

Research Paper Review

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Foot Bone Marrow Edema after 10-Week Transition to Minimalist Running Shoes Medicine & Science in Sports & Exercise 2013; 45(7):1363-8

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ABSTRACT

Purpose

Minimalist running shoes are becoming a more popular choice for runners in the past few years. However, there is little conclusive evidence about the advantages or disadvantages of running in these shoes. Although performance benefits may exist, injury may also occur from the added stress of running without the benefit of cushioning under the foot. Bone marrow edema can be a manifestation of added stress on the foot. This study measured bone marrow edema in runners' feet before and after a 10-wk period of transitioning from traditional to minimalist running shoes.

Methods

Thirty-six experienced recreational runners underwent magnetic resonance imaging (MRI) before and after a 10-wk period. Seventeen subjects were in the control group (ran in their traditional shoes only for 10 wk), whereas the other 19 were in the experimental group (gradually transitioned to Vibram FiveFinger running shoes for 10 wk). The severity of the bone marrow edema was scored on a range of 0-4 (0 = no bone marrow edema, 4 = edema in more than 50% of the length of the bone). A score of 4 represented a stress fracture.

Results

Pretraining MRI scores were not statistically different between the groups. The posttraining MRI scores showed that more subjects in the Vibram group (10 of 19) showed increases in bone marrow edema in at least one bone after 10 wk of running than that in the control group (P = 0.009).

Conclusion

Runners interested in transitioning to minimalist running shoes, such as Vibram FiveFingers, should transition very slowly and gradually to avoid potential stress injury in the foot.

ANALYSIS

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Background Information

Although often thought of as a recent concept, the history of distance running has predominantly involved minimalist running shoes (or no running shoes at all, minimalist sandals, etc.). It wasn't until recently (1970s) that we have developed the cushioned sole for the running shoe. As more people take up running, injury rates have naturally increased. In turn, many clinicians and experts have theorized that the modern day running shoe is responsible for decreased performance and increased rates of injury. This is the reason for the recent revival in the running community for minimalist shoes, and sporting goods manufacturers have been more than willing to accommodate with a plethora of 'minimalist' shoes lining the walls of retail stores.

Even though minimalist running is becoming a more popular choice for runners (achieving 'cult'-like status in some areas), there is little evidence on either side of the coin regarding efficacy, advantages or disadvantages, for this type of running. Although there may be some performance benefits, injury may also occur due to increasing impact force without cushioning (many of us have seen such patients in our offices). Bone marrow edema is one such manifestation, forming the focus of this particular study, in which the authors measured bone marrow edema (BME) in the feet of experienced runners before, and after 10 weeks of running in minimalist footwear.

PERTINENT RESULTS

Thirty-six subjects completed this study (21 males, 15 females, average age 26.5). 7 subjects withdrew for various reasons: 2 lost to follow-up, 3 did not complete the training, and 2 were injured in incidents not related to the study. In all, 17 were randomized to the non-VFF group, while 19 transitioned to the VFF footwear.

When comparing the VFF to non-VFF group at 10 weeks, there were no differences in soft tissue responses. The Vibram runners were similar to those individuals who did not make the minimalist transition (Achilles tendon, dorsi-flexor, plantar-flexor, peroneal tendons, and plantar fascia).

Bone, on the other hand, was a different story. The researchers were looking for signs of bone marrow edema (fluid accumulation) on the MRI images, and scored various bones of the foot using a standard rating protocol (0-4, with 4 being a full-blown stress fracture).

Pre-training MRI values were similar between the study groups. Post-training/transition, there was a higher incidence of intense signal sub-fracture bone marrow edema in the Vibram group (9 had edema grades of 0 and 1 [non-injured] and 10 had edema grades of 2, 3 or 4 [injured], compared to 0 out of

17 subjects in the control group). Two subjects suffered from stress fractures and 11 of the subjects in the Vibram group were classified as "injured" by the end of the study.

CLINICAL APPLICATION & CONCLUSIONS

The report of no differences in musculoskeletal injuries between the two groups is great, but cautionary, news for those who might be worried about the common injuries one might develop during a transition to minimal footwear. We have all heard anecdotal reports of injuries from minimalist running. However, it's important to understand that the possibility exists for longer-term usage to induce soft tissue problems.

The concern from this study stemmed from the bone stress results. The post-training MRI scores showed that more subjects in the Vibram group (10 of 19) showed increases in bone marrow edema in at least one bone after the 10 weeks of running when compared to the control group.

Let's play devil's advocate for a moment: I go lift some weights (ok, that is a stretch, but just hang in there with me). I haven't done this in a while. I do some bicep curls (for the beach, of course), some bench press (for the pecs) and some squats (for my stick-skinny legs). The next day I'm really sore but I'm buffed! I developed some muscle micro-damage. Should this be classified as an injury or a repair process? The damage is actually making me stronger. If I was smart, I'd let my muscles rest, recover and progress slowly with the training. The key to strength training is about stress – repair – stress – repair and so on.

Bone is like muscle - it adapts to repeated stress in order to better withstand future application of similar stress (remember Wolff's Law, osteoclasts and osteoblasts that chew up damaged bone and replace it with new bone – brings back nightmares of histology and exercise physiology I bet!). We all know that stress on bone is a good thing. However, a difference between bone and muscle is that bone adaptation in response to stress can take longer. If you add a new stress too quickly, microdamage can add up faster than the body can repair it and this can cause a stress fracture.

Let's bring the discussion back to the study results. Edema results might simply relate to the intensity of the remodeling process. A little bit of edema is ok – it means the bone is repairing itself and (hopefully) getting stronger. A lot of edema is bad, it might indicate that the bone has really been damaged and is working really hard to repair itself. Where the distinction lies between a little edema and a lot of edema seems rather uncertain.

There have been several studies to demonstrate that edema is a normal response to increased activity (e.g. starting running, increasing mileage etc.) (1-3). It is actually making our bones stronger. The edema may or may not be clinically significant. However, it's not clear that grade 2 bone marrow edema really is an "injury". A runner with a score of 3 ('stress injury') might also be asymptomatic and not go on to develop a stress fracture. It is important to see the forest for the trees, understand the big picture and not jump to conclusions on superficial information. This study reminds us that any change should involve cautionary progression. A quick and hard transition can potentially lead to trouble, no matter the type of footwear.

It is worth noting that in this review, we did not touch upon problematic feet (i.e. pes planus etc.) or

the relevance of unsupported footwear in the average non-athletic population or the problems that may develop up the kinetic chain – that's a whole different story, best left for a subsequent review once appropriate research is conducted.

For those interested, here is the Vibram FiveFingers protocol for transitioning to minimalist running:

- 1. Run no more than 10% of your typical running distance for the first 2-3 weeks
- 2. After 2-3 weeks, gradually increase mileage by 10%-20% every couple of weeks
- 3. If you ever start to feel pain during a run, stop! You can always try again in a couple of days
- 4. Never run 2 days in a row for the first month
- 5. Stretch before and after each run, focusing on calves and feet
- 6. If, after several weeks of training, you are consistently very sore, you need to rest and back-off on your mileage

STUDY METHODS

This study was conducted by a group of researchers who set out to investigate how transitioning into Vibram Fivefingers (VFF) from traditional running shoes might affect the anatomy of the legs and feet. Thirty-six experienced (15-30 miles/week for minimum of 6 months prior to the study), recreational runners were split into two groups – 17 continued running in their typical shoes for the next 10 weeks, while 19 made a gradual transition to running in Vibram Fivefingers over the same 10 week period. This transition advice was recommended by the Vibram website in 2011 (incidentally, this has advice has changed – their current stance is noted in the clinical application section). Subjects were excluded if they had run previously in VFF shoes or if they had suffered a lower extremity injury that had kept them from running for at least 3 days/week at any time in the previous 6 months.

Assessment of Bone Marrow Edema (MES):

The researchers took MRIs of the legs and feet of all runners both before and after the ten week period, with the goal of assessing whether there might be any signs of increased injury to the tendons or bones of the VFF group relative to the non-VFF group. The severity of the bone marrow edema was scored on a range of 0-4 (Marrow Edema Score (MES): 0 = no bone marrow edema, 1 = edema in 1-25% of the bone, 2 = edema in 25-50%, 3 = edema in more than 50% of the length of the bone, 4 = stress fracture).

STUDY STRENGTHS / WEAKNESSES

This is novel research in a new and increasingly popular area of running, providing some much needed evidence and insight for those considering a transition to minimalist running. The great value of this study is that it demonstrates that any shoe change should involve caution and reasonable progression. The more different the shoe is from what you are used to (i.e. the bigger the change), the more care you likely need to take in transition.

The biggest weakness of this study has to do with the interpretation of the study results, which was mentioned in the clinical application and conclusion section.

Additional References

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