The Human Locomotion
Metatarsal Pad

Originally developed in the 1930s, metatarsal pads are small cushions designed to distribute pressure away from the central metatarsal heads onto the neighboring metatarsal shafts and surrounding soft tissues (Fig. 1). Because they can offload a painful metatarsal head by as much as 60% (1), these pads are useful when treating a wide range of forefoot injuries, including plantar plate tears, capsulitis, bursitis, interdigital neuritis, and/or inflammatory arthritis. These pads are also useful when dealing with structural problems, such as elongated second metatarsals and/or plantarflexed lesser metatarsals. While several studies show these pads effectively reduce pressure on the metatarsal heads (1,2), there is little research identifying which specific metatarsal pad is most effective. Over the past 90 years, manufacturers have developed a range of metatarsal pads that come in all shapes and sizes (Fig. 2). These pads also vary markedly in density, as some metatarsal pads are made of lightweight EVA and urethane foams, while others are made of high-density rubber and cork. The wide range of sizes, shapes, and materials makes it difficult to make an evidence-based decision as to which metatarsal pad should be used for which condition.

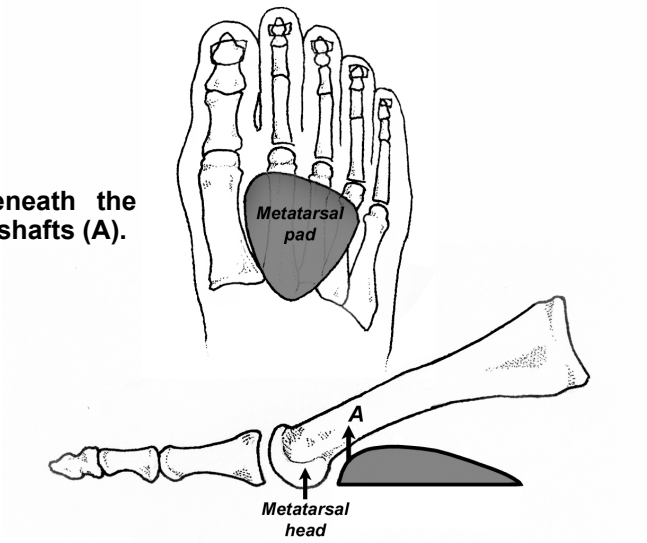

Fig. 1. Metatarsal pads reduce pressure beneath the metatarsal heads by lifting the distal metatarsal shafts (A).

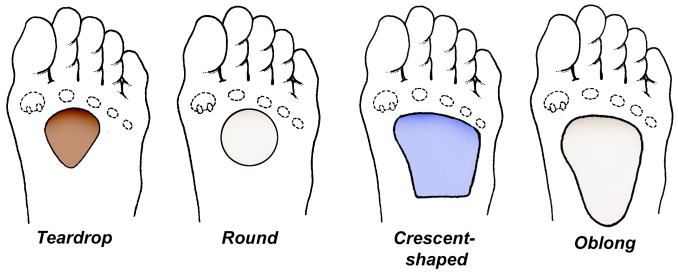

Fig. 2. Variation in the shape of metatarsal pads.

The significant variations in size, shape, and density also explains why metatarsal pads are often reported to be uncomfortable when first prescribed. The reason for the discomfort, which is usually in the soft tissues adjacent to the metatarsal pad, is that whenever you reduce pressure on one metatarsal head, you increase pressure on the neighboring tissues, which often become sore and irritated over time. Large metatarsal pads are notorious for causing discomfort, especially ones made from high-density rubber. Perhaps the main factor contributing to the often unpredictable outcomes when prescribing metatarsal pads is that manufacturers have not taken into consideration the specific alignment of the metatarsal heads present in the general population. As a result, the majority of metatarsal pads rarely support all of the central metatarsals, producing less than optimal outcomes.

To create an effective metatarsal pad, the pad should be designed to match the 3-dimensional shape of the metatarsal heads and be soft enough to avoid irritating neighboring tissues. A little over 10 years ago, researchers from Spain (3) evaluated metatarsal head alignment in 169 adults and determined the metatarsal heads form a smooth parabolic curve that is illustrated in figure 3. Because the goal of a metatarsal pad is to support the second through fourth metatarsal heads, it is important the metatarsal pad be contoured to match the shape of this parabolic curve. Unfortunately, few commercially available pads come close to matching this curve, which makes them less effective at distributing pressure away from all of the central metatarsals (Fig. 4).

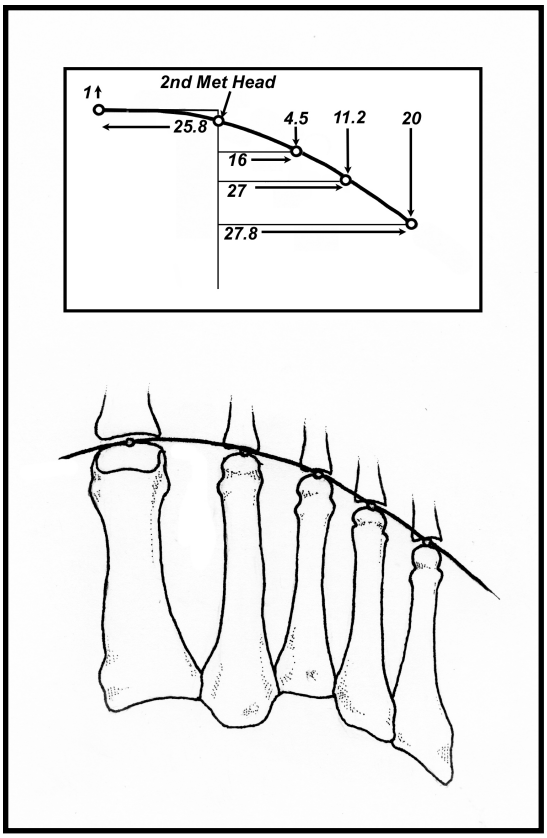

Fig. 3. The typical metatarsal parabolic curve is based on measurements taken from 169 x-rays (3). These numbers are almost identical to a prior x-ray study of metatarsal head alignment in 50 adults (4).

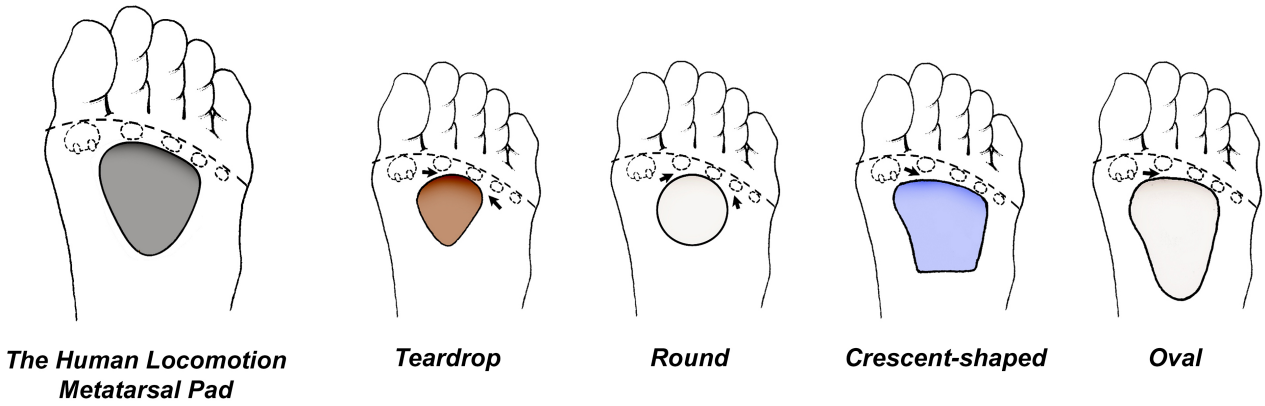

Fig. 4. The *Human Locomotion Metatarsal Pad* uniquely supports each of the central metatarsals by matching the typical metatarsal parabolic curve. The small arrows point to areas where the metatarsal heads lack sufficient support from their respective metatarsal pads.

Unlike conventional metatarsal pads, the *Human Locomotion Metatarsal Pad* was designed to match this ideal parabolic curve. To ensure proper alignment, the pads are marked with an arrow that points directly towards the second metatarsal head. In addition to matching the transverse plane alignment of the metatarsal heads, the *Human Locomotion Metatarsal Pad* angles back 70° in the sagittal plane to match the angles found in the proximal metatarsal heads (Fig. 5), and its upper surface tapers evenly so as to not displace the plantar fascia. To ensure comfort, the pad is made out of an EVA material that is slightly denser than skin, which allows it to distribute pressure off of a painful metatarsal head without irritating the neighboring soft tissues.

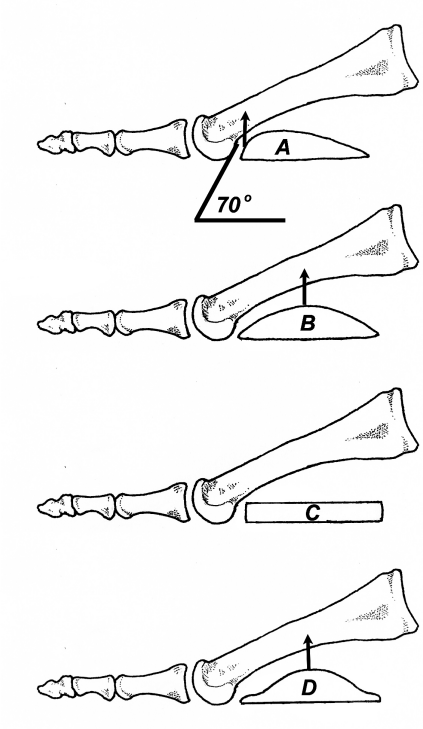

Fig. 5. In order to lift up as close to the metatarsal head as possible, the distal aspect of the metatarsal pad should angle approximately 70° from horizontal. This allows the forward aspect of the metatarsal pad to lift the metatarsal shaft as close as possible to the head (**A**). Metatarsal pads with dome-like shapes lift the central metatarsal shaft, making them relatively ineffective (**B**), while conventional round flat metatarsal pads are too thin to lift the metatarsal shaft (**C**). Other models with rounded heads also lift the metatarsal heads too far back to be effective (**D**).

Even when you have the ideal size, shape, and density, placement is one of the most important factors for success when using a metatarsal pad. Research by Hsi et al. (2) shows that optimal pressure reductions occur when the metatarsal pad is placed just behind the metatarsal heads. Because of this, when placing the pad on top of an insole, you have to accurately identify the location of the second metatarsal head, which can be tricky. The most accurate methods for placing a metatarsal pad are described in figure 6. While metatarsal pad prescription has historically been challenging, the *Human Locomotion Metatarsal Pad* simplifies the process as the arrows help guide specific placement, and the overall shape closely matches the contours of the average foot, making for better, more predictable treatment outcomes.

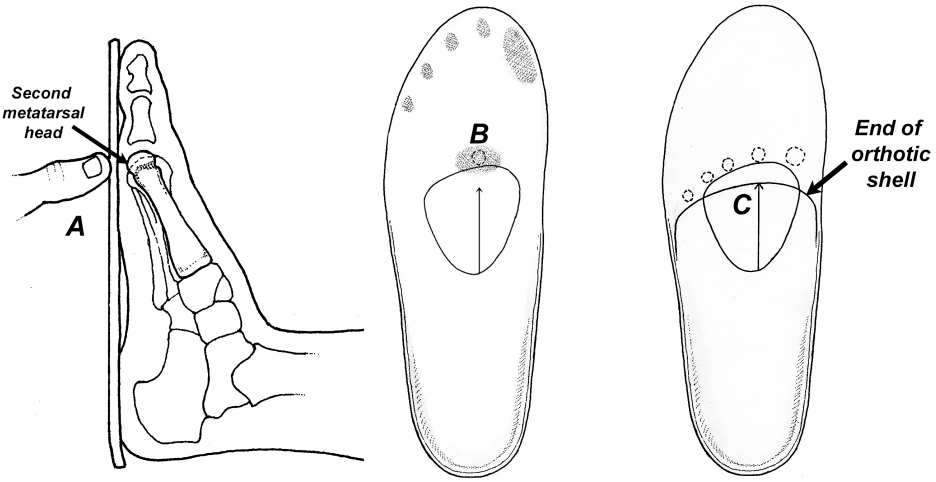

Fig. 6. Healthcare practitioners place a metatarsal pad by palpating through the insole and then marking the spot on top of the insole (A). This method allows for exact placement of the metatarsal pad. An alternative method for placing a met pad is to look at the wear pattern present on the insole and place the pad directly behind the area of greatest wear, which is usually beneath the second metatarsal head (**B**). Because it's difficult to get exact placement with this technique, you should test placement by applying two-sided tape to the back of the metatarsal pad and then stand on the insole with the pad taped to the top. The pad should feel comfortable right away if placed correctly. If it isn't, move the pad 1 or 2 mm in different directions (usually forward) until you find the most comfortable location. You then mark that spot on the insole with a pen, remove the self-stick back from the metatarsal pad, and place the met pad directly behind the marked spot. While placing a metatarsal pad on an insole can be challenging, placing the pad on top of an orthotic is simple as the end of the arrow on top of the *Human Locomotion Metatarsal Pad* should be positioned so the tip of the arrow meets with the far end of the orthotic shell (**C**). This almost always results in perfect placement right away.

References:

1. Holmes G, Timmerman L. A quantitative assessment of the effect of metatarsal pads on plantar pressures. Foot Ankle. 1990;3:141-145.

2. Hsi W, Kang J, Lee X. Optimum position of metatarsal pad in metatarsalgia for pressure relief. Am J Phys Med Rehabil 2005;84(7):514-520.

3. Domínguez-Maldonado G, et al. Normal values of metatarsal parabola arch in male and female feet. The Scientific World Journal 2014(1): 505736.

4. Domínguez G, Munuera P, Lafuente G. Relative metatarsal protrusion in the adult: a preliminary study. Journal of the American Podiatric Medical Association. 2006 May 1;96(3):238-44.