angle became larger, so that the knee recovery action occurred in a shorter time. From the above, it was suggested that FMR conducted in this study has an immediate effect of increasing the running speed for athletes with large stride. FMR may be a good tool for sprinting improvement to obtain a higher stride frequency.

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