Day-to-day footwear for people living with diabetes - Part I: Footwear for Low-Risk Feet

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Walking is a complicated motion, the product of several biomechanical mechanisms that allow the foot to adapt to different and uneven surfaces. Many foot problems are a consequence of walking on manmade hard surfaces wearing shoes that limit normal foot function. As the foot repetitively impacts a uniform unyielding surface in the same orientation, small differences in foot and skeletal alignment accumulate to escalate the risk of developing serious long-term consequences.

Footwear appropriate to Risk Staging

For people living with diabetes, footwear should be assessed according to the risk staging of their feet:

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Low Risk: Musculoskeletal, dermatological, vascular and neurological pathologies are absent. Patients with low risk feet still need education as to what constitutes a good day-to-day shoe, since poor choices cause dermatological and musculoskeletal pathologies over time.

Moderate Risk: The moderate risk foot presents musculoskeletal and/or dermatological pathologies. Over-pronated feet (valgus deformities), over-supinated feet (varus deformities), bunions, clawed toes, high pressure areas, reduced range of motion, calluses (hyperkeratosis) and even corns (helomata) are all signs of a moderate-risk foot.

High Risk: This foot presents with neuropathic and/or vascular pathology, often combined with musculoskeletal/dermatological complications. High-risk feet often have special needs, which require therapeutic or custom-made footwear, with appropriate orthotic or insole intervention.

This is the first of two articles addressing footwear choices for patients living with diabetes. In this first article, I will discuss the seven characteristics of a "good" shoe for those with low-risk and moderate-risk feet. In the second article, I will discuss footwear for high-risk feet.

Footwear for Low- and Moderate-Risk Feet

The seven characteristics for acceptable footwear are:

1. Flexibility
2. Appropriate upper vontact (and fastening)
3. Full heel contact
4. Toe-shaped shoes
5. Fixation at heel
6. Appropriate in-flare (shape of the shoe)
7. Low heel height

A shoe with these characteristics respects the anatomy of the foot, so that the shoe follows and supports the foot in normal gait, as opposed to a shoe that forces muscles to activate outside of a normal work role.

1. Flexibility: Flexibility across the tread is critical in allowing the foot to flex naturally during gait. Full range and easy flexibility allows the internal mechanisms of the foot such as blood supply and neural transmission to function correctly, promoting joint stability, foot muscle strength, ankle stability and retention of posture (Figure 1).

A suitably flexible shoe is one that can be flexed to a minimum of 55˚ with a single finger from a flat surface (figure 2).

Figure 1: Minimum 55˚ flexion at ball of the foot in gait (Anette Thompson & Associates)

Figure 2: The "finger" flexibility shoe test (Anette Thompson & Associates)

2. Appropriate Upper Contact (and fastening). Two areas on the foot should make contact with the footwear so that the shoe has synchronized movement with the moving foot. The first is the instep (dorsum of the foot extending across the metatarso-cuneiform joints) and the second is the back of the heel. In other words, footwear should incorporate adjustable fastening across the top of the foot together with fastening behind the heel, either in the form of a strap or a firm heel counter (Figure 3)

Since the foot must flex a minimum of 55 degrees at the ball of the foot (heel off and toe off), there must be fixation of the shoe to the foot across the top of the instep, otherwise the shoe will slip or the wearer will clench toe and foot muscles to keep the shoe on.

Figure 3: Locally manufactured, anatomically correct leather shoes, suitable for children and adults living with diabetes (Anette Thompson & Associates)

Low-cut pumps are popular and purported to be comfortable, but video x-ray analysis studies show that toes curl up and then clench to keep them on. Low cut pumps are also implicated in irritation of the metatarsophalangeal (MTP) joints (Figure 4)

Figure 4: Low-cut pump damage to the foot in diabetes (Anette Thompson & Associates)

The physics of natural gait dictate that forefoot "support" must be placed at the flex points at the ball of the foot. In other words, shoe upper material must cover both the first and fifth MTP joints.

Sandals that have straps positioned ahead of the inner joint are a poor sandal choice. Without other supportive straps across or just behind the inner joint, the sandal allows the foot to slide due to lack of support. Straps ahead of the first MTP joint can also promote bunion formation in patients predisposed to this condition by virtue of their hereditary bone structure, as they abduct the big toe with every step (Figure 5).

3. Full Heel Contact. Studies show that unnatural gait can result if the ground contact area of the heel of a shoe is less than 80 % of the heel seat width. Most men's dress shoes have block heels that fulfil this requirement, but casual shoes may have injection-moulded soles which have a narrower heel-to-ground profile. Wedged heels should be as wide as the heel pad of the foot.

Figure 5: Incorrect placement of front strap ahead of the joints (Anette Thompson & Associates)

4. Toe-Shaped Shoes (not shoe shaped toes). One may suppose that the shape of the front of a shoe is made for the shape of the foot, but this can be misleading (Figure 6).

Shoes need to allow the big toe to lie straight ahead, not deflected towards the centre line of the shoe. Similarly, footwear must allow the little toe to lay straight ahead, not deflected inwards. The end shape of the shoe should only take form once the toes can lay straight and flat in a shoe. This prevents toe compression. Correctly shaped shoes allow full, unhindered forefoot contact with the ground,

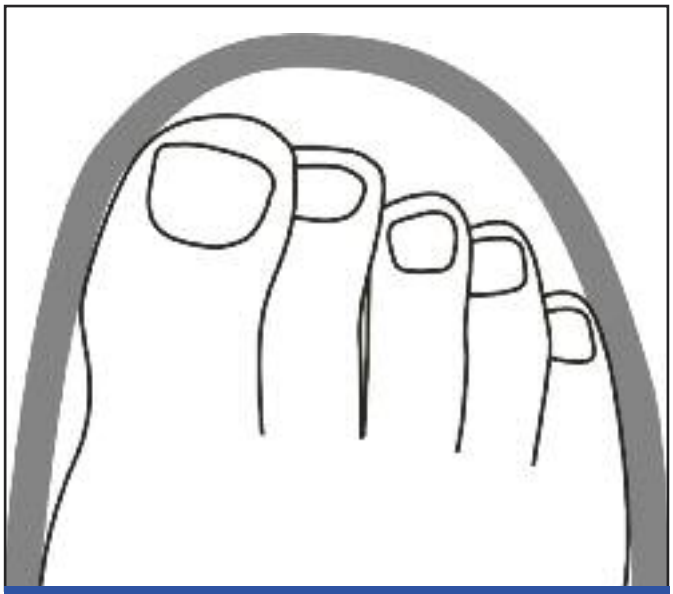

Figure 6: Rounded shoe yet inadequate extension prevents straight toe alignment (Anette Thompson & Associates)

allowing toes to contribute properly to propulsion. Toe extensions are the correct means of creating different toe box shapes in shoes (Figure 7). Manufacturers of some fashion shoes sometimes save cost by starting the inward curve of the toe area of the shoe immediately after the big and little toe joints. Good shoes utilize extra material to project beyond the straight line of the toes before commencing curvature for toe shapes.

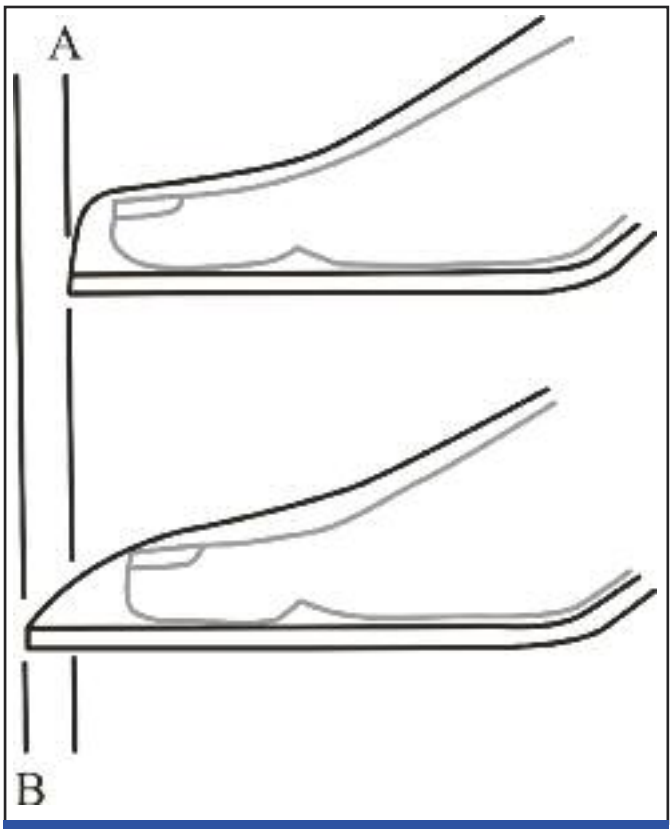

Figure 7: Toe extensions should project beyond the line of straight alignment of toes (Anette Thompson & Associates)

5. Fixation at the Heel: Studies of identical upper designs, one with a back strap and the other without, show that upper design, which includes a back strap, produces far less muscle fatigue. In styles that have no back strap, the foot can land in different positions, giving rise to continuous small muscle imbalances. Wearers of slip-on styles may experience accelerated formation of heel-border hyperkeratosis. The absence of a heel strap allows the heel to land on the edges of the shoe's heel area, provoking keratin build up.

Hyperkeratosis (callus and corn) is a red flag in care of the diabetic foot – it indicates the response of glabrous skin to pressure and/or friction. Musculoskeletal, biomechanical and footwear causes should be investigated to formulate correction.

6. Appropriate In-Flare (shape of the shoe): The overall shoe shape should match that of the foot. Studies show that low- to flat-heeled shoes for adults should not have more than 3 degrees of in-flare. Zero degrees is indicated for a flat arch or valgus foot, and up to six degrees in-flare for an extreme high arched or supinated foot. Morphology studies in South Africa show that 2.9 degrees is the average needed for the general population. Incorrectly curved footwear can cause areas of high pressure and musculoskeletal deformity (Figure 8)

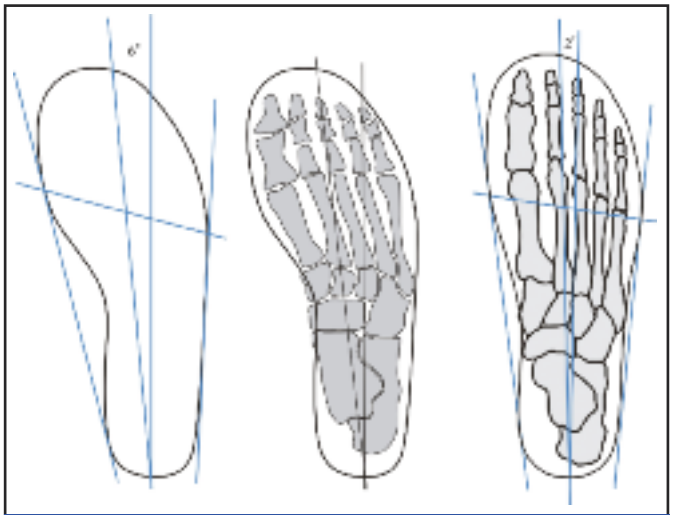

Figure 8: Excessively curved footwear (left) may cause areas of high pressure, compared to adequate room for toes in straighter shoes (right) (Anette Thompson & Associates)

7. Low Heel Height: Heel heights above 25 mm disrupt the body's centre of balance, trigger unnatural muscle actions, which cause fatigue and long-term muscle imbalance, and lead to disruptions of gait and foot structure. Excessive heel heights increase peak plantar pressure under the ball of the foot, leading to disruption of comfort. High heels fire the plantar flexor muscles more than is usual, reducing the function of the calf muscle pump mechanism by as much as 80 %. Similarly, excessive toe spring triggers unnatural muscle action (retracted extensors). This causes fatigue and imbalance, and thereby loss of comfort.

Cushioning and Offloading Considerations

For the foot to function in normal physiology, skin has to breathe, regulate temperature, and be free from pressure or friction. The glabrous skin on the sole of the foot, midway up the sides of the toes, and on the knuckles of the toes has the ability to create callus in response to pressure and friction. An impacted callus becomes a corn. This has implications for the contact surface of the shoe with the skin of the wearer. On top of the foot, linings should be breathable, soft and malleable to the foot.

Underneath the foot, (on the 'plantar' surface), numerous cost-effective offloading strategies can be employed by podiatrists to decrease plantar pressures. In adults, peak plantar pressure greater than or equal to 6 kg/cm^2 (588.6 kPa) is considered the threshold at which soft tissue damage may occur in older consumers, those with thinner skin, or those with systemic illnesses such as diabetes and peripheral arterial disease (poor blood circulation). In South Africa, the Podiatry Association's Footwear Committee works with local manufacturers to ensure pressures of less than 350 kPa and Shore A densities (A hardness scale showing the relative hardness and durability of lower density materials) of 50 to 55 for sole units.

Figure 9 shows an example of a varus anomaly, where sub-talar joint malalignment excessively loads the medial side of the heel.

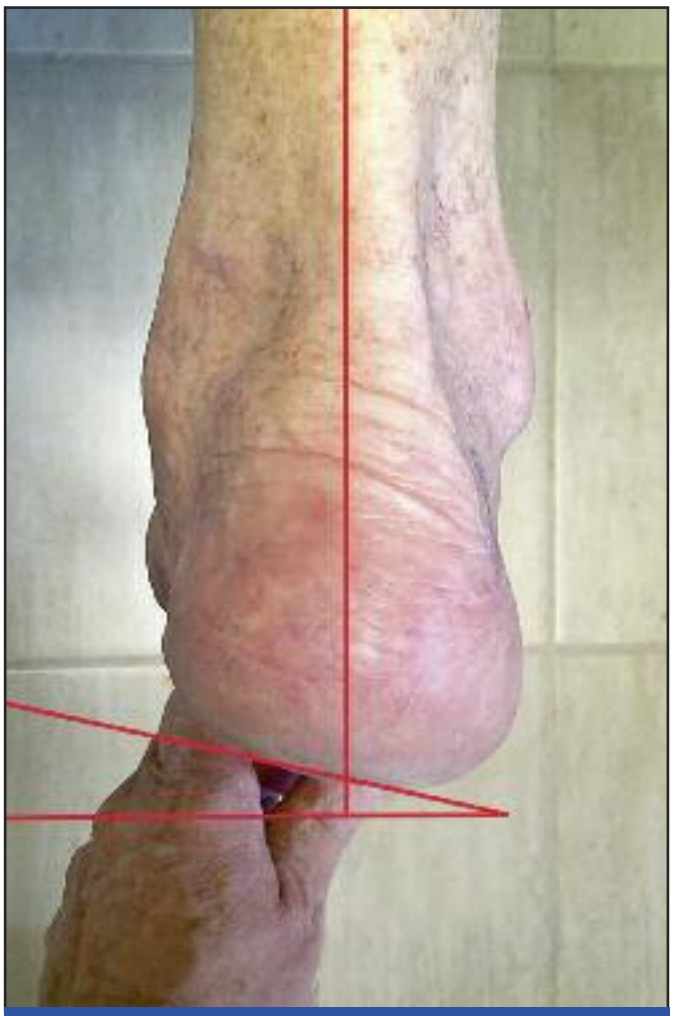

Figure 9: This calcaneovarus foot needs accurately measured medial heel wedging

Summary

Clever style designs allow for adjustable fit for low-risk feet. This translates into ease of foot function, prevention of areas of skin stress and thereby foot comfort. Cushioning components should be adequate and durable.

Moderate-risk feet should be referred to a podiatrist so that appropriate evaluation of all footwear and pathologies can be undertaken and a plan of treatment formulated. Custom soft or custom moulded shoe inserts may be needed to accommodate, offload and/or correct the imbalances. In the case of bunions, for example, there is always a degree of varus deformity of the forefoot, but the sub-talar joint involvement must be carefully measured before formulating the insole prescription. Patients with moderate-risk feet should not be dispensed or advised to purchase over-the-counter 'arch supports' without first seeking the biomechanical clinical evaluation of a podiatrist. Poorly selected inserts can cause more harm than good.

In today's busy medical practice, there is often too little time or information readily available to make care recommendations regarding footwear choices. Podiatrists and pedorthist-qualified orthotists are partners in the team approach to diabetic foot care. They have both the training and skills to educate patients on good footwear choices, and to prescribe and construct specialist corrective footwear.

REFERENCES AVAILABLE ON REQUEST