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EFFECT OF SOFT KNEE BRACE ON SHANK MOVEMENT IN RUNNING

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Abstract

Background: Soft knee braces are used for the protection and treatment of knee injuries in light-intensity activities of daily life. Soft knee braces have several functions, such as stabilizing and supporting the lower limb posture. However, previous studies did not investigate the effects of a soft knee brace on the lower limbs during vigorous-intensity activities.
Aims: The objective of this study was to investigate the effect of a soft knee brace on the physical load and stability of the lower limb during running as a vigorous-intensity activity.
Methods: Participants were asked to run with or without a soft knee brace, and lower-limb movements during running were measured using an inertial sensor on the shank.
Results: The result showed that soft knee brace significantly reduced the magnitude and mediolateral standard deviation of shank acceleration.
Conclusion: The results of this study indicate the possibility that wearing a soft knee brace can improve the physical load and stability of the lower limbs during running.

Keywords: knee brace, running, acceleration, shank, stability, physical load.

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Introduction

Generally, soft knee braces are used to protect and treat knee injuries (Cudejko et al. 2017, 2018; Dzidotor et al. 2024; Paluska and McKeag 2000). In addition, it is known that soft knee braces can be used to stabilize knee posture, support ligament tissues, and augment the knee joint (Cudejko et al. 2019; Dzidotor et al. 2024). Furthermore, the usefulness of soft knee braces has been reported in light-intensity activities such as walking and sit-to-stand (Naito et al. 2019; Yamamoto et al. 2022). Naito et al, reported that knee brace improved walking speed and muscle activity in gait of stroke patient (Naito et al. 2019). In our previous study, we found that knee braces improved lower limb muscle activity during sit-to-stand (Yamamoto et al. 2022).

On the other hand, there are only a few studies on the effects of soft knee braces on vigorous-intensity activities (Greene et al. 2000). Greene et al. investigated that the effect of wearing soft knee brace on running speed (Greene et al. 2000). However, previous studies have not investigated the effects of a soft knee brace on lower limb movement during vigorous-intensity activities. Soft knee braces might also contribute to lower limb movement during vigorous intensity activity because the knee brace has several functions, such as stabilizing and supporting lower limb posture (Cudejko et al. 2019; Dzidotor et al. 2024).

Based on this background, the objective of this study was to investigate the effect of a soft knee brace on lower-limb movement during running as a vigorous intensity activity.

Methods

The participants were 10 healthy young males. Table 1 shows characteristics of participants. This study was conducted in accordance with the Ethics Committee for Human Research of the National Institute of Technology, Hachinohe College (approval number R5-2).

The participants performed barefoot running on the treadmill without wearing a brace (control condition) and with a soft knee brace (soft knee brace condition). Barefoot was selected for avoiding influence in running due to difference of footwear. Figure 1 illustrates these two conditions. In the soft knee brace condition, participants wore a soft knee brace (EXAID KNEE LIGHT SPORTS 2, Nippon Sigmax Co., Ltd., Japan) on the right knee (dominant side for all participants).

The participants ran on the treadmill at 5.7 km/h speed for 30 seconds under both conditions (Figure 2). This speed can provide more than moderate intensity physical activity (Ainsworth et al. 2011). Note that running time of this experiment (30 seconds) is not recommended for vigorous-intensity physical activity. This running time was set as 30 seconds to save loads of participants. The order of running in the two conditions was randomized for each participant.

The acceleration of the lower limb during treadmill running was measured using an inertial sensor (SS-MS-SMA16G15, Sports Sensing Ltd, Japan) on the shank. Shank-mounted inertial sensors have been used in many studies on walking and running (de Jong et al. 2020; Thiel et al. 2018; Yang, Mohr, and Li 2011; Zeng et al. 2022). Figure 3 shows the position of the inertial sensor on the shank. This sensor position was chosen to measure acceleration related to shank and knee joint. The sampling rate of the measurements was set to 1 kHz.

The mean of the Euclidean norm from 3-axis acceleration was calculated as the acceleration magnitude. Euclidean norm as magnitude of acceleration was calculated as physical load on the shank because previous study indicated possibility that shank loads due to acceleration will cause lower limb injury such as fractures (Mizrahi, Verbitsky, and Isakov

2000). Lower Euclidean norm values indicate smaller physical loads on the lower limbs.

The standard deviation of the mediolateral (x-axis) acceleration on the shank was calculated as the knee stability during running. Lower standard deviation values indicate greater knee stability. Knee stability is related to balance and risk of injury during movement (Baldazzi et al. 2022; Lizama et al. 2015; Maeyama et al. 2011).

The Euclidian norm and standard deviation of the mediolateral axis for shank acceleration were compared between the control and soft knee brace conditions. Accelerations between the control and soft knee brace conditions were compared using the Wilcoxon signed-rank test. Significance level was set at p<0.05. These statistical tests were performed using EZR (Kanda 2013).

Figure 1. *Two Wearing Conditions*

Figure 2. *Running on the Treadmill*

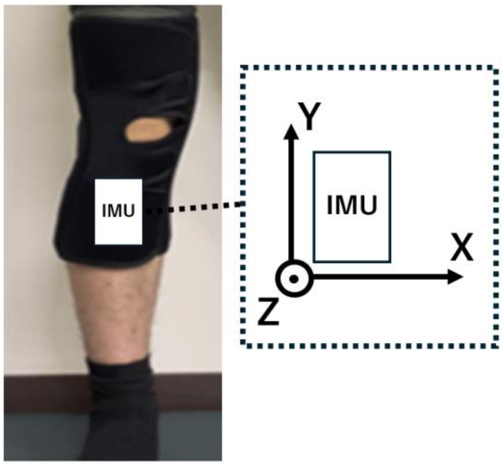

Figure 3. *Inertial Sensor Position on the Shank*

Table 1. Characteristic of Participants

Characteristic	**Value / Status (mean ± S.D.)**
Gender	Male (all participants)
Age [years]	19.6 ± 0.5
Height [cm]	169 ± 7.1
Weight [kg]	66.7 ± 10.7
Dominant Foot	Right (all participants)

Results

Figure 4 shows mean values of Euclidian norm as magnitude of shank acceleration during running. The results showed that Euclidian norm values of soft knee brace condition were significantly lower than control condition (p<0.05).

Figure 5 shows the standard deviation of mediolateral (x-axis) acceleration on the shank. The results showed that mediolateral standard deviation values of soft knee brace condition were significantly lower than control condition (p<0.05).

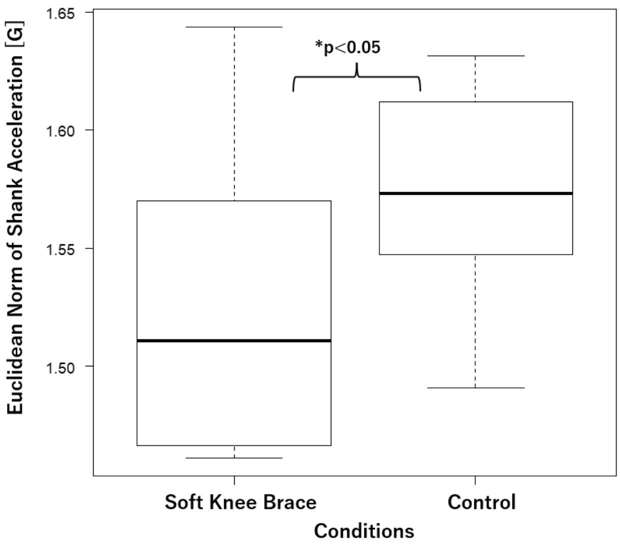

Figure 4*. Euclidian Norm of Shank Acceleration*

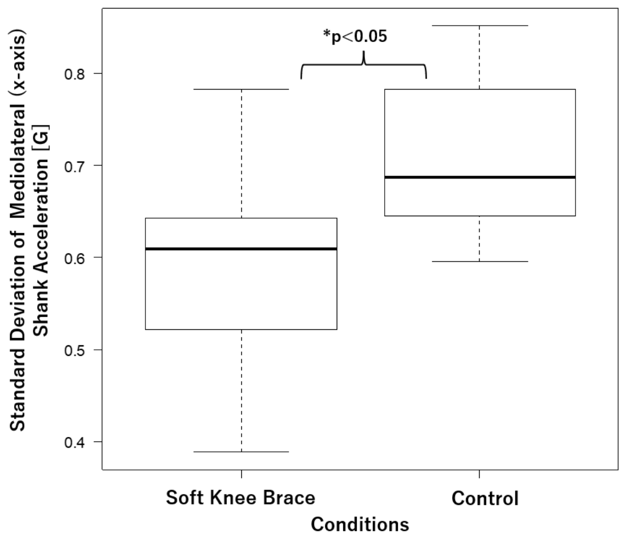

Figure 5*. Standard Deviation of Mediolateral (x-axis) Shank Acceleration*

Discussion

The results of shank acceleration showed that both the Euclidean norm and mediolateral standard deviation in the soft knee brace condition were significantly lower than those in the control condition. These results indicate that wearing a soft knee brace can improve the physical load and stability of the lower limbs during running. In addition, these results suggest that the soft knee brace is useful for stabilizing knee posture during running, which is more than moderate-intensity physical activity, as well as during light-intensity activities.

A limitation of this study was that a soft knee brace was not tested for overground running. Riley et al. suggested possibility that treadmill running can be generalized to overground running (Riley et al. 2008). However, they also reported that there were differences between treadmill and overground conditions in several parameters, such as joint moment (Riley et al. 2008). In future studies, a soft knee brace should be tested for overground running.

Additionally, this study did not investigate the kinematics of the healthy knee during running. Future studies should focus on both affected and healthy knee kinematics during running. Furthermore, the running speed was kept constant in this study. It is known that a faster running speed affects knee joint moment (Petersen et al. 2014). Moreover, the running time of this study was set as only 30 seconds to save loads of participants. Thus, soft knee braces will be tested for various conditions including more vigorous intensity running. Finally, soft knee brace will be investigated in various runners including patients, females, elderly, or athletes too.

Conclusion

This study investigated the effect of a soft knee brace on lower-limb movement during running as a vigorous-intensity activity. The results of this study indicate that wearing a soft knee brace can improve the physical load and stability of the lower limbs during running. In future work, the effects of soft knee braces on running will be investigated under various conditions.

Conflict of interest (COI)

The authors received only soft knee braces from Nippon Sigmax Co. Ltd.

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