Effects of footstrike on low back posture, shock attenuation, and comfort in running

Traci L. Delgado, SPT[1] • Emilia Kubera-Shelton, SPT[1] • Robert R. Robb, SPT[1] • Robbin Hickman, PT [1] • Harvey W. Wallmann, PT, DSc, SCS, ATC, CSCS[2] • Janet S. Dufek, PhD[3]

[1]Department of Physical Therapy, University of Nevada, Las Vegas; [2]Doctor of Physical Therapy Program, Western Kentucky University; [3] Department of Kinesiology and Nutrition Sciences, University of Nevada, Las Vegas

Purpose

To determine if a change from rearfoot strike (RFS) to forefoot strike (FFS) would change lumbar lordosis, influence shock attenuation, or change comfort levels in healthy recreational/experienced runners.

Background/Significance

- Barefoot running (BF) is gaining popularity in the running community.
- Biomechanical changes occur with BF, primarily a change in initial contact from RFS to FFS.[1]
- Changes in lumbar spine range of motion (ROM), particularly involving lumbar lordosis, have been associated with increased low back pain (LBP).[2]
- However, it is not known if changing from RFS to FFS affects lumbar lordosis or LBP.

Subjects

- 43 healthy subjects (Table 1)
- Mean age of 25 years old (SD=2.8)
- Convenience sample in which subjects were enrolled non-consecutively.

Participant Descriptive Data						
	(n = 43)	Minimum	Maximum	Mean	Mode	Standard Deviation
Height (cm)		154.9	193.0	173.0	172.7	9.70
Mass (kg)		46.72	120.2	74.0	56.70	18.65
Age (years)		19	31	24.2	25	2.48
	Category			N		%
Gender	Male			24		55.8%
	Female			19		44.2%
Race/Ethnicity	White			34		79.1%
	Hispanic, Latin, or Spanish Origin			3		7.0%
	Asian/Pacific Islander			4		9.3%
	Other			2		4.7%

Table 1

Methods and Materials

- Lumbar lordosis was measured in the sagittal plane using an Electrogoniometer (1000 Hz)
- Leg and head accelerations at impact were measured using uniaxial accelerometers (1000 Hz)
- The reliability and validity for these accelerometers has been reported to be within the frequency and amplitude range of human body motion[3]
- A Comfort Questionnaire (Figure 1) was selected and adapted from The Physical Activity Enjoyment Scale

At the moment, please rate how you feel about the current footstrike pattern you are using while running. Below is a list of feelings with respect to the current footstrike pattern while running. For each feeling, please mark the number that best describes you

	1	2	3	4	5	6	7	
1. I enjoy it.								I hate it.
2. I feel unstable.								I feel stable.
3. I feel awkward.								I feel agile.
4. I am very frustrated by it.								I am not at all frustrated by it.
5. I feel balanced.								I feel unbalanced.
6. I dislike it.								I like it.
7. I feel discomfort.								I feel comfortable.

Figure 1

- Comprised of seven questions assessing the subject's perception of stability, balance, level of frustration, comfort, likeability, and agility when running using each of the two different foot strike patterns
- Based on a 7 point scale with 1 and 7 being opposite extremes and 4 being neutral
- Warm up on the treadmill where a self-selected foot strike pattern was determined
- Instructions on running RFS/FFS were taught and the two conditions were visually validated
- Each condition consisted of 90 seconds of BF with RFS or FFS; Order randomly assigned
- Comfort Questionnaire was completed after both conditions
- Fifteen consecutive strides from each condition were extracted for analyses

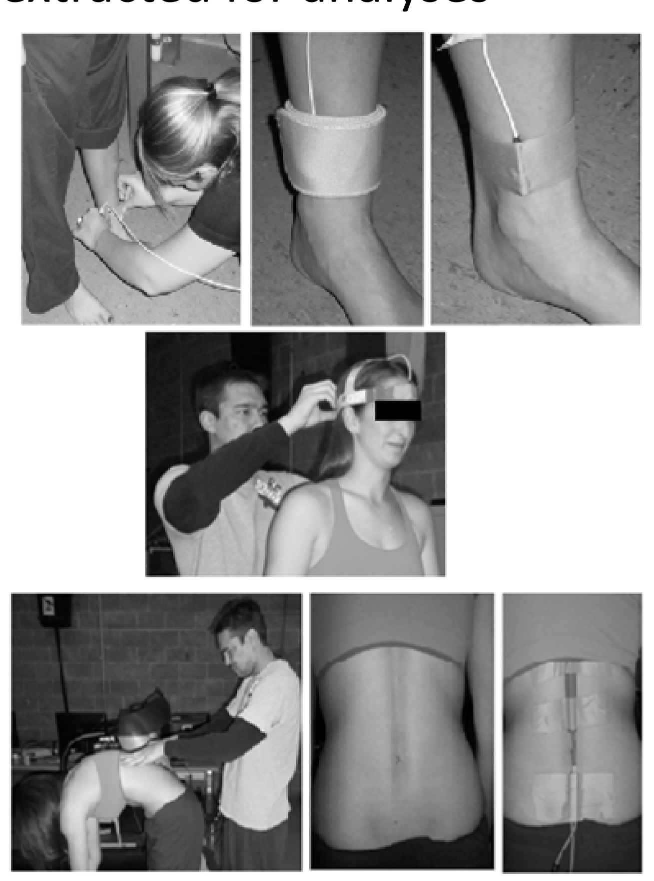

Figure 2

Figure 2: Placement of an accelerometer on the anterior medial aspect of the distal 1/3rd left tibia (top), securing the open helmet housing an accelerometer on the anterior portion of the head (middle) and placement of an electrogoniometer spanning the spinous process of the 2nd lumbar vertebrae (bottom)

Analyses

- All statistical analyses were performed using SPSS, Version 19 (IBM, Chicago, IL). The level of statistical significance was set to $\alpha<0.05$
- Paired samples t-tests were used to analyze the differences between the biomechanical variables (lumbar spine ROM, amount of flexion and extension, shock attenuation, and peak leg acceleration) in FFS and RFS running pattern
- A nonparametric Wilcoxon signed rank test was used to compare differences in comfort questionnaire responses between the two footstrike conditions

Results

- **Lumbar Spine Motion**
  - There were statistically significant differences between FFS and RFS lumbar ROM, t (42) =-2.069, p=0.045 (RFS=22.1degrees, FFS=20.9 degrees). There was no statistically significant difference between the FFS and RFS lumbar extension, t (42) = 1.367, p=0.179, or flexion, t (42) = -0.327, p=0.745.
- **Shock attenuation**
  - There was a statistically significant difference between FFS and RFS for shock attenuation, t (42) = -9.026, p<0.001 (FFS=56.5% SD=17.14, RFS=73.4% SD=10.88). There was a statistically significant difference in the peak leg acceleration between FFS and RFS, t (42) =-8.301, p<0.001, with a lesser leg acceleration peak in FFS (FFS=3.8g SD=1.78, RFS=6.1g SD=2.16).
- **Comfort**
  - Wilcoxon signed rank test results revealed that there was a statistically significant difference between the two running conditions for comfort/discomfort (question 7), Z=2.710, p=.007, in favor of RFS (RFS=4.3, FFS= 3.0). There was no statistically significant difference between questions 1-6 or the average score of all questions.

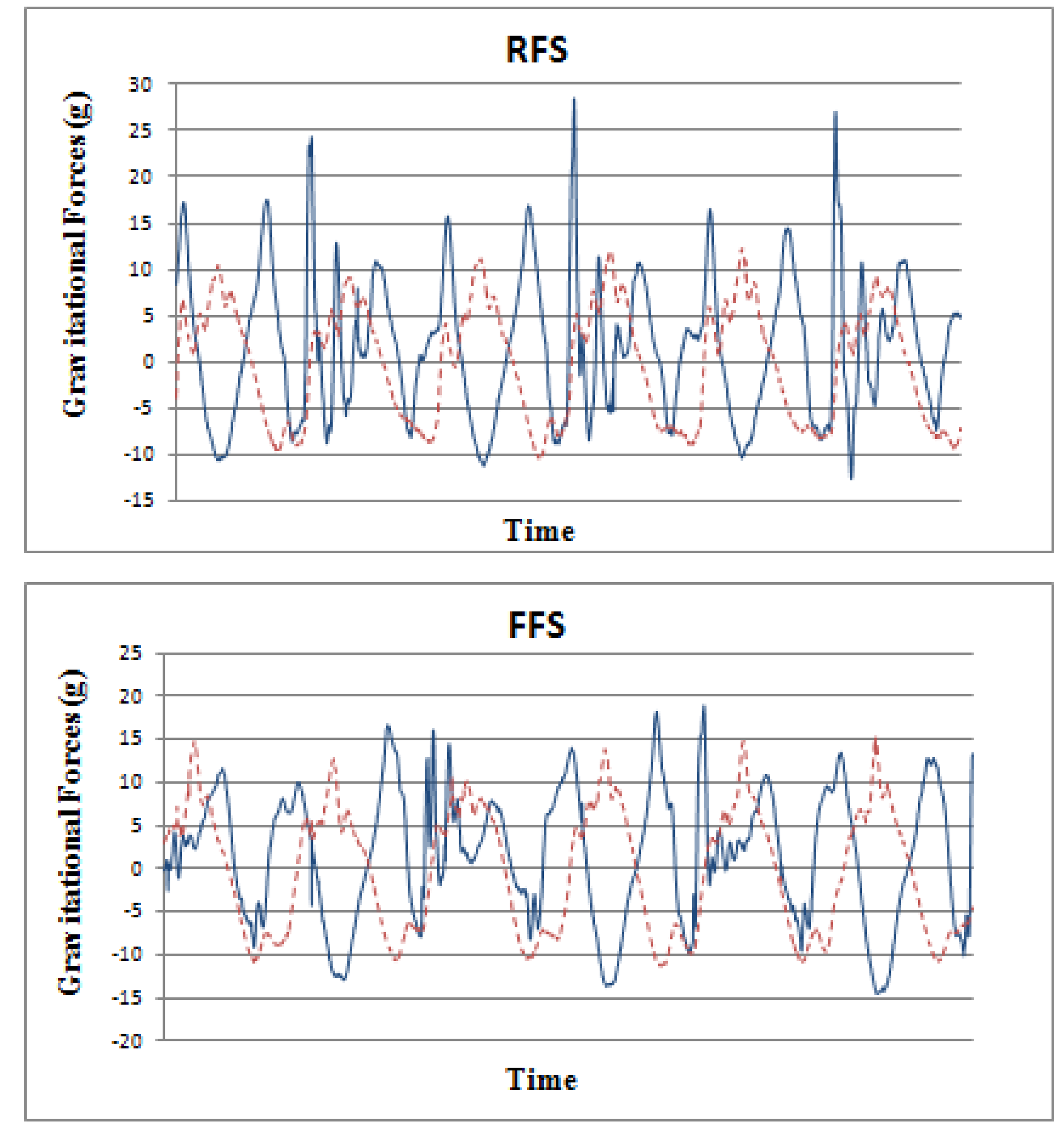

Figure 3: Exemplar accelerometer time history for the leg accelerometer (solid line) and head accelerometer (dashed line)

Conclusions

- Change in foot strike from RFS to FFS decreased overall ROM in the lumbar spine but did not make a difference in flexion or extension in which the lumbar spine is positioned.
- Shock attenuation was greater in RFS.
- RFS was perceived a more comfortable running pattern.
- Future research investigating the effects of FFS and RFS on individuals with LBP may provide additional insight into whether a change in footstrike pattern would affect low back motion and pain in runners.

Take home points:

- FFS running could help prevent or delay degenerative changes in intervertebral discs over RFS.
- In terms of directional preferences for the lumbar spine, changing the footstrike pattern from RFS to FFS is unlikely to be beneficial according to the current findings.

References:

1. Crowell HP, Davis IS. Gait retraining to reduce lower extremity loading in runners.
2. Levine D, Colston MA, Whittle MW, et al. Sagittal lumbar spine position during standing, walking, and running at various gradients.
3. Bouten CV, Koekkoek KT, Verduin M,et al. A triaxial accelerometer and portable data processing unit for the assessment of daily physical activity.