The effects of wearing a prophylactic knee brace on ground reaction forces and loading rates during landing of jump maneuvers in athletes without knee injuries

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Introduction

Prophylactic knee braces are often prescribed for athletes who injured the anterior cruciate ligament during rehabilitation to limit excessive knee range of motion and are worn even after the athletes return to sport. A previous study has shown the performance of athletes wearing a brace improved over time after return to sport [1]. However, the direct biomechanical effects of wearing a brace cannot be extracted in this type of study using patients, because factors such as neuromuscular adaptation over time, fear of re-injury, differences in the rehabilitation protocols, and the extent of injury would all influence the performance measures. A different study on effects of a knee brace worn by non-injured athletes has shown that the athletic performances decreased when wearing a brace, compared to the non-braced condition [2]. The same research group also examined the peak vertical ground reaction force (pvGRF) and time to pvGRF during drop landing in non-injured athletes, and found that the pvGRF in the braced condition was significantly lower than the non-braced condition [3]. However, the study only focused on landing in the vertical direction and did not include other types of landing that can occur in many athletic activities. Therefore, the purpose of this study was to examine the peak GRF (pGRF) and loading rate (pGRF divided by the time to pGRF) in the vertical, anterior-posterior and medial-lateral directions during three different landings performed by non-injured athletes with and without wearing a knee brace. We hypothesized that wearing a brace would decrease pGRF and loading rate.

Methods

The experimental protocols were approved by LeTourneau University's institutional review board, and 20 female collegiate athletes who had no previous knee injuries and have not worn a knee brace signed an informed consent form before participating in the study. The subjects performed three jumping maneuvers: hop jump, lateral jump, and forward jump in a random order with and without wearing a knee brace (DonJoy Renegade) on their dominant leg. Hop jump started with a short hop onto the force plates (FP4060, Bertec, Columbus, OH) followed by the subject's maximum vertical jump, landing with two feet on the plates. In the lateral jump, the subject stood on their non-dominant leg, hopped laterally over a box (17 cm high), and landed on their dominant leg. In the forward jump, subjects performed a horizontal jump with a distance proportional to the subjects' leg-length and landed with two feet on the plates. Three trials were performed for each jump. Ground reaction forces (GRFs) were collected at a sampling rate of 960 Hz. Using custom MATLAB scripts (R2023b, MathWorks, Natick, MA), the raw GRF data were lowpass filtered at 30 Hz [4], and peak magnitude and loading rate (peak magnitude divided by the time to peak) during landing were averaged for three trials in the vertical, anterior-posterior, and medial-lateral GRF components (pvGRF, pApGRF, pMlGRF), respectively. Paired t-tests were performed with Minitab (21.1.0, Minitab LLC, State College, Pennsylvania) to compare the average peak values and the loading rates between the braced and non-braced conditions on the dominant leg.

Results

Generally, peak GRF and loading rate were higher in the braced condition, except pApGRF Rate in forward landing (Figure 1). Note that pApGRF and pApGRF Rate were not presented for lateral- and hop-jump landing (Figures 1b, 1e), because the peak forces were inconsistent even within subject, being either in the anterior or posterior direction. Statistically higher values in the braced condition were found in pMlGRF, pApGRF, pvGRF, and pvGRF Rate in forward landing, and pMlGRF, pvGRF, pMlGRF rate, and pvGRF Rate in lateral landing.

Discussion

The objective of this study was to examine the "direct" effects of wearing a prophylactic knee brace on three types of landing. In athletic activities, the body is accelerated and decelerated in different directions. Therefore, knowing the influence of wearing a knee brace on GRFs is important for athletes' performance and injury prevention. We hypothesized that peak GRF and loading rate would be lower in the braced condition compared to the non-braced condition. However, the results showed the opposite trend. A previous study of vertical GRF in drop landing performed by non-injured athletes has shown that the pvGRF was significantly lower in the braced condition [3]. However, our results demonstrated that pvGRF in hop landing was slightly higher in the braced condition (Figure 1c, Hop). Potential reasons for the discrepancy may include the height of vertical landing (70 cm drop landing vs. landing after maximum vertical jump) and acclimatization to the brace (multiple sessions over three days vs. only one session to minimize acclimatization and examine direct effects of wearing a brace). The higher peak GRF and loading rate in the braced condition indicate higher loading on the knee joint. Therefore, using a prophylactic knee brace for injury prevention may need careful consideration, especially for non-injured athletes (e.g., football linemen).

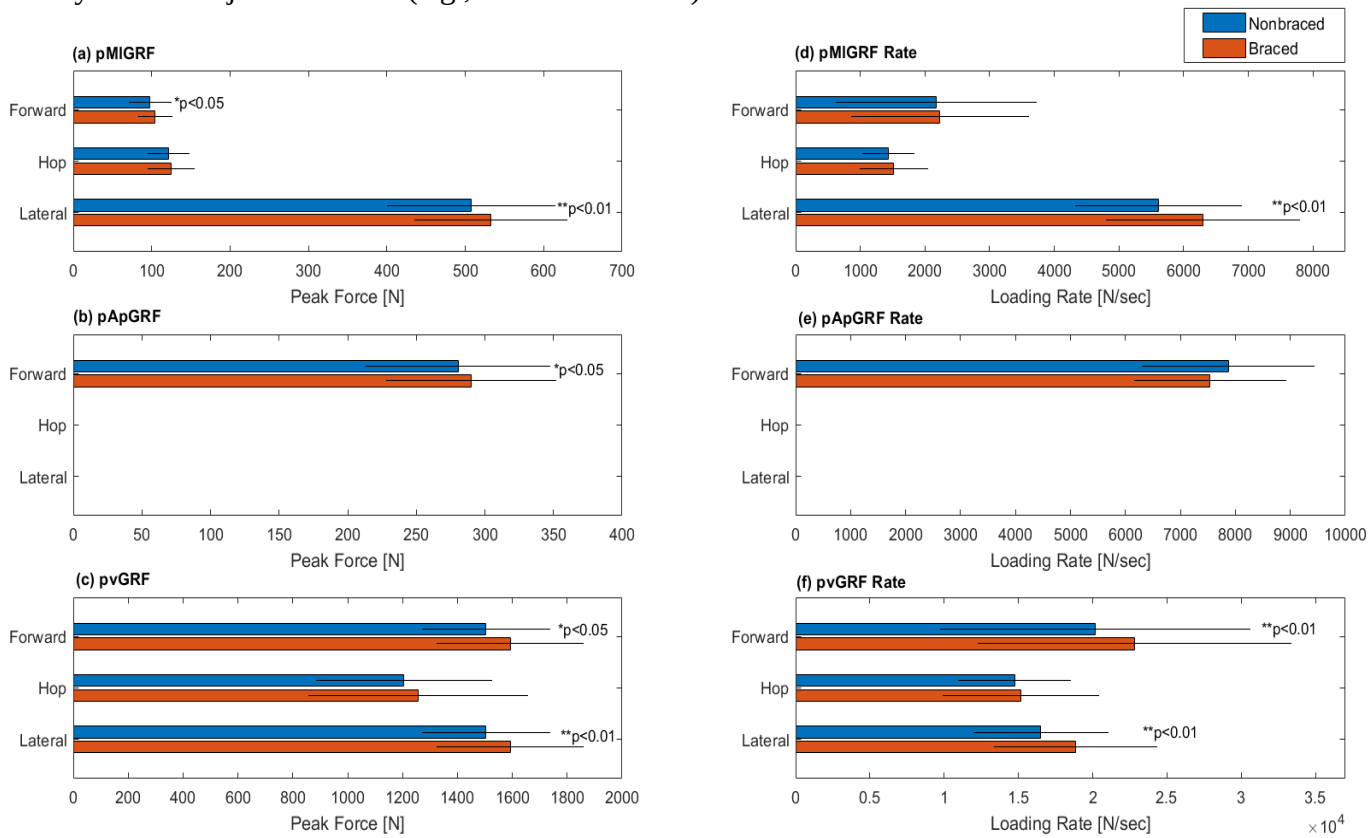

Figure 1: Average and standard deviation of peak GRFs (pMIGRF, pApGRF, pvGRF) and loading rate (pMIGRF rate, pApGRF rate, pvGRF rate) during landing in forward, hop, and lateral jumps with the braced and non-braced conditions.

Conclusion

Our study showed that in non-injured athletes, wearing a prophylactic knee brace led to higher peak GRF and loading rate in forward and lateral landing, which could cause excessive loading on the knee joint. Further research is warranted to assess the influences of wearing a knee brace on the risk of knee injury.

References

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