Case Study: The use of a hinged/rocker ankle foot orthotic in the treatment and rehabilitation of an Improvised Explosive Device related calcaneal fracture

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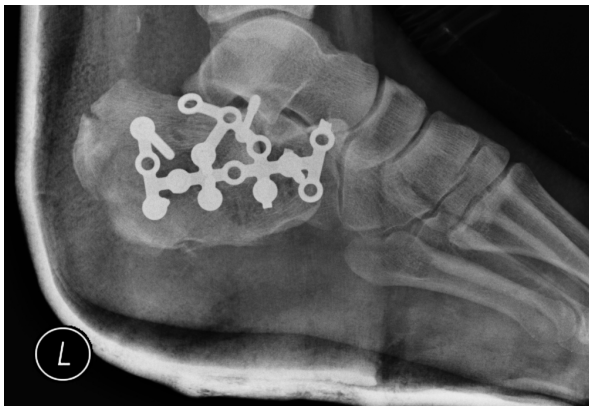
This article describes the rehabilitative progress of a patient who in 2010 stood on an improvised explosive device, (IED), while on patrol in Alfganistan This case study highlights the benefits of the newly developed hinged/rocker ankle foot orthotic (HRAFO) and its use in patients with limited range of motion at the ankle joint and more specifically for patients who have suffered lower limb injury due trauma. It also highlights the valuable input that Podiatrists can have in the management of this type of injury.

Initial injury

On 9th May 2010 a 31 year old British Army Captain who was patrolling with the Afghan Army stood on an IED. The detonation of this device caused multiple closed fractures to his left calcaneus, severe damage to his left ankle joint and the surrounding soft tissues, in particular the Achilles tendon.



Surgical Management

Following initial first aid at a field hospital he was evacuated to Selly Oak Hospital UK were on the 17th of May 2010 he underwent an open reduction

and internal fixation of his calcaneus using plates and screws. He was then put in a plaster of paris back slab for a period of 6 weeks.
He was re-admitted to North Allerton Hospital on the 8th of June 2010 when he underwent surgical debribment in an effort to improve the heeling.

On the 24th June 2010 some signs of delayed heeling and infection were observed. He was re-admitted on the 29th June 2010 for further debribement and negative pressure therapy and antibiotic therapy for a Staphlococcus aureius infection. This intervention was successful and the infection was clear when he was next reviewed on the 25th of August 2010.
He was then re-admitted to Nuffield orthopaedic centre when he was found to have a deep bone infection. The infected metal work was removed on the 17th March 2011 and Staphylococcus Aureus was cultured from his Microbiological samples. This was treated with further antibiotic therapy.
On the 29th of April his discharge summary stated that
"the infection is now under control and is likely to remain so in the long term. The subtalar joint and surrounding soft tissues including his Achilles tendon are substantially damaged. The joints of the rearfoot are significantly arthritic and there is also evidence of nerve damage. With regard to the functional prognosis it was stated that "there is no chance of complete recovery and there is a significant chance that further surgery may be required".
The patients level of disability was described as
"functioning at about the level that you would otherwise achieve with a below knee amputation".

Pic 1 Scar on lateral Calcaneus

Rehabilitation

He attended for rehabilitation at Catterick on the 20th Sept 2010 and when discharged on the 7th October was noted to have,

"moderate to severe intermittent pain, stiffness of his left foot and ankle, an antalgic gait pattern with poor hip knee control into terminal extension. There was also some weakness and balance deficit with loss of proprioception".

He attended for further rehabilitation between 3rd and 20th May 2011. This focused on non weight-bearing activities as it was felt that he was still unable to effectively walk of run. His discharge report stated that

"he had loss of movements in all directions in his ankle and subtalar joints with a significantly antalgic gait due to a total lack of propulsion on the left foot due to the pain and joint restriction allied to the weakness of the calf muscle".

The patient then underwent outpatient physiotherapy which he describes as irregular due to his other commitments.

Medical Board

During his final medical board on the 29thSept 2011 he was described as

"being able to walk only ½ a mile pain free and up to a mile with pain (located in the Subtalar joint region) and totally unable to run. His ankle joint is limited in both plantarflexion and dorsiflexion and his subtalar joint is limited in inversion and eversion".

Podiatry Management

He was referred to podiatry on the 30th Nov 2010 and was first examined on 3rd of Feb 2011. On examination he was found to have limitation of ankle joint dorsiflexion with early signs of mid-tarsal joint breakdown. He was also unstable laterally with poor muscle function in his tibialis anterior and peroneals. He had pain during heel strike and during propulsion. He was initially cast for an orthotic to increase his lateral stability and improve his forward progression by means of a heel raise. The device was designed with a 3 degree varus rearfoot post a high lateral flange and had extensive heel cushioning to reduce shock during heel strike.

His first orthosis where issued on his return on the 20th of May. He initially found these both comfortable and beneficial in reducing the stress on his mid-foot and ankle.

On review on the 1st of July he was very happy that the orthosis where of benefit and his gait had clearly improved. He was having some pain during heel strike due to the forced plantar flexion caused by the heel raise and for this reason it was decided that we should issue him with a rocker orthotic in an attempt to give greater shock attenuation to the heel and improve his propulsion. He was issued with an off the shelf rocker orthotic on a 'try it and see basis'. (For further information on the rocker see paragraph below)

He was again reviewed on the 15th Sept 2011. At this time it was clear that the patient had mistakenly placed the original left orthosis inside the rocker before using it. This had strangely been very successful and had given the benefits of the support of the orthosis allied to the rocking effect of the rocker splint. I discussed this at length with the patient and it was decided that we should attempt to make a fully custom rocker which would incorporate the geometry of the two devices into one. It was also decided to experiment with having this new rocker orthotic incorporated into and ankle brace as I felt that this would help to support the surrounding damaged soft tissues.

Pic 2 rocker

Pic 3 Orthotic inside rocker

The new rocker orthotic was issued on the 24th Nov 2011. The patient immediately found this to be both comfortable and beneficial. The rocking motion combined with the support allowed him for the 1st time to have a short run on a treadmill.

On the 9th December he was issued with the newly developed ankle rocker brace. The patient found the brace comfortable and supportive and reported that it gave him the confidence to run for greater distances. He initially ran

on a treadmill only but soon progressed to road running, covering distances of up to 7 miles. The patient continued to train on the new device and was not seen by myself again until the 16th March 2012.
On review on the 16th of March the patient was walking without evidence antalgic gait and had continued to run using his new brace. Some minor adjustments were made to improve the comfort of the device and what I expected to be a final review appointment was arranged for the 14th June 2012.

14th June 2012 the patient reported having completed a full marathon in a time of less than four hours.

Ankle Rocker Brace

What the patient said

In May 2010, whilst serving in the Upper Gereshk Valley, I trod on an IED; the resulting partial detonation shattered my calcaneus into nine pieces. Subsequent surgery achieved unity of the bone, but left uneven surfaces that caused degenerative arthritis.

Physiotherapy helped me to recover and to learn to walk again, but initial surgical prognoses suggested that I would never be able to run again due to the complexity of the damage in the subtalar joint.

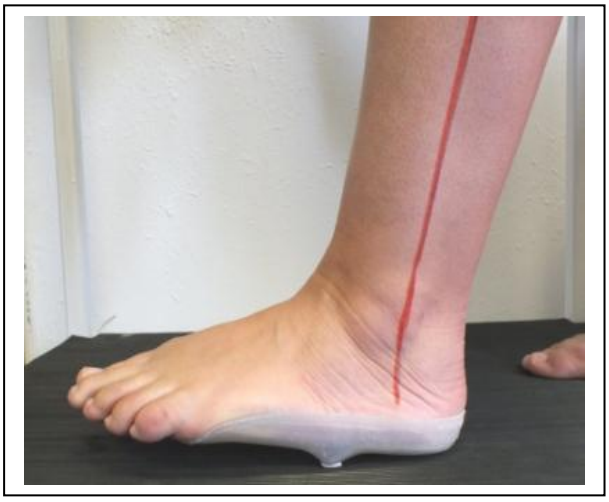
I was referred to a podiatrist, Mr David Hallowell, by my physiotherapist in a bid to initiate further progress in my rehabilitation. Although initially skeptical, I engaged with him and was given a set of orthotic insoles that made a significant difference to my daily level of comfort.

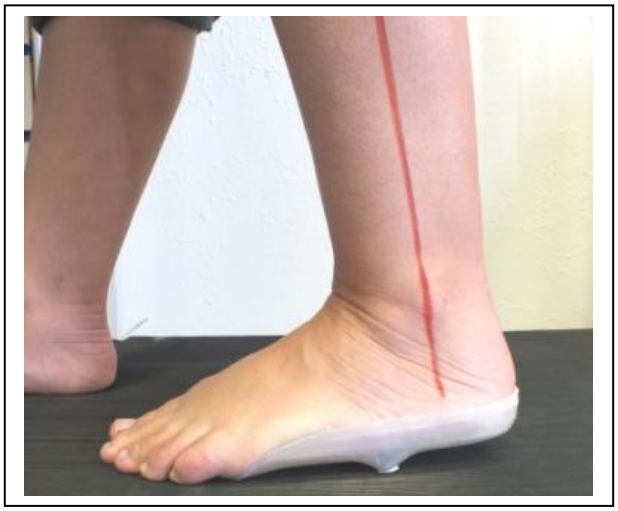
Mr Hallowell continued to re-evaluate my progress and adjust my treatment as necessary; I felt that I was being listened to and that it was a receptive and interactive process. The real difference was when he developed a rocker insole that was coupled with a leg-brace; this design gave me the confidence to run that I had not had since my injury occurred. The result was that I was able to complete the Belfast Marathon in a time of 3:57, a feat that I had been told was permanently beyond me.

Throughout the whole of my treatment for this debilitating injury, I can identify my treatment at the hands of Mr. Hallowell as the single point of success; it feels like everything else was merely supporting this process which has given me the best chance of replicating my pre-injury existence.

<u>How the rocker works</u>

During heel strike the rocker device absorbs shock through the vertical sidewalls creating mechanical shock absorbency quite different from that of a heel cushion. The device momentarily resists the normal plantar flexion holding the foot close to 90 degrees to the lower leg. As the body moves forward against this resistance energy is built up in the device. This energy is then released as the rocker triggers. When released the rear foot is projected upward and the body forward prior to propulsion. Throughout this process the ankle is kept close to a neutral position. In this way ankle joint movement is minimised while the body's forward movement is actively facilitated. The brace has the added advantage of supporting the surrounding soft tissues and creates greater stability as well as improving the triggering of the device (fixed ankle model).





Other uses for the rocker

Since it was first used in 2011, we have issued the rocker to over 25 patients, these include arthritic, trauma and even neurological patients. Most of whom have had very promising results. Several are currently being written up as further case studies. It is clear therefore that the rocker has a broad range of applications which need to be explored further so as to fully assess the devices benefits and applications and to establish a sound evidence base. Currently it is thought that the rocker may be beneficial in any patient with restriction of dorsiflexion including.

- Severe Achilles injury.
- After surgical fixation to rearfoot.
- Ankle fractures.
- Residual restrictive effects of club foot.
- Tibial and fibular fractures resulting in restricted rearfoot movements.
- Intractable plantar heel pain.
- Plantar fasciitis.
- Mid-tarsal disorders.
- Dropped foot disorders
- Tarsal Coaltions

It is my hope that as evidence of the rockers benefits to patients gathers, it will be accepted into the mainstream of orthopaedic devices. This would mean it was offered to any patient with limited ankle dorsiflexion either before surgery as a possible alternative or to augment surgical procedures which have reduced the patient ankle joint movement.