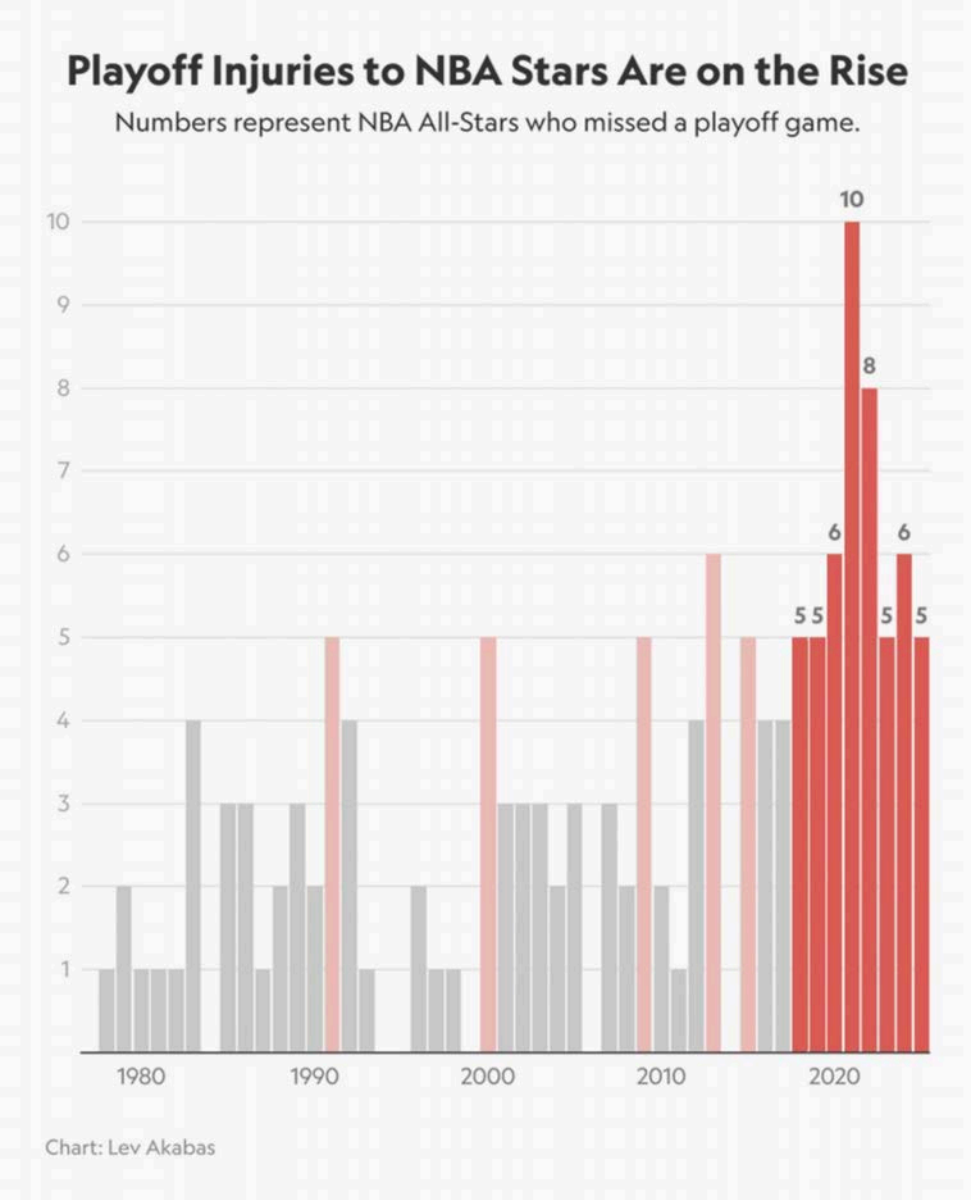
WHAT IS CAUSING THE HUGE RISE OF INJURIES IN THE NBA? IT'S THE SHOES



By Frampton Ellis

VERSION 1.1

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THE ALARMING INCREASE OF CRITICAL INJURIES IN THE NBA

What is causing the enormous increase of **Achilles tendon ruptures, ankle sprains, knee ACL ruptures, and hamstrings tears in the NBA today**? The simple answer: **it's the shoes.** Glaring evidence is abundant, but has been overlooked.

Lateral stability in the old classic basketball shoes was never great, but at least you had to step on another player's foot to rollover your ankle into a sprain. Today's high tech basketball shoes can rollover on their own now, as proven ad nauseam in **actual NBA game video**. Using that video, **expert analysis** reveals compelling evidence that **modern basketball shoes are uncontrollably unstable**.

Industry-wide, shoe design consensus is to **maximize comfort** today. So the **midsole foam** of modern basketball shoes **is too thick** and **too soft**, reinforced by **too rigid plastic that blocks natural foot motion. Gross instability is the result**.

The gradual evolution of these modern "improvements" has pushed basketball shoes slowly past a tipping point into **excessive instability**. All NBA players today have many more serious injuries – often recurring – than in the past, even the greatest superstars. So the obvious question cannot be avoided.

Are modern basketball shoes too unstable now for NBA players to wear?

THE MOST STABLE BASKETBALL SHOES AVAILABLE TODAY ARE OLD CLASSICS

Classic shoe soles are generally **too narrow with too much heel drop**. However, they caused far fewer serious injuries because they are relatively **much less unstable**. That is due to their much **thinner and firmer soles with foxing edge reinforcement**, especially in the **forefoot**, reducing ankle sprains & knee injuries.

Crucially, classic soles are also not "improved" by today's **rigid plastic anti-torsion systems** that block natural foot lateral motion between forefoot and heel, nor by **sole thickness taper under toes** – both causes of Achilles tendon ruptures.

Far more stable but much less comfortable than modern shoes are the original basketball shoe – the **Converse Chuck Taylor All Star** – in **Wide** size and the **Nike Air Jordan 1**. **Less stable, but more comfortable** are the **Converse Chuck 70** (also in **Wide**), **Puma Clyde, Adidas Forum,** and **Converse Weapon**, followed by the **Nike Dunk, Adidas Superstar,** and **Air Jordan 2**.

Although very far from perfect in either comfort or stability, these old classics are the most stable basketball shoes available to wear in the NBA today.

Note: the particular shape of a wearer's feet can determine which classic shoe provides the best stability for that wearer, so shoe fit is a critical factor in addition to sole structure.

SIMPLE REDESIGN OF MODERN SHOES PROVIDES MUCH BETTER STABILITY

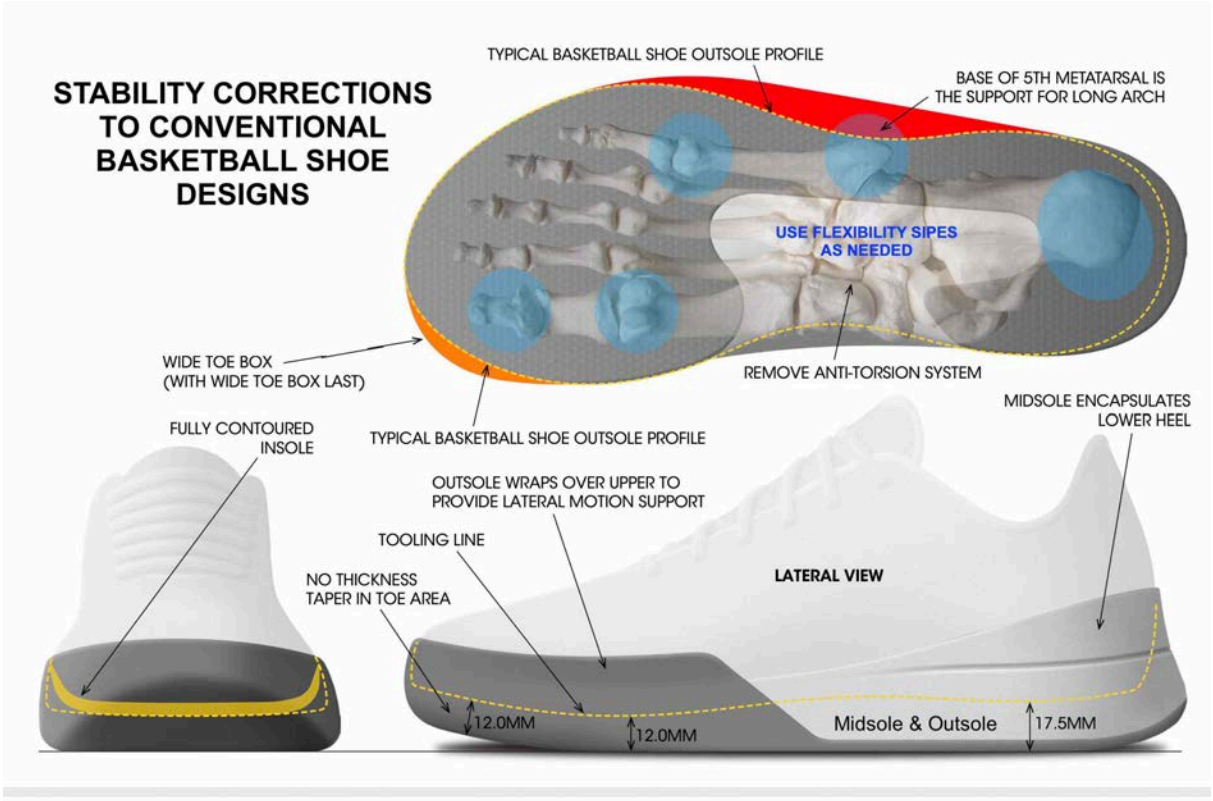
The most logical **Sole Redesign** (illustrated below) starts by **undoing** the single worst modern "improvement" by **replacing the excessively rigid anti-torsion plastic reinforcements with classic foxing or side wraps of outsole or flexible plastic**. They act as stiff sidewalls to offset the edge weakness of foam midsoles. Also, use sole **sipes or slits** as necessary to restore natural torsional flexibility to the shoe sole between forefoot and heel, like the wearer's foot.

The sole redesign also **undoes** other destabilizing modern "improvements" by substantially **reducing the excessive thickness and softness of midsole foam & using toe spring to bend up toe area, not tapering midsole thickness under toes.**

It also **corrects** the far less than perfect **Classic Shoe sole design** by**: using a wider toe-box on the narrow forefoot (wider by the big toe and by the head of 5th metatarsal bone); replace shoe sole under the base of the 5th metatarsal bone, not the large sole indentation;** and **reducing heel drop to about 3-7 mm**.

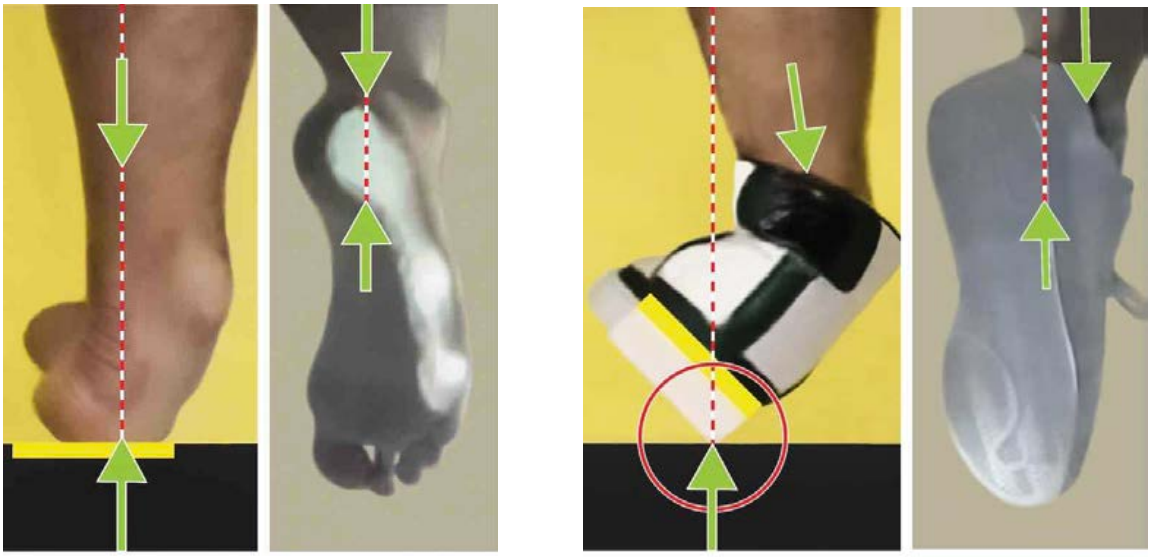
These vital stability corrections are technically easy for footwear companies to implement, since they are just routine revisions of existing designs that **merely undo** the sole instability that is well-defined in the detailed analysis that follows.

Quickest and easiest, with the least to undo, fix the Classic Shoes first!



A FIRST STEP TO THE BEST SOLUTION? Dump the Ancient Cobbler Sole Design

A key scientific discovery indicates all of the above sole fixes only patch up an ancient and fundamentally flawed basic design. The discovery revealed that, **without shoes, the ankles of barefeet are naturally stable in the classic rollover ankle spraining position** (shown below). Although obvious now, that simple fact was inexplicably overlooked for at least 2,000 years, hidden in plain sight.



STABLE BAREFOOT UNSTABLE SHOE

This discovery utterly contradicts what has always been blindly accepted in medicine and biomechanics as scientific fact: that **poorly evolved human ankles are inherently unstable**. Even though obvious now to non-experts**, the true cause of instability – shoe soles – has not yet been assimilated by the industry**.

So, if shoe soles are basically unstable, how can they be redesigned to have barefoot-like stability? The most direct answer structurally is **a new and totally different shoe sole, shaped like the bare sole of the foot** to retain its stability.

A**s a public service to test that answer,** a limited number of **barefoot sole-based basketball shoe prototypes** have been collaboratively designed with athletic footwear experts and factory-produced (US sizes 6-18M). The radically different prototypes have unique barefoot-like stability and surprising comfort.

Baresole® basketball shoe prototypes are available now for experimental testing and development. They use non-proprietary technology, free to use and improve. **Help us carefully test them in recovery, rehab, warmup and practice.**

See **FEbaresole.com**

WEAR TEST THE EXPERIMENTAL BARESOLE® BASKETBALL SHOE PROTOTYPE

Help us test and develop these shoes to design the next version.
Tell us how to make them better for you.



ALSO HELP US TEST BARESOLE® SLIDES: Super Comfort and Barefoot Stable

Some recovery slides are so unstable that just walking is tricky, but not these **experimental baresole® performance slide prototypes**. **Carefully wear test them during recovery, rehab, and warmup** to support feet and ankles with barefoot-like stability and extreme comfort. See **FEbaresole.com**.



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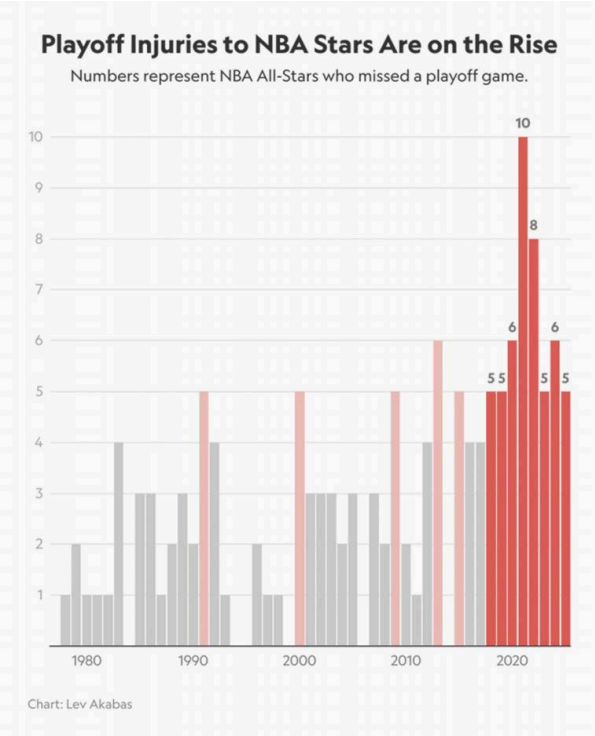
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ADDITIONAL FILES – BASKETBALL SHOE SPECIFICATIONS:

A. **CLASSIC BASKETBALL SHOES**
B. **2025 BASKETBALL SHOES - SAMPLE BASKETBALL SHOES WORN DURING ACHILLES TENDON RUPTURES**
C. **2026 BASKETBALL SHOES - NEXT MODEL YEAR OF SAMPLE BASKETBALL SHOES (B) AND SOME OTHER TYPICAL NEXT MODEL YEAR SHOES**

What Caused the Rupture of Tyrese Haliburton's Achilles Tendon?



A new plague of serious injuries in the NBA has grown slowly over past decades to today's sudden extraordinary peak. The peak injury years in the 2020 decade are up about 100% from prior decades going back to the 1980's. Total injuries are up about 400% from the 1980's, when classic basketball shoes were the much less risky and only option: less comfortable, but far safer.

The recent increase in NBA injuries is caused by a combination of innocuous structural "improvements" in the basic sole design of basketball shoes industry-wide.

The worst of these "improvements" is far too rigid and extensive plastic reinforcements in the shoe sole that prevent natural foot torsional flexibility. The rigid sole reinforcements evolved apparently in a counterproductive attempt to re-stabilize basketball shoe soles that became inherently unstable as they became too thick and too soft in order to provide greater comfort.

Centered in the sole's midfoot arch area and extending into the forefoot and heel, the relatively hard plastic sole reinforcement artificially locks together a player's forefoot, midfoot, and heel. This shoe sole rigidity is completely unlike the player's highly flexible foot.

The shoe sole's artificial rigidity prevents the natural torsional motion along the foot's long axis. That natural torsion motion is absolutely essential to prevent serious ankle injuries, like the **ankle sprains** that occur in the **classic rollover lateral ankle spraining position**. And equally essential to prevent the serious **associated knee ligament, hamstring, and other injuries** that result directly above and from the unnatural ankle twisting motion.

The rigid plastic reinforcement also puts abnormal twisting torque focused tightly during the **classic pushoff from a stepback position** on the heel bone. That and the modern shoe sole's inherent medial instability unnaturally **strains or ruptures the Achilles tendon** at its weakest point on the outside edge of its medial or inner base of attachment to the heel bone.

The artificial locking together of the forefoot and heel also prevents the natural toe-off flexing motion between forefoot and midfoot/heel. That forefoot flexibility is just as critical to preventing serious **Achilles tendon strain or rupture** by avoiding excessive medial instability.

The Recent Tipping Point:



In recent years rigid plastic sole reinforcements have been extended throughout the shoe sole forefoot of many basketball shoes, extending even to the toes (see upper **red arrow**), greatly increasing the unnatural forefoot inflexibility that induces Achilles tendon strains and ruptures.

Also in recent years, **the shoe sole indentation on the side of the lateral midfoot (inside blue oval) has often become enormous**, greatly increasing lateral instability and resulting in ankle sprains even without contact with other players, as well as directly associated knee and other injuries, including critically weakening the longitudinal arch of the foot and fracturing the base of the 5th metatarsal bone.

Together, both of these recent changes are most responsible for the latest rise in NBA injuries during the last decade.

The video evidence from NBA games that is included later in this analysis provides powerful support for this identification of modern basketball shoe sole design flaws as the primary causes of these potentially avoidable serious injuries, like Tyrese Haliburton's Achilles tendon rupture.

Background on the Anti-Torsion Problem:

Ironically, the worst of the backfiring improvements was apparently originally intended to improve shoe sole **torsional flexibility**, seemingly a well-meaning goal. But, instead, the original shoe sole device in the midfoot evolved rapidly into its polar opposite, **rigid anti-flexibility** for the entire sole. That has resulted directly, together with the increase in sole thickness and softness, in gross lateral instability in basketball shoes that is so bad that it is visually obvious in NBA game video. That extreme instability has led directly to its most direct effect: a major increase in ankle sprains and directly associated knee, hamstring, and other injuries, real problems now in the NBA.

The continued increase in rigidity recently may have been prompted at least in part by the widespread use beginning in 2017 of new running "**supershoes**", which were widely claimed to have much better efficiency performance. That performance claim was based on much thicker soles made of newly created softer and more highly resilient midsole material, together with an internal lever of relatively rigid carbon fiber material. It is certainly true that softer, thicker soles significantly increase comfort, while also having a markedly new and different springy feel due to the rigid levers embedded in the softer sole.

However, the two most authoritative formal scientific studies yet done, and by far the most influential, both published within the last two years in ***Footwear Science***[1], concluded that the claimed energy return benefits of "super shoes" are not real and are instead merely a **placebo**

effect. That is the same conclusion I reached in a critique of current footwear originally published in draft form several years ago in the **Appendix** section of my new footwear book, ***Unnatural Instability***. Moreover, the most recent biomechanical research[2] indicates that the ultra-stiff carbon-fiber plates used in "supershoe" soles alter the biomechanics of the ankle, knee, and hip joints, thereby elevating injury risk.

My book focuses on my surprising discovery that ankle sprains – the most common sports and medical injury by far – are caused beyond any reasonable doubt by an ancient and innately flawed shoe sole design, not the result of poorly evolved human ankle joints, as blindly believed in science and medicine before now. As a public service, the draft book is available for preview and free download at **FEbaresole.com/Books**.

Regardless of their questionable role in setting world records in distance running by relatively small and expected increments, both "super shoe" performance and. in general, running shoe performance have little if any direct utility for basketball shoe design. A prime example, running "super shoes" generally have extremely poor lateral stability, but good lateral stability is of critical importance in basketball shoes.

Nevertheless, "Super shoes" sole technology does have better comfort resulting from their softer, thicker soles. Moreover, comfort is the single most important factor in general footwear satisfaction and purchase decisions, critical in selling shoes.

So, apparently to noticeably improve comfort like that in "super shoes", in recent years basketball shoe designers have tried to introduce adaptations of the structural "improvements" of "super shoes" into basketball shoes. Unfortunately, that improved sole comfort comes from thicker and softer foam material, which both degrades responsiveness, which reduces reaction speed, and increases edge weakness, which innately increases lateral instability. Both are big problems for basketball shoe performance and for injury prevention.

Thickness and softness inherently reduce the quick reactions that are supercritical in basketball and other court sports. Excessive sole softness results in a player sinking down before bottoming out to push off, resulting in too many milliseconds and a quick first step lost.

As a result, today's basketball shoe designers have had to use rigid reinforcements throughout the entire shoe sole, from heel to toe, trying thereby to preserve a reasonable level of responsiveness, performance, and edge stability for lateral stability in the thicker and softer soles of new basketball shoes.

Preserving mandatory sole responsiveness, performance, and edge stability are certainly legitimate design goals. However, shoe designers seem to have been consistently blind to the potentially adverse consequences of the new rigid sole reinforcements introduced without limit to achieve them. A little basketball shoe history makes those consequences easier to see.

Today's Shoe Sole Thickness Problem

The drastic change in sole structural design crept in slowly. For comparison, back in 1984, the then brand new **Nike Air Jordan 1** basketball shoe had no rigid sole reinforcements and a very thin forefoot without a cushioning midsole (only outsole and insole in the forefoot), like earlier basketball shoes. The forefoot of the Air Jordan 1 was only about **11** mm thick, compared to a **21.6** mm average today, an extraordinary **+96%** thickness increase.

It's worth remembering that **Michael Jordan** wanted his first basketball shoes to be "…close to the ground. I didn't want to feel like I was playing in high heels shoes because it would increase my chances of twisting an ankle. **I wanted to feel like a racecar, close to the ground**" (from his autobiography, ***Driven From Within***).

Simple biomechanics dictates that the **forefoot thickness** of a basketball shoe is the

primary factor in determining its stability in lateral motion, since the sport of basketball is played primarily on the balls of players' feet. The very thin **11** mm and firm forefoot of the Air Jordan 1 guaranteed instant responsiveness for the quickest possible start.

That may help to explain Jordan's otherworldly quickness in his earliest NBA years, when his first step seemed to be a full step faster than anyone else in the NBA. At times he seemed to move around other players like they were standing still, as you can still see again in **Netflix's The Last Dance**, Episodes 2 & 3 (also before he had to bulk up later with significantly more muscle to survive the Detroit Piston's "Jordan rules").

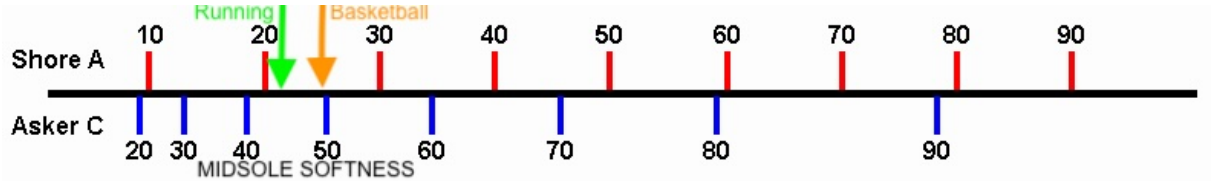
The **11** mm **Air Jordan 1**, as well as the similarly thin forefoots of the older **Converse All Star** and **Adidas Superstar** basketball shoes (both about **13** mm) – **all were too firm to be comfortable**, especially by today's standards. **But footwear-related serious injuries were also much rarer in the NBA then – unlike today,** when injuries have become the focus of intense attention due to their alarming frequency, seriousness, and recurrence.

Today's Shoe Midsole Softness Problem:

Basketball shoes with increased sole thickness and softness compared to the past are **inherently less stable in lateral motion**, causing more ankle sprains and many other associated serious injuries.

Essentially for comfort, all modern basketball shoes today have midsoles made of soft foams that are on average are only **22% firmer** than those of running shoes **(25.1** HA **vs. 20.6** HA**)** and with a forefoot only **17% less thic**k than a running shoe forefoot **(21.6** mm **vs. 26.0** mm**).** (The averages are of 73 basketball shoes and 267 running shoes from **runrepeat.com** reviews of the past few years; HA stands for Shore A durometers, a midsole softness measure; the higher the firmer)

This durometer scale shows how unusually close to the same midsole softness both running shoes and basketball shoes are now. Both had significantly higher firmness ratings in the past (perhaps due to limitations in the chemical composition of injected foam plastic then), and were also farther apart relative to each other, with basketball shoes and running shoes both firmer in the past.



To compare the above averages of all running shoes directly to several well-known running supershoes, the **Nike Vaporfly 2** supershoe had midsole foam of **19.0** HA, only slightly less than the **20.6** HA average of all running shoes. And the **Vaporfly 3** supershoe had a forefoot thickness of **26.0** mm, exactly the same as the average for all running shoes. So running supershoes can have sole softness and thickness very close to the average of all running shoes today (data from **runrepeat.com**).

Today's Shoe Sole Rigid Structure Problem:

The rigid sole structures of running supershoes are designed as levers to help propel the runner forward. In a roughly analogous way, elaborate plastic rigid structural reinforcements are now incorporated throughout basketball shoe soles, often from tip of the toes to the back of the heel. This highly variable pattern of rigid plastic reinforcements between shoes has the erratic look of a dike-plugging attempt to put back as much as possible of the stability and control

inherently lost from today's greater shoe sole softness and thickness.

However, they cannot do so even partially without creating their own unique problems, because these rigid structural reinforcements are foreign objects completely different from any anatomical structures of the foot, which are linked by flexible joints. So the rigid shoe sole structures dangerously obstruct the natural motion of the foot, which involves the complex biomechanical interaction of many bones, joints, ligaments, muscles and tendons, all required for the natural motion needed to avoid unnatural injury.

The fundamental problem is that the extreme structural torsional rigidity in shoe soles today is completely unlike the natural flexibility of the human foot. As carelessly evolved now, today's flawed basketball shoe sole design uses anti-flexibility reinforcements that rigidly lock together the shoe sole's forefoot, midfoot, and heel, in stark contrast to the foot's natural flexibility provided by the joints between its forefoot, midfoot, and heel.

This major structural flaw drastically increases shoe sole instability that has tragically resulted in the ever-increasing incidence of ankle sprains, Achilles tendon ruptures, knee ACL injuries, and many other directly associated serious and recurring injuries.

It is an absolutely crucial structural mistake, making the shoe sole function in a manner wholly unlike that of the wearer's foot, the heel of which can easily move independently relative to the forefoot through a wide range of lateral motion transmitted through the midfoot.

To use a rough car analogy, the flexible natural foot has an independent suspension, whereas the today's rigid basketball shoe sole has a solid axle. The catastrophic result in professional sports is that the player's heel and ankle joint cannot maintain their crucial natural alignment with the player's lower leg when the forefoot of the shoe is firmly planted by a player's full bodyweight on the ground at a much different angle in the frontal plane.

To take Tyrese Haliburton's **Achilles tendon rupture** as a key injury example, his heel bone and the base of his Achilles tendon attached to it were artificially forced out of natural alignment with each other on an excessively routine basis by his shoe heel's artificially rigid sole alignment to the shoe's forefoot. The constant repetition of this misalignment over time weakened his Achilles tendon proximate to its innermost attachment to the base of the heel bone.

That led to an ever-increasing risk of unnatural rupture during maximum Achilles tendon stress, which usually occurs during the **classic push off from a step-back position**. Unnaturally excessive and repetitive strain without sufficient recovery led to rupture.

The unplanned design evolution over decades of structural sole "improvements" in the form of rigid reinforcements into dangerous anti-flexibility problems – widely used by most athletic footwear companies today – might be an all too classic comedy of unforced errors if its medical consequences were not so extreme.

I believe that the too rigid hard plastic reinforcements were introduced to counteract the basic instability created by the edge weakness problem inherent in using "super shoe-like" thicker and softer midsole materials that significantly enhance wearer comfort in basketball shoes. So the hard plastic reinforcements must now be replaced with modern versions of the foxing or outsole overlays that served as stiff sidewalls counteracting edge weakness on old basketball shoes, like the **Converse All Stars** up through the 1980's **Nike Air Jordan 1**, which have much less effect on torsional rigidity.

Modern basketball shoes obviously also need to have thinner and firmer soles, which may reduce comfort. However, modern materials and better design can keep the comfort reduction at a reasonable level, and the major increase in stability is required to avoid the continuation of needless preventable serious injuries.

Not to remove these extreme stability defects as quickly as possible would be unconscionable. The defects provide somewhat greater comfort at the cost of much more frequent and serious injury. That kind of trade-off does not serve the interests of the NBA; not its owners, its players, or its fans.

ENDNOTES

1. **Energy return in footwear – revisited**. Martyn R. Shorten. ***Footwear Science*** published online 28 Jun 2024, with **14,901** Current Views, the second most of all published studies. Dr. Shorten is a former head of R&D at Nike.

   Are super shoes a super placebo? A randomized crossover trial in female recreational runners. Kim Hebert-Losier et al. ***Footwear Science*** published online 17 Feb 2025, with **6,454** Current Views, a very high total for recent studies. This study is definitive!

2. **Influence of carbon-plated running shoes and fatigue on lower limb biomechanics.** Xiangdong Luo, Ruijao Liu, and Bo Li. ***Journal of Biomechanics*** 195 (2026) 113102

   Injury and performance-related running biomechanics in advanced footwear technology compared to minimalist footwear. J. J. Hannigan, Luisa Westley and Li Jin. ***Footwear Science*** 2024, Vol 16, No. 2, 115-121

PART I:
INJURY ANALYSIS BASED ON ACTUAL NBA GAME VIDEO

1. THE CURRENT NBA EPIDEMIC OF ACHILLES TENDON RUPTURES

The consequences of the shoe sole "improvements" for the sports world have been terrible. There is no better proof of this than with **Achilles tendon ruptures**. Previously rare, eight occurred in the NBA in 2025, by far the most ever! And three Achilles tendon ruptures occurred in the 2025 NBA playoffs alone, again, by far the most ever!

All are extremely serious injuries that require a year or more of medical care and major rehab before to return to play, which is not assured, even with the best modern care now possible. Although NBA basketball today is a pretty rough sport played between very muscular athletes, Achilles tendon ruptures are **non-contact injuries,** which makes their occurrence all the more surprising and difficult to understand.

Tragically, all three of the Achilles ruptures that occurred in the 2025 NBA playoffs hurt current or budding NBA superstars: **Jayson Tatum**, **Damian Lillard,** and **Tyrese Haliburton**! The Haliburton injury is especially upsetting, since it robbed many millions of fans of what otherwise would likely have been the most thrilling NBA final game 7 in decades, if not ever, given the surprisingly reasonable possibility of a miracle final win by the Cinderella **Indiana Pacers** against the seemingly unbeatable **Oklahoma City Thunder**, who had been expected to win the Finals series easily in only 4 games.

Moreover, the Pacers were already at a huge disadvantage because of a shockingly number of other unusual injuries. Astonishingly, Tyrese's Achilles rupture was the **third** Achilles tendon rupture in the Pacers team in the 2024-25 season. Earlier, the Pacers lost **James Wiseman** and **Isaiah Jackson**, both for most of the 2024-25 season and at least part of the next, assuming they are able to recover sufficiently to play well again.

This is an historical anomaly that is so great it is nearly impossible to fully comprehend. Only 45 NBA players ruptured their Achilles tendons from 1990 to 2023, just slightly more than one Achilles tendon rupture a year for the entire NBA league. Obviously, something wildly wrong is suddenly happening now.

The best way to begin an analysis of Achilles tendon injuries is to start with a simple example of an actual game injury for which the best broadcast game video is available. Unfortunately, good game video of game injuries are extremely rare phenomena, and entirely happenstance, since nearly all available video is not close enough to see the injury with adequately clear resolution and/or is taken from too poor an angle to properly see the injury mechanism.

VIDEO ANALYSIS OF JUSTIN MOORE'S ACHILLES TENDON RUPTURE REVEALS ITS PROBABLE CAUSE

However, a pretty good video example of the actual injury mechanism is shown by the rupture of the right Achilles tendon of **Justin Moore**, a Villanova player in the NCAA Division 1 South Regional Final in 2022. His tendon rupture occurred when he moved his right foot into a **classic stepback position**, which put his right Achilles tendon under maximum tension as he started to **push off**. PLAY VIDEO

At the stepback start, Moore's heel is approximately aligned vertically with his lower leg and Achilles tendon, but as he pushed back hard and then pushed off to go forward fast, the

forefoot of his shoe sole rolls off its inside edge just as he is in the final toe-off phase of forward propulsion. The unnatural inward tilt of the ground-contacting forefoot of Moore's shoe also forced his airborne shoe heel inward or medially because of his shoe sole's rigid midfoot anti-torsion system rigidly locking the shoe sole's forefoot to its heel. Only his shoe's forefoot is ground-contacting at this critical point, not his shoe's heel and midfoot. PLAY VIDEO

It is critical to understand the rupture mechanism to recognize that without his shoe sole's rigid locking of his heel to forefoot, his non-ground-contacting heel would have naturally remained in alignment with his lower leg and Achilles tendon, even though the forefoot of his shoe and foot rolled inward to a very different frontal plane angle.

Only the shoe sole locking of his heel to his forefoot caused his Achilles tendon to rupture, since his shoe sole forced his heel out of its natural alignment with his lower leg. His shoe sole's forefoot lateral instability in combination its rigid midfoot anti-torsion device clearly caused the rupture, a tragedy for him personally as well as for the Villanova team.

More detail will come later about the anatomy and biomechanics behind the specific injury mechanism shown here, but the crucial fact to remember that is clearly visible in the game video is that, with his unstable shoe forefoot planted on the floor and rolling inward artificially, **the unnatural inward tilting, rolling sideways of his airborne heel happened just before his Achilles tendon ruptured**. The rupture caused his calf muscles to "balloon" and vibrate upwards, the only outwardly observable indication of the rupture. PLAY VIDEO PLAY VIDEO

This is initial evidence of a potentially significant discovery, since it indicates the substantial probability that the inward rolling, lateral motion of his airborne heel relative to his forefoot fixed to the floor is the direct cause of the Achilles tendon rupture, not an effect of it.

The video obviously is not at all perfect, but is the best available by far in a fairly extensive NBA and NCAA game video personal library. Real game video is crucial for truly meaningful analysis, since attempts at injury simulation in the lab are not currently very realistic (hopefully, in the future the sports networks can find and make available other, perhaps better injury examples for analysis and/or arrange for ground level filming.)

The rupture occurred because the unnaturally inward tilted position of Moore's heel must necessarily then have put enormously excessive tension tightly focused unnaturally on the innermost medial edge of his Achilles tendon, instead of the intense load being spread naturally over the entire tendon if aligned.

As a result, after the inward tilting, rolling sideways motion of his heel, that innermost edge of his extremely strong Achilles tendon must have suddenly given way and continued to tear instantly all of the way to the other side of his tendon, with as little resistance as a piece of paper easily being torn in half, so fast it audibly popped.

At the time of the injury in 2022, Moore was wearing a pair of **Nike Kyrie 3 Promo Academy PE**'s, a special new release of the 2017 Kyrie 3 shoe model. A very moderately used pair of the Kyrie 3 basketball shoes was obtained to evaluate in hands-on and feet-on testing, as well as sole surgery to analyze its internal construction.





No midfoot anti-torsion device is outwardly visible in the sole, since an opaque outsole covers all of that surface area, but an internal device in the form of a simple hard plastic midfoot shank was exposed with sole surgery. With that component and its other internal construction, the longitudinal axis torsion of Kyrie 3 sole was felt to be extremely rigid.

In addition, the heel counter is also relatively rigid and the heel upper is a "mid" that is so high that it covers most of the ankle, making it close in functionally to being a hightop that restricts the natural sideways or lateral motion of the ankle (which is important in causing injury, as will be detailed later).

As is typical of all modern basketball shoes (and most other athletic shoes), the forefoot **width** of the Kyrie 3 sole tapers very rapidly around the toes, although this is a very old, standard feature in basketball shoes. However, at the same time, the recent increase in forefoot **thickness** of the basketball shoe sole also tapers very significantly around the toes (like running "supershoes"). The forefoot thickness tapering is a relatively recent basketball shoe feature that, together with the existing forefoot width tapering results inevitably in increased forefoot lateral instability.

In new, thicker, softer basketball shoe soles, the combination of both the forefoot width and thickness tapering together cause a critical medial sole instability relative to the inside or medial edge of the big toe during the toe-off phase that occurs at the end of the classic stepback/pushoff phase of forward motion typical of Achilles tendon ruptures.

Moreover, the greatest point pressure that routinely occurs on the human foot occurs at the big toe during the toe-off propulsion phase and is twice as high as any other part of the foot. That intense pressure combined with the medial big toe instability facilitates the powerful inward rolling of the shoe sole's forefoot that led directly to Moore's Achilles tendon rupture.

The modern forefoot sole combination of both width tapering and thickness tapering is a major stability problem. Much more about that later in **PART III, 14**.

Finally, the most subtle but perhaps the key problem of the Kyrie 3 sole design (which is also common to all the other shoes that follow) is the extreme rigidity of the forefoot connection to the midfoot and heel, in contrast to its unrestricted flexibility in the foot. This is important because, in the common toe-off position in running and court motion, the forefoot is flat on the ground, while the midfoot and heel are flexed up in the air.

In the Kyrie 3, this toe-off position still occurs, due to the tremendous bodyweight pressure often concentrated on the forefoot during motion, but as the unnatural inward rolling of the shoe's forefoot described above occurs, the extreme rigidity of the sole acts as a powerful spring that suddenly unwinds as it unbends to straighten. That abruptly puts a powerful artificial torque on the Achilles tendon, focused on its inside or medial edge, causing it a tear to start that continues easily across the entire otherwise exceptionally strong tendon. If the shoe sole was flexible like the foot, instead of rigid, there would be no such artificial spring or torque.

All of the above injury analysis strongly suggests a new general rule of safe shoe sole design: if any elements of it are the opposite of the foot's structure or function, they should be treated with extreme skepticism, if not automatic rejection. Guilty until proven innocent, instead of the current harmless assumption given to all sole structural innovations.

DAMIAN LILLARD & JAYSON TATUM

The Achilles tendon ruptures to **Damian Lillard** PLAY VIDEO and **Jayson Tatum** PLAY VIDEO are both tragic examples of the same basic Achilles tendon rupture, although the available broadcast game video for both is from such a long distance that its resolution is poor.

Both show the Achilles tendon rupture when the heel in the problematic **classic step-back/pushoff position**.

Most significantly, in each case their Achilles tendons are forced under extreme tension to twist inward (or medially) from vertical alignment by their shoe heels, which are twisted to the inside by their very thick and rigid shoe soles, as well as highly tapered toe areas.

The second video on Tatum shows how his foot is artificially twisted inward by his unstable rigid shoe sole forefoot when loadbearing. That is proven when his shoe becomes non-ground-contacting and his heel then twists outward to realign with his lower leg PLAY VIDEO

Again, much more about the specific injury mechanisms to come later, but the crucial point demonstrated in both of these videos is the **inward rolling of both their heels occurred when their Achilles tendon ruptured.** Although it is not apparent in these videos due to their poor resolution, remember that the Justin Moore video clearly showed that the inward heel rotation happened just before his Achilles tendon rupture, indicating that inward lateral shoe heel motion due to shoe sole forefoot medial instability is again a probable cause of their Achilles tendon ruptures.

The shoe evaluator website, **runrepeat.com**, gave Damian Lillard's basketball shoe worn during the injury, the **Adidas Dame 9**, the same highest possible sole torsion stiffness rating as the Puma All-Pro Nitro, but a significantly less high rating in heel counter stiffness, although still above average. Its visible anti-torsion "midfoot" support shows a design evolution into a support enveloping the entire horizontal profile of the translucent shoe outsole, making the entire sole rigid with only a small break in it at the rearmost heel.



The new **Adidas Dame X** shows the same internal rigid structural reinforcement in the sole, but is now continuous in the rearmost heel and disconnected in the forwardmost toe, slightly the opposite of the Dame 9.



This internal rigid structural reinforcement is not a unique design that is out of the mainstream for basketball shoes. For comparison, the **Adidas Anthony Edwards 1** shown here has a very similar anti-torsion structural reinforcement visible underneath the entire translucent outsole, with no break in it except at the tip of the forefoot. The **Adidas Harden Volume 9** also has a similar construction. Both are popular.



The general design trend toward these internal rigid structural reinforcements may be getting more extreme, given the example of the new **Nike Zion 4**, which shows a massively robust internal sole structure.



Unfortunately, Jayson Tatum's green **Nike Jordan Tatum 3** signature basketball shoe has not been evaluated by RunRepeat as of this writing, but a hands-on evaluation yielded the result that, although the heel counter seemed relatively flexible, probably around average, the sole torsion stiffness was exceptionally high, with heel and forefoot locked firmly together.



No obvious anti-torsion device is outwardly visible, but some sole surgery indicated the presence of a thin solid plastic layer originating from the outer surface to between the outsole and midsole in at least a substantial portion of the midfoot area.



For comparison, the **Nike Jordan Tatum 1** had an elaborate internal plastic structural reinforcement, indicating the high probability of extreme stiffness. A comparison possible is the previous version of Tatum's signature shoe, the **Nike Jordan Tatum 2**, which was tested by RunRepeat. It had the highest possible torsion rating, just like the shoes worn by Haliburton and Lillard when they ruptured their Achilles tendons. Its heel counter stiffness was less than average. Neither shoe was available for hands-on or feet-on evaluation.



And although not visible in a bottom view of the Tatum 3, Nike makes other basketball shoes with clearly visible anti-torsion devices, like the popular **Nike GT Cut 3**, which has very rigid shoe sole, shown here in a bottom sole view.

Another potential major factor in his injury, Tatum's Achilles may have been stressed in the preceding game by a dangerous tripping foul leading to an unusually hard crash landing that uncontrollably put his right foot in the classic stepback/toeoff position that usually precedes Achilles tendon ruptures. PLAY VIDEO

Incidentally, that presumably accidental episode very strongly suggests that NBA superstars need to be protected by more aggressive league officiating in the same way as quarterbacks are protected in the NFL. Perhaps like the NBA did several years ago after the critical injury to Kawhi Leonard that may well have changed an NBA championship that year.

Without more protective league rules and enforcement, the Celtics will likely be forced to protect Tatum in the same classic way Red Auerbach protected his Celtic stars, which was by burly teammate "enforcers", the same way Wayne Gretzky was protected in the NHL. Hopefully that can be avoided with better rules instead of greater counterforce.

In addition, Tatum's previous play in an earlier Nike shoe demonstrated considerable instability PLAY VIDEO

TYRESE HALIBURTON

Now, to focus on **Tyrese Haliburton's Achilles tendon injury**, he started wearing an entirely new basketball shoe during the NBA playoffs – his first signature shoe, the **Puma Hali 1**. A typically **massive black anti-torsion system** that extends from the heel through the midfoot far into the forefoot, and nearly as wide as the entire midfoot



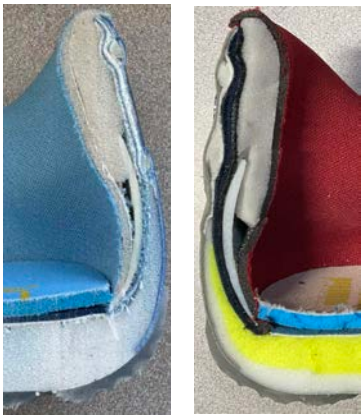
area. Such expansive rigid sole structural reinforcements are becoming common in recent years in many high-end basketball shoes worn in the NBA and NCAA. This one is among the very largest such rigid structures.

Prior to the playoffs this year, Haliburton wore one of Puma's other basketball shoes, the **All-Pro Nitro**. Only a much less substantial **gold anti-torsion device** is visible in the midfoot and it extends about 1 cm into both the heel and the forefoot (seen through a translucent outsole in another colorway sample). Although smaller in scope, the device is thicker plastic than any of the other basketball shoe soles examined.



Based on a hands-on/feet-on evaluation, both the Hali 1 and All-Pro Nitro's torsional rigidity is exceptionally stiff, due in part to other midsole structures. Sole surgery revealed that the midsole of the shoe is composed of two different layers, a 5 mm firm layer next to the thick outsole of 5 mm, so in combination that configuration throughout the sole significantly increased sole torsional rigidity. (Unfortunately, that later information is somewhat inconclusive, since the blue & white Dennis Schroder release of the same All-Pro Nitro model had a single layer of uniform midsole density – although also judged to be very stiff. Which version Tyrese was wearing during the regular season is unknown, since the outsole covers the midsole from view. The Hali 1 has a single layer of very stiff midsole.)

The heel widths of the All-Pro Nitro and Hali 1 are exceptional, with much more side midsole material that also goes higher on the sides around the wearer's heel than is typical, resulting in an extraordinarily stiff heel counter that encases the wearer's heel. The plastic heel counter piece is also thicker and more robust than all the other basketball shoes examined with sole surgery.



The comprehensive online shoe evaluator website, **runrepeat.com,** gave the All-Pro Nitro its highest possible rating in both sole and heel counter stiffness categories, far above their averages for all basketball shoes evaluated.

Also complicating matters, the adjoining heel counter cross-sections of two different colorways and/or models of the All-Pro Nitro, the heel counter on the right is the thickest plastic of any basketball shoe evaluated here, but the Dennis Schroder version on the left has a thinner plastic heel counter.

As mentioned earlier, the forefoot structure around the big toe is a medial stability problem in all basketball shoes, but is the worst I have seen in the All-Pro Nitro because of its exceptional sole thickness and toe taper. Again, more about this injury mechanism later.

Tyrese was exposed to the potential adverse effect of both of his super stiff shoes for at least most of the 2024-25 NBA season, so wear and tear on his Achilles tendon may have accumulated significantly over time, particularly during the extended period of intense playoffs, putting him at high risk of injury.

The actual rupture of Haliburton's Achilles tendon occurred in three stages. The first stage was his serious right **calf strain** in game 5 of the final series between the Pacers and the Thunder. The second stage was Tyrese playing a substantial amount of game 6 when not fully recovered from the strain injury, instead of resting and recovering. The third and final stage

was the actual **tendon rupture** in game 7.

Calf Strain: In the game 5 first stage, Tyrese cut sharply to the left to drive quickly around the Thunder 7 footer Chet Holmgren. The slow-motion video PLAY VIDEO shows the first step of his right leg during which his calf strain occurred, as he made a **classic step-back** in order to **push off** to begin moving forward quickly.

His shoe sole then partially lost traction and his right shoe and foot slid backwards and inward into the most exaggerated possible step-back position, thereby putting unusually great pressure on his innermost right Achilles Tendon and attached calf muscles, severely straining both and creating pain in his right calf muscles. Observe the erratically bulging calf muscles dealing with suddenly changing powerful loads.



Tyrese's uninjured left foot and leg provides an important insight into the unnatural effect of his rigid shoe soles on his lower legs and Achilles tendons. It is clear from the video that his left shoe is toeing off on its medial or inner side, but as soon as it is no longer ground-contacting and therefore under the physical control of only of his Achilles tendon and lower leg, his heel twists outward to align naturally with them. PLAY VIDEO

So, when it is loadbearing on the ground, the unstable forefoot sole of his shoe is forcing his entire foot to twist inward, including his heel because of the sole's artificial rigidity, so it twists inward away from the position of alignment with his lower leg and Achilles tendon. As a result, his Achilles tendon is being unnaturally twisted sideways at the same time it is subjected to its normal high vertical load at toe-off, artificially putting the tendon under highly unnatural strain.

The point is that, as will be shown in video of the actual Achilles tendon rupture, Tyrese's injured right foot and Achilles tendon appear to be subjected to the same unnatural inward twisting caused by his rigid and unstable right shoe sole.

Tendon Rupture: In the game 7 final stage, Tyrese attempted a very similar cut to the left around a Thunder player, this time 2025 MVP Shai Gilgeous-Alexander. PLAY VIDEO Tyrese again made a **classic step-back** in order to begin moving forward quickly, with essentially the same sequence occurring as during his calf strain sequence, except this time his Achilles tendon ruptured.



Though far from perfect, the camera angle is better compared to the calf strain video and it is much easier to see the alignment of right shoe heel and Achilles tendon/lower leg immediately before and after the tendon ruptured. **In the first frame**, both of the black heel triangles of Haliburton's shoe heels are aligned with his Achilles Tendons and lower legs.

But as he steps all the way back, his right shoe heel is again forced to ***twist inward*** by the rigid black anti-torsion sole device, misaligning his heel from his Achilles Tendon, and thereby tragically rupturing it. PLAY VIDEO

The ***inward twisting*** motion of the heel relative to the lower leg is critical in causing the

Achilles tendon rupture. It is directly caused by the huge anti-torsion device, as shown conclusively **in the second frame:** after the tendon rupture: his shoe heel remained in this tilted inward position with the black heel triangle on his right shoe heel pointed inward, no longer aligned with his lower leg or Achilles tendon. Instead, his shoe heel is locked rigidly to the shoe forefoot as the shoe heel lifts off the floor.



A key point: since this is definitely after the Achilles tendon rupture, there can be no doubt that the extremely rigid anti-torsion device is forcing the unnaturally inward tilted position of the shoe heel.

This clearly shows the unnaturally inverted position into which the shoe heel actively forced Tyrese's heel, forcefully away from his Achilles tendon attachment, as his shoe rolls inward led by his forefoot. PLAY VIDEO

The heel twist inward is critical in causing Haliburton's Achilles tendon to rupture because it puts excessively extreme tension on the innermost edge of the tendon, overloading that edge and causing the tendon to tear first at that innermost edge. Its separation instantly overloaded the part of the tendon next to it, so that the tendon tear ripped instantly across the entire tendon from innermost to the outermost edge.



So, despite being terrifically strong and robust, Tyrese's Achilles tendon was torn like a piece of paper in a fraction of a second, from the medial to lateral side.

Again, looking at Haliburton's uninjured left foot and leg, it is even more clear that he is toeing off on the inside of his left shoe's forefoot. In the still frame shown, his last shoe sole support appears to be directly on the tip of the black hard plastic strut in his shoe sole forefoot. PLAY VIDEO

And again, as soon as the tip of his shoe is no longer loadbearing on the ground, his heel twists outward, naturally under the control of his Achilles tendon and so aligning with it, instead twisted-in out alignment by his artificially rigid and unstable shoe sole forefoot.

KEVIN DURANT

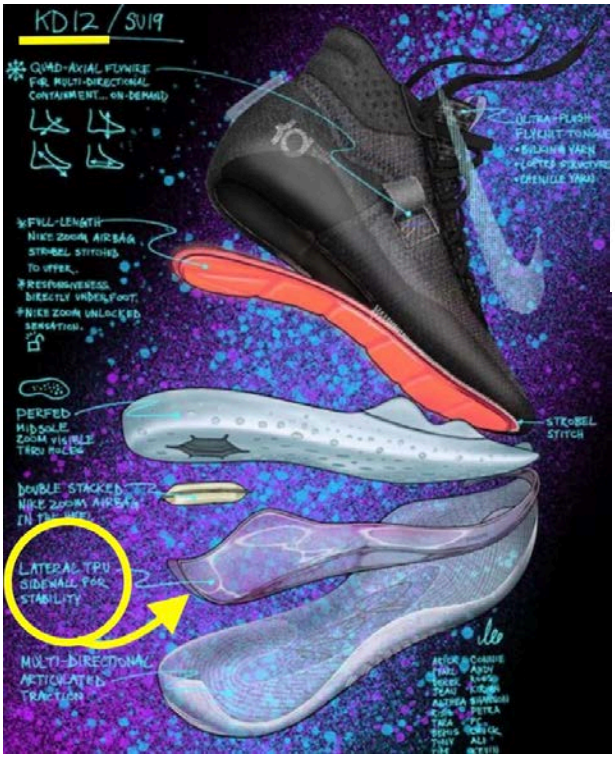
And, of course, any review of NBA Achilles tendon ruptures in NBA basketball must include **Kevin Durant's infamous ruptured Achilles tendon** in the 2019 NBA championship finals. PLAY VIDEO KD's injury mechanism is simple to understand. He simply put his leg in the problematic **classic step back/push off position**, but his right foot landed relatively angled out of a second, from inner to outer sides.

As seen clearly in game video, KD's shoe heel and lower leg/Achilles tendon were aligned initially in the first frame. But as he planted his foot, the excessive rigidity of his shoe sole forced them out of alignment, as shown in the second frame, an instant before the rupture.





KD's shoe was the 2019 **Nike KD 12**, which had an unusual <u>lateral</u> side anti-torsion device in its complicated and novel construction (see diagram), but it did force the heel of his shoe sole into the same angled out position as the forefoot of his shoe sole, which is not in vertical alignment with his lower leg and Achilles tendon.







I have evaluated a slightly used KD 12 model with hands-on or feet-on testing, as well as using some sole surgery. It is exceptionally rigid in terms of forefoot flexibility with the rest of the sole and of longitudinal torsion, which is twisting the shoe sole on its long axis. It is probably reasonable to assume all of his signature shoes have had similarly rigid midfoot support to fully support the midfoot area of his foot since his Jones fracture to the base of his 5th metatarsal bone in 2014.

In addition, the KD 12 has an unusually thick shoe sole, with high amount of reduction in forefoot sole thickness to the toe (or toe taper) of about 5 mm, which creates instability allowing it to roll inward with little resistance.

The rigid heel counter of the KD 12 is an unusually substantial plastic that would have held his heel firmly in position on the rigid shoe sole

In addition, like the Kyrie 3 above, the KD 12 is not a lowcut, so its mid height heel upper, which is higher than most mids, puts extra sideways tension on the Achilles tendon since it restricts the heel from following the independent lateral motion of the lower leg with the Achilles tendon in the **classic stepback/pushoff position** common to Achilles tendon injuries.

As analyzed in detail in my book, ***UNNATURAL INSTABILITY***, (see free copy at **FEbaresole.com/Books)**, KD's injury and the injuries of Haliburton, Lillard, Tatum, and Moore were also caused by too narrow shoe soles in the forefoot, which is a critically important contributing injury factor in all basketball and other shoes, as will be discussed in detail below, starting on page 15.

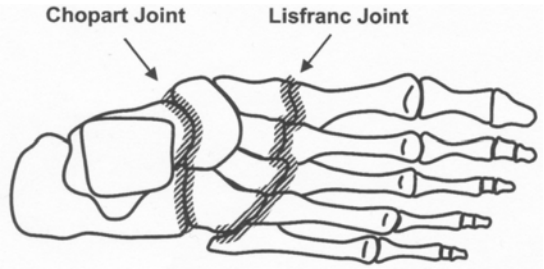
The result again is enormously extreme tension, this time focused on the outer or lateral edge of his Achilles tendon. That edge of the tendon was stressed beyond its limits and separated, instantly tearing apart all the way to the other side of the tendon, rupturing it completely. PLAY VIDEO Among the fortunate few, KD has seemed fully recovered from it.

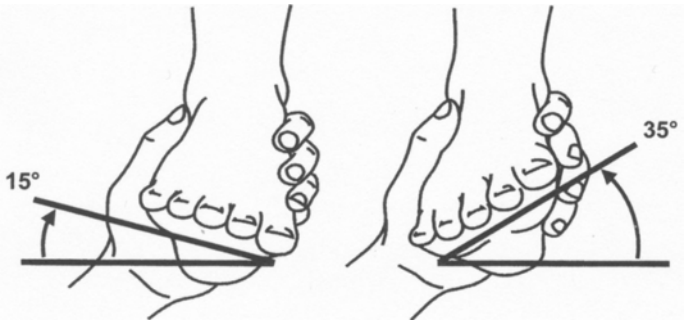
In summary, the available actual video evidence points strongly in the direction that the rigid anti-torsion device plays a primary role in the sudden drastic increase in horrific Achilles tendon ruptures, which were rare before now. Besides this actual game video evidence, there is a very sound anatomical basis for understanding the major misalignment problem for the Achilles tendon caused by rigidly locking together the heel and forefoot of the shoe sole.

THE BASIC PROBLEM WITH TORSIONAL RIGIDITY

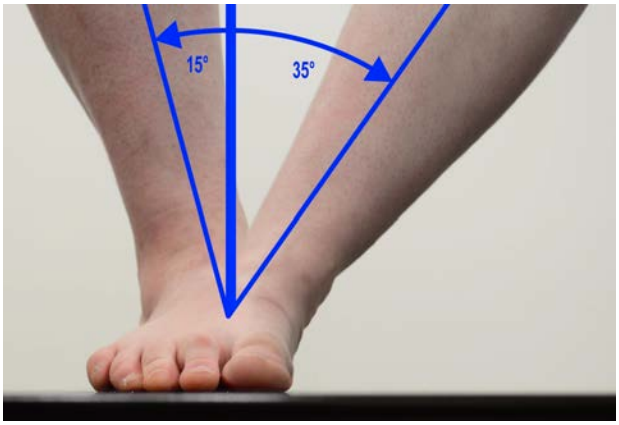
The basic problem is made clear by comparing this new total lack of torsional flexibility in modern shoe soles to that of the human foot, which has very substantial torsional flexibility provided by the Chopart and Lisfranc Joints. Acting together, those two joints of the foot typically allow about 15-20° of forefoot eversion motion relative to the heel and about 35-40° of forefoot inversion motion relative to the heel, although the ranges vary widely between individuals. (This foot eversion and inversion is commonly associated with the more familiar terms, pronation and supination, respectively, of the subtalar joint, located between the heel and ankle bones.)

When the barefoot is loadbearing, flattened on the ground, the forefoot position becomes fixed, often by many times full bodyweight. In that position, the ankle then has a total of 50-60° range of natural sideways motion in the frontal plane relative to the fixed forefoot.





However, when the wearer's foot is laced up tight in a modern basketball shoe, the rigid anti-torsion sole device keeps the heel in a horizontal position on the ground, like the forefoot. **But when the heel rises into the air and the forefoot remains on the ground the rigid device also keeps the heel horizontal, like the forefoot**.



However, the lower leg can rotate inward about 35° or more and outward about 15° or more. This is a big problem because this frontal plane motion happens all the time in competitive sports like basketball. For example, NBA superstar Jayson Tatum says he always tries to play on the balls of his feet.

To make matters much worse, the **relatively rigid heel counters** on modern basketball shoes also force the ankle into an inflexible upright, vertical position with a very limited range of unconstrained motion. So, in effect, the shoe's rigid heel counter literally fights the wearer's ankle's natural attempt to move sideways in order to remain aligned with the lower leg and Achilles tendon as an athlete's lower leg moves through its entire potential 50-60° range of natural sideways motion during active sports.

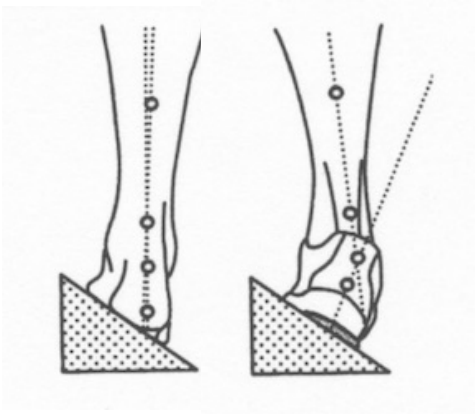


Basketball players typically have to lace their shoes very tightly in order to perform the quick stop and start and cutting motions routinely required to play the game. So the player's heel may be forced into alignment with the shoe forefoot under a full bodyweight load at the same time the player's lower leg is forced by the player's upper body into a 30° to 40° angle to it – a recipe for Achilles tendon disaster.

THE ANTI-FLEXIBILITY FLAW IS ALSO BEHIND THE SUDDEN RISE IN NBA ANKLE SPRAINS

Why it is that natural torsional flexibility is crucial to ankle stability is easy to see in a stability test where the **bare foot** is forced into the **classic lateral ankle spraining position** by using an inclined plane – a conventional biomechanical lab wedge used as an ankle spraining mechanism. The forefoot is stable, within its natural 35-40° range of inversion motion relative to

the ankle, and the heel remains vertical and therefore in line with the lower leg, so that the forces of bodyweight and ground reaction are aligned through the ankle joint, maintaining natural ankle stability.

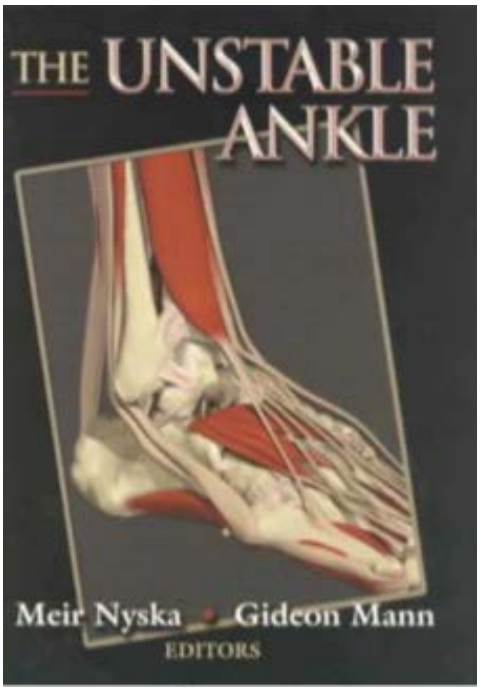


However, if the foot is in a **shoe** landing on the same inclined plane wedge, the ankle is forced into the same 35-40° angle of inversion that the forefoot is in, creating a powerful destabilizing torque on the ankle, caught between the misaligned body-weight and ground reaction forces.

Just like the inclined plane wedge, the anti-torsion devices force the heel of a shoe sole again into precisely the same inversion position of the forefoot. The trouble is, although that 35° inversion position is within the normal range of motion of the forefoot, but it is an extremely unstable position for the ankle.

The practical effect of rigidly locking the positions of the shoe heel and shoe forefoot together is devastating to ankle stability. During basketball games, stepping on another's player's foot with the forefoot, thereby tilting it extremely, is the primary cause of ankle sprains. The consequence of doing so is that whenever the shoe forefoot is tilted into inversion or eversion, the locked-in heel and ankle are subjected to a sudden artificial torque. The greater the inversion or eversion, the greater the artificial torque and resulting ankle instability.

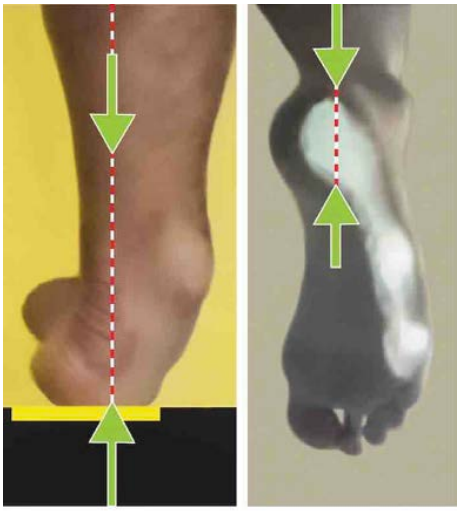
There has been a relatively sudden increase in ankle sprains in the NBA, even among the greatest superstars, a situation that has gotten so bad that the NBA set up several years ago a medical committee of experts to solve the problem. No findings have yet been released, so what if anything has been found is currently unknown.



The focus of previous research on ankle sprains has been on the ankle itself and how to better support it directly, since the ankle has long been considered in **medical texts** like the one shown here to be the weakest link in human evolution due to its all-too-frequent injury. In other words, the weak ankle is the problem blamed for ankle sprains. In the U.S. population, ankle sprains are by far the most common reason for visits to hospital Emergency Rooms, despite the fact that most ankle sprains are never treated medically at all.

However, surprisingly, exceptional evidence strongly suggests that the anti-torsion flaw also plays a primary causative role in ankle sprains, including the same kind of video evidence from NBA and NCAA basketball games. But first some biomechanical background.

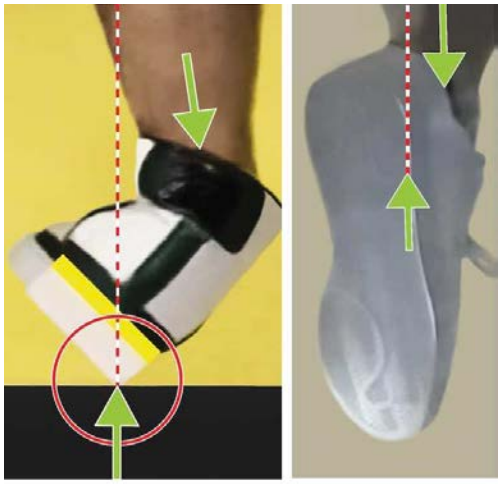
Look at the human foot alone, how it performs without any perverse influence from an anti-flexibility flaw. By doing so, it is rather astonishing to discover uniquely simple proof that the human ankle is completely stable in the typical, outward tilted **classic lateral ankle spraining position**. Although that seems like a self-evident fact, it was apparently hidden in plain sight for several thousand years. Now, in hindsight, it is glaringly obvious.



STABLE BAREFOOT

As shown here, **a barefoot is naturally stable when rolled outward into the classic lateral ankle spraining position**, with opposing forces exactly inline and directly supported by leg, ankle, and heel bones, all interlocked in perfect natural alignment. The bare foot sole enjoys a wide base of support, especially under the calcaneus or heel bone, as well as under the base and head of the fifth metatarsal bone (all three bones sites indicated by the large white areas of support in the underneath view).

In stark contrast, **a shoe sole is artificially unstable when tilted outward as far as the foot's subtalar joint naturally allows it to go, into the same classic lateral ankle spraining position**. Like a seesaw, the entire ankle joint and the bodyweight force transmitted through it pivot on a knife-edge (the thin white streak in the underneath view) of a shoe sole that contacts the ground. The opposing forces are out of alignment, artificially creating a powerful destabilizing torque on the extremely tilted ankle primarily held together by ankle ligaments and tendons alone, not interlocking bone.

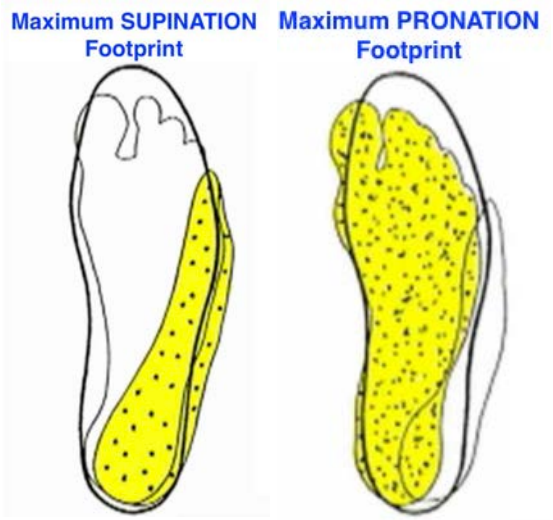


UNSTABLE SHOE

Note this critical fact: the forefoot and heel of the typical **unstable shoe,** shown above in the typical lateral ankle spraining position tilted at a 45° angle, are locked together at the same angle, which is **exactly the principle effect of the anti-torsion flaw described previously. The heel is forced into an unstable tilted position by the natural tilted forefoot motion, unlike the barefoot where each are stable within their normal, different ranges of natural motion.**

The artificial lack of stability in the ancient design of shoe soles is due to the foot sole simply rolling over the outside edge of the upper surface of the shoe sole uncontrollably, which causes lateral ankle sprains, breaks, and falls with serious injuries.

When the wearer's foot rolls as far as the subtalar joint permits, as shown in **Maximum Supination Footprint** (in yellow, superimposed on an upper surface outline of a typical shoe sole), most of the side of the load-bearing foot sole is not supported by the too narrow conventional shoe sole, unchanged from its original ancient cobbler design. Only the heel remains mostly on the shoe sole due to its more limited range of motion.



The same kind of basic mismatch in sole width exists between shoe sole and the **Maximum Pronation Footprint** (also in yellow) of the wearer's foot. The foot tends to roll onto or over the inside (medial) edge of the shoe sole's upper surface, unnaturally destabilizing the shoe sole by causing an inward tilt, particularly at the big toe, which is subjected to peak pressure at toe-off that is twice as high as any other part of the foot.

When the inward rolling motion is extreme, uncontrollably tilting the shoe sole inward, the resulting gross instability provides a simple explanation for the ongoing epidemic of acute knee injuries, particularly among female athletes, including anterior cruciate ligament (ACL) ruptures and tears of the knee.

If the shoe upper is removed to uncover this fundamental width mismatch in the **classic lateral ankle spraining position**, the wearer's forefoot and midfoot simply roll off the outside edge of the too narrow shoe sole as the angle is increased, finally followed by the heel, as seen from this early stage testing. PLAY VIDEO



2. THE UNBELIEVEABLY BAD LATERAL INSTABILITY OF BASKETBALL SHOES:

Lateral Stability Is So Bad The Player's Foot Simply Rolls Off The Too Narrow Shoe Sole:

During athletic motion, the too narrow conventional shoe sole has to constantly fight the tendency of the wearer's foot to roll off one side or the other, resulting is a shoe sole that wobbles from side to side so incessantly that the instability seems routine and normal. This shoe wobble is frequently excessive and occurs even in the greatest of NBA superstars, very often without apparent injury of an acute nature, although potentially serious overuse injury from repetition over time, like runner's knee, but definitely prone to potentially avoidable serious acute injury.

Combining the too narrow shoe sole with the torsional rigidity that has been increasingly introduced in the past several decades, and with the softer midsole material now in use, the current design of athletic shoe soles is a disaster for ankle joint stability, artificially stressing it like never before.



Current basketball shoes are substantially deformed into grossly warped shapes by the wearer's feet simply rolling off the side edge of their too narrow shoe sole during a wearer's simple side steps during routine cutting motion to change direction and do not result in acute injury. **Only the upper keeps the foot attached to the shoe sole.**

Nothing illustrates better than actual NBA and NCAA game video the serious mismatch between the narrow width of conventional shoe soles and the much greater width of the **dynamic foot sole** of the wearer, which can roll sideways through its full range of subtalar joint motion, typically about 35-40° of supination and about 15-20° of pronation.



The result is the wearer's foot rolling off the side of the shoe sole, dramatically deforming the shoe sole. Softer midsole material very popular today makes the problem worse. **SGA** is shown above rolling out of his shoe without immediate injury or misstep. And **Tyrese Haliburton's** signature shoe shown on left certainly had the same kind of warping problem.

Another example, NBA MVP superstar **Kevin Durant's** shoe sole is grossly unstable even when making a routine jab step in a cutting drill. PLAY VIDEO Although this instability caused no immediate injury, this routine shoe sole instability over time probably caused KD's Jones Fracture of the base of his fifth metatarsal in 2014, which is analyzed in more detail in my book, ***UNNATURAL INSTABILITY***, p. 17. And to state the obvious in all three examples, this is an non-contact instability problem.



Other video examples of similar routine basketball shoe sole gross instability involving no apparent related injury include NBA superstars like **Steph Curry** PLAY VIDEO PLAY VIDEO **Giannis Antetokounmpo** PLAY VIDEO PLAY VIDEO **Kawhi Leonard** PLAY VIDEO **Kawhi and Andre Igoda** PLAY VIDEO **, Jimmy Butler** PLAY VIDEO **, Jamal Murray** PLAY VIDEO **Pascal Siakim** PLAY VIDEO **and SGA** PLAY VIDEO , the last one by this year's NBA and Finals MVP being the most spectacular**.**

3. THE NEW SHOCKINGLY NON-CONTACT ANKLE SPRAINS :



The gross instability of even the best current modern basketball shoes is so shockingly bad that NBA MVP superstar **Kevin Durant** sprained his ankle during a practice layup in a routine pregame warm-up drill PLAY VIDEO and during a game PLAY VIDEO , both times without stepping on another players foot, instead just rolling his foot off the lateral edge of his shoe's forefoot.

This kind of non-contact ankle sprain never happened decades ago and is only possible in today's extremely unstable shoes!

Most of today's basketball players have had the same kind of non-contact ankle sprains, like the example of NBA MVP superstar **Lebron James**, PLAY VIDEO , often repeated sprains. Or so often as to be career threatening, or season-ending, like the example of NBA MVP superstar **Steph Curry**, who has sprained his ankles so many times so seriously that he wears plastic braces on both ankles, but has still managed to sprain those elaborately protected ankles. PLAY VIDEO

The potential other examples just in the NBA or NCAA Division 1 basketball seem to be endless, but two examples of non-contact ankle sprains that each determined a NCAA Division 1 National Championship really stand out.

In 2017, UNC beat Gonzaga when Gonzaga's star **Nigel Williams-Goss** sprained his right ankle PLAY VIDEO and in 2021, UNC lost to Kansas when UNC star center **Armando Bacot** also sprained his right ankle when driving in for what would have been the winning layup. PLAY VIDEO We'll never know which team would have won either championship, but for the instability of those shoes.



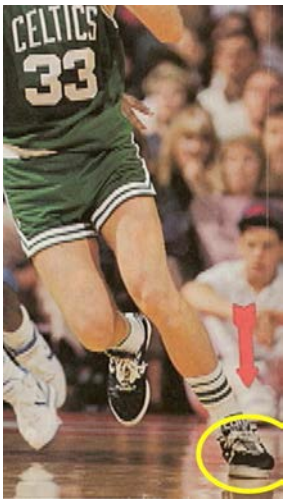
Bacot's shoe, the **Nike Air Jordan 36**, is a particularly unusual design, since it features what is a two-level anti-torsion system with side-to-side upper plastic section separated by open air from a lower continuous bottom sole. Together they form the most rigid midfoot structure I have ever seen, sort of biplane Air Jordan with a midfoot dual wing.



Other video examples of similar routine basketball shoe sole gross instability involving ankle sprains with no contact with another player include super athletes like **Marcus Smart** PLAY VIDEO **G. Vincent** PLAY VIDEO , **Steph Curry** PLAY VIDEO , **Chet Holmgren** PLAY VIDEO , **Lonzo Ball** PLAY VIDEO , **Terese Walker** PLAY VIDEO , **Jamal Shead** shown here, with right ankle laterally sprained outward and left foot hyperpronated inward PLAY VIDEO , **Cameron Payne** PLAY VIDEO . and **A. Zverev** PLAY VIDEO

An unusual non-contact example from the 2025 NBA Playoffs, in which superstar **Donovan Mitchell** is unable to continue playing after an assortment of previous ankle injuries. PLAY VIDEO

Finally, as shown in these examples from the 1980's (Larry Bird) and 1990's (Christian Laettner), and even the 1960's (Gail Goodrich), the narrowness of basketball shoes (forefoot and midfoot) has always been a problem, but far less as egregious a mismatch as it has become today. Without the modern addition of with softer and thicker midsoles and too rigid plastic reinforcements, there were far fewer ankle sprains (or associated injuries) back in the day.







PLAY VIDEO

4. ANKLE SPRAINS – THE FOREFOOT OF THE WEARER'S SHOE STEPPING ON ANOTHER PLAYER'S SHOE:

Ankle sprains caused by a NBA player's forefoot stepping on another player's foot are the most common. **Kawhi Leonard**'s sprain was the most consequential, since it may have cost the San Antonio Spurs the NBA Championship in 2017. His left ankle sprain might not have even occurred, but for the shoe sole's locking his heel into the same tilted angle as his forefoot. Nevertheless, his too narrow shoe sole definitely allowed his foot to roll over easily, thereby badly spraining his ankle, which had already been injured earlier. The sole of his Air Jordan XXXI is extremely stiff, although no anti-torsion device is visible or noted in its construction. .



PLAY VIDEO

As is often the case, Kawhi's forefoot tilt is roughly within the safe range of normal motion provided by the subtalar joint, but his locked heel is forced into the same unnatural tilted position described earlier in this analysis. The bodyweight and ground reaction forces on his ankle joint are far out of alignment, thereby artificially generating a powerful destabilizing torque on the highly vulnerable ankle joint, which is primarily held together in that position by ligaments and tendons alone, not interlocking bones, resulting in a severely sprained ankle.



This was a tragic injury. Before it, and seemingly almost by himself, Kawhi was completely dominating the San Francisco Warriors on both offense and defense, but was unable to play in the playoff series after it. Given that the ankle sprain may have determined the NBA Championship in 2017, and since the role of the Warriors player causing the Kawhi's sprain looked suspiciously intentional, this injury led directly to an important NBA rule change, making it a flagrant foul. More on this infamous injury in my ***UNNATURAL INSTABILITY*** book.

Jayson Tatum's ankle sprain in the first minutes of game 7 of the 2023 NBA Eastern Division may be the next most consequential ankle sprain, delaying the Boston Celtics NBA Championship until 2024. PLAY VIDEO

Other examples include NBA superstars **Jayson Tatum** PLAY VIDEO **, Kyrie Irving** PLAY VIDEO **, Anthony Edwards ,** PLAY VIDEO **Nicola Jokic** PLAY VIDEO , and future NBA superstar **Cooper Flagg** PLAY VIDEO .



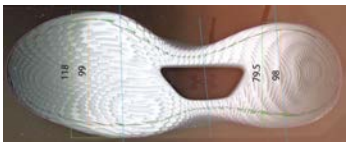
Like Kawhi's injury, **Jalen Brunson** PLAY VIDEO **,** as well as **Aaron Nesmith** PLAY VIDEO **, Chet Holmgren** PLAY VIDEO , and **Dennis Schroder** PLAY VIDEO **.**

Several other examples from NCAA Division 1 games during March Madness: **Zach Smith** PLAY VIDEO , **Matthew Myer**, shown here PLAY VIDEO , and **Jaime Jaquez** PLAY VIDEO .

5. ANKLE SPRAINS – THE HEEL OF THE WEARER'S SHOE STEPPING ON ANOTHER PLAYER'S SHOE:



The most interesting example here is of **Steph Curry**. It occurred when he stepped glancingly on another player's foot while wearing a state-of-the-art plastic ankle braces on both feet and still had a horrible sprain of his right ankle. PLAY VIDEO



What specific Under Armour model he is wearing is unclear, but the Curry 8 shown here is a typical example of UA technology of this era. Sole surgery indicates that shoe has a substantial midfoot hard plastic shank, visible in this view, that extends far into the forefoot, making the sole very rigid, as were all of the Curry UA shoes of that era. It also has substantial indentation on the lateral midfoot, increasing lateral instability due to lack of direct support to the base of the 5th metatarsal bone (discussed in detail later in Section 12).

Other NBA superstar examples include **Klay Thompson** PLAY VIDEO and **Nicola Jokic** PLAY VIDEO .



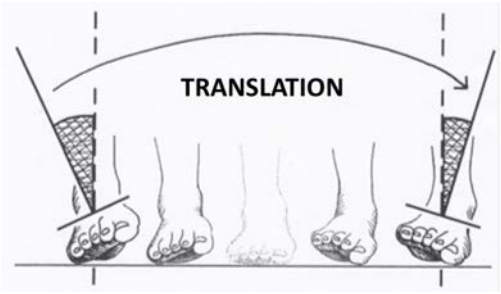
Trae Young's injury was doubly extraordinary: like Steph Curry, Trae was wearing state-of-the-art plastic braces on both ankles, but he still managed to sprain his right ankle by stepping backwards with his heel landing on an official's foot rather than another player's foot. PLAY VIDEO

Another typical example is **Grant Williams.** PLAY VIDEO

6. KNEE ACL INJURIES – NON-CONTACT:

Anterior Cruciate Ligament (ACL) tears in the knee are one of the worst sports injuries, usually career-ending for professional athletes a few decades ago. Now ACL's can be treated, but full recovery from medical treatment is never sure and prevention is at the earliest stage. Pioneering work is occurring at **Peak Performance Project (P3)**, led by **Dr. Marcus Elliott, M.D**., and is described in great detail in a 2025 book, ***Ballistic***, by Henry Abbott (with two illustrations shown below by John Early).

P3 has treated a large number of the best-known NBA superstars and many other elite athletes by recording detailed measurements of their motion in sports, collecting the data, diagnosing specific biomechanical problems using individual data and comparing it to a data base of many others, and developing tailored exercises and training, like **landing with "toes up"**, to prevent specific types of injuries tailored to individuals. (As will be discussed soon, modern shoe design dictates toe sole tapering in thickness, creating the opposite, a "toes down" position, thereby increasing the odds of injury)



The head of P3's sports science lab, biomechanics expert **Eric Leidersdorf**, discovered that there is a 100% correlation between ACL tears and the movement of the foot landing on the ground he called "**translation**", as shown in this drawing by John Early from the *Ballistic* book.

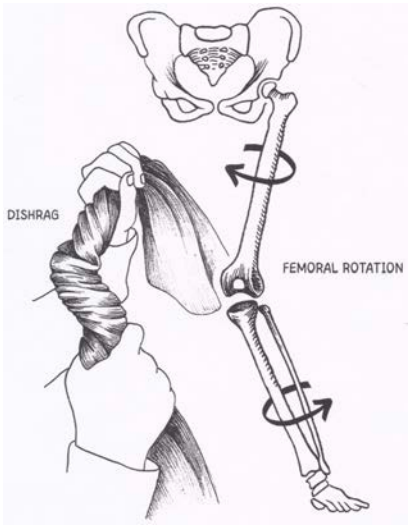
Translation is the landing of the foot on the ground on its outside edge, called an inversion position. Then the foot rolls inward to flatten on the ground and continues to roll inward into what is called an eversion position. About 18° of such ankle rolling is normal for NBA players, but excessive motion of 25° indicates risk of ACL tear. So, basically, too much lateral instability in the inversion-to-eversion translation is a potential problem.

As noted earlier on **page 21**, the too narrow footprint of conventional basketball shoe soles compared to the much wider natural footprint of the foot is the precise cause of shoe sole instability resulting in increased abnormal translation motion. That is because, in landing there is insufficient lateral sole support under the 5th metatarsal foot bone (both base and head) to prevent excessive inversion/supination, and in toe-off there is insufficient medial sole support under the big toe to prevent excessive eversion/pronation.

So the mismatch created by too narrow soles of conventional basketball shoes inherently cause the range of lateral motion during translation to increase to dangerous levels, and often beyond, often resulting in serious injury.

Kudos to P3 for conducting their translation testing with subjects in their bare feet. Having done so, they are now in a position to also test the same subjects in the same translation protocol while wearing the test subjects' usual basketball shoes so as to compare the two sets of measurements. Finding the difference is likely to be scientifically significant and of great interest to their subjects.

In P3's research, ACL tears are also accompanied by opposing rotations of the tibia (lower leg bone) and femur (thigh bone), which together form the major loadbearing surfaces of the knee joint held together by four ligaments, including the ACL. So when the femur is rotating inward, the tibia is translating from its outmost position, so the upper and lower surfaces of the knee joint are stretched in opposite positions, twisting and overstressing the ACL that holds them together. (As severe as this twisting motion can be, it is never results in a right foot attached to a left leg, as shown here, from the *Ballistic* book.)



Of course, when the feet of NBA players land on the ground in "translation" during warm-ups, practices, and games, they are always in shoes with too narrow conventional soles. As seen consistently in prior video and in those to be shown here as well, **NBA players' landings in actual games are frequently accompanied by an excessive degree of lateral motion that far exceed P3's safe parameters, particularly so for the landings that involve ACL tears shown in videos here.**

Most typically, the players' shod feet roll outward unstably in inversion rotating their tibias outward at the same time their femur is rolling inward. NBA players' shod feet are inherently far less stable than their bare feet as discussed earlier.

In all of the video examples found and shown here, the ACL tears occurred coincident to the player's foot landing in a relatively flat position and then inverting or rolling to the outside excessively. So the real world sequence indicates that the actual injury "translation" does not start with foot inversion, but rather ends with it, or cycles to it and back, often from a neutral or flat position.

The key takeaway fact is that the substantial outward motion of the foot in inversion results in substantial outward rotation of the tibia against the upper surface of the knee, formed by the femur, which is typically rotating inward, causing a highly unnatural twist that strains or ruptures the knee ACL. **These unnatural counter-rotations are both due to the fundamental lack of lateral instability of too narrow conventional shoe soles.**

Again, to emphasize the most critical point, the sole of conventional shoe soles is artificially narrow compared to the much wider natural footprint made by the wearer's foot in the full range of supination and pronation motion allowed by the subtalar joint (as described on **page 21**). That substantial mismatch inherently increases the range of lateral motion dangerously during translation, since the edge of the foot sole rolls to or even over the edge of the shoe sole, causing unnatural tilting due to the restraint provided by the shoe upper against the unnatural rollover.

Paige Bueckers' ACL tear was tragic. PLAY VIDEO First, her left foot slips into a fully extended, straight position, which locks her knee joint because of the knee's screw-home mechanism as her femur rotates substantially inward. Then her foot and shoe roll outward in inversion, forcing her tibia to rotate outward. So the upper and lower surfaces of her left knee joint were rotating in opposite directions under her full body weight. That is exactly the twisting injury motion that is expected, based on P3's analysis.



It seems clear in the second video that Paige's problem with her left foot and knee were originally caused by the gross instability of her right shoe sole, which twisted uncontrollably inward, rolling off the medial edge of the shoe sole's forefoot, due to excessive toe taper and sole rigidity. PLAY VIDEO



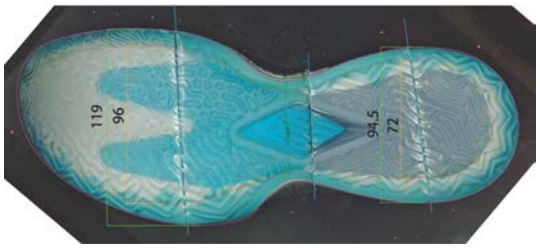
Focusing on her uninjured right foot and leg, it again demonstrates even more dramatically an extreme rolling outward, a twisting corrective motion of the shoe as it becomes non-loadbearing, so her heel can align properly with her lower leg again, relieving artificial twisting tension on her right Achilles tendon. PLAY VIDEO

Kawhi Leonard simply tore his ACL while driving to his right. PLAY VIDEO His right foot rolled outward in a straight leg position with knee locked by its screw-home mechanism under his full body weight (and some of opposing player #2's). PLAY VIDEO His right foot and leg is rolling outward, as his hip and femur are rotating inward. Again, the same twisting injury motion, as expected, based on P3's analysis.



By happenstance, from a prior survey of basketball shoes, I have the same shoe model Kawhi was wearing at the time of his injury, the New Balance Kawhi, including the results of sole surgery. In the context of previous evaluations here of basketball shoes, this shoe has two obvious problems based on prior analysis.

First, a major hard plastic shank structural reinforcement extending from the forefoot thru the heel area, locking the entire sole into a rigid anti-torsion structure.



Second, there is one of the largest indentation on the lateral midfoot area that I have ever seen, leaving the base of the 5th metatarsal without any direct structural support and degrading lateral stability, as seen in the video (and discussed in detail later in Section 12).

Derrick Rose landed from a jump on his left foot in an everted position that then transitioned instantly into an inverted position, forcing his tibia to rotate outward as his femur rotated inward with his hip, bending his left leg inward. PLAY VIDEO PLAY VIDEO PLAY VIDEO

Jamal Murray drove to his left under defensive pressure and when he planted his left foot, it tilted outward, particularly in the forefoot, as his hip and femur rotated inward. PLAY VIDEO PLAY VIDEO

Klay Thompson's injury is different in one major component. He was driving in for a layup and landed from leaping on his right foot, which landed slightly everted (instead of inverted) and continued to roll inward very substantially as his hip and femur rotated inward, leaving his lower leg at a large angle to his femur in the frontal plane. PLAY VIDEO PLAY VIDEO

Dario Saric's injury shows perhaps better than any other video how, when the player's rigid shoe sole lands on its inner side edge and slaps down flat suddenly, the automatic motion of the player's subtalar joint forces the player's tibia to rotate to the outside powerfully, but at the knee joint the tibia is rotating powerfully against a stationary femur, causing in knee ACL to separate and the knee to explode, which you can see as the tibia at the front of the knee suddenly lurches forward against its containing compartment. PLAY VIDEO Ugly graphic violence.



Without the artificial sole rigidity, his shoe's forefoot would have rotated to flatten against the ground, leaving his heel and tibia unaffected and correctly aligned with his knee and femur, avoiding unnatural twisting and serious injury.

Becky Harmon's injury two decades ago is similar to Klay Thompson's, an inward roll of the big toe directly into uncontrolled eversion rather than inversion. PLAY VIDEO Also shown is **Ivory Latta**, 2006 NCAA National Player of the year, showing an ACL injury resulting from an outward roll in uncontrolled inversion, with a straight-legged locked knee, similar to Paige Buecker's injury.

7. HAMSTRING PULLS – NON-CONTACT



Hamstring pull injuries have occurred to many NBA players that seem to be directly related to the same kind of lateral instability of the player's foot on the ground as seen in the preceding injuries. The best example is of **Aaron Gordon**, whose left foot quickly rolling out and in at initial ground contact apparently resulted in an immediate left hamstring pull. PLAY VIDEO PLAY VIDEO PLAY VIDEO

A hamstring pull to **Donovan Mitchell** is less distinct, but shows the same kind of shoe inversion or rolling out when his left leg makes ground contact as he drove to the basket for a layup. PLAY VIDEO PLAY VIDEO

Another less distinct pull is shown by **Exum**, whose drive around another player resulted in his straight left leg being tilted in at a severe angle twice in a row, the second time causing the hamstring pull. Both times his left foot was planted, it had to evert or roll in substantially. PLAY VIDEO

8. CLEATS – ANKLE BREAKS & SPRAINS AND HAMSTRING PULLS

I will preface this analysis of cleated footwear injuries by noting that I had completely ignored cleats until I happened to see **ESPN**'s ***30 For 30*** episode on **Alex Smith** and his long battle back from near death from a horribly broken leg to leading his Washington NFL team deep into the playoffs.

His personal story compelled me to take a careful look at cleats in football, soccer, and baseball shoes, and I was utterly appalled by what I found. **All cleats for those sports have absolutely terrible lateral stability!** Inexplicably bad, especially in comparison to the barefoot, but also much worse than basketball or other court shoes or even running or casual shoes. Examples abound.

To start with **Alex Smith**, his right leg was rolled over into the typical ankle spraining position when he was being gang tackled, but instead of spraining his ankle, his tibia and fibula suffered a compound fracture that put him near death from infection. PLAY VIDEO PLAY VIDEO PLAY VIDEO

Manny Machado is an example of a common inversion ankle sprain in baseball, an ongoing problem. PLAY VIDEO



Kyle Schwarber pulled his hamstring while running to first base wearing baseball cleats that are among the least stable athletic shoes I have ever seen. An accident waiting to happen. PLAY VIDEO PLAY VIDEO

Finally, a video of a soccer ball being kicked, which is noteworthy because it surprisingly shows the kicker's plant foot in a fully inverted, ankle spraining position with ankle joint apparently resting on the ground during the act of kicking. This would seem to indicate that the soccer cleat worn had no resistance to rolling over whatsoever and occurred routinely. PLAY VIDEO

A two decades old video of **Jan Koller** showing in a soccer game clearly the connection between lateral rotation of foot and shoe with hamstring muscle pulls. PLAY VIDEO

Alyssa Naeher PLAY VIDEO PLAY VIDEO suffered a severe knee ACL injury during USA Women's National team play when her cleat demonstrated clearly the lack of any resistance whatsoever to rolling out in uncontrollable lateral instability.

To summarize, in my opinion cleated footwear generally is by far the most laterally unstable type of athletic footwear, likely leading to a massive number of avoidable serious injuries.

9. UNCONTROLLABLE SLIPS & FALLS WITHOUT CONTACT DUE TO EXCESSIVE SHOE RIGIDITY

As discussed previously on **pages 17-18** under the heading, "THE BASIC PROBLEM WITH TORSIONAL RIGIDITY", about 50° of lateral motion exists between the heel and forefoot of the foot. However, excessive shoe sole rigidity, especially of the midfoot, locks the heel and forefoot together. One result of this unnatural restriction is lack of traction.

If a player's leg and heel is planting at significant angle to the ground, then the player's forefoot must rotate relative to the heel to make full, flat contact with the ground. If the forefoot is locked to the heel and cannot rotate, it can only make contact with the ground at the same significant angle as the heel. The forefoot cannot gain traction since it contacts the ground with only a narrow edge that cannot provide traction and therefore the forefoot slips uncontrollably, causing the player to fall unexpectedly.

Novak Djokovic PLAY VIDEO is an excellent example of this rigid sole problem. His leg is at a severe angle to the outside causing his severely angled shoe, heel and forefoot locked together, to slip on the inside edge of his severely angled forefoot. The lack of traction of the forefoot's inside edge resulting in an uncontrollable fall – just before match point at Wimbledon.

Jayson Tatum PLAY VIDEO is also an excellent example of the same rigid sole problem, but this time with Tatum's leg severely angled to the inside, not the outside. With his heel and forefoot locked together, he is forced to slip on the inside edge of his severely angled shoe's forefoot, resulting in a hard fall from its lack of traction.

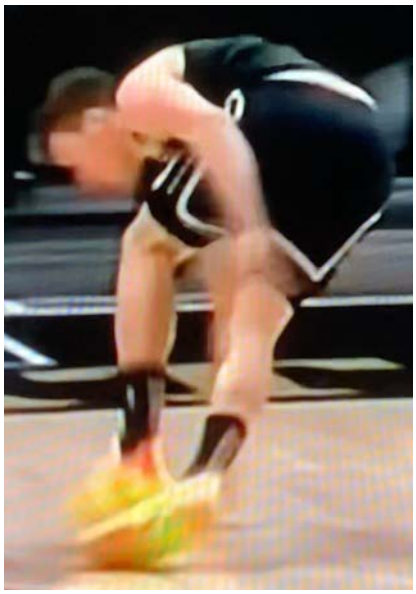
The most interesting and novel example is from a hamstring pull in 2024 by **Tyrese Haliburton,** who experience an uncontrolled slide on the inside edge of his right shoe. He could get no traction from the edge of his shoe and the position of his leg locked the heel into that tilted position. The rigidness of his shoe locked his shoe forefoot into the same severely tilted position as the heel, so that it's traction surface automatically broke contact with the ground. In the same position, the bare foot could naturally twist relative to the heel in order to maintain contact with the ground and provide traction, if possible. PLAY VIDEO PLAY VIDEO

The basketball shoes with the most extensive and robust network of hard plastic sole structural reinforcements ever made in a basketball shoe, to the best of my knowledge, is the **Adidas Crazy BYW III** (the Pharrell Williams 0 TO 60 edition shown here).

Those blue sole structural reinforcements extend unbroken from the rearmost heel to the foremost forefoot and, in the critical midfoot, also extend up both sides and onto the upper. Short of turning a basketball shoe into something closer to an all-plastic ski boot, this shoe probably has the greatest amount of hard plastic that any basketball shoe will ever have. Crazy indeed.



Bogdan Bogdanovic, one of the very best European players in the NBA (and All Second Team at the 2024 Paris Olympics), had the misfortune to wear a pair of the Crazy BYW III shoes in an NBA game. He thereby inadvertently provided a real-world demonstration of their stability performance.



The video pretty much speaks eloquently for itself, but I feel compelled to add that I have never before seen a player "posterized" by the basketball instead of another player. Much less because his shoes apparently would not allow him to simply stay upright on his feet while cutting, unguarded, without contact. PLAY VIDEO

Frankly, I have to confess that this innocent victim's uncontrollable stumble touches a nerve for me, still a little raw after several decades. After all, **BYW** stands for **Boost You Wear**, apparently Adidas' second attempt to finally make the **FYW** technology work after abandoning it in the early 2000's.

I invented and licensed the patents to Adidas that covered the barefoot sole structure technology used in **Feet You Wear** basketball shoes (and a multitude of other **FYW** shoes). However, I was allowed no actual role in the design and development of FYW shoes. Perhaps because of that, I believe Adidas was able to use my technology effectively enough to achieve the barefoot-like stability demonstrated by my 1993 athletic shoe prototypes.

But I also believe the main reason FYW shoes were not stable like barefeet or my 1993 shoe prototypes was that Adidas' **Torsion System** was integrated into all of them, making them far less stable because of its extreme sole rigidity. By the time the integration with FYW happened, the torsion system had already evolved into a rigid anti-flexibility system that unnaturally locked the forefoot and heel together, as detailed earlier.

So it is somewhat bitter irony for me that Adidas's BYW failure is in effect the second FYW technology failure. Also, that it occurred mainly for the same reason as the first, the anti-torsion system on steroids that they used with it that overwhelmed BYW's potential stability benefits, not that they were necessarily perfect either as developed by Adidas without input from me.

On the other hand, to be fair about the Crazy BYW III shoe, Bogdanovic suffered no apparent physical injury, so a case can be made that the other basketball shoes analyzed in previous sections here are actually worse, since strong evidence indicates they caused serious injuries. However, a better case might be that the Crazy BYW III shoes were just not used in enough games to cause many injuries.

PART II

SIMPLE REDESIGN CORRECTIONS TO FIX BASIC FLAWS IN CONVENTIONAL BASKETBALL SHOE SOLES

10. UNDO THE TOO THICK AND TOO SOFT MIDSOLES, REMAKING THE SHOE SOLE BOTH THINNER AND FIRMER, PARTICULARLY THE FOREFOOT

To recap the earlier analysis on the shoe sole thickness problem, the drastic change in sole structural design crept in slowly, evolving gradually over decades. For comparison, back in 1984, the then new **Nike Air Jordan 1** basketball shoe had no rigid sole reinforcements and a very thin forefoot with no cushioning midsole (only outsole and insole in the forefoot), like earlier basketball shoes. The forefoot of the Air Jordan 1 was only about **11** mm thick, compared to a **22** mm average for basketball shoes today, an extraordinary **+100%** thickness increase.

It's worth remembering that **Michael Jordan** wanted his first basketball shoes to be "…close to the ground. I didn't want to feel like I was playing in high heels shoes because it would increase my chances of twisting an ankle. **I wanted to feel like a racecar, close to the ground**" (from his autobiography, ***Driven From Within***).

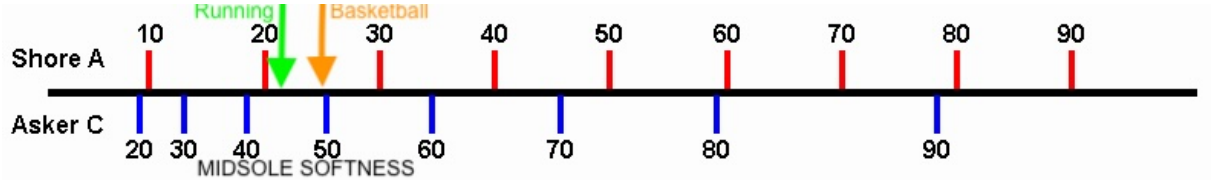
Simple biomechanics makes the forefoot thickness of a basketball shoe the primary factor in determining its stability in lateral motion. The very thin **11** mm and firm forefoot of the Air Jordan 1 guaranteed instant responsiveness for a quick start. That may help to explain Jordan's otherworldly quickness in his earliest NBA years, when his first step seemed to be at least a full step faster than anyone else in the NBA. At times he seemed to move around other players like they were standing still, as you can still witness in **Netflix's The Last Dance**, Episodes 2 & 3 (which is also before he had to bulk up with significantly more muscle to survive the Piston's "Jordan rules").

The **11** mm **Air Jordan 1**, as well as the similarly thin forefoots of the older **Converse All Star** and **Adidas Superstar** basketball shoes (both about **13** mm) – **all were too firm to be comfortable**, especially by today's standards. **But footwear-related serious injuries were also much rarer in the NBA then**, **unlike today,** when the sudden increase in injuries have become the focus of intense attention due to their frequency and seriousness.

Today, **essentially for comfort**, all basketball shoes have midsoles made of soft foams that are on average are only **22% firmer** than those of running shoes **(25.1** HA **vs. 20.6** HA**)** and with a forefoot only **17% less thic**k than a running shoe forefoot **(21.6** mm **vs. 26.0** mm**).** Basketball shoes with increased sole thickness and softness compared to the past are **inherently less stable in lateral motion**, causing more ankle sprains and other serious injuries. Simple biomechanics rules! (The averages are of 73 basketball shoes and 267 running shoes from **runrepeat.com** reviews of the past few years; HA stands for Shore A durometers, a midsole softness measure, the higher the firmer)

This durometer scale shows how unusually close to the same midsole softness both running shoes and basketball shoes are now. Both had significantly higher firmness ratings in the past (due to the limitations in the chemical composition of injected foam plastic back then),

and were also farther apart relative to each other, with basketball shoes even firmer back then relative to running shoes.



To compare the above averages of all running shoes directly to several well-known running supershoes, the **Nike Vaporfly 2** supershoe had midsole foam of **19.0** HA, only slightly less than the **20.6** HA average of all running shoes. And the **Vaporfly 3** supershoe had a forefoot thickness of **26.0** mm, exactly the same as the average for all running shoes. So running supershoes can have sole softness and thickness very close to the average of all running shoes today (data from **runrepeat.com**).

The rigid sole structures of running supershoes are designed as levers to help propel the runner forward. In a roughly parallel design, elaborate plastic rigid structural reinforcements are now incorporated throughout basketball shoe soles, sometimes even from tip of the toes to the back of the heel. This highly variable pattern of rigid plastic reinforcements has the erratic look of a dike-plugging attempt to put back as much as possible of the stability and control inherently lost from today's greater sole softness and thickness.

However, they cannot do so even partially without creating their own unique problems, because these rigid structural reinforcements are foreign objects completely different from any anatomical structures of the foot. They dangerously obstruct the natural motion of the foot involving the complex biomechanical interaction of many bones, joints, ligaments, muscles and tendons, the proper functioning of which is required to avoid injury.

The first step in fixing the problem of too thick soles in the shoe forefoot is, obviously, to make them thinner, more like the old classic basketball shoes. This is, again obviously, a classic engineering trade-off between comfort on one side and performance, including injury avoidance, on the other. However, modern materials and better design can make even the very thin 11-13 mm forefoot soles of classic basketball shoes significantly more comfortable than were the originals. With the correct design and materials, somewhat thicker soles can also be made reasonably stable.



There are two currently available brands of modern minimalist or "barefoot" basketball shoes, **Xero** and **TYR**, which under the existing loose definition mainly means a basketball shoe with a thin sole and no heel lift (or drop). They have a sole thickness of **18 mm** and **10 mm**, respectively, with uniform thickness from heel to toe, including the forefoot, with no thickness tapering around the toes.

The **Converse "The Weapon"** model is a classic basketball shoe introduced in 1986 and presumably worn by Magic Johnson and Larry Bird during some of their prime NBA years. It is included here as another still available basketball shoe with a relatively thin **14 mm** forefoot thickness, but also using substantial cushioning midsole to test and, with a heel lift (or drop) of **10 mm**, to compare directly to current basketball shoes with substantial midsole thickness, which all have a heel lift (or drop). In addition, the Weapon has no thickness tapering around the toes, unlike current shoes, so it is stable in the classic stepback/pushoff position that accompanies Achilles tendon injuries.



11. REMOVE RIGID PLASTIC SOLE REINFORCEMENTS AND/OR RESTORE NATURAL MIDFOOT TORSIONAL FLEXIBILITY WITH LONGITUDINAL SOLE SIPES OR SLITS

Hard plastic or carbon fiber structures that are too rigid should be removed or fundamentally redesigned to better stabilize basketball shoes. In addition, or alternatively, the excessive rigidity of existing designs can be modified to provide more natural flexibility through the use of **sole sipes or slits**.

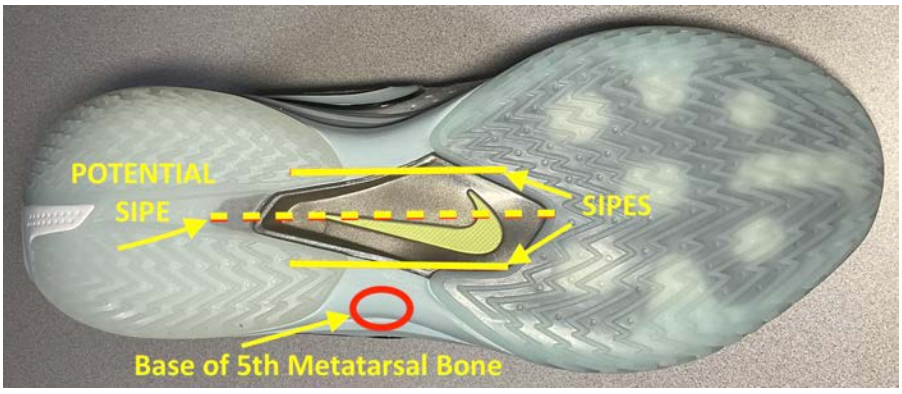
To put it as simply as possible, the most urgent need is to make sole flexible enough that the forefoot can move independently from the midfoot and heel, like the human foot does. The goal is to restore the shoe sole flexibility that modern basketball shoes now lack, instead of eliminating it completely like most now do.

The first step is to make the **midfoot** of the shoe sole flexible, not rigid. This fix makes a particularly big improvement in avoiding or reducing the effects of **step-on ankle sprains** analyzed in Parts 4 & 5. This fix also makes a particularly big improvement in avoiding or reducing the effects of **Achilles tendon ruptures** as analyzed in Part 1.

Critically, this can be done immediately for testing, but stability improvement is very limited, since the shoes' too thick and too soft midsoles remain. However, the more flexible soles allow for a noticeably more natural interaction with the ground during walking or running.

The quickest and easiest way to introduce flexibility into an existing shoe sole is to slice it (carefully using, for example, a sharp craft knife) to create one or more **flexibility sole sipes** in the form of **slits** – a barefoot sole-like footwear sole technology I invented in the early 1990's (see a copy of U.S. Patent '964 cover page in APPENDIX 2) and used later by Nike in developing its **Free** line of athletic footwear in the early 2000's.

To maximize naturally functional torsional flexibility along the long axis of the shoe sole, longitudinal **sole sipes** are theoretically optimal and initial testing on existing shoes has confirmed this.



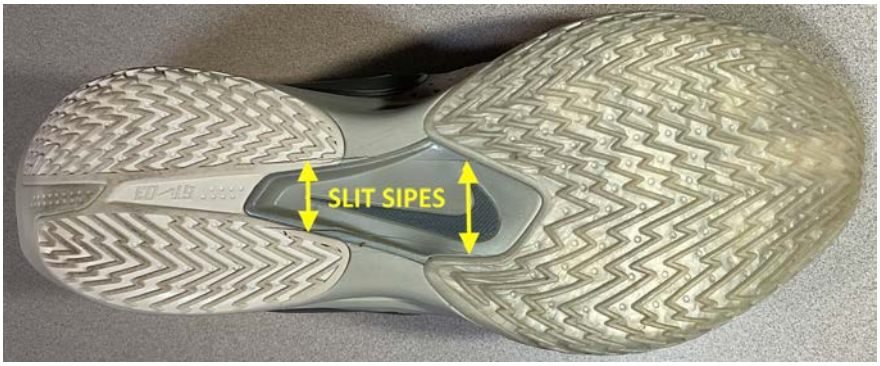
If the plastic shank locking the heel to the forefoot is particularly robust, it may also be necessary to cut across it between the midfoot and both the heel and forefoot; that is, cut transversely. In the example shown, that was not necessary since the too rigid plastic piece is relatively thin in this shoe.

Many other **sole sipe** variations were tested as well, as described in APPENDIX 2. In the example shown (a popular **Nike GT Cut 3** basketball shoe), a longitudinal **sole sipe** in the form of a slit is located on the lateral and the medial sides of the midfoot of the shoe sole. A third potential longitudinal **sole sipe** is shown between them as a dashed line.

To tune the amount of longitudinal torsion (which is twisting the shoe sole on its long axis) that is desired in a specific shoe sole (whether existing or new design), the number, length,

depth, and thickness of the **sole sipes** can be varied to adapt to the structure and material configuration of the specific shoe sole being modified. So the **sole sipes** can vary between shoe soles. The **sole sipes** can be cut in or molded in or printed.

This is an example of the Nike GT Cut 3 basketball shoe with 2 longitudinal **sole sipes** in the form of **slits**. As you can see, the change in appearance is practically invisible, even from a normally hidden view of the bottom sole, and the view from the sides or upper is obviously completely unchanged.



This invisibility highlights a basic virtue of this minimalist approach: it is as close to risk-free as any structural change can be, since it is narrowly focused on changing the longitudinal torsion of the shoe and only that, leaving every other component of structure or function completely alone. Not only that, but the change is totally tuneable, meaning the change can be as incremental as preferred, starting with a lesser change, then testing with each increment of change, until the degree of change wanted in longitudinal torsion for a specific shoe model has been obtained.

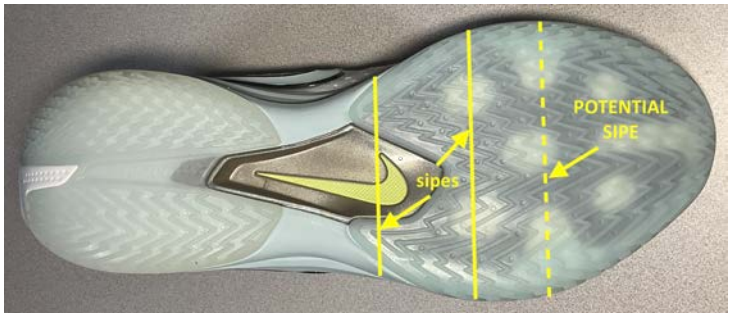
However, on the downside, it does decrease the shoe sole's resistance to edge weakness, which decreases its resistance to rollover instability. So it is not preferred in the absence of decreasing the excessive midsole thickness and softness of modern basketball shoes.

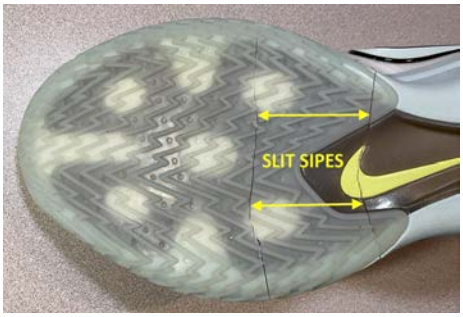
12. REMOVE RIGID PLASTIC SOLE REINFORCEMENTS AND/OR RESTORE NATURAL MIDFOOT TOE-OFF FLEXIBILITY WITH TRANSVERSE SOLE SIPES OR SLITS

Again, the most urgent need is to make sole flexible enough that the forefoot can move independently from the midfoot and heel, like the human foot does. The goal is to restore the shoe sole flexibility that most basketball shoes now lack, instead of eliminating it like most now do.

The corrective step is to make the **forefoot** of the shoe sole flexible, not rigid. This fix makes a particularly big improvement in avoiding or reducing the effects of **Achilles tendon ruptures** as analyzed in Part 1. This can be done immediately to test, tune, and improve.

To maximize naturally functional flexibility of the shoe sole between the forefoot and the midfoot and heel, transverse **sole sipes** are theoretically optimal and initial testing on existing shoes has confirmed this.





This is an example of the Nike GT Cut 3 basketball shoe with 2 transverse **sole sipes** in the form of **slits**. As you can see, the change in appearance is practically invisible, even from a view of the bottom sole, and the view from the shoe sides or upper is obviously completely unchanged. Even the crudely made slits shown are functionally effective.

13. TO REPLACE TOO RIGID PLASTIC REINFORCEMENTS, USE CLASSIC FOXING OR OUTSOLE WRAPS TO IMPROVE LATERAL STABILITY

Modern designs of foxing or outsole side wraps or other forms of stiff sidewalls should be used to replace or substantially reduce/redesign the hard plastic structures currently in use in modern basketball shoes to reinforce their too thick and too soft midsoles.

The old classic **Nike Air Jordan 1**, **Converse All Star**, **Adidas Superstar,** and **Converse The Weapon** basketball shoes all had **foxing or outsole wraps** around the outside edge of the shoe sole and extending onto the shoe upper. These functioned as stiff sidewalls to provide lateral stability by counteracting edge weakness caused by powerful lateral forces, particularly in the forefoot (which is ground-contacting even when the heel and midfoot are not in court sports).

14. USE MODERATE HEEL DROP (OR LIFT)

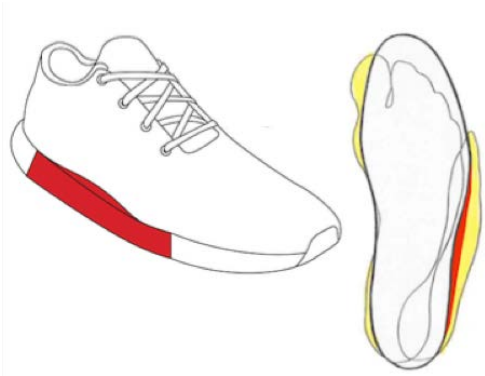
Unlike the **Nike Air Jordan 1** and **Adidas Superstar**, the safest **heel drop (or lift)** of basketball shoes should be moderate, in the range of about **4-8 mm**. I think both of these shoes were more injury prone than the other two because of their excessive heel drops (or lifts) of **11 mm** and **13 mm**, respectively, compared to **7 mm** and **8 mm** for the **Converse All Star** and **The Weapon** basketball shoes, respectively.

The thicker the sole under the heel is, the more unstable it is inherently, by simple biomechanics, and the greater the heel drop of lift, the thicker that sole.

15. EXTEND THE SHOE SOLE UNDER THE BASE OF THE 5TH METATARSAL BONE

Just eliminate the conventional lateral indentation between heel and forefoot on the lateral side of the midfoot. Simply fill-in the lateral midfoot sole indentation shown in **red**. Doing so will directly and much more effectively support the foot's longitudinal arch.

That is highly preferable to using the existing but very poor method pioneered hundreds of years ago by shoe cobblers, which is to put a **rigid shank** under the long arch, between elevated heel that was added to the forefoot typical of a casual or dress shoe, specifically to literally bridge the large gap in support between them (but completely unnecessary in a conventional athletic shoe which typically has a continuous in the midfoot from direct midsole and outsole support). The central location of the typical shank means it gives no direct support whatsoever to the critical base of the 5th metatarsal bone.



As the second quickest possible step after using **sole sipes** to recreate natural flexibility, **there is a simple structural fix that noticeably reduces the effect of the instability flaw of conventional shoe soles.** It is a worthwhile increase in the stability that can be retrofitted with little expense almost immediately to existing conventional shoe sole designs.

This relatively quick and easy initial fix involves only a minor extension of the midfoot on the lateral side of the shoe sole. The extension simply eliminates the conventional lateral indention between heel and forefoot – a previously unnoticed stability flaw that has become larger and more pronounced in recent years. The addition of a straight-sided **Midfoot Lateral Sole Extension** (shown in **red**) is located where the mismatch (in yellow) is greatest between the narrow shoe sole and the much wider bare sole footprint in extreme supination, thereby **substantially reducing an existing dangerous trigger of instability leading to ankle sprains**.

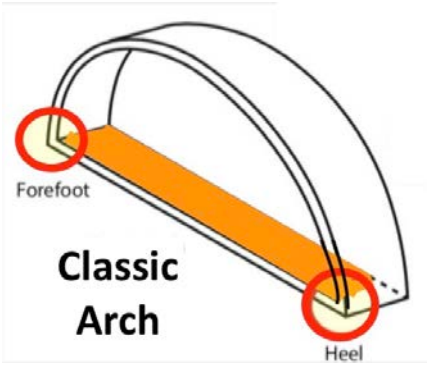
Without the **Midfoot Lateral Sole Extension**, the base of the 5th metatarsal is the first bone to roll off the upper surface of the shoe sole when the shoe upper is removed and the sole tilted outward. The stationary heel remains on the shoe sole, the 5th metatarsal head is teetering on the edge, and the 5th metatarsal base is off, forcing the rest of the foot off too, thus **triggering a lateral ankle sprain** (which happens if the sole had an attached shoe upper to pull it over, as it normally always does).







Using the **midfoot lateral sole extension** can reduce the number and severity of lateral ankle sprains and falls during walking and standing, particularly among the elderly. It lowers injury incidence and severity for athletics to a much lesser, but still worthwhile degree.



The principal function of the **midfoot lateral sole extension** is to provide full support to the base of the 5th metatarsal bone. A critical point needs to be made here about the overlooked but **key role of the base of the 5th metatarsal bone in anchoring the medial longitudinal arch of the foot**. The long arch is generally misunderstood to be a simple arch with a classic uniform 2D structural shape stretching from the heel to the forefoot. See the **Classic Arch**.

Long ago, shoe cobblers added a **shank, a plank-like piece of metal or hard plastic** connecting the heel and forefoot to support the long arch between structural gap separating the the heel and forefoot.

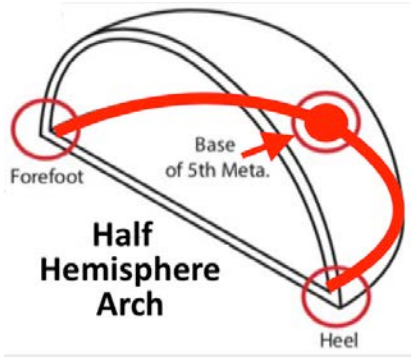


The original 1989 **Adidas Torsion System®** was designed to bridge the gap between separate sole sections for the forefoot and the heel with a centrally located hard plastic bar (seen in **orange**), similar to the steel shank used in classic leather dress or casual shoes, which typically have a separate and elevated heel.

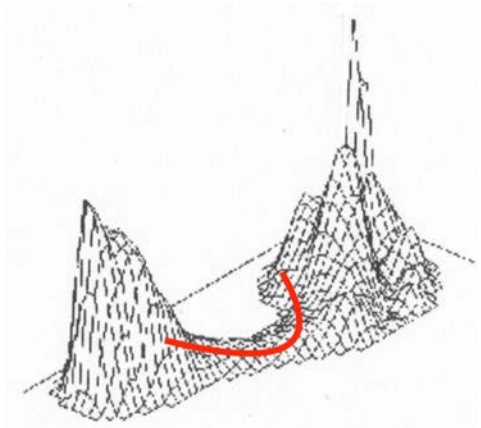


The purpose of the **Torsion System®** was to allow the shoe sole of the forefoot to pivot relative to the heel along the long axis of the shoe, as some scientific studies of the period suggested was important biomechanically, particularly during running.

Unfortunately, it quickly developed into a massive midfoot **anti-torsion system** used by most major athletic shoe brands, now often spanning the entire length of the shoe sole, from the tip of the toe to the rearmost heel, as shown in several examples previously.



Unlike the Classic Arch 2D model, the actual shape of the medial longitudinal arch is much more like a complex 3D structure formed like half of a hemisphere, with the base of the 5th metatarsal bone crucially providing the only direct support in the middle of the arch. This is illustrated here in the **Half Hemisphere Arch**, with the base of the 5th metatarsal bone as the major base support of its foundation, as important as a keystone in maintaining essential structural support for the long arch.



This is clearly demonstrated by a **running bare**

footprint of peak plantar pressure distribution shown here. Obviously, there is no ground-contacting portion of the foot in the medial long arch area normally, even at three times bodyweight experienced during running. The loadbearing portion of the midfoot is only on the lateral side, and the base of the 5th metatarsal bone is the only structural component located in that midfoot area.

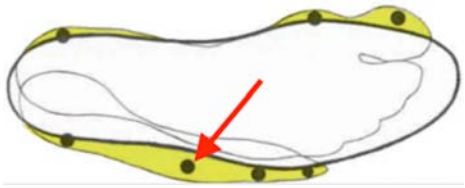
Even some running shoes are starting to slowly move in the direction of accommodating this fundamental reality, as you can see in the forefoot of this **Adidas Adizero Evo SL** where the bottom sole is focused on the medial side by the big toe but totally absent on the lateral side. But full medial support for the big toe is still lacking during the toe-off phase of running, resulting in exaggerated pronation in this and virtually all other running or other athletic shoes. There should be no inward taper around the big toe toward the centerline of the shoe sole. A wide toe box is functionally required to provide direct structural support to the big toe during running.



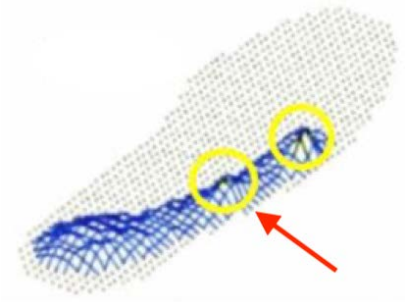
Note that there is typically no ground-contacting portion of the medial long arch, so providing direct structural support to it is far less important than to the base of the 5th metatarsal bone. Even for severe pronators, finally supporting the base of their 5th metatarsal and their big toe properly will result in reduced pronation from effective direct structural support.

By the way, the occasional use today of the term "lateral arch" is plainly incorrect to refer to the area around the base of the 5th metatarsal bone, since in essential functional terms, it obviously does not exist except as an unfortunate artifact of disfunction last design relating to providing heel drop or lift..

In this diagram of a **Dynamic Footprint** superimposed on the outline of a conventional shoe sole, the principal bones on the sides of the foot are shown. The largest mismatch between the footprint of the fully supinated foot and a conventional shoe sole is in the lateral midfoot centered around the position of **the base of the fifth metatarsal bone**, located between the forefoot and heel (indicated by **arrow**).



The base of the 5th metatarsal bone is even more important in the typical **lateral ankle spraining position**, where the bare foot is rolled outward as far as its subtalar joint allows. In the position, the base of the 5th metatarsal bone has the second highest peak plantar pressure, just behind that of the head of the 5th metatarsal bone. The peak pressure on the heel is much lower.



It is therefore absolutely essential for a stable shoe sole to provide direct structural to the base of the 5th metatarsal bone to naturally support the foot's longitudinal arch (like the red section shown in the peak pressure running footprint above), unlike conventional shoe soles with their indentation at the midfoot lateral side, an important structural gap, as shown in this assortment of basketball shoes (the **red line** shown below highlights how far inward from the heel and forefoot edges the indentation goes).

In a real sense, the base of the 5th metatarsal bone is the keystone of the foundation of the medial longitudinal arch. So, conventional supports for the long arch of the foot, like the Adidas Torsion System®, since they are located on either the medial or central portion of the midfoot, are inherently not effective.



That is because they are treating the symptom of falling long arch by propping it up directly, rather than preventing it by fixing the true cause, which is lack of support of the base of the 5th metatarsal bone, a key part of the arch's foundation.

Logically, as a result of providing better, more natural support, the **midfoot lateral sole extension** should have the additional benefit of preventing or reducing Jones fracture of the 5th metatarsal base like that which occurred to Kevin Durant, as mentioned previously.

The base of the fifth metatarsal bone would be supported in a natural way by the midfoot sole extension, instead of being unsupported even when standing upright or walking, much less during running or other athletic movements, which often includes the extreme supination that occurs in sharp cutting maneuvers in court sports and other rigorous activities, or in the extremis situation of a lateral ankle sprain.

A few years ago, at my direction, **i-generator** conducted comparison testing between a wide variety of modern basketball shoes that had been modified with the straight-sided **midfoot lateral sole extension** and unmodified shoes of the identical shoe model. They included the Nike ***Air Jordan XXXVI***, Nike ***Zoom Freak*** 3, Nike ***Zion 1***, Under Armour ***Curry Flow 8***, and Adidas ***D.O.N. Issue #3*** (shown below), as well as the Converse ***All-Star***. The lateral stability of all of the shoe models was improved, with variation between models and test subjects.



Another modern basketball shoe proved to be the lone exception. The Nike ***LeBron 19*** could not be modified because it already features unique direct structural support under the base of the 5th metatarsal and is already more stable than the others in lateral midfoot

stability testing.

Example Modifications in a Nike Pegasus 38 Running Shoe: Shown here is a test model example of an earlier model running shoe with test modifications to the midfoot sole to better provide direct sole support to the base of the 5th metatarsal bone (adding a lateral section of midfoot midsole). Although the mod to the 5th could only be made in a limited way on its upper surface due to its existing structure, the overall effect of both mods is extremely successful, with the most distinct difference being better lateral stability.

All running shoes including older models need these critical improvements, because running shoes are the most popular athletic shoes, widely used as casual shoes, even by the elderly, who need the best lateral stability possible.



Of course, the NBA and NCAA desperately need basketball shoes with the same critical modifications, and the good news is than any basketball shoe model in current use can be modified for quick and easy testing in the same general way shown above, each model having minor specific adjustments to optimize the potential improvement. So athletic shoe companies should have no difficulty in filling that need in the near future.

Another example shown here is a **midfoot lateral sole extension** glued onto a **Nike GT Cut 3** basketball shoe. A very important structural point is that the **extension** obviously makes this shoe or any other with a rigid midfoot device even stiffer and therefore require the addition of **sole sipes** shown previously to provide torsional flexibility in the midfoot. Below that is a comparison of a unmodified GT Cut 3 with one modified with the **midfoot lateral sole extension**, photoshopped to have a finished production look.









16. USE A WIDE TOE BOX TO EXTEND THE SHOE SOLE FOREFOOT ON THE MEDIAL SIDE OF THE BIG TOE

As pointed out previously relative to Justin Moore's **Nike Kyrie 3** basketball shoes, all modern basketball shoes (and most other athletic shoes) have a forefoot with a **width** that tapers very rapidly around the sides of the toes. From an appearance perspective, the steep tapering gives the basketball shoe's forefoot an attractive streamlined appearance, so it is universally used in women's high heels as well.

At the same time, the soles of basketball shoes have recently become much thicker and the **thickness** of its forefoot sole also tapers very rapidly around the toes. This trend comes directly from the technical trend in running shoes to thicker soles with softer and more resilient sole materials like Nike Pebax for better comfort.

However, the steep forefoot tapering causes excessive pronation, led by a critical medial or inward rolling stability problem relative to the **big toe.** The inward tapering leaves the big toe literally perched on the medial or inside edge of the shoe sole, posed to easily roll off during the extreme lateral motion during the cutting and side-stepping that is a fundamental part of any basketball game.

This is an inherently unsafe position for the big toe to be in, especially risky because the big toe is subjected to by far the highest peak pressure of any part of the foot during sports, as shown by the **red oval** in this **running bare footprint** showing peak plantar pressure distribution. **It indicates that the big toe is subjected routinely to roughly twice as much pressure as any other part of the foot**.



This is an exceptionally crucial biomechanical and anatomical fact that has been, by custom, entirely overlooked by virtually all athletic shoe designers, especially in basketball shoes and even more crucially in most running shoes as well.

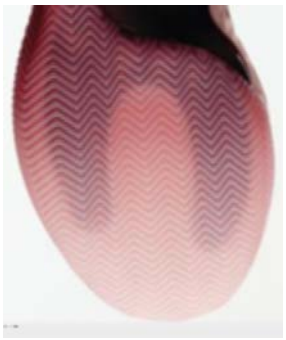
The exceptionally extreme point pressure on the big toe frequently results in the breakdown of the medial long arch of the foot, which causes the foot to flatten and the big toe to bend in and remain pointed inward. This is very common in exceptional athletes, like the **former NBA superstar's forefoot** shown here, as well as in the feet of so many women who love to wear high heels despite their typically extreme discomfort.





In stark contrast, next to it is the remarkably different shape of the **natural barefoot sole of a human foot that has never worn shoes.** Most surprising, scientific observation of those "primitive" natural feet indicates that they do not pronate when running, unlike the deformed feet of modern shoe-wearing runners.

In similar contrast, a modern foot with an un-collapsed long arch typically has a much straighter big toe, roughly like the **classic Greek foot**, as seen here in the forefoot of an ancient Greek statue. Next to it, the right forefoot bottom sole of the **Puma Hali 1** that Tyrese Haliburton was wearing when his Achilles tendon ruptured. Note the obvious impossibility of an undeformed big toe being able to fit into the Puma Hali 1, typical of all basketball shoes. That is, unable to fit unless the foot's long arch is also collapsed in conjunction with the bent-in big toe.





So, an obvious case can be made that designers are currently designing forefoot of athletic shoes mostly to look great and primarily fit superstar's deformed feet with their collapsed arches and bent-in toes.

Or, for that matter, **is it not more likely that the bent-in big toe of NBA superstars is actually caused by the enormous pressure of their feet bound within the pointed forefoot shape of the traditional basketball shoe sole and upper**, unnaturally deformed just like the extraordinarily unnatural shape of the bound feet of concubines in premodern China?

The basic problem with this traditional sleek approach to forefoot design is that it does not seem to work, even for the superstars for whom the design seems to match their foot shape. Preceding videos seem to indicate that it plays a role in severe injuries.

In **Part 1, Section 1 on Achilles tendon ruptures** and in **Section 6 on knee ACL ruptures** (and of course tears as well) the injury mechanism shown in videos seems clearly to be initiated by an inward rolling of the shoe sole's forefoot. That can most easily be explained by the probability that, under enormous pressure, the superstar's big toe is rolling off its unsafe perch on the inside edge of the narrow forefoot, following the path of least structural resistance.

The following are the forefoots of the **Nike Kyrie 3**, **Nike Tatum 3**, and **Adidas Dame 9**, respectively, all with greater width for the heads of the metatarsal bones (**red** arrow) and less width for the toes (**orange** arrow). The **Nike KD 12** and **Puma All-Pro Nitro** also look the same. All have the same pointed toe section that allows the big toe to easily roll off it uncontrollably to the inside in the **toeoff position** at the end of the **classic stepback/pushoff** motion that game video indicates precedes Achilles tendon ruptures of many NBA superstars.







The extra big toe protection evident in the fabric upper of the **Kyrie 3** is common in many athletic shoes and indicates clearly that the narrow, pointed area in forefoot is not just intended as a "**toe thrust**" area, an empty area in front of the actual position of the toes in the shoes. Rather, it is designed specifically to contain the big toe.

However, for the large portion of the basketball shoe-wearing population that have feet with a straighter big toe more like the Greek foot statue above, the pointed area theoretically could become much more of a true empty space, technically called the **toe thrust area,** located in front of the toes, simply because their feet will not fit into the toe thrust area, at least initially. Logically that would seem to present a major stability problem in the toe-off position of active motion in sports, since the narrow and empty toe bumper would by its narrow shape inherently tend to allow the foot to suddenly roll off to the inside out of control of the player.

So, the simple and direct solution is to this apparent instability is to add some medial width to the narrow forefoot of the shoe sole next to the big toe by using a wider toe box (and last). The result would be a shoe forefoot that looks somewhat less sleek and less traditional, but fits everyone better, including the superstars. And those superstars' long arches should also be better supported under the base of their 5th metatarsal bone, as shown directly above under Part 18, so their unbound big toes may become straighter in the future, also with less pain.

There are two brands of modern minimalist or "barefoot" basketball shoes, **Xero** and **TYR**, which under the existing loose definition mainly means a basketball shoe with a thin sole and no heel lift (or drop). More to the point here, it also means a more natural, wider toe box with a straighter medial side to better support the big toe.

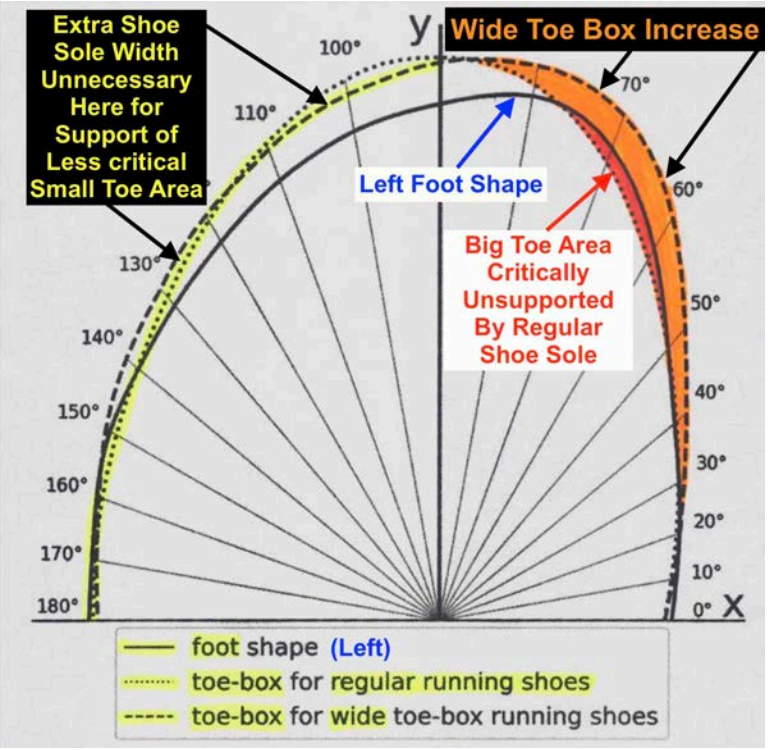
The difference from existing mainstream basketball shoe forefoots is easy to see in this side-by-side comparison of those two shoe models with the models previously analyzed: the **TYR & Kyrie 3** and the **Xero & Tatum 3**. The **TYR** shoe on the far left having the most natural toe box with the straightest big toe, but the **Xero** still straighter and more natural than more conventional basketball shoes. This is a simple case of better function over existing form.





A recent formal research study reinforces the conclusion that the conventional toe-box used in basketball shoes and most other athletic shoes does not provide crucial structural sole support to the big toe. It compares the composite scan of **1.2 million male foot shapes from North America, Europe, and Asia** with the **toe-box for regular running shoes**.

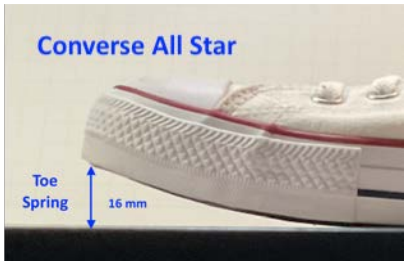
It shows clearly that the medial tip of the big toe goes over the edge of the **toe-box of the regular shoe sole (red)** and thus has no direct underlying sole structural support, which causes medial instability during the toe-off phase of the running stride. In contrast, the medial tip of the big toe is safely supported within the **wide toe-box for running shoes (orange)**, thereby has underlying sole structure to provide the direct support to the big toe needed for medial stability during the toe-off phase of the running stride.



Medial support is of course even more important for basketball shoes than for running shoes, due to frequent major lateral loads experienced in the sharp side-to-side motion common in all court sports. So the severe structural flaw in regular running shoe toe-box and crucial underlying sole structure established by this study does definitively point to an even greater problem in basketball shoes. (See Ales Jurca and Saso Dzeroski. A comparison of male foot toe shapes and running shoe toe-box designs. ***Footwear Science***, 2025, Vol 17, No. S1, S114-S115, **Figure 2** modified by author)

17. ELIMINATE SOLE THICKNESS TAPERING AROUND THE TOES

Another major toe problem is thickness taper from the heads of the metatarsals down to the toes. This is less obvious visually. Nearly all shoes have what is called "**toe spring**", which is the upward curvature from the metatarsal heads to the toes. It can be entirely benign, only a bending up of the very front of the shoe sole, with no thickness taper at all. The toe spring may come entirely from the curved shape of the conventional shoe last, the **Converse All Star** being a great example of this.





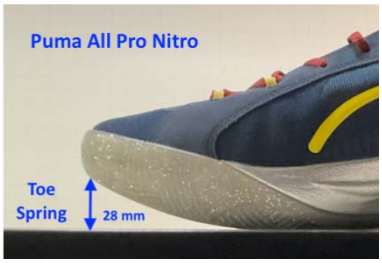


In classic basketball shoes, toe spring is low to moderate. The **Converse All Star** have a toe spring of about **16** mm, the **Adidas Superstar** has a toe spring of about **12** mm. while the **Nike Air Jordan 1** has a toe spring of about **18** mm).

Of the shoes being analyzed here relative to the Achilles tendon ruptures, the **Adidas Dame 9** and **Nike Tatum 3** both have moderately more toe spring, about **20** mm and **18** mm, respectively. The **Puma All Pro Nitro**, **Nike KD-12**, and **Nike Kyrie 3** all have substantially more toe spring, about **28** mm, **28** mm, and **30** mm, respectively.

Unfortunately, the toe spring increase in these current basketball shoes is directly related to the toe spring increase in **running supershoes** like the **Nike Vaporfly NEXT%**, which has an enormous toe spring of **55** mm! The big difference is that more than half of that huge increase in toe spring is due to a tapering of the Vaporfly's sole thickness, not simply bending up the forefoot like the classic basketball shoes.



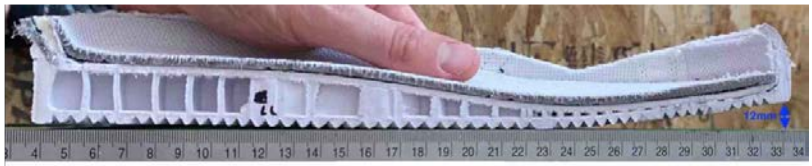




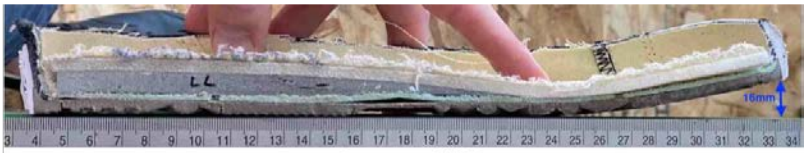
Since the older classic basketball shoes are associated with far fewer serious game injuries than now, it is likely that one of the main reasons is that their toe spring is entirely due to the toe of the sole being bent up, with the sole thickness not being tapered. (Although the Superstar does have a very small taper of **2** mm, that was probably due to the shoe's very high heel lift or drop of **13** mm, the tapering reduction of which extended only into the rear of the forefoot, not the toes).



So the real issue in modern basketball shoe design is the very substantial tapering of sole thickness in the forefoot downward through the toe area, from under the heads of the 5 metatarsal bones to the end of the toe section of the forefoot.



Adidas Superstar



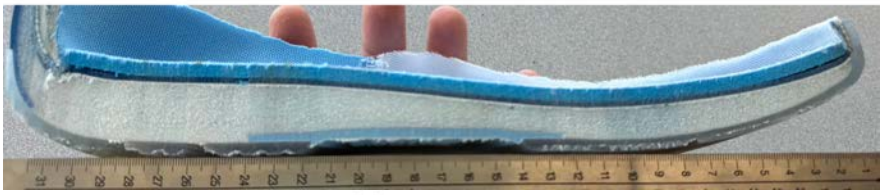
Converse All Star

The five modern shoes involved Achilles tendon ruptures listed above are prime examples of this toe tapering. All of them have major forefoot sole thickness reductions downward through the toe area. This apparently comes from the influence of running supershoes and the associated industry trend to new materials that are softer and used to make thicker soles.

Only the midsole portion of the modern shoe sole tapers, the other layers remaining constant, so only the midsole portion was measured for toe tapering.

Of the shoes being analyzed here relative to the Achilles tendon ruptures, the **Adidas Dame 9**, **Nike Tatum 3,** and **Nike KD 12** have toe tapering of about **5** mm, **4** mm, and **4** mm, respectively. The **Puma All Pro Nitro** and **Nike Kyrie 3** have substantially more toe tapering, both about **7** mm.

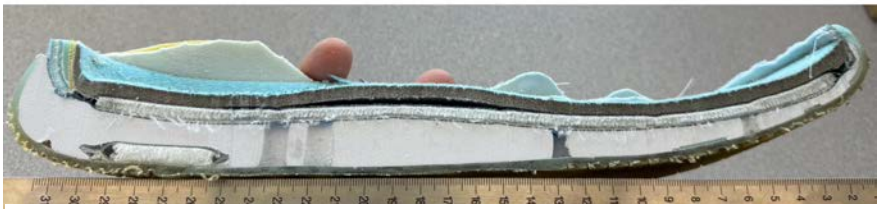
Puma All Pro Nitro



adidas Dame 9



Nike KD 12



Nike Kyrie 3



Both the **Dame 9** and the **KD 12** have hard plastic structural reinforcements in the toe area, moderate in the Dame 9, but extending through the big toe, and substantial in the KD 12, including the metatarsal heads 2-5, but omitting the medial side, also omitting the big toe area.

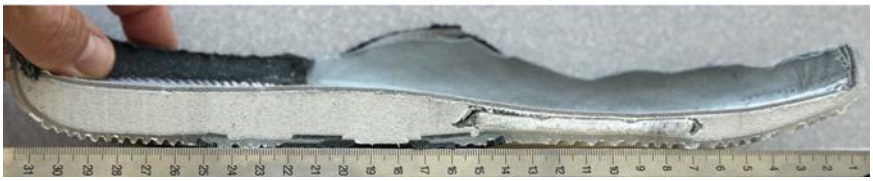
(All of the measurements are somewhat approximate because of the position of a potential wearer's metatarsal heads and toes must be estimated and cutting the soles distorts the forefoot.)

Although the magnitude of the midsole toe tapering, from **4** mm to **7** mm,

may seem trivial in absolute terms, in relative terms the thickness differences are enormous. For the **Kyrie 3**, it is a **70%** thickness reduction, for the **Tatum 3**, **KD 12**, and **Dame 9**, it is a **50%** thickness reduction, and for the **All Pro Nitro**, it is a **42%** thickness reduction.

It turns out that most of the toe tapering in all five of these shoes actually occurs in the relatively short distance between the middle of the big toe and the approximate end of the toe-off section of the sole forefoot. For the **Dame 9** and **All Pro Nitro**, the final toe tapering is **5** mm; for the **Kyrie 3** and **Tatum 3**, it is **4** mm; and for the **KD 12**, it is **3** mm.

Nike Tatum 3



That final thickness reduction for the five shoes ranges from **50%** to **42%** of the total reduction. While those percentages may not seem especially noteworthy, it is extremely alarming to recognize that for three shoes, **Tatum 3**, **KD 12**, and **Dame 9, all** **of the thickness tapering is focused in the short final distance at the end of the toe-off phase of the classic stepback/pushoff motion that typically precedes Achilles tendon ruptures.** And the **Dame 9** has a **hard plastic strut** there too. In combination with conventional forefoot width tapering, this sharp final toe thickness tapering would powerfully facilitate the inward rolling lateral instability of the shoe forefoot that game video indicates likely causes Achilles tendon ruptures.

So the resulting overall structural problem from the toe thickness tapering is lateral instability. With generally thicker soles in the tapering toe area, the shoe becomes especially unstable in the toe-off position. As noted, that is even more particularly true at the end of the **classic stepback/pushoff motion** that puts maximum tension on the Achilles tendon, as well as maximum pressure on the big toe, and occurs just before the ruptures shown previously in game video. The inward rolling around the big toe area also is shown in game video to occur in knee ACL ruptures and tears.

These five modern shoes provide little to no resistance to the rolling inward motion that preceded Achilles tendon rupture in the videos shown previously. This instability is extreme when a player places his foot at an angle to the outside to pushoff to the opposite side.

This is in stark contrast to the classic shoes with no toe thickness taper, or only a tiny amount. In my **stationary simulations** in the **classic stepback/pushoff position**, **the old classic shoes all provide stable support to the forefoot with no tendency to roll inward dangerously like the modern basketball shoes do the same static simulation.**

The obvious conclusion is that the examples of recent modern basketball shoes analyzed here have shoe soles that are too thick and have too much toe tapering to compensate for the excessive thickness. It is not difficult to provide reasonably similar or better comfort and far better stability by not inappropriately following largely irrelevant design trends from running supershoes, the actual benefits of which are coming under ever increasing challenge anyway.

In fact, the most authoritative and influential formal scientific studies by far, both published in the past few years in ***Footwear Science***[1], concluded that the claimed performance benefits of supershoes are not real and are instead merely a **placebo effect**. That is the same conclusion I reached based on different evidence in a critique of current footwear sole design published three years ago in the Appendix section of my recent book, ***Unnatural Instability***. Moreover, the most recent research[2] indicates that the ultra-stiff carbon-fiber plates used in "supershoe" soles alter the biomechanics of the ankle, knee, and hip joints, elevating injury risk.

ENDNOTES

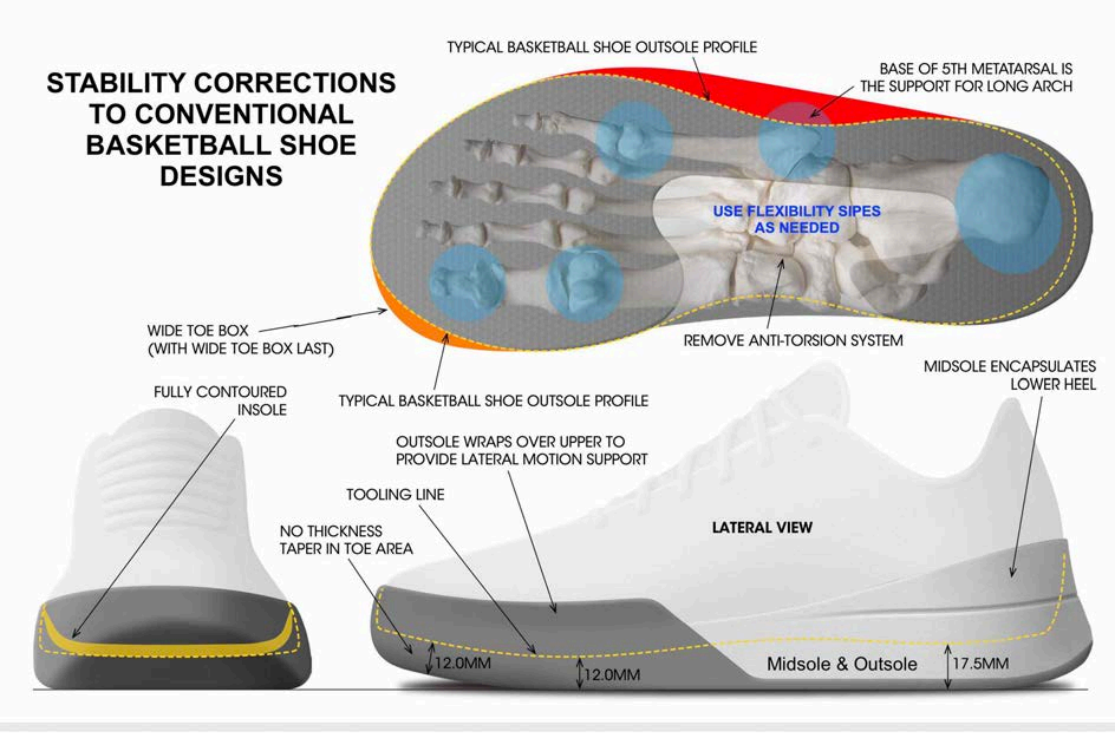
1. **Energy return in footwear – revisited**. Martyn R. Shorten. ***Footwear Science*** published online 28 Jun 2024, with **14,901** Current Views, the second most of all published studies. Dr. Shorten is a former head of R&D at Nike.

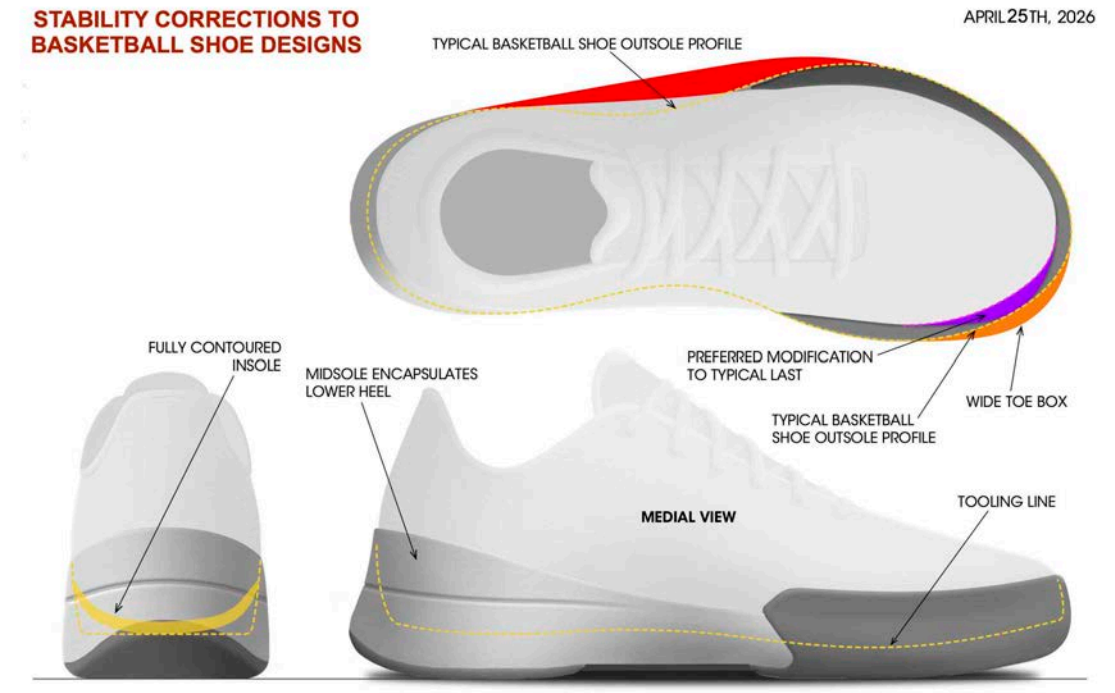
   Are super shoes a super placebo? A randomized crossover trial in female recreational runners. Kim Hebert-Losier et al. ***Footwear Science*** published online 17 Feb 2025, with **6,454** Current Views, a very high total for recent studies. This study is definitive!

2. **Influence of carbon-plated running shoes and fatigue on lower limb biomechanics.** Xiangdong Luo, Ruijao Liu, and Bo Li. ***Journal of Biomechanics*** 195 (2026) 113102

   Injury and performance-related running biomechanics in advanced footwear technology compared to minimalist footwear. J. J. Hannigan, Luisa Westley and Li Jin. ***Footwear Science*** 2024, Vol 16, No. 2, 115-121

18. GENERIC BASIC DESIGN FOR STABLE CONVENTIONAL BASKETBALL SHOES: much thinner and firmer sole with no toe taper in forefoot thickness; wider sole for extended lateral support underneath the big toe and 5th metatarsal head & base; eliminate rigid plastic reinforcement, use sipes for transverse forefoot flexibility & longitudinal midfoot flexibility, as needed; stiff sidewalls like outsole wraps or classic foxing for sole & forefoot upper; upper heel counter flexible; fully contoured insoles.





REDESIGN MODERN SHOES FOR GOOD STABILITY, NOT JUST COMFORT

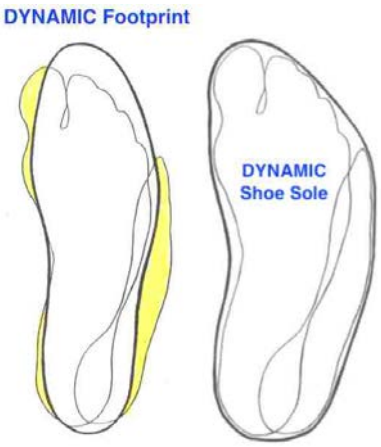
Modern basketball shoes need the following basic design corrections to provide good stability, and all are technically easy for the industry to do:

1. To keep the major stability advantage of the classic shoes, a **thinner sole** in the **hypercritical forefoot** under the ball of the foot, which is the only ground-contacting part of the shoe sole during "ankle-breaking" cutting motions. The thinner forefoot sole inherently resists shoe rollover resulting in ankle sprains, so maximum thickness of the forefoot **outsole/midsole** together should be no greater than about **12 mm**, exclusive of the **insole** of about **5 mm**. The thinner, the more stable.
2. Unlike many of the classics, extra **heel thickness** should also be kept **low**, no greater than a **heel drop of about 6 mm** to resist excessive thickness-induced ankle rollover, a significant stability problem in some classic shoes.
3. The **midsole material** should be **firmer** than the "supershoe" softness in frequent use now, preferably firmer than the current average of **25 Asker C**, or effectively counter-balanced by classic foxing side reinforcement (4). Thinner modern cushioning plastics can provide better cushioning than classic midsole materials.
4. Especially in the forefoot, midsole must be reinforced with side wraps like **classic foxing** of outsole or flexible plastic overlapping with the shoe upper to counteract edge weakness, thereby providing good resistance to rollover-caused ankle sprains.
5. There must be **no anti-torsion semi-rigid plastic sole reinforcements.** Natural torsional flexibility between forefoot and heel, like the bare foot, prevents the natural extreme inversion of the forefoot in the **classic lateral ankle spraining position** from rigidly forcing artificial inversion of the heel, causing ankle sprains.
6. Use **longitudinal and/or transverse sipes** as needed for natural **torsional and/or toe-off flexibility** between forefoot, midfoot, and heel to avoid Achilles tendon ruptures. Or indent the main arch and/or sculpt an arch into the sole under it.
7. Use a wide toe box to increase the **too narrow width of the hypercritical forefoot under the big toe and the head of the fifth metatarsal bone** to ensure sufficient medial/lateral support to resist excessive pronation and lateral ankle rollover.
8. **Remove the midsole thickness taper under the toes in forefoot** to avoid unnatural medial instability in the **classic stepback/toeoff position** in which Achilles tendon strains and ruptures occur. Instead, elevate the toes by bending up the sole of the forefoot, using **toe spring**.
9. **Remove the sole indentation on the lateral midfoot side** so the **base of the 5th metatarsal bone** supports the main longitudinal arch & resists lateral ankle sprains.
10. The **insole** should have **rounded and tapered sides** in the forefoot (like the insole heel often does) to improve lateral stability and to provide better comfort by covering sole/upper seams and avoiding the abrupt edge of untapered insole sides.

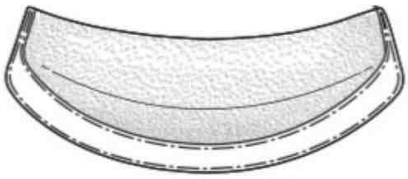
PART III

19. AS PUBLIC SERVICE, BASKETBALL SHOE PROTOTYPES WITH BAREFOOT-LIKE SOLE STABILITY ARE AVAILABLE NOW TO TEST

Although athletic shoe soles with the above modifications provide extraordinary functional improvements compared to existing shoes, they still fall far short of the stability performance of the barefoot unencumbered by footwear. The central problem is that the soles are too narrow.



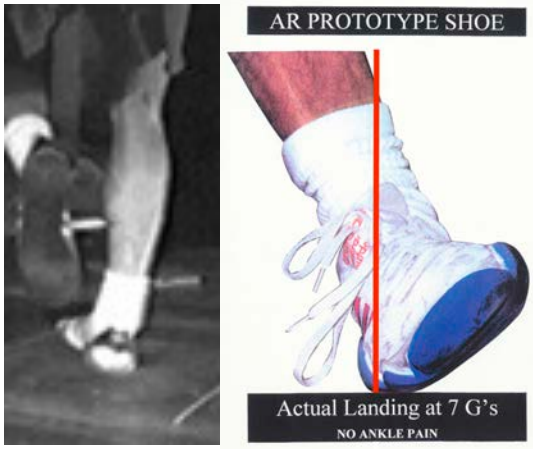
Enabled and controlled by the subtalar joint, the full range of normal lateral motion of the foot sole during the extreme sideways motion that often occurs in athletics and running extends the sides (in yellow) of the **Dynamic Footprint** sufficiently outside the sides of structural support provided by a conventional shoe sole to provide complete support to the foot sole, including the lateral ankle spraining position.


DYNAMIC SHOE SOLE

To be as stable as the barefoot, the sides of a **Dynamic Shoe Sole** must extend as far as the foot's dynamic footprint to provide naturally safe locomotion. In addition, instead of being flat, the extra width of the Dynamic Shoe Sole must be curved up around the sides of the **rounded** sole of the foot to avoid creating unnatural destabilizing levers. The shoe sole must also be sufficiently **flexible** to flatten under a bodyweight load, as does the rounded barefoot sole, particularly the heel. Finally, the dynamic shoe sole must have a **uniform thickness** in frontal plane cross-sections to maintain natural barefoot lateral stability, as seen in the example heel cross-section.

This is not a theoretical design. An **Anatomic Research Prototype shoe** incorporating these features was developed by **Frampton Ellis** in 1993 and tested at the biomechanics lab at U. Mass at Amherst.

Its performance in a revolutionary new lab test was unprecedented, proving capable of **stable single foot landings in the maximum supination classic lateral ankle sprain position at peak forces as high as 4 to 7 G's without any ankle sprains or even pain**. PLAY VIDEO



That unique lab test was obviously impossible to perform in conventional shoes due to the probability of serious injury, but a similar standing test indicated an ankle pain threshold in conventional shoes of as little as 0.25 G in the maximum supination ankle spraining position.

The patented technology owned by Frampton Ellis was exclusively licensed to **Adidas** from 1994 to 2003 and was worn by its superstar endorsers like **Kobe Bryant** and **Steffi Graf**. But Adidas' commercial footwear development, which they called **Feet You Wear**, never

produced shoes with the natural stability breakthrough clearly demonstrated in testing by the AR Prototype. Many factors were involved in that critical inability to develop barefoot-like stability, including that Frampton's role at Adidas was strictly limited to patent license issues and he was not included in Adidas' design and development process.

However, the most important factor in that inability probably was that Adidas independently introduced another, entirely different footwear sole technology a few years before **Feet You Wear** that it called the "**Torsion System®**". And it included that faulty technology in its Feet You Wear shoes, which seriously degraded their lateral stability, as detailed directly above in Section 9.

As described previously, the Torsion System blindly evolved to eliminate the natural torsional flexibility that exists between the forefoot and heel of the human foot, which is essential to provide crucial protection against twisting the ankle joint. Widely copied in the athletic footwear industry, the now ubiquitous torsion system is therefore a major cause of the increase in ankle sprain and associated injuries in recent decades.

Its inherent instability has become much worse in recent years as the footwear industry has moved to thicker and softer shoe soles both in court shoes like basketball and running shoes. This provides more cushioning and therefore greater comfort, and a questionable claim to better endurance performance in running shoes.

However, this trend has created a major new structural stability problem, **extreme edge weakness**, which significantly increases the rollover ankle stability problem caused by already too narrow conventional shoe soles. Locking the heel to the forefoot to eliminate torsional flexibility mitigates this problem by reducing pressure at any single critical point.

For example, if there is extreme point pressure at the big toe, medial rollover of the shoe sole is initially resisted by the entire medial side of the stiff shoe sole, including the heel, not just the forefoot. Initially resisting rollover gives the shoe sole overall a firmer feel so that it responds more quickly in sharp cuts, an important feature in elite sports.

Unfortunately, engineering is all about tradeoffs. In this case, the benefit of increased initial resistance to rollovers has resulted in a much worse instability problem caused by the too rigid shoe sole, as already described in detail.

At any rate, after Adidas gave up on Feet You Wear, independent development by Frampton Ellis continued at his company, **Anatomic Research**. It included pioneering testing in the actual ankle spraining mechanism.

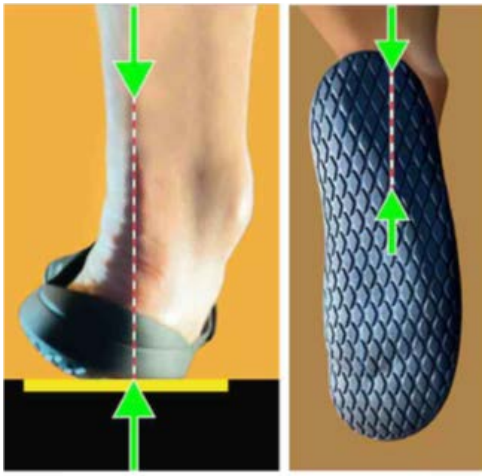
This included leaping and landing in various shoes (and barefoot) onto a reinforced shoe by a test subject with a safety line. The test simulated a typical ankle sprain during a basketball game with one player landing on another player's shoe, as seen here from some early testing decades ago.

PLAY VIDEO
PLAY VIDEO
PLAY VIDEO





That testing and research, as well as an association with footwear industry design and production experts at **i-generator** of Portland, OR, led to the development of new footwear models designed around a footwear sole that closely mirrored the structure of a bare foot in a way that did not reduce its natural stability.



Frampton Ellis Slide

The first result is this new corrected and naturally stable sole of the experimental test prototype **Frampton Ellis® slide.** It incorporates a new **BARESOLE®** structural technology, the basic design of which is open and free to use without any licensing cost.

The **Frampton Ellis® slide** is factory produced and fully stable **– completely different, like a barefoot**. The utility patents originally covering the structural elements of this proven barefoot-based stability technology have expired, so the basic **BARESOLE®** technology is free to use by the footwear industry to copy, test, and improve with new shoe sole designs.

As a public service, samples of the experimental test prototype **Frampton Ellis® slide** with **BARESOLE®** structural technology is now available to shoe companies so they can use the slides as the simplest general models to directly copy and test the slide's simple basic sole structure in order to develop commercial products with much better stability and comfort.



A limited number of FE slides in US sizes 6-18M/7.5-19.5F are available now for testing. They are also available for research and testing to the NBA, NCAA, and other organizations or teams that use footwear in sports. See **FEbaresole.com**.

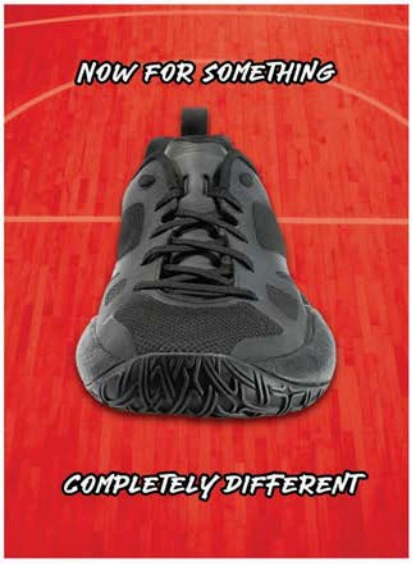
Also designed and developed by **Frampton Ellis** at **Anatomic Research** is a corrected experimental basketball shoe for testing, the **BARESOLE® Basketball Shoe**. It has a more complex upper, insole, midsole and outsole combination, and includes a removeable heel lift and a competition insole to fit a player's preference and to facilitate shoe performance testing.

It is the first step forward in finding a truly stable basketball shoe. The sole specifically uses pelletized TPU, initially introduced by Adidas as Boost, to achieve barefoot-like flexibility in combination with a unique structure that is



shaped essentially like the wide footprint of the barefoot sole. Many new materials are becoming available now based on EVA might also be sufficiently flexible to be used instead of pelletized TPU.

It is also available as a public service as an experimental test prototype to serve as an initial standard model of stability and comfort for the athletic footwear industry and other interested organizations to copy, test, and improve. A limited number of **BARESOLE®** **basketball shoes** are also available in US sizes 6-18M/7.5-19.5F for research and testing to the NBA, NCAA, and other organizations or teams with an interest in footwear use in sports. See **FEbaresole.com**.





A simple example of the use of the corrected stability **BARESOLE®** technology in potential redesigns of any shoe, even a classic basketball shoe like the **Converse *All Star***. It has been modified by a *Photoshop* simulated integration of the **Frampton Ellis® *slide*** baresole structure into the classic ***All Star*** shoe upper (obviously, the classic tread pattern would also be retained in a real shoe).



The result shows little change to the basic look of the classic **Converse *All Star***. The sole sides go from vertical to tilted out about 20°. The sole sides are less angled than the flared sides of soles of running shoes that were introduced in the 1970's, but are now a part of a completely different internal sole structure, one that is finally stable after two thousand years of instability.

Any conventional shoe can be modified in this general way to maintain a classic look but with far superior natural barefoot-like stability and much better comfort.

Most ankle sprains are clearly unnatural and avoidable, but remain the most common cause of both athletic injuries and hospital ER visits. Many of these sprains are not preventable in

conventional shoe soles, even when the best existing commercial shoe and ankle anti-sprain technologies are used, or even with the elimination of the anti-torsion systems.

20. FULLY CONTOURED INSOLES FOR MUCH BETTER FOREFOOT COMFORT IN CONVENTIONAL BASKETBALL SHOES

The conventional athletic shoe insole is contoured or rounded around the heel and long arch area and flat elsewhere, principally the forefoot area. The problem with that is that the edge of the insole is located near the major seam of the shoe upper and strobel board, rather than fully covering it, so that area of several edges is a frequent source of nagging irritation.

However, if the insole is rounded or contoured on the edge entirely around its perimeter, that source of irritation is eliminated, since the relatively soft insole covers the major seam joining the shoe upper and strobel board.

Here are two examples. The **yellow insole** has rounded forefoot sides and comes standard in **BARESOLE® Basketball Shoes** by **Frampton Ellis®**. Also included with those shoes, the **red insole** has higher rounded forefoot sides to provide a tighter, more responsive fit for game days. Either can be used and tested in a conventional basketball or other shoe for much better forefoot comfort and fit.





21. CONCLUSION: THE BASIC SCIENCE

The basic science presented here is so simple and the results so unequivocal that it is quite unprecedented in modern scientific research. Its basic simplicity is much more typical of scientific discoveries that were made centuries ago, when modern science was just getting started.

Modern scientific studies are universally done in sophisticated labs with lots of expensive equipment. They usually produce test results with only very small differences that often are not statistically meaningful, so most are too trivial for anyone to bother replicating them.

Moreover, trivial or important, nearly all studies are never replicated, so their actual validity is unverified, even though later studies may rely on them. [For more relating to this major problem, a single page summary titled, **THE BASIC SCIENCE**, is attached at end of this analysis.]

In this case, in contrast, the difference between shoe sole instability and barefoot stability is so dramatically different that even a young child can prove it for themselves in the simplest way, without any equipment other than a barefoot and an ordinary shoe.



But never ignore this serious WARNING: never try tilting-out your ankle, especially while in a shoe, without firm support from a safety spotter to prevent a potentially dangerous fall). Replication is easy here, since dramatic proof of artificially unstable shoe soles is easy to obtain by anyone and scientifically valid beyond serious question.

It should also be noted here that, in addition, there is no formal scientific or medical research that contradicts the research evidence presented here for the simple reason that there is no formal medical or biomechanical research whatsoever that examines the difference in extreme stability between shoe soles and barefoot soles. That enormous difference has been entirely overlooked in medicine and science, despite its now obvious relevance to ankle sprains.

It's easy to understand why it has been missed. Despite their carefully cultivated reputation for being high tech, the footwear companies do not do basic research. They spend all of their R&D funding narrowly focused on the development of the deeply flawed but unquestioned existing sole design, thousands of years old. Even with that narrow focus, their total R&D funding is only 1/10 of the average R&D funding for all U.S. companies. And, of course, no private or Federal funding exists for truly basic research in footwear, generally, or soles in particular, which in fact are the most critical element in human structural support, with fundamentally important medical and anatomic implications.

In light of this, it seems difficult if not impossible even to conjecture what a reasonable counter argument might be to the now obvious evidence presented here on the basic instability flaw in footwear soles. The only available defense might be a plea to believe industry experts,

not your own lying eyes. Or in this instance, also not your own lying feet and shoes.

Instead, simply put, the irrefutable and easily reproducible evidence of the natural stability of the human ankle when barefoot absolutely proves that the well-known instability of the ankle in a shoe is entirely due to the shoe and absolutely not the ankle. The instability of all current shoes is therefore clearly due to the **artificial instability flaw** in their shoe soles.

Consequently, there can be no reasonable defense of the status quo in footwear by its industry. No delay can be justified by footwear companies to begin working immediately with the greatest possible urgency to finally correct the now obvious sole flaw with available technologies that are free and open, not proprietary.

Moreover, the previously undiscovered dangerous instability of shoe soles likely causes many or most of the **serious falls** that resulted in **$151 billion in medical costs caused by 6,570,000 ER visits, 1,700,000 hospitalizations,** and **47,000 fall deaths** in 2022 in the U.S. alone (CDC data). To put that level of fall deaths in context, only **41,000 traffic deaths** occurred in 2023 in the U.S.

The total annual U.S. medical cost of the accidental falls of about **$151 billion** dwarfs the estimated total annual branded athletic footwear sales worldwide of about **$99 billion** and about **$37 billion** in the U.S. Unmistakably, this appears to be a serious national health crisis with a magnitude of death and economic damage that may far exceed the 9/11 attack in the U.S. And it reoccurs every year.

Cumulatively, over the last two decades it totals almost as many deaths in the U.S. as caused by the opioid crisis. In contrast to that crisis, this one has relatively simple solutions that are proven and effective. Moreover, the relative financial cost of a one-time general design and manufacturing correction within the footwear industry of the flawed design of shoe soles is, without question, tiny in comparison.

And the relatively small one-time financial cost to the footwear industry should be paid for easily within the industry by a likely substantial increase in sales and profits fed by increased consumer demand for footwear that is much safer and, a major bonus, also much more comfortable. It is a unique **win-win solution** for both industry and its consumers!

CONCLUSION

Expert analysis of actual broadcast game video provides conclusive evidence that current high-performance basketball shoes used in the NBA are grossly unstable, thereby causing **ankle sprains**. The lateral instability is so bad today that ankle sprains are common even without contact with another player's foot. Such non-contact ankle sprains were unknown in the past.

Moreover, a recent scientific discovery proves indisputably that a player's bare foot is extremely stable in the **classic lateral ankle spraining position**. That indicates clearly that any shoe instability is artificial and therefore likely preventable. The shoe instability is definitely not because of an inherent ankle instability problem caused by incomplete and/or faulty human evolution, as commonly believed currently in science and medicine.

The video-based analysis also identifies the specific shoe-based mechanisms that cause most of the other serious injuries to NBA basketball players, including **knee ACL, Achilles tendon, and hamstring muscle injuries**. All are caused by artificial shoe instability that can be reduced substantially in conventional shoe soles and may be entirely preventable in basketball shoe soles based on the natural stability of the barefoot.

The grossly excessive instability of today's best basketball shoes is at least in part due to

recent sole design changes that incorporate the principal structural features of running "supershoe" soles. Those are much thicker and softer midsoles that incorporate rigid internal sole structural reinforcements to compensate for the excessive thickness and softness.

Copying running "supershoes" has been a major fiasco in basketball due to the vastly different functional requirements. And, ironically, the most authoritative of recent formal scientific studies now indicate that the highly publicized performance-enhancing benefits of "supershoes" in distance running are due to placebo effects, not actual biomechanical benefits.

Copying running shoes was never a good idea. Basketball shoes obviously have very different performance requirements. Their sole structure must focus on stability during lateral motion, not just the constant straight-ahead motion of distance running for which "supershoes" are designed.

In summary, recent high-performance basketball shoes with thicker and softer soles together with expansive rigid reinforcements spanning all or most of the sole are inherently far less stable than older classic basketball shoe designs without these comfort-based "improvements". All of these new features are major causes of lateral instability that lead directly to otherwise avoidable serious injuries.

The preceding analysis included highly specific recommendations for most effectively undoing the recent flawed "improvements" in basketball shoe sole design. The fixes can work immediately in both existing shoes and in developing new conventional designs.

The fixes are simple, free, and easy to make and test at micro or macro scale, whether by the individual cobbler or by industry design and development, as well as factory production. The fixes should involve little risk since they essentially undo the new "improvements", but should nevertheless be widely tested immediately before widespread use given the many interacting sole components involved!

In addition, an entirely new and very different prototype design for basketball shoes based on the barefoot sole to provide truly barefoot-like natural stability and comfort. The prototype has been factory produced in relatively large quantities and a wide range of sizes. As a public service, the prototype shoe is available now at cost for extensive experimental testing by the footwear industry and other interested parties.

Initial limited testing indicates the prototype baresole® basketball shoe eliminates the gross stability flaw in existing shoes. However, it is critical that additional, much more extensive testing takes place to ensure that its fundamentally new design does not have any hidden side effects.

BOOKEND FIXES:

Together, these two alternatives to current modern basketball shoes provide bookends in effect at the opposite ends of the degree of change used to fix the glaring problems of today's high-performance basketball shoes. **The first bookend is simply undoing now obvious mistakes**, an easy and simple fix for existing shoes to make them noticeably better and quickly ready for extensive testing. These simple fixes to future conventional shoe will require some time for redesign and development and factory production, as well as tuning and testing for safe use.

The second bookend is based on a potential new paradigm shift to a far more basic change that requires more extensive experimental testing now of the available basketball shoe prototypes as a first step toward optimizing a general design that provides barefoot-like stability and comfort to future basketball and other shoes made by the footwear industry. The prototypes

are intentionally about as different from existing basketball shoe design as is possible, in an attempt to properly frame the entire range of potential designs.

Between those two bookend fixes, there are endless design variations possible to optimize comfort, performance and stability to make much better performance footwear. Both open up a vast new multitude of potentially better designs that are possible to develop and test by footwear companies to significantly improve the performance, stability, and comfort of much safer basketball for the players who must wear them, including NBA players and superstars.

For more detailed information on ankle sprains and other injuries caused by shoe sole instability, see my recent book, ***UNNATURAL INSTABILITY***, available now at **FEbaresole.com/Books** for free download, as a public service. See also **AnatomicResearch.com** for related information.

APPENDIX 1

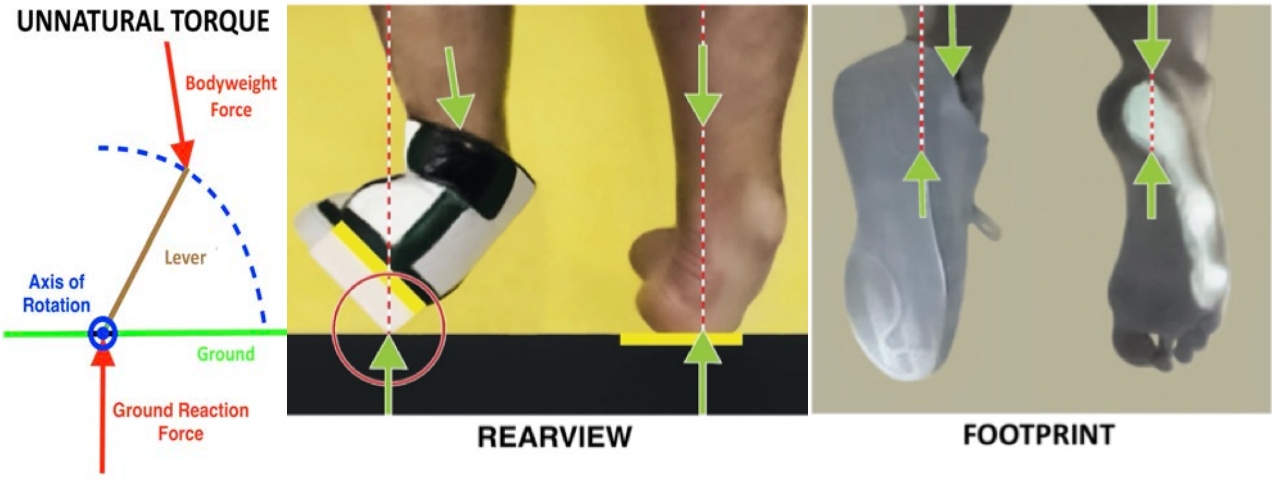
THE BASIC SCIENCE COULD NOT BE SIMPLER

ARTIFICIAL SHOE: When tilted on the edge of its sole in the **classic lateral ankle spraining position,** the shoe sole creates an unnatural **Lever** that moves the **Bodyweight Force** out of alignment with its opposing **Ground Reaction Force**. The force misalignment creates a powerfully destabilizing **Torque**, which rotates around an **Axis of Rotation** formed by the edge of the shoe sole**.** Only the shoe upper keeps the foot from sliding off the highly tilted shoe sole.

The unnaturally tilted ankle joint is perilously balanced on the sharp knife-edge of the shoe sole –literally the bleeding edge of the ancient shoe sole design. All that opposes the powerful artificial **Torque** acting directly on the ankle joint that hold it together are relatively weak ligaments and tendons under excessively unnatural tension.

NATURAL BAREFOOT: In stark contrast, but hidden in plain sight for thousands of years, the ankle joint of a barefoot is completely stable in the same **classic lateral ankle spraining position**. The downward **Bodyweight Force** and its opposing upward **Ground Reaction Force** are in perfect alignment so that each cancels the other out naturally, thereby maintaining a **Stable Equilibrium** throughout the entire range of the foot's sideways motion on the ground.

Moreover, those opposing forces are transmitted entirely within naturally interlocking joints and bones that are optimally aligned to contain the high compression forces for which bone structure is designed to withstand. Underfoot, the ankle is also always safely supported by a wide base of direct support that is provided by the barefoot sole, including the heel bone as well as the base and head of the 5th metatarsal bone. The discovery that the natural ankle is innately stable directly contradicts a basic tenet of modern medical science that incorrectly teaches that the ankle is very unstable because it is a recent and unfinished human evolution.



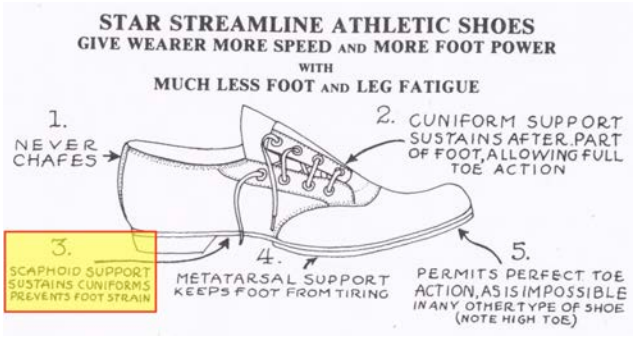
The simple physics illustrated in this **UNNATURAL TORQUE** diagram is basic **Force Couple Mechanics** that supports proof so simple as to be irrefutable. Such simplicity is virtually unprecedented in a new discovery in modern science. Obvious in hindsight – even self-evident – this alarming discovery forms the critically important leading edge of footwear safety. The summary shown above is simple enough to be in a high school science textbook. Moreover, it is so simple to prove that anyone can easily confirm the test results shown above for themselves with their own shoe and barefoot (but only with the greatest possible care, never without using safe support from a spotter to prevent a dangerously uncontrollable fall).

APPENDIX 2

HISTORICAL BACKGROUND ON THE TORSION/ANTI-FLEXIBILITY CONFUSION

The original purpose of the **Adidas Torsion System®** was ostensibly designed to provide torsional flexibility between the separated forefoot and heel of shoe, while at the same time providing midfoot support for the medial longitudinal arch of the foot. However, it evolved quickly, in just a few years, into an **anti-flexibility system** which did provide extremely rigid support to the midfoot area of the shoe sole. Doing so, it supported the long arch of the wearer's foot, although not in the most effective way, but it also substantially eliminated torsional flexibility between the forefoot and heel of the shoe.

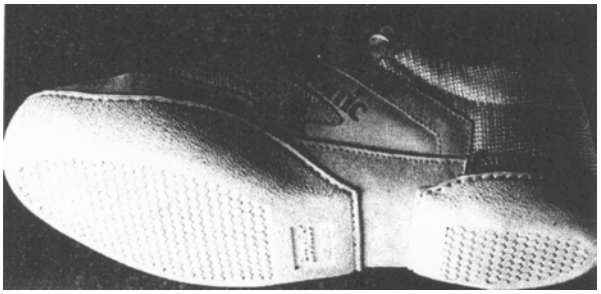
How exactly this inexplicable design reversal occurred is not clear, but a little footwear design history sheds some light. Early running shoes had separate heel and forefoot sections like the one shown here from the 1940's, much like other shoes of that era.



However, it also included midfoot support on the medial side, under the three cuneiform foot bones that form the key stones of the medial longitudinal arch. This support is traditionally provided by a midfoot shank, often metal, common in traditional leather shoes with separate, attached heel.

Other sports shoes like **Converse All-Stars** or **Keds** or running shoes in the 70's and 80's had a continuous shoe sole running from heel to toe, with no separation between heel and forefoot.

A unique new tennis shoe was introduced in the 1980's, the **Etonic Allegra**, which separated the forefoot from the heel so they could each move independent of each other. Unfortunately, its complete lack of midfoot support resulted in midfoot problems for its wearers, presumably lack of arch support, so the shoe was rather quickly pulled from the market.



In 1989, Adidas introduced its **Torsion System®** in a running shoe, apparently with the intent of providing both **midfoot arch support** and **torsional flexibility** between separate heel and forefoot.



Unfortunately, the Torsion System® somehow quickly evolved into an anti-torsion system that provided midfoot support to the long arch, but also eliminated torsional flexibility.

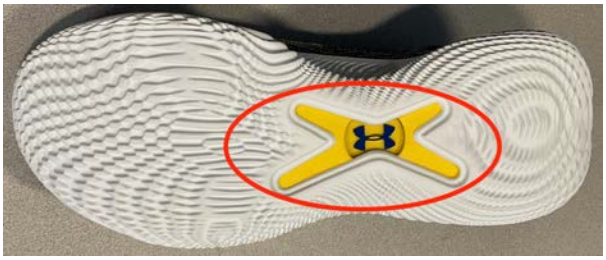
How that happened one can only guess, but when Adidas introduced its new **Feet You Wear** shoes in 1996, they included the Adidas

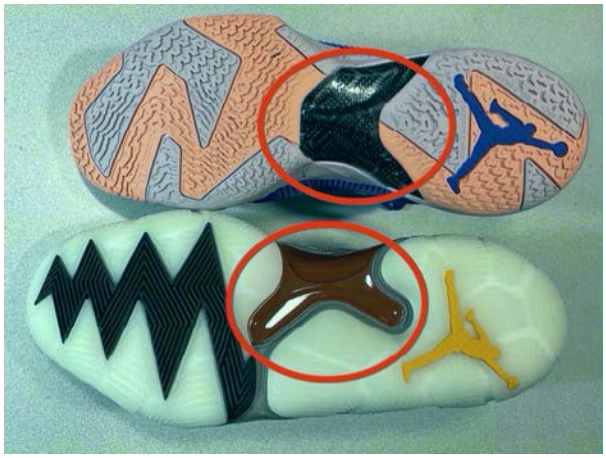
Torsion System® as well. That rigidity significantly reduced the lateral stability of the Feet You Wear shoes.

Just as the rest of the footwear industry copied the look of the contoured sides look of Adidas' FYW, so too it also copied the anti-torsion system. The result has been athletic shoes with absolutely rigid midfoot portion of the sole that allow little if any torsional flexibility.

In recent years shoe companies have extended the rigid midfoot devices into the heel and forefoot, thereby creating an entirely rigid shoe sole structure, completely unlike the human foot.



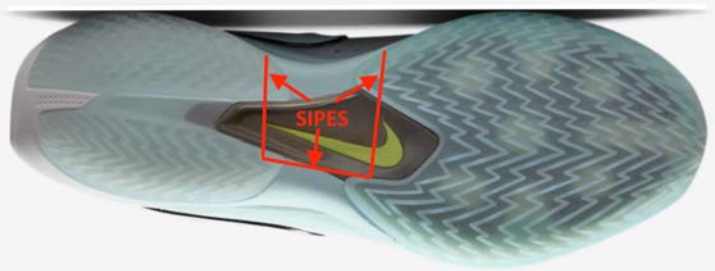




APPENDIX 3

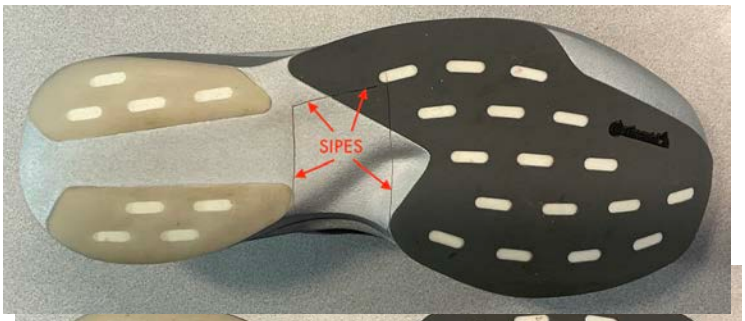
EXAMPLES OF EARLIER SIPE TESTING TO PROVIDE MIDFOOT SOLE TORSION IN EXISTING SHOES

To maximize naturally functional flexibility, a **sole sipe** is located between the heel and the midfoot (which includes the base of the 5th metatarsal bone that is centrally located on its lateral side). The position of the **sole sipe** should coincide approximately with the **Chopart Joint** of the foot. Even this single **sole sipe** is highly effective in creating the missing flexibility between heel and forefoot.

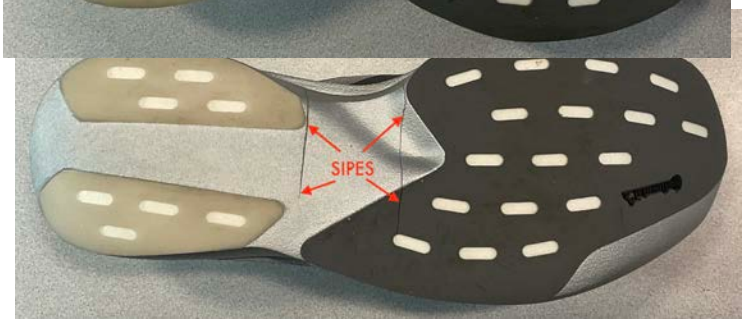


Another **sole sipe** is located between the midfoot and the forefoot, roughly coinciding with the **Lisfranc Joint**, except that the **base of the fifth metatarsal bone** should remain in the midfoot through the means of a **third sole sipe** connecting the lateral end of the other two **sole sipes** to form approximately a **U-shape**.

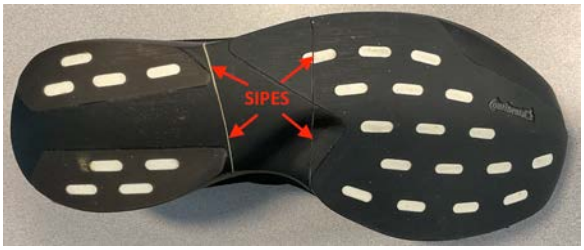
The first two examples shown here are of the three **sole sipes** forming a **U-shape** is shown in a bottom view of a left foot **Nike GT Cut 3** basketball shoe sole and a right foot **Adidas Adizero EVO SL** running shoe sole.

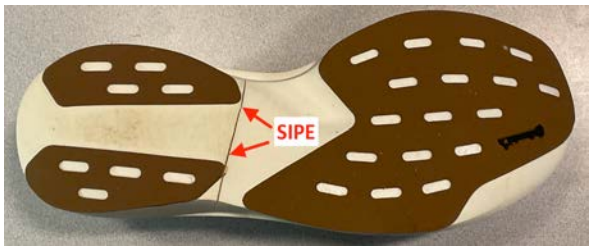


The last example is of a left foot of the same **Adidas Adizero EVO SL** shoe model shows an earlier, two **sole sipes** model made for testing.



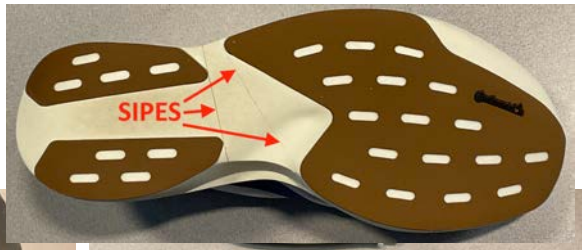
A single **sole sipe** test model example is shown in a bottom view of an example left **Adidas Adizero EVO SL** running shoe sole. The second view of the same shoe model but with a black right outsole shows another **sole sipe** located between the midfoot and the forefoot, roughly coinciding with the Lisfranc Joint, except that the base of the fifth metatarsal bone should remain in the midfoot in this test model.



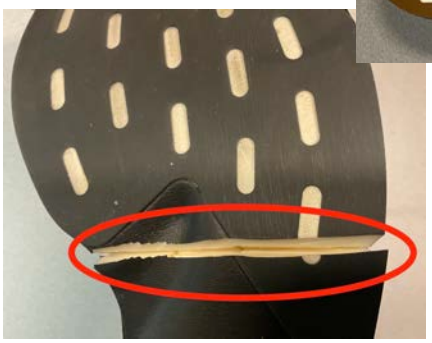


Alternatively, the **sole sipe** can include the base of the 5th metatarsal bone with the forefoot, so that it more closely coincides with the Lisfranc Joint, as shown in this test model.

Note that it is a good idea to mark the position of a wearer's base of the 5th metatarsal bone on the lowest side of the shoe upper before creating the **sole sipes** to ensure the accuracy of their locations relative to the 5th base.



In this partially blown-up example, a **sole sipe** was made with a slit cut through the black outsole and white midsole material, but not through the strobel board under the insole. This example of the **sole sipe** was done to separate the sole forefoot from the midfoot/heel combination, allowing the forefoot to twist without forcing the heel and ankle to twist with it.

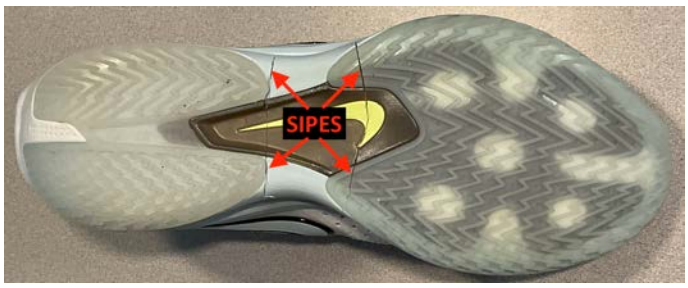




As shown below, an initial investigation made by lifting the shoe's insole indicated that the sole did have a midfoot bridging **plastic shank**, but it was located above the midsole, as seen here in black under the white upper fabric. Leaving the upper-positioned shank intact did not seem to reduce noticeably the major increase in torsion gained from the **sole sipe** shown in this example.



Also shown is a bottom view of another test model example, a **Nike GT Cut 3** basketball shoe with a two **sole sipe** example cut deep into its midsole in a similar location as that shown above in the Adidas EVO SL. In this case, however, the plastic shank-like plastic piece bridging the midfoot located on the lower, outer surface of the midsole next to the outsole was also sliced through entirely in order to create a reasonable level of torsion between forefoot and midfoot/heel.



In the single **sole sipe** examples above, the midfoot should preferably also be separated with the additional **sole sipe** shown above in the dual **sole sipe** examples to further increase torsional flexibility. However, amazingly, as noted above, even a single simple **sole sipe** by itself can create an enormous increase in torsional flexibility, particularly in reducing the otherwise destabilizing effect of stepping on another player's foot during a game. Nevertheless, two **sole sipes** are more effective in providing optimal flexibility like the human foot by approximately replicating the positions of both of its Chopart and Lisfranc Joints in the shoe sole.





An alternative configuration of **sole sipes** is possible that includes a midfoot **sole sipe** as shown above and a heel **sole sipe** that is aligned with the long axis of the shoe sole that splits the heel into lateral and medial halves in order to enhance stable support for the heel in the fully inverted position of the typical lateral ankle spraining position. The examples shown are of a **Nike Pegasus 41** running shoe and a **Nike GT Cut 3** basketball shoe.

For shoe companies to fix existing shoe model designs for future production, their approach would obviously be to remove any rigid torsion bars of plastic or equivalently hard material in the midfoot area because direct support by midsole/outsole material is preferable for flexibility. In addition, if necessary, or alternatively, make the midfoot midsole foam plastic material a softer durometer or carve out a portion of a too firm midsole foam or introduce flexibility sipes or slices in the midfoot material (like Nike Free flexibility) in the manner shown above.

The effect of inherently stiffer rubber outsole wrapped up around the sides of the shoe sole, including the midfoot and forefoot and/or heel must be evaluated carefully and compensated for with **sole sipes** as necessary as well, since the outsole wrapping can have a significant effect on the sole's torsional flexibility.

Included here is a copy of the first page on a U.S. Patent 6,115,945 on **sole sipe technology** that I received in 2000, originally filed in 1990.

US006115945A

United States Patent [19]

Ellis, III

[11] Patent Number: 6,115,945

[45] Date of Patent: *Sep. 12, 2000

[54] **SHOE SOLE STRUCTURES WITH DEFORMATION SIPES**

[75] Inventor: **Frampton E. Ellis, III**, Arlington, Va.

[73] Assignee: **Anatomic Research, Inc.**, Arlington, Va.

[*] Notice: This patent is subject to a terminal disclaimer.

[21] Appl. No.: **08/162,371**

[22] Filed: **Dec. 3, 1993**

Related U.S. Application Data

[63] Continuation of application No. 07/855,489, Mar. 23, 1992, abandoned, which is a continuation of application No. 07/478,579, Feb. 8, 1990, abandoned.

[51] **Int. Cl.**[7] **A43B 1/10**; A43B 13/14; A43B 13/16

[52] **U.S. Cl.** ..... **36/102**; 36/88; 36/103; 36/30 R; 36/25 R; 36/59 R

[58] **Field of Search** ..... 36/59 R, 59 C, 36/32 R, 28, 29, 114, 116, 12, 107, 108, 76 R, 102, 88, 103, 30 R, 25 R

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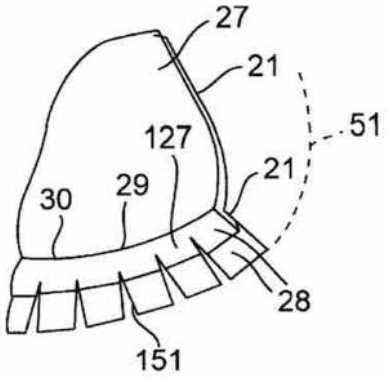
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Primary Examiner—Ted Kavanaugh
Attorney, Agent, or Firm—Finnegan, Henderson, Farabow, Garrett & Dunner, L.L.P.

[57] **ABSTRACT**

A construction for a shoe, particularly an athletic shoe, which includes a sole that conforms to the natural shape of the foot shoe, including the bottom and the sides, when that foot sole deforms naturally by flattening under load while walking or running in order to provide a stable support base for the foot and ankle. Deformation sipes such as slits or channels are introduced in the shoe sole along its long axis, and other axes, to provide it with flexibility roughly equivalent to that of the foot. The result is a shoe sole that accurately parallels the frontal plane deformation of the foot sole, which creates a stable base that is wide and flat even when tilted sideways in extreme pronation or supination motion. In marked contrast, conventional shoe soles are rigid and become highly unstable when tilted sideways because they are supported only by a thin bottom edge.

9 Claims, 8 Drawing Sheets

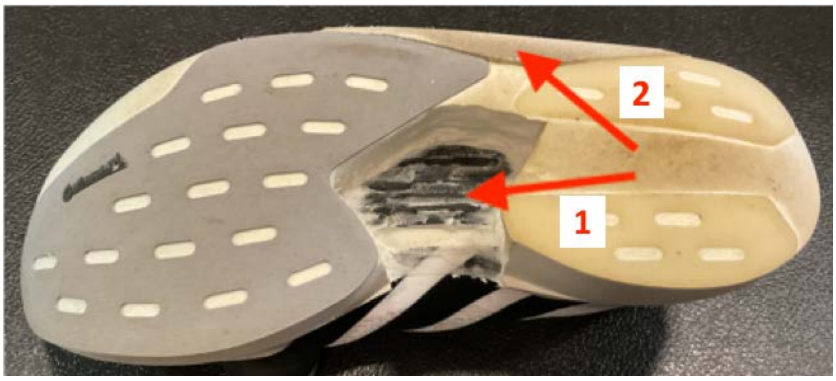


APPENDIX 4

EXAMPLES OF EARLIER TESTING TO EXTEND SHOE SOLE UNDER BASE OF THE 5TH METATARSAL BONE IN EXISTING SHOES

Eliminating the conventional lateral indentation between heel and forefoot so that the base of the 5th metatarsal bone is properly supported, since it is the midfoot keystone support of the main longitudinal arch.

Example Modifications in an Adidas Adizero Evo SL: Shown here is a test model example of a recent model running shoe with test modifications to the midfoot sole to better provide: (1) natural torsional flexibility (removing an entire medial and central section of midfoot midsole, instead of sipes) and (2) direct sole support to the base of the 5th metatarsal bone (adding a lateral section of midfoot midsole).





Although the mod to the 5th could only be made in a limited way on its upper surface due to its existing structure, the overall effect of both mods is extremely successful, with the most distinct difference being far better lateral stability and better subjective feel from the "independent suspension".

The difference is not subtle. Anyone running around the block can feel the improvement.

What is truly remarkable here is that anyone can copy these modifications, and the simpler flexibility sole sipes mods shown previously, to existing models to test the mods for themselves, and to potentially improve upon them. This is true for both amateur cobblers and to established shoe companies. So have at it! It's simple, a brand new and far better design to copy and improve.

This particular running shoe was particularly chosen as an example because it has the thicker, softer midsole typical of the newer running shoes. Because of those two new characteristics, those running shoes have much poorer lateral stability than older models and urgently need the mods shown above. But all running shoes including older models need these critical improvements, because running shoes are the most popular athletic shoes, widely used as casual shoes, even by the elderly, who need the best lateral stability possible.

And there are a wide variety of potential specific ways to make the improvements. For example, the above running shoe midfoot area can much more easily modified with the

flexibility sole sipes to provide natural torsional flexibility, instead of evacuating all of the medial and central midfoot midsole area, or the midsole in that area could have been carved out with a thin layer remaining to cover the black shank. The potential effective design variations are virtually without limit.

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June 8, 2026

FRAMPTON ELLIS - Brief Biography

Frampton is a footwear designer and inventor, as well as an investigative researcher and author. He invented the precursor barefoot sole-based technology used by **Adidas** in its **Feet You Wear** line of footwear that was worn by **Kobe Bryant** and **Steffi Graf**, and was widely copied in the footwear industry. He also developed the basic technology used in **Free** line of **Nike** footwear, also barefoot sole-based and widely copied in the industry.

Frampton is a prolific inventor with over two hundred U.S. utility and design patents in many different technology fields, but particularly in footwear soles (with many more than anyone at Nike or Adidas) and also in a basic architecture for secure connected computers. One of his recent U.S. Patents, No. 11/901,072, is for **a generative artificial intelligence (AI) computer system for footwear**: a cloud computer system connected to big data from millions of sensor-equipped smartphones, which are connected to their users' configurable footwear soles with sensors and connected to body sensors as well.

He also has completed the first full draft of two footwear-related books currently in preparation for publication. The first book is **UNNATURAL INSTABILITY**, which focuses on the long-hidden instability defect of footwear soles compared to the natural stability of the human barefoot. It also provides substantial detail on the design and development of experimental test prototypes, including the **Baresole®** in the **Frampton Ellis® slide** and the **Baresole® Basketball Shoe**, as well as critical commentary on related footwear products made by the industry. More information is available at **www.FEbaresole.com.**

The second book is titled **UNNATURAL DEFORMITY**, which investigates another long-hidden effect of modern shoes, this time the effect of elevated heels on the foot's subtalar joint (which is located between the ankle and heel bones). Confirmed in recent formal research, the previously undetected effect is to tilt and twist the ankle joint outward about 8° and 18°, respectively, seriously misaligning the underlying structural support for the entire modern human body. This occurs when running, during which the peak loads (3 G's) routinely experienced by the human body significantly interrupt normal bone and joint formation.

The abnormal misalignment results in widespread and often serious bone, joint, and other bilaterally asymmetrical deformities. The abnormal asymmetrical deformities begin in early childhood and, once established, gradually increase throughout life, becoming most serious in the elderly**.** The shoe heel-induced asymmetrical anatomical abnormalities – from knee structure to brain structure – have been tragically mistaken for normal anatomical development. Weak human anatomy has been incorrectly blamed on imperfect recent human evolution into its highly unique form of bipedalism (which is incorrect, since humanoid bipedal evolution has resulted in a basic ankle structure unchanged in the last 3 million years).

The AI computer system described above offers what is likely the only solution to this otherwise impossibly complex medical catastrophe of unprecedented magnitude and consequence. Much more information is available at **www.AnatomicResearch.com**.

After graduating of **Duke University**, Frampton served several years in the U.S. Navy Reserve as the navigator of a guided missile destroyer, the **USS Towers DDG-9**.