Podiatrists—and Patients—Give Thumbs Up to 3D Orthotics

Go 4-D provides an easy and affordable way to adopt 3D printing for custom orthotics.

BY ANDREA LINNE

Resonating with Patients

When Mark Lewis, DPM, prescribes orthotics for a patient, he no longer has to deal with the mess and dust of plaster casting. Instead, he invites his patient into a comfortable room outfitted with a scanner, pressure plate and large screen TV mounted on the wall. After Dr. Lewis scans the patient's feet and the patient walks on the pressure plate, the data collected from both devices is transmitted to a software program that creates digital images of the feet and recommends a custom prescription for orthotics.

Dr. Mark Lewis

Dr. Lewis and his patient sit down to review the images on the screen and discuss how the orthotic can correct the foot problem. "It's a process," Dr. Lewis says. "While I scan their feet, I discuss the problem. Then I can talk through the problem with the patient using the visual guide. I explain the data, and the patient feels informed. It's very interactive. It even breaks down barriers with nervous patients. Once I transmit the prescription to Go 4-D, which uses a 3D printer to create the orthotics, it takes two weeks for the patient to receive them."

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Since adopting Go 4-D's system for printing custom orthotics in April, Dr. Lewis says he now prescribes roughly 80 pairs a month, a 45 percent increase. "My practice, Northwest Foot and Ankle Center, is located in Renton, Washington, near Seattle, a technologically progressive area," Dr. Lewis says. "I thought the system would resonate with my patients. I moved out of my office, which was large, into a closet so I could create a welcoming environment. I do all the scanning myself. Patients want to know that I'm paying attention. Go 4-D lets you create an awesome patient experience. The result has been internal viral marketing. Patients are sending their friends and family members to get orthotics."

Advanced Technology

Go 4-D is an alliance with HP, which developed the Fitstation technology for printing custom orthotics. Go 4-D markets the solution to podiatrists. Fitstation by HP includes a 3D foot scanner, a 2D pressure plate and Footscan 9 software. The Fitstation platform helps podiatrists prescribe orthotics based on each person's unique biomechanics, says Steve Smith, senior director of engineering at HP.

When a patient places his or her foot inside the scanner and stands on the glass, nine laser-powered cameras capture 3D images of the foot up to the ankle. During the scan, the foot is broken down into 10 distinct areas. "The scanner measures each foot's length and width, its arch height, length and width, and other biometric data," Smith says. "It picks up subtle differences between feet that a visual inspection cannot." The pressure plate measures when each area of the foot strikes the floor, how long it stays there and how much pressure goes through one area compared to another. "We get detailed informa-

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New Concepts and Studies

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tion through the entire gait cycle, so it provides a dynamic analysis, not just a static analysis," Smith says. The software integrates the data from both devices to help the doctor create a custom prescription, which can be adjusted, if necessary, based on knowledge of the patient. An athlete, for example, might want an orthotic that's a little more rigid.

The orthotic is segmented in five zones and each can be manufactured with varying degrees of stiffness and torsion. "That's because 3D printing is additive manufacturing, meaning the orthotic is built from the ground up using a lattice structure," says Bruce Williams, DPM, a consultant for Fitstation by HP and medical director for Go 4-D. "Each zone can be made to be more flexible or stiff." The 3D printed orthotics are also thinner and more lightweight than traditional orthotics manufactured with polypropylene, he says.

Dr. Bruce Williams

"If, for example, a patient has a high arch foot, you can decrease the medial arch stiffness, while still having very high conformity," Dr. Williams says. "This is often as much of a comfort issue as it is a mechanical control issue. But in some lower arch feet, you can also increase the stiffness of the orthotic device in the medial column and potentially decrease the need for extreme values of varus posting that many podiatrists will use in these types of feet. You can also decrease stiffness in the lateral column if an athlete has had a fracture of the fifth metatarsal or is at risk for one. Moreover, you really can't build a forefoot addition onto a CNC milled orthotic because it will be too stiff at the forefoot transition area at the ball of the foot. We need the foot to bend there during gait. But with 3D printing you can make the transition area very flexible so that forefoot and full-length additions can be utilized. A traditional lab would need to do this by hand, which costs time and money."

"With 3D printing you can make the transition area very flexible so that forefoot and full-length additions can be utilized," says Dr. Williams.

"When patients or practitioners think of orthotics, it's synonymous with arch support," Dr. Lewis says. "But it's more than arch support. It's about controlling the entire foot. With this solution, we can capture data about how the foot connects with the ground and address a patient's problem to relieve their pain. Patients often say, 'Wow, my entire foot feels really supported.'"

The orthotics are printed at a factory in Ferndale, WA. "We are partnering with Flowbuilt for production and distribution," Smith says. "There are 3 HP Jet Fusion printers dedicated to our workflow. One printer can produce 80 to 100 devices per day. We will expand to more printers as needed." HP says printed orthotics is a more sustainable technology. It uses renewable raw material made from castor oil and reduces waste by 90 percent compared with traditional CNC manufacturing processes.

Paul Linton, CEO of Go4D

Innovation and Economic Viablilty

Paul Linton, CEO of Go 4-D, founded the company with Chris Patten, COO, in January 2018, and the firm began taking orders for orthotics in September 2018. Linton, who has a bachelor's degree in kinesiology, worked for many years in the orthotics industry, first in sales and development for a Canadian company and then as owner of an orthotics firm in Australia. He sold that business because there was no innovation in the industry. Then, HP invited him to an event where he learned about the future of digitization of the foot. "Thinking about the potential of using data to produce a customized orthotic or shoe in a short period of time is what got me back into feet," he says.

Additive manufacturing (AM), commonly called 3D printing, was developed in the 1980s and generally refers to a process in which a computer-aided design (CAD) model is printed by adding layer upon layer of material, as opposed to a subtractive manufacturing process in which material is removed from an item, such as carving a canoe from a tree. A 2012 study of AM for foot orthosis design found evidence that "biomechanical changes can be achieved using novel devices which take advantage of the design freedom provided by AM." However, among the obstacles cited were cost and the lack of a complete solution.[1] A 2013 study of patients with early rheumatoid arthritis (RA) found that orthotics produced with CAD and AM, based on 3D gait analysis with biomechanical data from a camera and pressure plate, provided better foot

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Tiger 3D foot scanner

function over standard orthotics. It's estimated that 70 percent of patients with RA report pain and swelling in at least one metatarsophalangeal (MTP) joint and 60 percent report walking disability. The custom orthotics redistributed load from weight-bearing sites, particularly painful MTP joints. This study also acknowledged that while the cost of AM and supporting software has decreased during the previous decade, economic cost models for the combined technologies used must be evaluated.[2]

While 3D printing for orthotics has been done for more than 3 years, Linton says, it's now economically viable and HP provides a complete solution for custom orthotics. There is no cost difference for patients between a traditional orthotic and a printed one, and Go 4-D's business model makes it affordable for podiatrists. Dr. Lewis, like 95 percent of Go 4-D's clients, rents the equipment. If he orders approximately 20 pairs of orthotics a month, the rental fee is waived. But Dr. Lewis is quick to say that's not why he's prescribing more orthotics since he adopted the system. "It's because patients are asking for them," he says. In fact, he recently ordered a second Fitstation solution for an office he's opening roughly an hour away from his current location.

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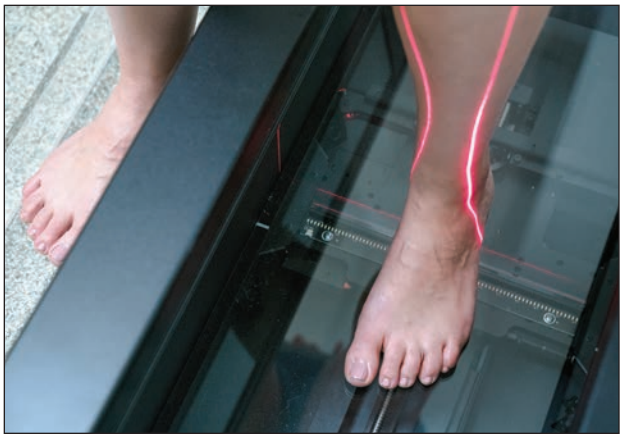
Ease of Use and Data Collection

"Setting up the system was very smooth and intuitive," Dr. Lewis says. "I just unpacked it and used the online video Go 4-D provides." For podiatrists who do need help getting started, Linton and Dr. Williams are available to answer questions and provide training. Linton points out that if you have a small office without a dedicated space for the devices, you could put the pressure plate in a hallway; it comes with a 10-foot long cord that's connected to a computer via a USB port. The scanner is compact and light enough to be stored in a corner and picked up and moved when needed.

Ali Sadrieh, DPM, of Evo Advanced Foot Surgery in Studio City, CA, who adopted the 3D solution in February, agrees that setting up the system is easy. "I bought a PC because I had a Mac, connected it and we were in business," Dr. Sadrieh says. "We are the most cutting-edge foot surgical practice in the world, so I'm always looking for innovative technologies. When I found Go 4-D, I talked to Paul [Linton] and our visions synched. Then I met with folks from HP, and the solution for printing custom orthotics made sense to me."



HP Fit Station

Dr. Sadrieh also rents the equipment and now prescribes between 35 and 50 orthotics a month, up from roughly 20 to 30. He is meeting his quota and gets reimbursed for the rental fees. "Patients like them," he says, "because they're thinner and more comfortable. And the prescription is more accurate. In the past, I often had to modify the orthotic." He typically has an assistant guide patients through the scanning process, because it frees him up.

"I scan every foot, even if the patient is not coming for an orthotic," Dr. Sadrieh says. "The data collected provides priceless information that helps me plan surgeries. I show patients the data and images of their foot before and after bunion surgery. Patients love it.

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And, of course, it's very accurate in prescribing orthotics. When, for example, a patient with diabetes walks across the pressure plate, you can see where he puts pressure on a wound and use a custom orthotic to relieve it. Similarly, by analyzing the gait of a patient with plantar fasciitis, the system can detect even a very subtle amount of pronation. So, whereas a traditional orthotic would stabilize a patient's arch and heel, it might not relieve her pain. However, she will benefit from a 3D orthotic that can better prevent pronation." Dr. Williams also points out that if the patient has plantar heel pain, that area on the orthotic could be made significantly softer.

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Stepping Up to the Future

For a look into the future of 3D printing and foot innovation, consider the Brooks Genesys personalized running shoe created with Fitstation by HP. By incorporating a runner's digital profile, including an analysis of gait, it aims to improve comfort and performance.

As for the future of 3D orthotics, Dr. Lewis says this technology is not going away because "it's efficient, informative and precise."

It's currently being beta tested by a small group of runners. As for the future of 3D orthotics, Dr. Lewis says this technology is not going away because "it's efficient, informative and precise. Most professional sports teams are using it. It's just a matter of when people adopt it."

Dr. Sadrieh says he would definitely recommend 3D printing for orthotics. "It's an affordable way to step up the future," he says. "You're not paying for hardware. They're just loaning it to you. I can't imagine going back to traditional orthotics. No more dirty plaster splints. There's only an upside. I love it."

So, if it's 3D printing, why is the company called Go 4-D? "We added another dimension, time," Patten says. "And the 'Go' is for patients who want to correct their foot problems so they can be more active." **PM**

References

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