FACTORS ASSOCIATED WITH DECELERATION OF RUNNING VELOCITY IN THE LAST PHASE OF THE 400-M SPRINT BASED ON KINETICS CHANGES

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The purpose of this study was to investigate the factors associated with deceleration of running velocity during the 400-m sprint (at the 350-m point) based on kinetics changes. Fourteen male collegiate sprinters performed the 400-m sprint (50.26 ± 2.27 s) at a subjective effort level of 100%. The ground reaction force (1000 Hz) was measured 350 m from the start point, and running movements were recorded from the side by a high-speed camera (300 Hz). The results were as follows: 1) High running velocity was associated with a high stride length. 2) A statistically significant positive correlation was observed between the stride length and the angular impulse of hip flexion in the second half of the support phase. These results suggest that the angular impulse of hip flexion is higher, the leg which has been supported is being swung out forward greatly after ground release.

KEY WORDS: kinetics analysis, running velocity, Joint torque

INTRODUCTION: In the 400-m sprint, running velocity decreases after peaking at 80 m from the start(Ogata1998). In order to shorten the 400m running time, it is necessary to maintain the running velocity. Nummela et al. (1992) reported that in the 400-m sprint, a deceleration in the running velocity begins to occur after passing the 100-m point. The cause of this deceleration is a shift in the energy supply mechanism to glycolysis from the adenosine triphosphate–phosphocreatine system, resulting in decreased rate of energy supply and lactic acid accumulation. Muscle is more likely to be related to decreases in running velocity after the 300-m point than is the central nervous system(Nummela,1992).
In a biomechanical study, Ogata (1998) found that during the last phase of the 400-m sprint, the rise of the knee is low compared to the early phase, the free leg throwing out from back to front is small, and the supporting leg back swing speed is reduced in the support phase. This suggests that the hip flexors have a marked effect on the ability to raise the knee. Kinematic analyses have been performed during the 400-m run, but no kinetics analyses have been carried out.
This study was performed to identify the factors associated with running velocity by measuring the ground reaction force at the 350-m point during the last phase of the 400-m run.

METHODS: The subjects of this study were 14 sprinters who specialized in the 400-m run and were part of the athletics program of a university. Each subject performed the 400-m sprint, and the ground reaction force was measured at the 350-m point using a ground force platform. A high-speed camera (300 Hz, Sony Corp.) was placed on the side of the force platform to evaluate running movements. The photographed images were synchronized with the ground reaction force. It was analyzed by FRAME DIAS IV. Twenty-three point digitizing of the whole body was performed to determine sagittal plane kinematics.
The following parameters were analyzed: running velocity at the 350-m point (s), step length (m/height), step frequency (Hz), contact time (s), flight time (s), support distance (m), flight distance (m), support distance at touch down (m), and support distance at release (m). The ground reaction force was used to calculate the angular impulse of hip flexion by time integration of the hip torque of the support leg (Nm*s/kg) and the exertion time of hip flexion torque of the support leg (%). Hip flexion occurs in support phase/support leg at the typical case(Figure 1). Correlations between each item were determined using Pearson's product-moment correlation analysis. Statistical significance was set at 5%.

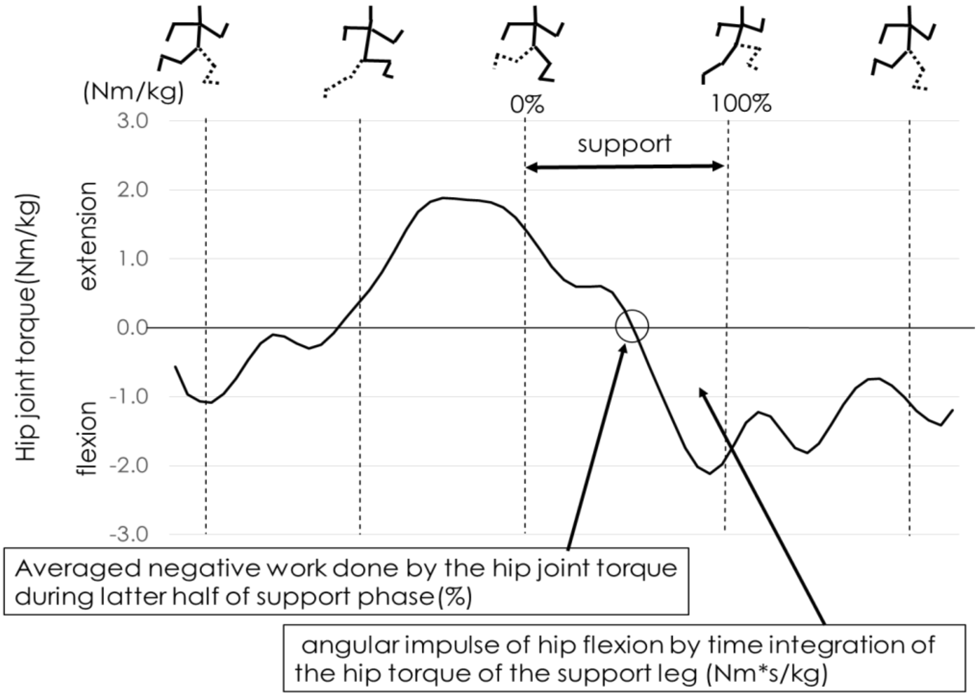

Figure1:A typical example of the hip joint torque in two steps

RESULTS: The mean 400-m running time was 51.33 ± 1.54 s. Table 1 shows the results of the analysis of the association between running velocity at 350 m and each item.

Table1
Comparison of the association between each item and running velocity

Item	Mean±SD	correlation coefficient	Significant
1)400m running time(s)	51.33±1.54	0.756	p=0.015*
2)Stride length(m)	2.01±0.19	0.732	p=0.022*
3)Stride frequency(Hz)	3.55±0.15	-0.234	p=0.826
4)Contact time(s)	0.13±0.009	-0.564	p=0.011*
5)Flight time(s)	0.13±0.02	-0.169	p=0.676
6)Support distance(m)	0.83±0.02	0.340	p=0.386
7)Flight distance(m)	1.05±0.14	0.311	p=0.430
8)Angular impulse hip by time integration of the hip torque(Nm*s/kg)	8.33±2.08	0.524	p=0.154
9)Exert timing of hip flexion torque(%)	57.66±9.40	0.068	p=0.867.

+…p<0.1 *…p<0.05 n.s. (not significant)

A significant positive correlation was observed between the 350-m running velocity and the 400-m running time. A significant positive correlation was also observed between the stride length and the running velocity. And, a significant positive correlation was observed between the support distance and the stride length(r=0.712, p=0.018). Finally, a significant positive correlation was also observed between the stride length and the support distance at touch down(r=0.904, p=0.0001)

Among the 14 people during the calculation of torque, five people landed in force platform unnaturally were excluded. There was no significant correlation between the timing of the exertion of hip flexor torque (timing point of the hip joint torque in support has moved from extension to flexion) and the running velocity. And, a no significant was observed between the angular impulse of hip flexion and the running velocity. However, from there, a significant positive correlation was observed between the angular impulse of hip flexion and the stride length that determined the running velocity(r=-0.671, p=0.046). In addition, a significant trend was observed between the angular impulse of hip flexion and the touch down at the support distance(r=0.638, p=0.064). Figure 2 shows the correlation between the angular impulse of hip flexion and the stride length.

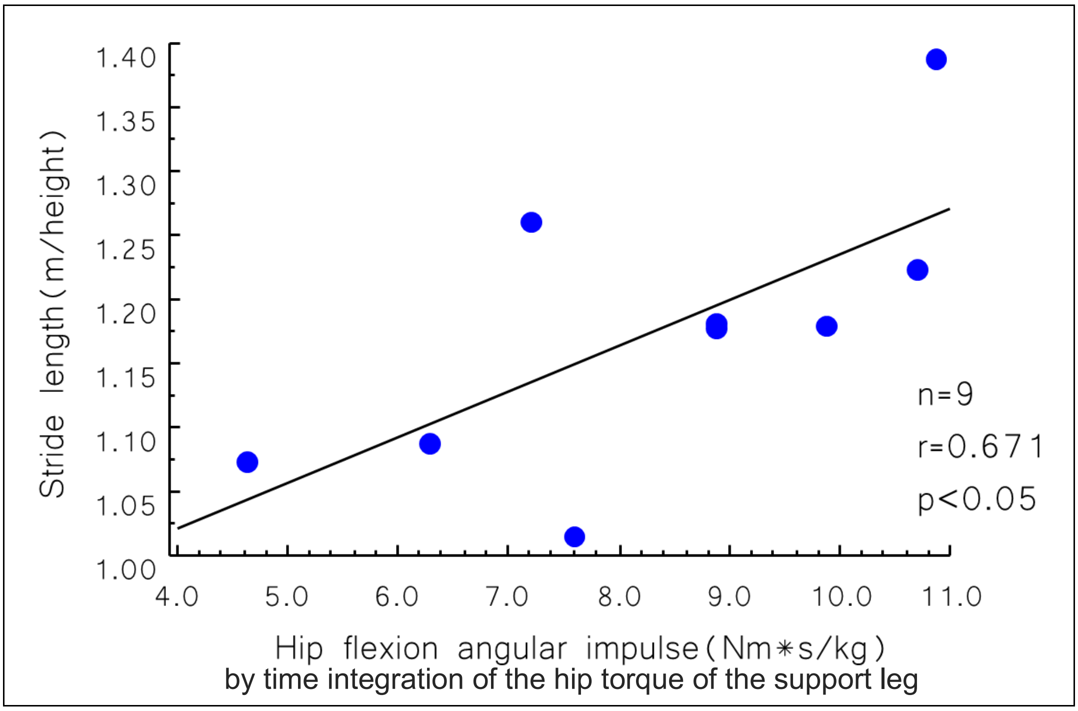

Figure2: Correlation between hip flexion angular impulse and stride length

DISCUSSION: Comparison of the participants best recorded times of the 400-m sprint with the times in the present study revealed an achievement rate of 97.3%, which was close to their best performance. In this study, the total 400 m running time was correlated with the running velocity of the last phase.

Ogata (1998) reported that the running velocity begins to decrease in the 80- to 100-m interval and continues to decline as the goal is approached. Therefore, it is considered that high running ability at the 350-m point is associated with a decrease in the 400-m running time. A significant correlation was observed between the stride length, not the stride frequency, and the running velocity of the last phase of the 400-m run. Endo et al. (2008) attributed the decrease in running velocity of the last phase of the 100-m sprint to a decrease in stride frequency. The timing of to exert hip flexion torque of the last phase of the support phase is delayed, the legs remain backyard.

In the present study, no statistical significance was found in the timing of exertion of the hip flexion torque in the second half of the support phase. However, a significant correlation was found between the stride length and angular impulse of hip flexion, that greater exertion of the hip flexion angular impulse during support phase relates to a large stride length. A significant trend was observed between the touch down at the support distance and the angular impulse of hip flexion. Hip flexion angular impulse of the support phase may not be directly related to the stride. However, it is considered that hip flexion angular impulse is good, the leg which has been supported is being swung out forward greatly after ground release. It is considered that support distance at touch down is extended because the leg which has been supported is swung forward greatly. An increase in hip flexion is necessary to maintain the running velocity in later phases of the 400-m sprint.

CONCLUSION

This study examined factors that affect running velocity by measuring the ground reaction force at the 350-m point during the last phase of the 400-m run. A significant positive correlation was observed between the 400-m running velocity and the 400-m running time. A significant positive correlation was also observed between the angular impulse of hip flexion and the stride length that comprise the 400-m running velocity. An increase in hip flexion is necessary to maintain the running velocity in later phases of the 400-m sprint. For the maintenance of sprint speed, it is possible to train the muscular endurance of the hip joint is important

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