

Each Person's Collapse of the Arches of the Foot May Be Unique but its Correction is Standard. A Large Study Explains Why

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Abstract

The human foot is the site at which external forces are applied to the body. The feet, as the foundation of the architectural human body, are the first point of interest when looking for maximum injury prevention for the feet, ankles, knees, hips, and low back. That's because when there is collapse of one or more arches of the feet, there is a domino-like effect up the kinetic chain producing increased and abnormal loading throughout the body. This increased loading increases the vulnerability to injuries and accelerates the degeneration process. With the help of laser foot scans, we amassed the results of 1,001 patients and proved that there is some degree of arch collapse in every person. High quality-over the counter orthotics which create symmetry and balance of the feet are the first step when addressing these global imbalances. We've proven it isn't necessary to spend on custom orthotics. After providing orthotics we then performed one standing A-P L- S x-ray with the orthotics inside the patient's shoes. The results showed diverse and often abnormal hip or femoral head height differences (fhhd), suggesting abnormal loading of the low back and lower extremity joints, muscles and tendons. The conclusion of this study is that the collapse of the arches of the feet must be addressed first with orthotics for the prevention of injuries and to delay degenerative changes, however, this must be followed with the appropriate x-ray and measurement of the femoral head heights.

Keywords: Arch collapse; Orthotics; Foot scan; Biomechanical symmetry

Introduction

We humans are bipedal, and our feet have worked as our foundation for hundreds of thousands of years now. Walking upright on two legs is the trait that defines the hominid lineage: Bipedalism separated the first hominids from the rest of the four-legged apes [1]. Exactly why h. Erectus appeared remains controversial even after decades of research. A modern healthcare researcher will most likely come across a similar controversy as to why the industry does not focus on the feet as the foundation of the human body. The feet are unequivocally the site at which forces from the environment - and predominantly the ground - are applied to the body. They have to be looked at and examined first when it comes to load distribution and joint reaction forces assessment. When any arches of the feet collapse, the way we stand, walk and run will not be optimal. The entire kinetic chain [2] and nervous system is affected. If the feet are overlooked and left untreated, the intimate relationship between the feet and the alignment, balance and function of both the musculoskeletal and

nervous systems will remain disturbed. This will lead to increased injury rates, prolonged rehabilitation period and increased probability of a relapse regardless of whether we're talking about an elite athlete, a recreational athlete or simply an everyday citizen.

Like any other element or material in our world, ligaments and tendons (made of collagen fibrils mainly) are able to withstand loads and external forces up to a certain point. If a tendon stretches beyond its physiological limit, the intramolecular cross-links between collagen fibers will fail. If micro-failure continues to accumulate, stiffness ensues and the tendon begins to fail, resulting in irreversible plastic deformation. If the tendon stretches beyond 8 - 10% of its original length, macroscopic failure soon follows [3]. There seems to be a threshold when any part of the musculoskeletal system of the human body will undoubtedly become injured and reinjured when put into motion, strained or overloaded. And while this happens over and over again affecting

millions of people and demanding massive emotional, financial and societal resources, the reactive approach to muscle and tendon injuries continues. Instead, we are promoting a proactive approach to prevent these events from happening in the first place.

Materials and Methods

Back in 2020 we published a series of studies dealing with how the biomechanics of our feet can affect our whole-body structure and the impact that has on our entire healthcare industry. Our aim was to promote the proactive approach to musculoskeletal injuries instead of the reactive one which is so frequently used and applied. In our first study, we identified five separate biomechanically flawed structures and proved that every human being falls into one of these five categories as a Crooked ManSM 1-5. In our second study, we proved, using a digital A-P L-S x-ray to measure femoral head heights, that regardless if the patient wore orthotics or not, the femoral head height difference was excessive in the majority of cases. In our third study, we used the digital laser foot scan of 400 patients and determined in every case there was foot collapse. In this present study, we are using the scans of a much larger database, 1,001 patients. Again, there is collapse in every case, and as unique as each patient's foot collapse is, we also will show the correction of the feet does not require custom orthotics, only quality over the counter orthotics. The collapse is custom, the correction of feet is standard. Study participants were patients seeking care in our office over a 5-year

period. No one was acutely injured or presenting with antalgia or a compensatory posture. All patients presented in their normal postures.

We collected data from 1,001 individuals. They ranged from 8 to 89 years old.

- 8-19 years old -- 208 patients
- 20-39 years old – 296 patients
- 40-59 years old – 297 patients
- 60-79 years old – 189 patients
- 80+ years old—11 patients

The test that was performed on patients was a digital laser scan of their feet. Here is some technical information about the Kiosk scanner.

- Approximately 6 feet tall
- Approximately 2.5 feet wide
- Approximately 3 feet deep
- Takes 26 key measurements
- 250 micrometers scan resolution
- Uses a Class 2M Diode Laser Product with line generating optics (Figure 1)



Figure 1: Digital Laser Scan of the feet.

Our 3D scanners use a laser triangulation method to capture true 3D data. It's accurate to within 250 microns, which is one quarter of a millimeter. By capturing the foot with this much precision, we're able to determine imbalances in the plantar vault of either or both feet.

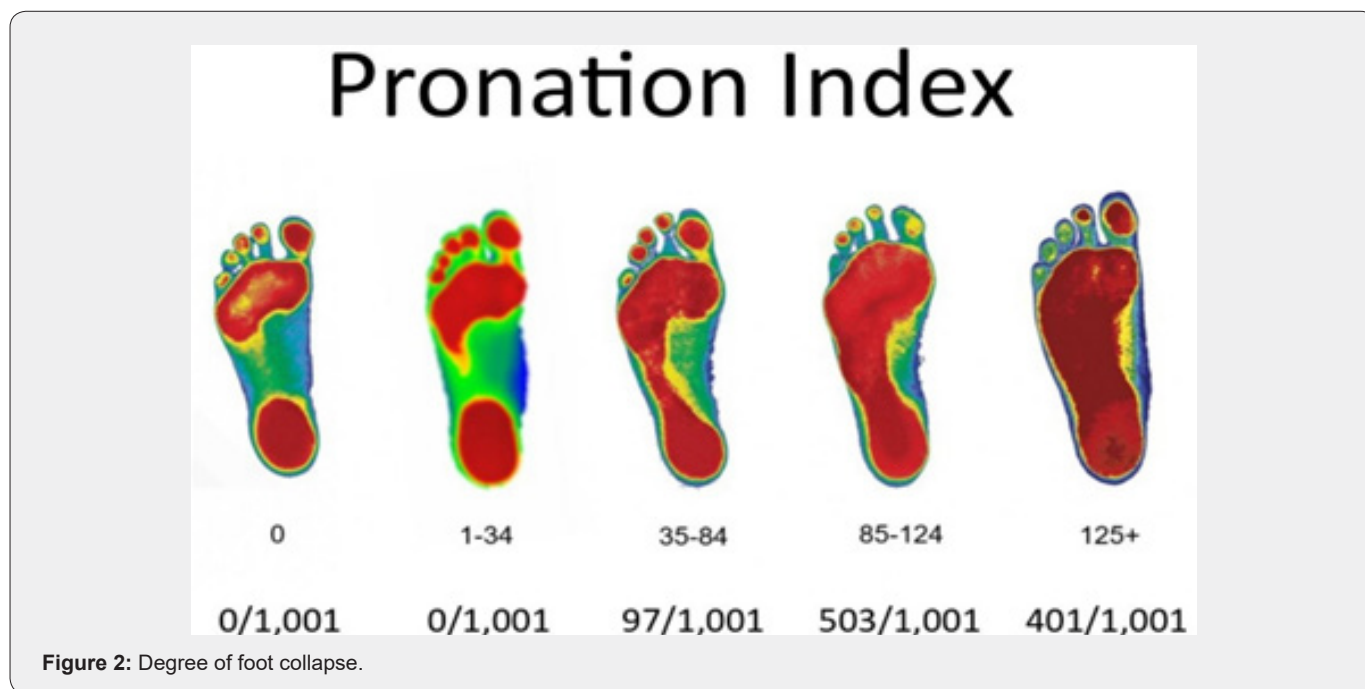
The digital laser scan provides the following information:

Pronation Index

This is the number attached to every scan that represents the amount of collapse of the feet relative to the "Optimal Feet". The

range is from “0”, which are optimal feet, to “200”, which is total collapse of the feet. Research has shown the PI increases with age as the feet continue collapsing following tissue weakening. The Pronation Index of each patient fell into one of the five following categories depending on the score:

- i. Optimal which is 0
- ii. Mild Pronation is 1-34
- iii. Moderate Pronation is 35-84
- iv. Severe Pronation is 85-124
- v. Total Pronation is 125+ (Figure 2)



Pronation Index (from 0-200) represents the degree of foot collapse:

- i. Optimal: (0) 0/1,0011
- ii. Mild Pronation (1-34) 0/1,001
- iii. Moderate Pronation (35-84) 97/1,001
- iv. Severe Pronation (85-124) 503/1,001
- v. Total Pronation (125+) 401/1,001

Body Weight Distribution

50/50 is optimal. The number reflects anatomical imbalances, collapses and compensatory effects.

Arch Height Difference

This is a number that represents the volume of space that lies beneath each foot. The optimal difference should be 0. Normal should be <=1. Arch height difference >1 means that the body weight distribution throughout the entire body is imbalanced, and some areas of the body are under abnormal loading which is a predisposal factor to injuries and premature degeneration (Figure 3).

Results

Table 1: Age groups’ PI and AHD distribution.

	Pronation Index	Arch Height Difference
8-19 years (208)	113.67	3.88
20-39 years (296)	115.68	4.65
40-59 years (297)	124.51	4.19
60-79 years (189)	124.53	5.11
80+ years (11)	121.27	4.97
Full group (1,001)	119.61	4.44

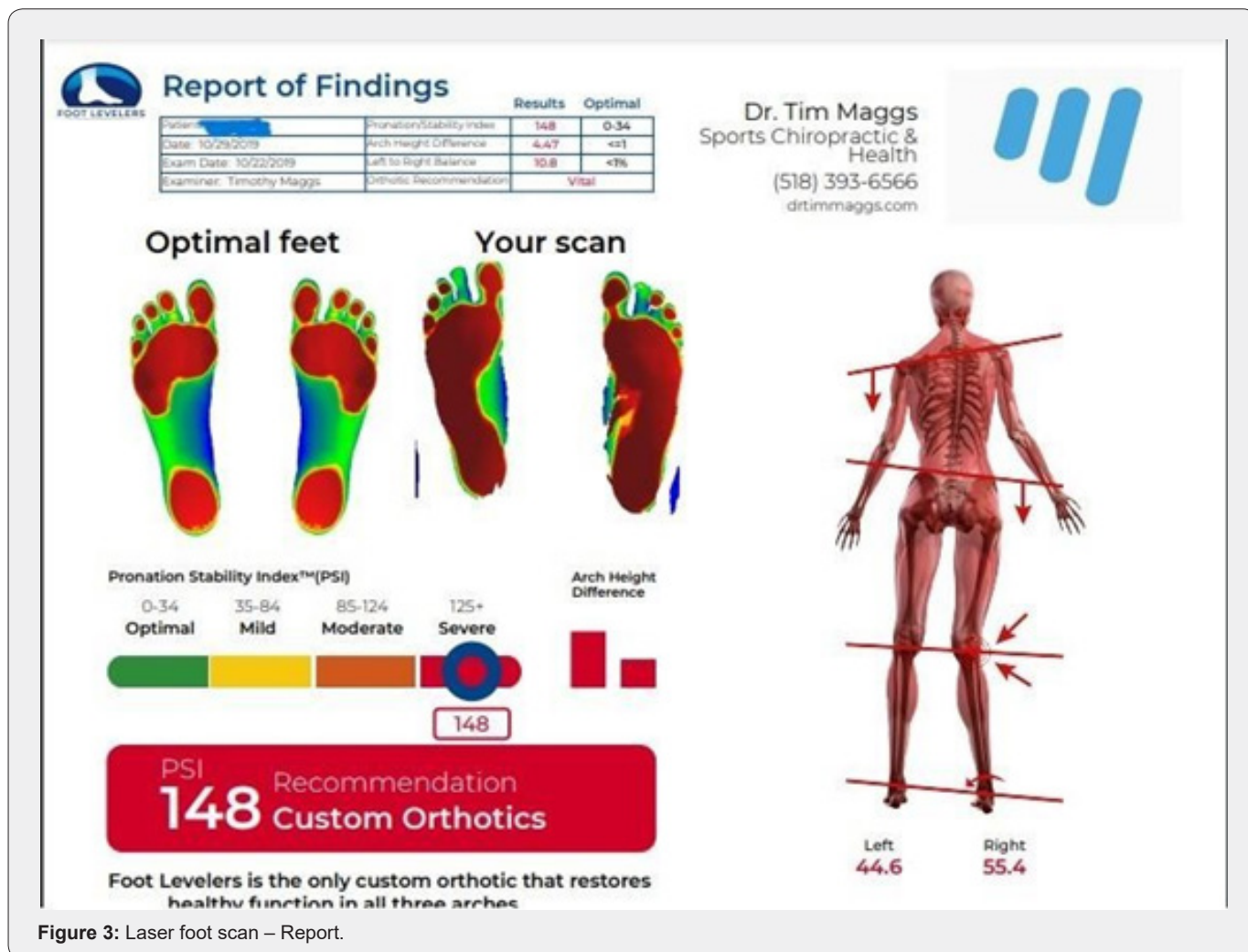


Figure 3: Laser foot scan – Report.

In this study, there were 1,001 participants who underwent a digital laser scan of their feet. They were instructed to stand on the platform in a neutral position/normal posture while barefoot. Each scan took 3 minutes to complete. The results of the Pronation Index and the Arch Height Index are as follows (Table 1):

The results show a deterioration of the patients' feet collapse as time progresses. Collagen fibers tend to fail as time goes by and elderly patients often struggle with keeping posture and balance, which accounts as the main predisposal factor for recurrent falls. This is also consistent with what we know about senile sarcopenia which is the loss of muscle mass associated with aging and one of the main causes of muscle weakness and reduced locomotor ability in old age [4]. Still, younger patients present with a dramatic >110 score in the Pronation Index, indicating that the need for correction and balance affects literally all age groups. The degree of foot collapse was also profound. 90% of the participants had Severe and Total Pronation while 0% presented with Optimal feet or Mild Pronation. As for the Arch Height Difference results, our results showed imbalances in body weight distribution can also

be seen in arch height differences. Femoral head height difference plays a key role in these findings.

Discussion

More than 52 million people in the United States between the years 2010- 2012 [5] responded "yes" when asked if they suffer from joint arthritis. This only highlights in part how often someone experiences persistent joint pain and seeks help from a healthcare professional. However, in virtually all cases, the care given is based on the reactive approach from the healthcare specialist involving painkillers, anti-inflammatory drugs, multiple steroid injections, numerous physiotherapy sessions and oftentimes, surgery. While all the above are meaningful and even necessary for some patients, we would like to point out that this approach is dreadfully wrong. The reactive approach is failing because it focuses on alleviating the symptoms long after tissue damage and fixed deformity has been established. In addition, we must consider the financial burden this approach is causing. Stress, strains and long hours of sitting are taking a toll on musculoskeletal health, affecting more than 1 in 2 adults and costing the health care system an estimated

\$420 billion—more than diabetes, heart disease or any other chronic condition [6]. Instead, our team launches and promotes a revolutionary proactive approach to musculoskeletal ailments focusing on the before rather than the after severe damage can occur.

In the trio of our studies back in 2020-2021, we established that everyone is a Crooked ManSM and contributed by and reflected in the collapse of the foot arches. This collapse, if diagnosed and left untreated, will inevitably deteriorate and become permanent creating a fixed Crooked ManSM. The ability of muscles and tendons to absorb load and adapt to any discomfort may be present but it is not infinite or total. The laws of physics also apply to the human body forcing it to yield when abnormal and asymmetrical loading is consistently applied to the joints. This simple observation led us to integrate the x-ray scanning of the hip joints with and without orthotics to diagnose any leg length discrepancies and to evaluate how the human body behaves. The results from our second study were more than revealing. 22% of the time orthotics are put into the shoes of a patient, the femoral head height difference (fhhd) increases. 6% of the time from normal (≤ 3 mm) to abnormal and 16% of the time from abnormal to more abnormal. 61% of the time orthotics are put into the shoes of a patient, the fhhd exceeds 3mm. 40% of the time, fhhd exceeds 5mm [7].

On one hand foot collapse cannot be left untreated and, therefore, orthotics are necessary and on the other hand orthotics sometimes worsen fhhd creating more imbalance. Are orthotics harmful and obsolete? Absolutely not. Let us take a minor step back here. Our experience with orthotics is significant in terms of years of practice, patient education, clinical evaluation and re-evaluation of the patients and ongoing research. This accumulated experience has led us to believe that the role of orthotics is merely to provide support and create biomechanical symmetry of the feet and to put the feet into an optimal biomechanical position. Remember, everyone is a Crooked ManSM so orthotics are vital in creating symmetry and balance. Orthotics are merely the first step in truly reducing injuries and improving performance. The feet must be symmetrical in their biomechanical positioning, and once this is achieved, a standing digital x-ray of the femoral heads (hips) will provide the most important information. If the difference is greater than 3mm, an appropriate lift will be needed under the orthotic on the low femoral head side.

All the aforementioned modalities which this proactive approach consists of were applied and tested on more than 10 players of the Albany Patroons professional basketball team since 2019 with a simple yet unimaginable goal of preventing injuries from happening in the first place. We treated each player two to three times per week for the first nine games of the season before COVID forced the season to stop in early March of 2020. At that time, the statistics were 10 players under total care and zero injuries [8]. Speaking of present time, the Albany Patroons are currently 15 - 2, and they are still fully engaged in this approach.

And, so far, no injuries. The correction of the feet with custom orthotics without testing for femoral head height is an inefficient and ineffective means of preventing injuries. Our approach to injury prevention helps provide symmetry, support and balance in the feet while ensuring the femoral head height is as level as possible. This produces a more even weight distribution through the low back and lower extremities and a more balanced foundation for the middle and upper spine.

Our conclusion after all these decades of evaluating patients, reviewing their data and actually being a part of the orthotics' production is that custom orthotics are no longer needed. The collapse of every patient's foot is truly unique; however, custom correction is not the solution. Symmetry and balance of the feet can be achieved with quality over the counter orthotics. Greater concern should be paid to subsequent femoral head height difference. And since symmetry and balance can be created without custom orthotics, this means the laser foot scan, plaster molding, and foam casting kits become obsolete and will no longer be needed. This truly revolutionary approach dramatically reduces costs and will now make orthotics available to the masses. These benefits will be seen in the healthcare industry, the sports industry, the running shoe industry as well as the quality-of-life industry.

Conclusion

Our feet can no longer be looked at independently from the rest of the human kinetic chain. There is an intimate relationship between the feet and the alignment, balance and function of both the musculoskeletal and nervous systems of such salient importance that everyone in healthcare should be mindful of it. Nevertheless, without checking and addressing femoral head height differences, our chances of changing the reactive approach is reduced. We've been trained to think that the running shoe industry along with custom orthotics companies have done all the necessary research and have found the magic formula to reduce injuries and improve performance. Not so. Ultimate improvement and results begin with affordable orthotics combined with the appropriate x-rays and interpretation of findings.

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