Improved step length symmetry and decreased low back pain with the use of a rocking-soled shoe in a patient with unilateral hallux rigidus

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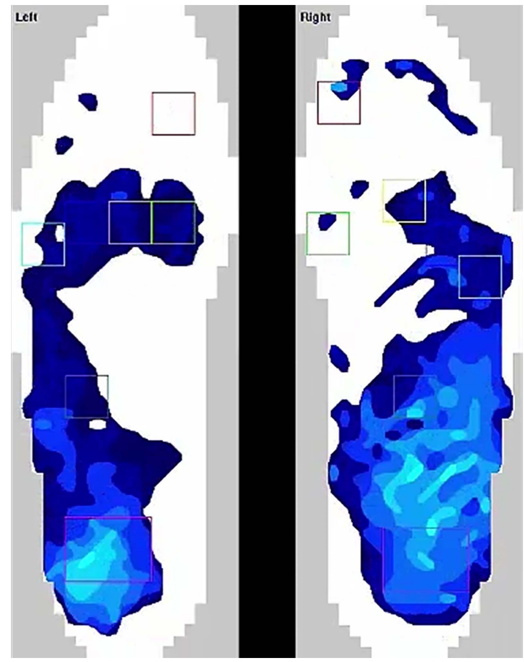
DESCRIPTION

A 53-year-old African-American man presented to a local podiatry outpatient clinic with a chief symptom of unilateral pain in the first metatarsophalangeal joint (MTPJ) of his left foot as well as a secondary concern of chronic low back (lumbosacral) pain. He stated that the onset of the foot pain several years ago was insidious, but has been gradually increasing in intensity. He stated that the foot pain was proportionate to the amount and speed of ambulation, and was decreased with non-weight-bearing. He also related that he noticed that the foot pain was also somewhat lessened if he 'slowed down', and took shorter steps. He stated that he had tried several types of corrective foot orthotic devices, both over the counter and custom made, none of which provided any significant relief. With regard to his back pain, the patient reported that he was told by his chiropractic physician that he had 'arthritis' at the L4–L5 disc level. The patient stated that his back pain also was not the result of any precipitating trauma, but rather seemed to have increased over the years. He denied any sciatic radiation of pain. While surgery was offered as an option for his foot pain, the patient declined and was seeking any possible non-surgical options.



Video 1 Baseline in-shoe pressure and timing analysis (F-Scan) revealed a planus foot, with a complete arthrodesis of the left first MTPJ. In-Shoe pressure and timing analysis with the patient wearing rocking-soled shoes reveals markedly increased active propulsion on the left.

Figure 1 Dorsoplantar radiograph of the left foot: arrow reveals degenerative changes at the first metatarsophalangeal joint.

Video 2 Video gait analysis with the patient barefoot reveals a decreased step length on toe-off of the left foot when compared with toe-off of the right. There is decreased time in the propulsive phase of gait, a decreased stride length, and a decreased dorsiflexory range of motion at the left MTPJ.

Video 3 Video Gait analysis of the patient in a flat soled shoe reveals a decreased step length in both the left and right lower extremities.

Video 4 Video gait analysis of the patient wearing rocking-soled shoes. Note the improved step length and improved symmetry of the patient's gait. There is increased velocity, and improved forefoot loading in propulsion.

Physical examination, which included a static examination, radiographs (figure 1), video gait analysis (barefoot, in a flat-soled and rocking-soled shoe), in-shoe pressure and timing analysis (video 1), revealed a planus foot, with a complete arthrodesis of the left first MTPJ. There was a decreased step length on toe-off of the left foot when compared with toe-off of the right (video 2). A set of flat-soled shoes was then given to the patient to wear as a control. The stiff sole shortened the step length of the left and right foot (video 3). The patient was then given a pair of rocking-soled shoes (figure 2) and asked to walk. Subsequently an immediate increase in step length of the left foot was observed (video 4). An improved symmetry was noted between the step length of the left and right foot. The active propulsion of the left foot markedly increased when the patient was wearing rocking-soled shoes (table 1).

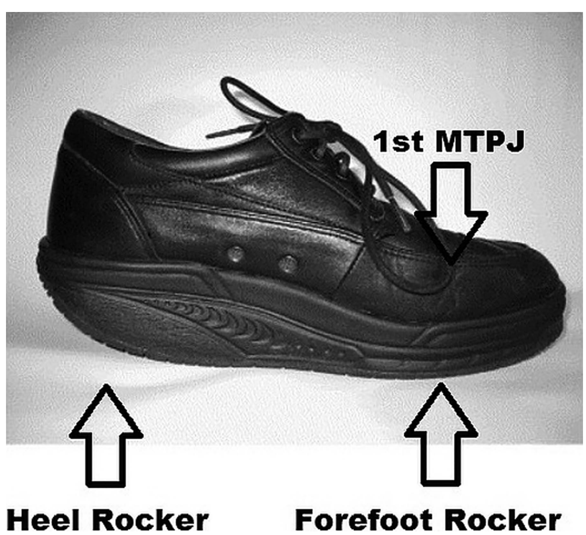


Figure 2 An example of an MBT (Masai Barefoot Technology) brand rocking bottom shoe. Note the heel-rocker, forefoot-rocker and location where the first metatarsophalangeal joint is housed. Reprinted from Romkes *et al*,[5] with permission from Elsevier.

Hallux limitus and the end-stage consequence, hallux rigidus is a condition that ultimately inhibits dorsiflexion at the first MTPJ. During the active propulsive phase, also known as terminal stance, simultaneous dorsiflexion at the MTPJ's as the heel lifts from the ground is crucial to enable maximum forward movement of the swinging limb.[1] This permits the storage and ultimate release of stored elastic energy through the gluteal region, thereby minimising the amount of input from the iliacus and psoas muscles as the stance limb begins to leave the ground.[2 3] If pivotal movement at the first MTPJ is blocked, increased hip and knee flexion is only one of several compensatory mechanisms employed. Unfortunately this places an increased strain just below the origin of the psoas muscle in particular, resulting in an abnormal torque at the L4–L5 disc level.[4]

The rocking-shoe, by virtue of its ergonomically-engineered rocking platform, enables the wearer to artificially enhance their structurally-limited step length, as the first MTPJ can remain neutral while the shoe permits 'extension' across the forefoot. The improvement in step length once again enables the wearer to develop adequate hip extension, enabling the storage of energy which can then be released as elastic recoil. Clinically, the patient reported a reduction in foot as well as back pain (as noted in an analogue reporting chart) from a '10' to a '3' level.

Table 1 Baseline timing analysis module of F-scan verses the rocking-soled shoe timing analysis module of F-scan

TAM phases of gait in % of stance							
Parameter	**Normal range**	**Average**	**Left foot variation**	**SD**	**Average**	**Right foot variation**	**SD**
Baseline F-scan measurements							
Contact	14–20	18	14–20	2	19	18–20	1
Foot flat	16–22	*30*	20–59	15	*51*	27–67	15
Midstance	29–37	*60*	49–86	13	*39*	22–64	16
Propulsive	45–55	*22*	0–31	11	*42*	18–59	16
→ Active propulsive	31–35	*0*	−36–11	18	*24*	5–41	15
Passive propulsive	14–20	16	0–20	8	18	13–20	3
Single support	60–72	59	49–63	5	63	60–69	3
Total double support	28–40	41	37–51	5	37	31–40	3
Initial double support	14–20	18	14–20	2	19	18–20	1
Terminal double support	14–20	*23*	19–37	7	18	13–20	3
Rocking-soled F-scan measurements							
Contact	14–20	15	13–18	2	20	19–22	1
Foot flat	16–22	*26*	23–29	2	*51*	31–75	14
Midstance	29–37	*38*	31–48	7	*39*	29–58	11
Propulsive	45–55	47	36–54	7	*40*	19–51	12
→ Active propulsive	31–35	*25*	15–31	6	*26*	6–40	12
Passive propulsive	14–20	*22*	21–24	1	15	11–18	2
Single support	60–72	63	62–65	1	65	62–69	2
Total double support	28–40	37	35–38	1	35	31–38	2
Initial double support	14–20	15	13–18	2	20	19–22	1
Terminal double support	14–20	*22*	21–24	1	15	11–18	2

Italics indicate an average value that is outside the normal range.
Note the active propulsion of the left foot markedly increased when the patient was wearing rocking-soled shoes.

Learning points

- Hallux limitus/rigidus can have a profound adverse effect on not only the foot, but the entire superstructure.
- The use of a rocking-soled shoe can artificially replace lost metatarsophalangeal joint movement and offers a practical, non-surgical approach to this commonly encountered condition.
- Hallux limitus/rigidus can be visualized radiographically by the presence of dorsal exostoses, joint space narrowing, and metatarsal head flattening. These radiographic changes indicate degenerative changes at the 1st metatarsophalangeal joint.

Competing interests None.

Patient consent Obtained.

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