Why Shoes Make “Normal” Gait Impossible

How flaws in footwear affect this complex human function

by William A. Rossi, D.P.M.

from *PODIATRY MANAGEMENT—MARCH 1999*

Each year, consumers spend hundreds of millions of dollars for “walking shoes” promising to help the wearer walk “right” or more comfortably. Each year, additional hundreds of millions of dollars are spent for orthotics designed to “normalize” foot balance, stability, and gait. Podiatrists and other medical practitioners are constantly applying therapies and ancillary products to correct gait faults and re-establish “normal” gait.

While such therapies provide some relief from gait-induced distress symptoms, they are largely ineffectual in re-establishing natural gait. Why? Because natural gait is biomechanically impossible for any shoe-wearing person. Natural gait and shoes are biomechanically incompatible because all shoes automatically convert the normal to the abnormal, the natural to the unnatural. And no therapy or mechanical device, no matter how precisely designed or expertly applied, can fully reverse the gait from wrong to right.

Let’s now see if these seemingly presumptuous statements can be substantiated by the evidence of the shoe/gait conflict.

Gait is the single most complex motor function of the human body. So complex, in fact, that it is the only motor function for which a definition or standard of “normal” does not exist. It involves half of the body’s 650 muscles and 200 bones, along with a large share of the joints and ligaments. And despite all the serious gait studies that have been done since Hippocrates to the present, all the mysteries of human gait have yet to be revealed.

First, it’s important to distinguish between “normal” and “natural.” Normal is defined as an accepted standard, a mean or average. For example, everyone occasionally catches a cold, hence the common cold is “normal,” though it is neither healthy nor *natural*, Conversely, natural means the pristine, ideal state, the ideal of form and function stemming from nature itself. Hence the difference between normal and natural is essentially the difference between what is and what can or ought to be.

Applying this to human gait, we can say that in shoe-wearing societies many people have what appears to be “normal” gait, while in shoeless societies they have “natural” gait. And there are pronounced differences between the two both in form and function.

In shoe-wearing societies a visibly faulty gait can often be corrected and made normal, but it can never be made natural as long as conventional shoes are worn. It is biomechanically impossible because of the forced alterations from the natural in foot stance, postural alignment, body balance, equilibrium, body mechanics and weight distribution caused by shoes.

Let’s now see some of the specifics of how these inevitable gait faults are caused by shoes.

The Role of Heels

The role of heels or heel heights has been given much attention in the literature because their influence is so obvious, especially on heels two or more inches in height.

Barefoot, the perpendicular line of the straight body column creates a ninety degree angle with the floor. On a two-inch heel, were the body a rigid column and forced to tilt forward, the angle would be reduced to seventy degrees, and to fifty-five degrees on a three-inch heel. Thus, for the body to maintain an erect position, a whole series of joint adjustments (ankle, knee, hip, spine, head) are required to regain and retain the erect stance (Fig. 1).

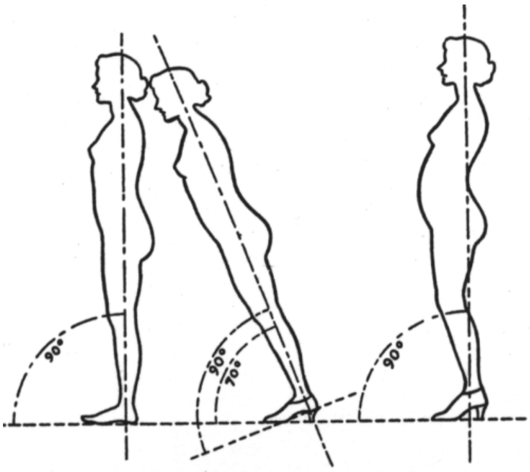


Fig. 1: *Left*, barefoot stance, 90 degree angle with perpendicular, *center*, if body column were rigid, on medium 2-inch heel angle Is reduced to 70 degrees, *right*, to regain 90 degree angle on 2-inch heel, body column must make adjustments.

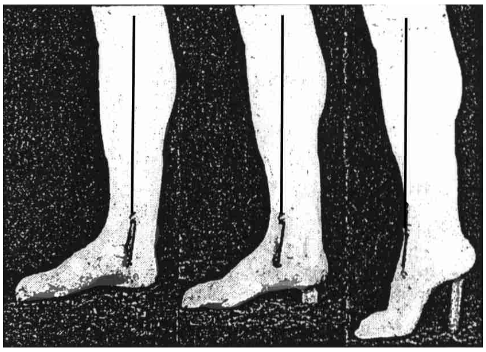


Fig. 2: Forward shift of failing body weight on leg and foot from barefoot (*left*) to medium heel (*center*) to high heel (*right*)

In this reflex adjustment scores of body parts—bones, ligaments and joints, muscles and tendons—head to foot must instantly change position. If these adjustments are sustained over prolonged periods, or by habitual use of higher heels, as is not uncommon, the strains and stresses become chronic, causing or contributing to aches of legs, back and shoulders, fatigue, etc.

But the alterations are internal and organic, as well. For example, when standing barefoot, the anterior angle of the female pelvis is twenty-five degrees; on low, one-inch heels it increases to thirty degrees; on two-inch heels to forty-five degrees; on three-inch heels to sixty degrees (Fig. 3). Under these conditions, what happens to the pelvic and abdominal organs? Inevitably, these must shift position to adapt.

Does the wearing of low, one-inch “sensible” heels prevent these problems of postural adaptation? No. All the low heel does is lessen the intensity of the negative postural effects. Hence, the wearing of heels of any height automatically alters the natural erect state of the body column. (Note: millions of men habitually wear boots or

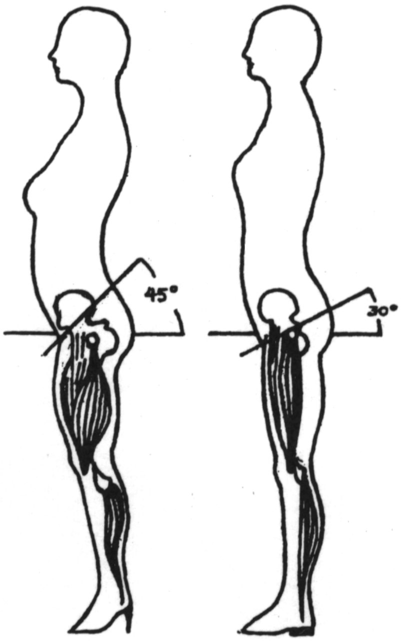


Fig. 3: *Right*, normal 30 degree angle of pelvis with barefoot stance, *left*, on medium heel height, pelvic angle increased to 45 degrees (and to 60 degrees on high heel).

shoes with heels one and a half to three inches in height, such as on western boots or elevator shoes.)

But shoe heels have other, lesser known influences on gait. For example, any heel, low to high, requires a compensatory alteration or forward slant on the last, which is translated to the shoe. This slant is known as the “heel wedge angle”. This is the slope or slant of the heel seat, rear to front, to compensate for the shoe heel height. The higher the heel, the greater the angle. (Figs. 4, 5)

On the bare foot there is no wedge angle. The bottom of the heel is on a level one hundred and eighty degrees, with body weight shared equally between heel and ball. In side the heeled shoe the wedge angle shifts body weight forward so that on a low heel body weight is shared forty percent heel, sixty percent ball; and on a high heel ninety percent ball and ten percent heel. (Fig. 6).

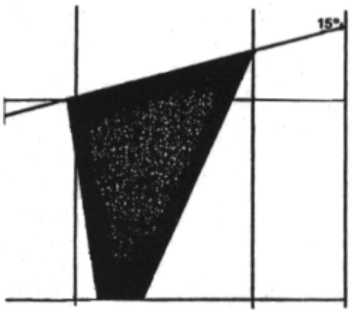


Fig. 4: Wedge angle on medium (2-inch) heel. The higher the heel the greater the wedge angle, shifting body weight forward to the ball

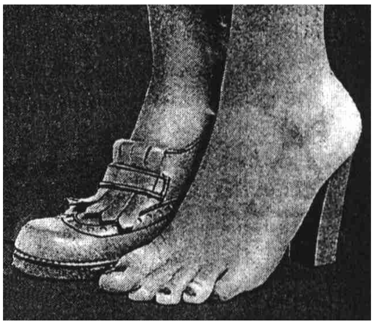


Fig. 5: Effect of wedge angle on angle of foot on 2½ inch heel.

Under these conditions the step sequence is no longer heel-to-ball-to toes and push-off, as with the bare foot. On heels two or more inches in height little weight is borne by the heel of the foot, and step pushoff is almost wholly from the ball.

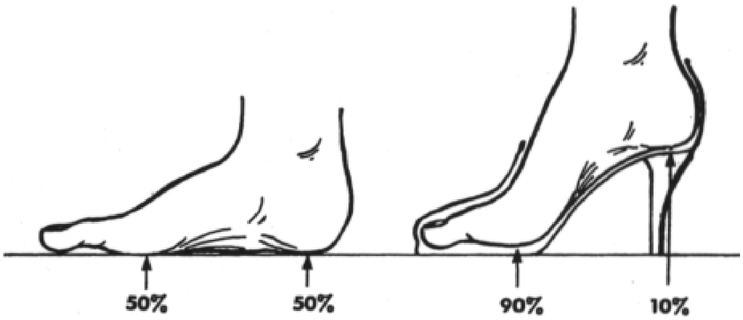


Fig. 6: *Left*, barefoot, weight shared equally on heel and ball; *right*, on 3-inch heel weight shared 10% on heel, 90% on hall.

On medium to higher heels, due to the reduced base of the heel top-lift, the line of falling weight shifts, causing a wobbling of the less-secure ankle, which tilts medially. (Fig. 7). The shift in the body’s center of gravity alters the equilibrium of the body column and prevents a natural step sequence.

Fig. 7: Small base (toplift) of 2-inch heel diminishes gait stability as foot pronates.

One consequence is that heel strike moves to the lateral-rear corner of the heel toplift. (Fig. 8). This is not natural. The heel of the shoeless foot receives its initial heel

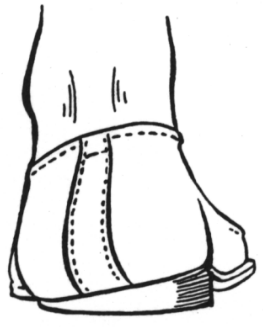


Fig. 8: Typical wear pattern of heel toplift on lateral-rear corner of heel, causing faulty tread and gait instability.

strike not at the lateral-rear corner but in the center at the site of the plantar calcaneal tuberosity. (Fig. 9) The natural plantar path of the step sequence—heel to lateral border to ball to hallux and push-off (Fig. 10)—is forced to shift, further affecting natural gait.

Let's add one further influence of shoe heels, low to high. The shoe's elevated heel shortens the Achilles tendon and there is also an accompanying shortening of the calf muscles (Fig. 11). Both the tendon and the muscles are, of course, vital to step propulsion and gait stamina—which may help to explain the performance dominance of marathon runners from nations where the barefoot state is common from infancy to adulthood.

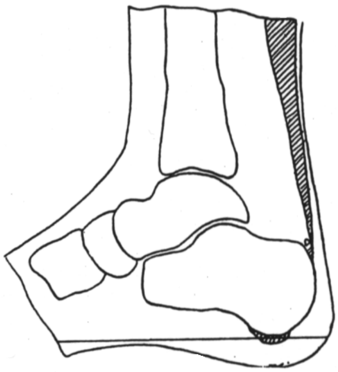


Fig. 9: Bursa under plantar tuberosity of calcaneus—normal Initial heel strike site.

The heeled shoe "steals" much of this propulsive power from the tendon and leg muscles. This not only places more stress on them to achieve needed propulsion, but power must be borrowed from elsewhere—knees, thigh muscles, hips, and trunk. A small army of anatomical reinforcements must come to the rescue of the handicapped tendon and calf muscles.

Thus a shoe heel of any height sets in motion a series of gait-negative consequences, making natural gait—meaning the barefoot form—impossible. But this is only the beginning.

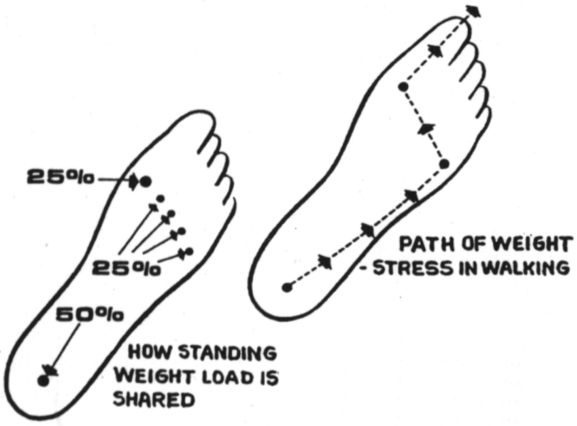


Fig. 10: Left, pattern of weight distribution on standing; right, path of weight distribution in step sequence.

Toe Spring

If you rest a shoe, new or old, on a table and view it in profile from the side, it reveals an up-tilt of the toe tip varying from five-eighths to one inch or more. More on worn shoes. This is known as "toe spring' and is built into the last (Fig. 12).

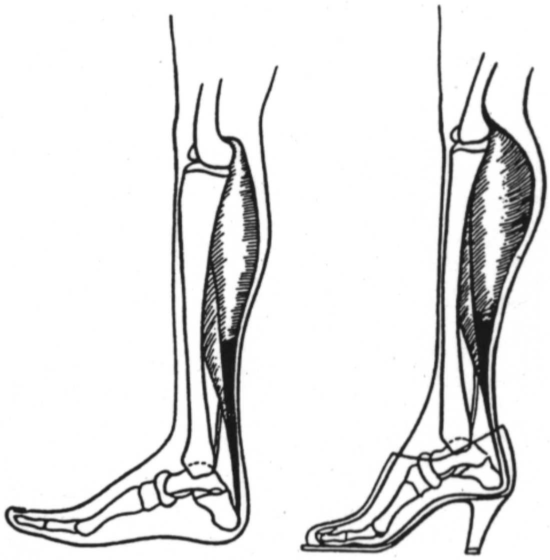


Fig. 11: *Left*, normal state of Achilles tendon and calf muscles barefoot; *right*, shortening of tendon and muscles on medium 2-inch heel—and greater still on 3-inch heel.

Fig. 12: Toe spring, the uptilt of toe end of the shoe, built into the last and transferred to the shoe.

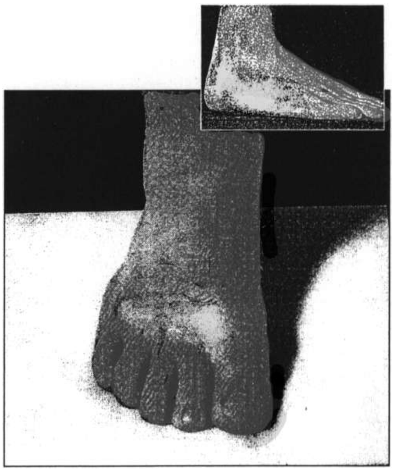


Fig. 13: Normal flat plane of digits, enabling them to fulfill natural ground-grasping action in taking a step. They are functionally immobilized by uptilted toe spring of shoe.

On the bare, natural foot the digits rest flat, their tips grasping the ground as an assist in step propulsion. (Fig.13). Inside the shoe, the digits are lifted slantwise off the ground, unable to fulfill their natural ground grasping function.

So why is toe spring built into the last and shoe? To compensate for lack or absence of shoe flexibility at the ball. The toe spring creates a rocker effect on the shoe sole so that the shoe, instead of full flexing as it should, forces the foot to "roll" forward like the curved bottom of a rocking chair. The thicker the sole, such as on sneakers or work boots, or the stiffer the sole (such as on men's Goodyear welt wingtip brogues), the greater the toe spring needed because of lack of shoe flexibility.

With toe spring, the toes of the foot are constantly angled upward five to twenty degrees, depending upon the amount of shoe toe spring. Functionally, they are "forced out of business," denied much or all of their natural ground-grasping action and exercise so essential to exercising of the whole foot because 18 of the foot's 19 tendons are attached to the toes.

The combination of the up-tilted toes caused by the toe spring, and the down-slanted heel and foot caused by the heel wedge angle, create an angle apex at the ball where the two angles converge. The angle apex has a dagger-point effect on the ball (Fig. 14). This is certainly an important contributing cause of metatarsal stress symptoms and lesions.

But equally important, the natural gait mechanics are affected. Because the hallux and other digits are largely

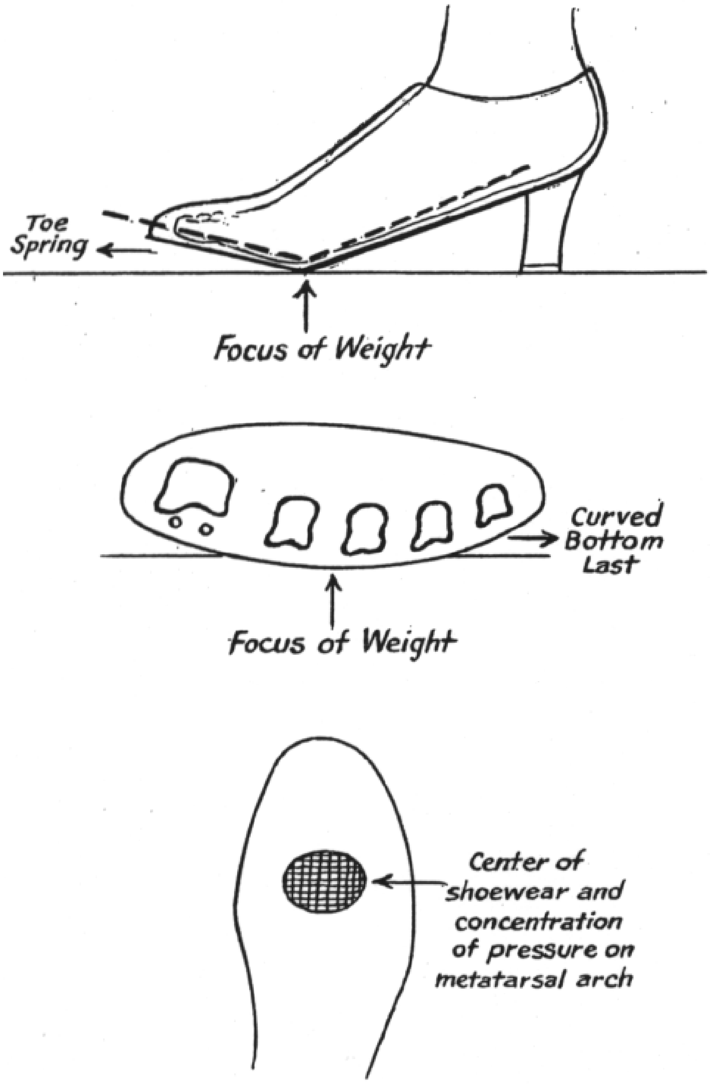


Fig. 14: *Top*, apex of heel wedge angle and toe spring angle focuses weight at "dagger point" at ball; *center*, concave bottom last across ball further accentuates weight focus on middle metatarsals; *bottom*, tread surface concentrated on center of ball.

immobilized by their uptilted position, the step propulsion must come almost wholly from the metatarsal heads. This not only imposes undue stress on the heads, but forces an unnatural alteration of the gait pattern itself.

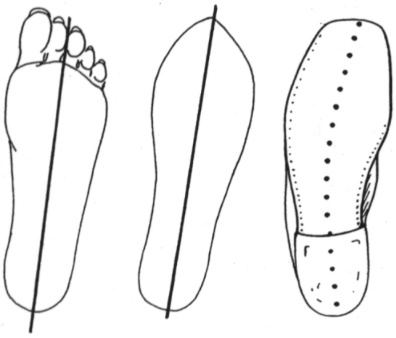


Fig. 15: *Left*, normal straight axis of foot, divided into two equal longitudinal halves; *center*, corresponding straight-axis last (rare); *right*, inflare last, typical of most conflicts with straight-axis foot.

Gait Hazards of the Last

The shoe’s last, the form of mold over which the shoe is made, is not visible to the consumer, but it bears much influence on the shoe and gait. There are several built-in design faults with most commercial lasts, but two in particular have relevant influence on gait.

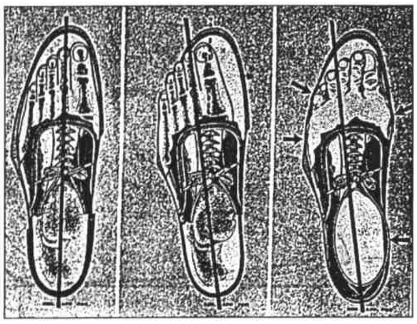


Fig. 16: *Left*, foot in straight-axis shoe; center, foot in inflare or crooked-axis shoe (most common); *right*, consequence of straight-axis foot in inflared or crooked-axis shoe.

First, almost all shoe lasts are designed with inflare, whereas almost all feet are designed on a straight axis (Fig. 15). This automatically creates a biomechanical conflict between foot and last (or shoe) (Fig. 16). This is the prime reason why virtually all shoes go out of shape with wear—because foot and shoe are mismatched. If, because of this conflict, the foot cannot function naturally inside the shoe, it cannot take a normal or natural step.

A second common fault of the last is the concavity at most lasts under and across the ball, which is automatically “inherited” by the shoe at the same site (Fig. 17).

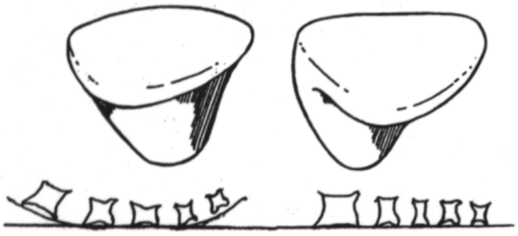


Fig. 17: *Left*, concave-bottom last (common) causing “failing” of middle metatarsal heads; *right*, flat-bottom last (rare) allowing normal flat plane of metatarsal beads.

Why are lasts made with a concavity under the ball? Tradition. About 80 years ago a shoe manufacturer discovered that the foot could be made to look smaller and trimmer by allowing it to “sink” into a cavity under the ball of the foot that no one would see—thus reducing the amount of foot volume visible above. It was so successful in its mission of smaller-looking feet that it was quickly adopted by other manufacturers. It has long since become a standard part of last design.

This cavity is further accentuated by the construction of the shoe itself, wherein the space between outsole and insole must be filled with a special filler material (ground cork, foam rubber, fiberglass, etc.). However, the combination of the foot’s heat, moisture, and pressure forces the filler material to compress and “creep”, deforming its original flat surface (Fig. 18).

The combination of the concave-bottom last at the ball and the compression and creep of the filler material sinking into the cavity, creates a sinkhole into which the three middle metatarsal heads fall as the first and fifth heads rise on the rim. We thus have the classic “fallen” metatarsal arch. The application of a metatarsal pad, whether in the shoe or via an orthotic or strapping, provides relief—not because it “raises” the arch but simply by filling in the cavity and returning the heads to their natural level plane (Fig. 18).

Thus the important role of the metatarsal heads as a fulcrum and the toes as grasping-gripping mechanisms for step propulsion is seriously diminished. The step push-off is now almost entirely from the ball, and weakly so because the metatarsal heads are pushing from a cavity rather than from a flat surface. (Fig 19) A propulsive energy must now be drawn from other sources—legs, thighs, hips, the forward tilt of the trunk and shoulders—with undue strain on all those body sectors. The gait loses natural form and function.

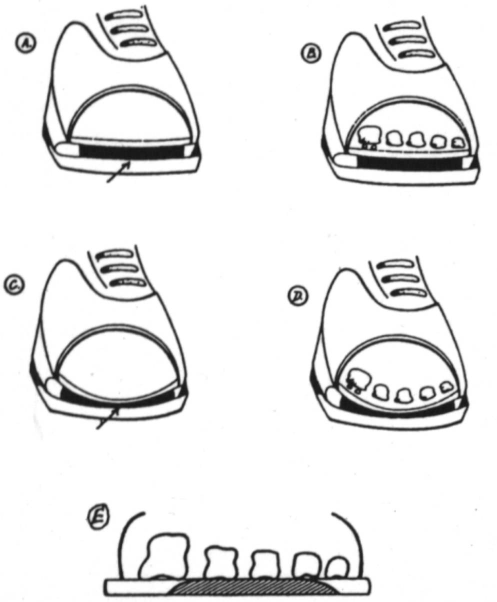


Fig. 18: *A*) bottom filler (dark area) when shoe is new, *B*) metatarsal heads assume normal flat plane, *C*) compression of bottom filler with wear creates filler “creep” and concavity. *D*) metatarsal heads sink into cavity to cause “fallen” metatarsal arch: *E*) metatarsal pad fills cavity and returns beads to normal flat plane.

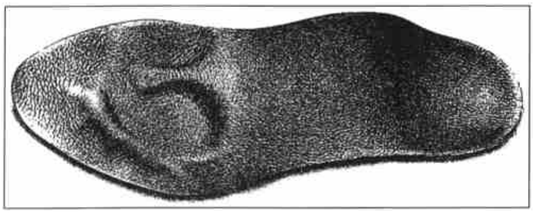


Fig. 19: Not uncommon consequence of insole depression under ball caused by compression of bottom filler and concave bottom of last.

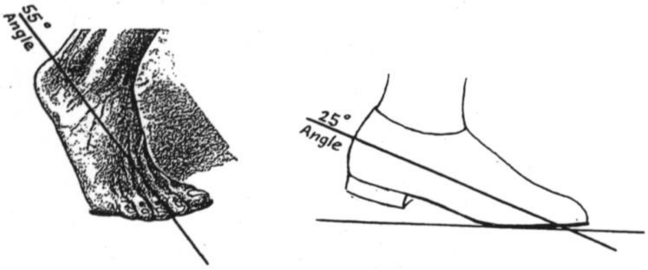


Fig. 20: *Left*, normal 55 degree angle of foot flexed for step pushoff, *right*, typical 25 degree flex angle of shoe, creating flex resistance and energy strain for the foot.

Shoe Flexibility

On taking a step, the foot normally flexes approximately 54 degrees at the ball on the bare foot (Fig.20).

But all shoes flex 30 to 80 percent less than normal at the ball. (Fig. 20) This obviously creates flex resistance for the foot by the shoe. The foot must now work harder to take each of its approximately eight thousand daily steps. The required extra energy imposes undue strain and fatigue on the foot.

Why are most shoes inflexible? First, the average shoe bottom consists of several layers of materials or components: outsole, midsole, insole, sock liner, filler materials, cushioning. This multiple-layered sandwich poses a formidable challenge to bending or flexing. Second, many types of footwear—athletic, sneakers, work and outdoor boots, walking, casual, etc.—have thick soles which add further to inflexibility.

Many elderly people whose feet have lost elasticity and flexibility over the many years of shoe wearing have difficulty climbing or descending stairs. They must use stair rails for pull-up power and security.

The National Safety council reports that in 1994 (latest figures) 13,500 fatalities occurred from stair fails-and 2,500 of the victims were over age 65. An even greater number of casualties from stair falls resulted in serious injuries (fractures, sprains, etc.), occurring with people of all ages. Climbing and descending stairs requires both foot flexibility and the lift power from the Achilles tendon and calf muscles. If both have been diminished and handicapped by habitual shoe wearing, then the stability and security of the gait itself are diminished and handicapped.

Any heel, low to high, requires a compensatory alteration or forward slant on the last, which is translated to the shoe. This slant is known as the "heel wedge angle".

Most people, including medical practitioners and shoe people, test for shoe flexibility in a wrong manner, by grasping the shoe at both ends and bending the sole. But that flexes the shoe *behind* instead of *at* the ball. If the foot were flexed in the same manner, the five metatarsals would be fractured. (Fig. 21)

To properly test for flexing, rest the shoe sole down on a table or counter. Insert one hand inside, using a couple of fingers to press down on the ball. With a finger of the other hand, lift the toe tip of the shoe. If the toe end, tip to ball, lifts easily, the shoe is flexible. The degree to which it resists toe lift is the degree to which it is inflexible. (Fig. 22)

The more inflexible the shoe, the more flat-footed the gait manner. With inflexible or semi-flexible shoes (which include most) the step push-off is almost wholly from the ball, thus fulfilling only half to three-fourths of the natural step sequence.

Fig. 21: Two views of deceptive shoe flexion. The flexion is behind, not at the ball.

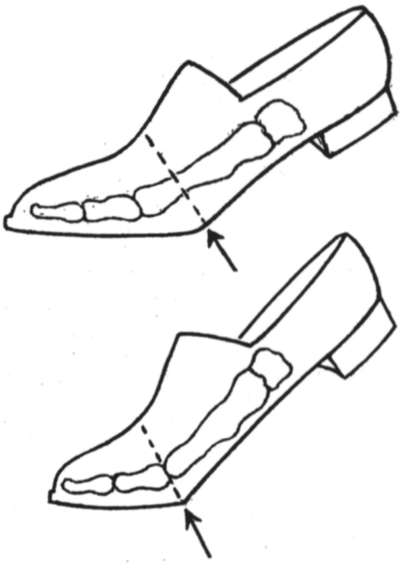


Fig. 22: *Top*, wrong shoe flexion, with bend behind ball; *bottom*, correct flexion at ball.

Shoe Weight

Most shoes weigh too much. The average pair of dress shoes weighs about 34 ounces; a pair of wingtip brogues about 44 ounces; some work and outdoor boots up to 60 ounces or more. Women's dress and casual shoes average 16-24 ounces a pair; women's boots about 32 ounces.

A lightweight pair of 16-ounce shoes amounts to a cumulative four *tons* of foot-lift load daily (16 ounces times 6,000 foot-lift steps). If the shoes weigh 32 ounces, daily footlift load is eight tons; 44 ounces adds up to 11 tons a day. Every added four ounces of shoe weight adds another one ton to foot-lift load.

These foot lift loads impose an energy drain not only on the foot but the whole body. It is a common though little recognized source of foot and body fatigue which is why, after a long day on one's feet, one arrives home feeling "dog-tired" and kicks off one's shoes.

Snug or narrow fit has a negative effect on gait because the natural expansion of the foot with each weight-bearing step is prevented.

You can walk several miles carrying a four-pound weight on each shoulder. But you can barely manage 100 yards with the same weight attached to each foot. The reason is simple physics: the farther the load from the center of gravity, the heavier the energy and "lift" strain.

No footwear, with certain exceptions, should weigh more than 12 ounces a pair for women, 16-18 ounces for men.

Excessive shoe weight forces an alteration of natural gait form. The drag effect and energy drain of the shoes creates alterations in the natural step sequence—a smooth, easy movement heel to lateral border to ball to toes is disrupted. The common descriptive expression "dragging one's feet" aptly applies here.

Shoe Fit

There is substantial and incontestable evidence that no commercial footwear fits properly, regardless of type, brand, style, or price. This is because of a combination of inherent faults in the lasts, shoe design and construction. Even the shoe sizing system itself is riddled with faults (we are, incredibly, still using the "system" introduced 630 years ago and "updated" 117 years ago).

One example is width fit. A recent study was conducted by Dr. Francesca M. Thompson, chief of the Adult Orthopedic Clinics at St. Luke's Hospital, New York, involving several hundred women. The average measurement across the ball of the foot was 3.66 inches, but the shoe measurement at the same site measured less than three inches. Thus, almost all were wearing shoes 20 percent too narrow at the ball (Fig. 23).

Fig. 23: Foot inside snug-fit shoe. Whole lateral rim of metatarsals and digits are pushed in by the shoe, depriving them of normal function.

Too-narrow or "snug" width fit occurs with about 90 percent of men's and women's shoes alike. In the stores it has long been the contention that snug fit is right because the foot needs "support" and also because the snug fit allows the shoe to "conform" to the foot with wear. It is also regarded as proper fit by most doctors and consumers.

Snug or narrow fit has a negative effect on gait because the natural expansion of the foot with each weight-bearing step is prevented. The normal plantar surface at the ball is diminished, affecting foot balance and the security of the gait itself.

Reduced Foot Tread

One of the most insidious of the numerous negative effects of footwear on gait is loss of foot tread surface. With the shod foot, 50 to 65 percent of the foot's natural tread surface is lost. This is easily seen by examining the sole surface of a worn shoe. Most of the wear is concentrated at the rear-outer corner of the heel top-lift and the center or medial undersurface of the ball. The rest of the sole is usually unworn or only slightly worn. A footprint will show 50 to 70 percent greater tread surface.

Under these conditions we automatically have an unbalanced foot receiving excessive strain on small portions receiving the brunt of the wear. It is impossible for such a foot to "walk right," meaning with natural function and full tread.

> ***Throughout all history to the present, nobody has yet designed an ideal shoe while at the same time providing the esthetics and styling desired by consumers.***

A dog (or any other four-footed animal) has a much greater and more stable base beneath its body than does a human (Fig. 24). We humans stand erect with a relatively tiny base beneath us and with the center of gravity about hip high. The dog has a much lower center of gravity, plus a much larger base area beneath its body balanced on four legs.

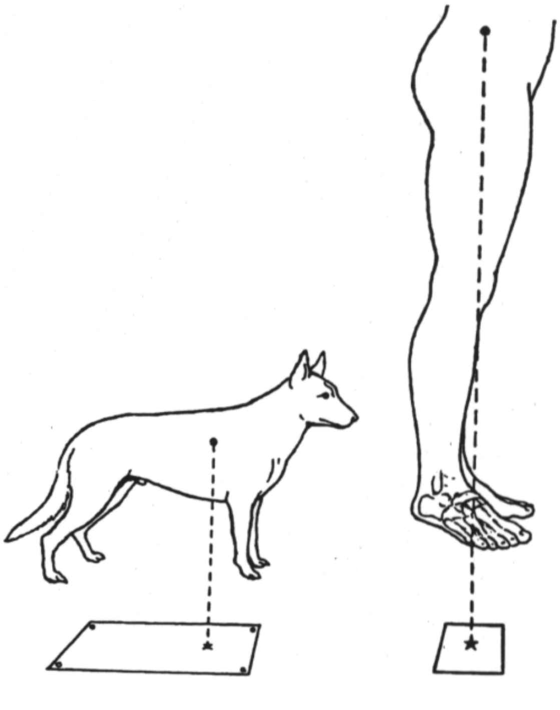


Fig. 24: *Left*, dog has lower center of gravity and more than twice the base area beneath Its body, allowing greater stability of weight distribution; *right*, man has much higher center of gravity and very small base for falling weight, making body balance and equilibrium much more fragile and requiring enormous skeletal and muscular support for stable stance and gait.

It's the difference between balancing a small cube in the palm of your hand, then trying to balance a long, thin pencil on its end in the same manner. This is why half of the body's 650 muscles and 208 bones (plus most of its joints and ligaments) are required just to stand and walk. They are necessary to keep that long pole of body erect.

To further jeopardize this fragile balance of the body column by denying it half or more of its base tread surface is pushing the biomechanics of gait to extremes of risk. Yet, that is exactly what happens because of the various tread faults of the shoes we wear.

Sensory Response

Podiatry, unfortunately, along with all the other medical specialties, has given little attention to the role of the earth's bioelectromagnetic forces relative to sensory response of the foot, which bear enormous influence on gait. It is a field begging investigation by podiatry, because the foot is so intimately involved.

The soles and tips of the toes contain over 200,000 nerve endings, perhaps the densest concentration to be found anywhere of comparable size on the body. Our nerve-dense soles are our only tactile contact with the physical world around us. Without them we would lose equilibrium and become disoriented. If the paws or feet of any animal were "desensitized," the animal could not survive in its natural environment for an hour.

Says orthopedist Philip Lewin, "The foot is the vital link between the person and the earth, the vital reality of his day-to-day existence."

City College of New York anatomists Todd R. Olson and Michael E. Seidel write, "Because the sole is so abundantly supplied with tactile sensory nerve endings, we use our feet to furnish the brain with considerable information about our immediate environment.'

Thus there is a sensory foot/body, foot/brain connection vital to body stability, equilibrium, and gait.

Yet, much of it is denied us because of our thick-layered, inflexible shoes that shut off a considerable amount of this electromagnetic inflow and our sensory response to it. B. T. Renbourne, M.D., of England's Brookside Hospital, has done considerable research in this field. He writes, "Modern shoes give good wear, but they also impair the foot's sensory response to the ground and earth, affecting the reflex action of the foot and leg muscles in gait. This sensory foot contact is essential for stable, surefooted walking.'

It is well known by both common experience and clinical testing that infants are able to walk with much more confidence and stability barefoot than with shoes on. In fact, the same can be said of adults. This is not only because of the foot's biomechanics (flexing, toe grasping, heel-to-toe step sequence, etc.), but also because of the neural energy assist from the sensory response.

However, when several layers of shoe bottom materials are packed between foot and ground, a certain amount of sensory blockage is inevitable, and the gait loses some of its natural energies and functional efficiency.

The Role of Orthotics

The foregoing comments concerning natural human gait require a completely fresh perspective concerning the use of foot orthotics-especially those designed to establish or re-establish "normal" foot balance and stability of gait.

To put the conclusion first: natural gait is impossible for the shoe-wearing foot—at least shoes as traditionally designed and constructed. And it is equally impossible for any orthotic to achieve "correct" foot and body balance and gait stability with the orthotic inside the gait-negative shoes, no matter how correct and precise the biomechanical design of the orthotic.

A secure, stable superstructure cannot be erected on a design-defective base or foundation (the Tower of Pisa is a classic example). In regard to "restoring" natural gait, shoe and orthotic are biomechanically incompatible. While orthotics may assist as therapy in more extreme gait faults, they are not suitable therapy to correct or stabilize gait and return it to its natural, unadulterated state.

Summary

We have always assumed that most people in modern shoe-wearing societies walk "normally." It is true only if we use the term "normal" in its liberal context, meaning to conform to an accepted standard or general average.

But *natural* walking—the pure manner without faults of form or function—is quite another perspective. All ambulatory creatures in nature walk naturally, hence with maximum efficiency. That includes all shoeless people, who are the only "pure" walkers on the planet. All the rest of us, by grace of the shoes we wear, are defective walkers in varying manner or degree. And who knows how many of our foot problems stem, directly or indirectly, from those shoe-caused postural and gait faults.

Does all this suggest that the only means of retaining or regaining the natural state of gait is to go barefoot? Unfortunately, yes. That is, until the "ideal" shoe, devoid of all the faults of design, construction, and performance of traditional footwear, is made available. But, throughout all history to the present, nobody has yet designed such a shoe while at the sane time providing the esthetics and styling desired by consumers.

A secure, stable superstructure cannot be erected on a design-defective base or foundation.

But how about modern custom-made, custom-fitted shoes? Certainly they should permit natural gait. Not so. While they provide custom fit they also include the usual biomechanical faults—the use of heels, lack of flexibility, toe spring, excessive weight, etc., which largely nullify the custom fit.

Ironically, the closest we have ever come to an "ideal' shoe was the original lightweight, soft-sole, heel-less, simple moccasin, which dates back more than 14,000 years. It consisted of a piece of crudely tanned but soft leather wrapped around the foot and held on with rawhide thongs. Presto! custom fit, perfect in biomechanical function, and no encumbrances to the fool or gait.

The vital importance of the foot to gait is only too obvious: no feet, no gait; the lower the functional performance of the feet, the lower the functional performance of the gait.

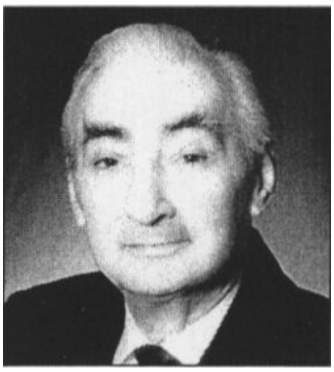
But the foot's role in gait has even greater significance which most podiatrists themselves don't fully realize or appreciate. The foot's architectural design and its consequent biomechanical function was responsible for our distinctive erect manner of gait, walking on two feet with a stride.

That accomplishment-perhaps the single most significant development of bioengineering in all evolutionary history-was responsible for making us human in the first place and the spawning of the human species. More than any other distinctive human capacity-the huge brain, language, conceptual thinking, etc.-our unique form of gait, unduplicated in all evolutionary history, was the very seed of our humanity.

The noted anthropologist Frederick Wood-Jones states, "Man's foot is all his own and unlike any other foot. It is the most distinctive part of his whole anatomical makeup. It is a human specialization; it is his hallmark, and so long as man has been man, it is by his feet that he will be known from all other creatures of the animal kingdom. It is his feet that will confer upon him his only real distinction and provide his only valid claim to human status." To that, Donald C. Johanson, paleoanthropologist and Chief of the Institute of Human Origins, Berkeley, California, adds, "Bipedalism is what made us human," Thus, man stands alone because only man stands.

It took four million years to develop our unique human foot and our consequent distinctive form of gait, a remarkable feat of bioengineering. Yet, in only a few thousand years, and with one carelessly designed instrument, our shoes, we have warped the pure anatomical form of human gait, obstructing its engineering efficiency, afflicting it with strains and stresses and denying it its natural grace of form and ease of movement head to foot. We have converted a beautiful thoroughbred into a plodding plowhorse.

True, despite all these shoe-induced handicaps of gait, the human species is doing fine. But we might make our lives a shade better if we could find a way to regain our natural manner of walking and at the same time keep our shoes on our feet.



Dr. Rossi, a frequent contributor to this magazine, serves as a consultant for the footwear Industry, and resides In Marshfield, MA.