Comparing barefoot and shod running: 2D analysis, pressure treadmill analysis, and relation to risk of injury

Belen S, Connor S, King M, Schulte N

Background

In recent years there has been a current trend among runners to transition to run barefoot. Individuals hypothesize that because humans have evolved to run barefoot it can help to avoid injury due to the minimization of impact peaks.[1] It is also believed barefoot running can enhance running efficiency and lead to an increase in proprioception and foot strength. However, running shoes were invented to prevent lower chain injuries, run in/on different environments/conditions and accommodate corrective orthotics.[2] There is limited evidence to suggest that there is a significant difference in frontal and sagittal plane biomechanics in barefoot versus shod running, meaning running mechanics do not change based on shoe predference.[3] Decreased vertical GRF have been attributed to a forefoot strike pattern aka mid foot while a rearfoot strike pattern or shod running, as commonly seen in barefoot running, shows a definitive peak in vertical GRF.[3] Some literature describes a potential increased risk for Achilles tendon pathology with barefoot running due to the increase in ankle plantarflexion moment.[3] However, there is currently a lack of scientific evidence that barefoot running prevents injury or enhances running performance. This research works to determine the difference in pressure prints, vertical GRF, and biomechanics using sagittal plane 2D analysis at the knee and ankle between barefoot and shod running during self-selected running speeds and a potential relation to risk of injury.

Methods

For this study, 2 participants (Subject 1: age=23yr, weight=180lbs, gender= male; Subject 2: age=23yr weight=123lbs, gender=female) were analyzed running at self-selected running speeds for 1 trial of 30 seconds barefoot and 1 trial of 30 seconds with shoes on. A Noraxon myoPRESSURE (Noraxon U.S.A., Inc.) treadmill was used to capture pressure prints, average vertical force curves and force parameters measured by the ground reaction force, and left vs right vertical force curves. Hudl Technique Application: 2-Dimensional Video Analysis (Agile Sports Technologies, Inc.) was used to capture sagittal plane hip, knee, and ankle peak joint angles. Screen shots of the 2D video analysis were used to measure peak hip, knee, and ankle joint angles during barefoot and shod running. The results from each subject were averaged and results from shod versus barefoot were compared.

Results

Based on our study we found that pressure is more diffuse, as shown by Noraxon MyoPRESSURE pressure prints (see table 1), during shod running as compared to barefoot running. This means that with barefoot running there is more average pressure on the heel and ball of the forefoot bilaterally (roughly 40 N/cm^2), but with shod running the pressure is more spread throughout the entire foot bilaterally never getting above 26 N/cm^2 in any one spot. Sagittal plane joint analysis demonstrated a decrease in peak knee flexion, suggesting an increase in patellofemoral joint forces (see table 2). Shod running demonstrated an increase in hip, decrease in knee, and decrease in ankle range of motion. Furthermore, impact transient and peak forces were observed to be increased in shod running as compared to barefoot running. Based on 2D Analysis and Left/Right Force curves (see table 3), there is increased force through midfoot and decreased force through forefoot and hindfoot with shod versus barefoot running.

Discussion and Conclusions

As seen in the sagittal plane 2D analysis of shod running, there is a decrease in peak knee flexion, suggesting an increase in patellofemoral joint forces, and as a result patient who are shod runners may be more at risk of Patellofemoral Pain Syndrome. Increased forefoot & medial midfoot pressure is consistent with Bone Stress Injuries (BSIs) in runners.[6] Therefore, shod running may be better at preventing these injuries since pressure is more diffuse and evenly distributed throughout the foot. Running forms, preferences and styles vary greatly from person to person, so it is important to not make general conclusions for all runners based on these statistics. The clinical implications of this data, are that if a runner comes into a clinic wanting to change their running form this may not be the best course of action unless they are having repeated pain and injuries, and if a patient comes into a clinic with patella femoral pain syndrome or BSIs it may be important to evaluate their style of shoes (if they wear shoes) and their striking pattern in order to best help and prevent future or further injuries.

Bibliography/Works Cited

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Table 1:

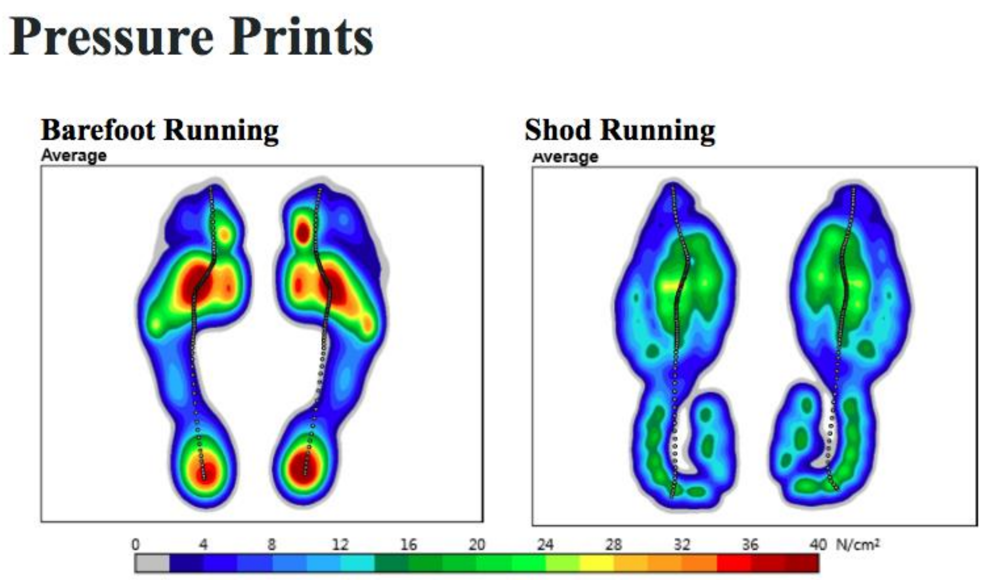

Table 2:

Barefoot Running-Average Peak Joint Measurements			
Joints	Flex.	Ext.	Range
Hip	25.90°	-21.14°	4.76°
Knee	97.59°	-11.69°	85.90°
Ankle	8.37°	41.89°	50.26°

Shod Running-Average Peak Joint Measurements			
Joints	Flex.	Ext.	Range
Hip	30.52°	-7.71°	22.81°
Knee	86.59°	-16.61°	69.98°
Ankle	12.27°	27.34°	39.61°

Table 3:

Left and Right Force Curve