The Next Generation: Noraxon's FDM-Treadmill System for Stance and Gait Analysis

By Dr. Jay Segel, D.P.M.

The world of technological advancements continues to grow in the medical field, making available to us the quantitative measurements to validate our qualitative findings. For the health care professional clued into the importance of gait analysis, we now have tools to expand our understanding, with great specificity as to what things are happening during gait and when they occur.

Pressure analysis is an old and useful tool for podiatrists that began with examining wear patterns on insoles and graduated to carbon transfers of the static weight bearing foot. As computer imaging and CAD systems developed, we began to see gait analysis inventions like the Electrodynagram (EDG) in the early 80's with it's force data collectors and all those wires. EDG was functional but clumsy and time-intensive. Recently we have seen force distribution measurement systems like the in-shoe F-Scan and TOG's GaitScan™, in which diagnostics and communication of data are used for orthotic fabrication.

Figure 1.

The Next Generation

The next generation of force distribution tools is **Noraxon's FDM-T system** for stance and gait analysis [Figure 1]. As the initials might suggest this force distribution measurement treadmill allows us more useable information by controlling the speed and walking field as well as a high density of calibrated pressure sensors (5,376) over an area of 150 x 50 cm, capable of firing and capturing data in a repeating fashion until the examiner stops the test. The unit has a proprietary technology developed by Zebris to automatically stabilize the belt for accurate data acquisition from initial heel contact through gait roll-off. The connection to the computer is via USB interface.

The gait analysis system packaged in the housing of a treadmill allows for superior flexibility in measurement using any speed within reason, any footwear, and any device (such as an orthotic) with easy comparison capability. The practical applications of using the FDM-T patient-specific graphics help patients understand the way they currently walk and the moments and forces that create the pains and problems that brought them to your office. The gathered data and pictures also create an avenue to explain how orthotic intervention will improve their gait. A barefoot test with any patient gait pattern or deformity can be quickly contrasted to that of shoes or orthotics with no patient preparation. This FDM-T test is easy to perform as it requires no pre-calibration and has no expendables or fee-per-analysis concerns so it is ideal for obtaining a baseline of biomechanical data for new patients, and assessing progress on subsequent appointments.

Three-Part Report

The default auto report consists of three main sections [Figure 2]. The first involves the complete spatial and temporal parameters, with timing and left to right symmetries highlighted here for easy analysis and comparison. The second provides the analysis of the center of pressure (COP) data for each step, left and right stabilities, and an illustration for the total body center of pressure, with balance summary. The third part shows a summary of every step and an averaging of the maximum pressure plots with overlaid gait lines. A fourth section is available to those using the video module to gather kinematic data, time curves, loading responses and segmented force separated out by specific foot region.

Solidifying the Primary Diagnosis

After capturing the raw data we can dig into the numbers and images to find statistically relevant patterns that will solidify our primary diagnosis, suggest underlying factors and provide direction or nuance to our treatment protocol. Noting the increased cadence for barefoot runners or temporal variations and compensations and even altered foot rotations helps add understanding to how a prescribed device or running style might correct such imbalances and side to side deviations. Changes in these param-

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eters after gait training, therapy, shoe choices or orthotic dispensation may well prove useful throughout treatment adjustment and process.

In this section, you can also see the shifts in the center of pressure through each step, overlaid. To link complaints of pain during ambulation and/or plantar tenderness to the dynamic measurement you can pick out the peak pressure areas, areas you might need to unweight or more efficiently distribute to reduce risk factors and predisposition to gait-related pathologies. For example, after performing your adds and mods to offload a particular plantar segment, I recommend rerunning the FDM-T tests to validate that the orthotic alteration is achieving the desired correction.

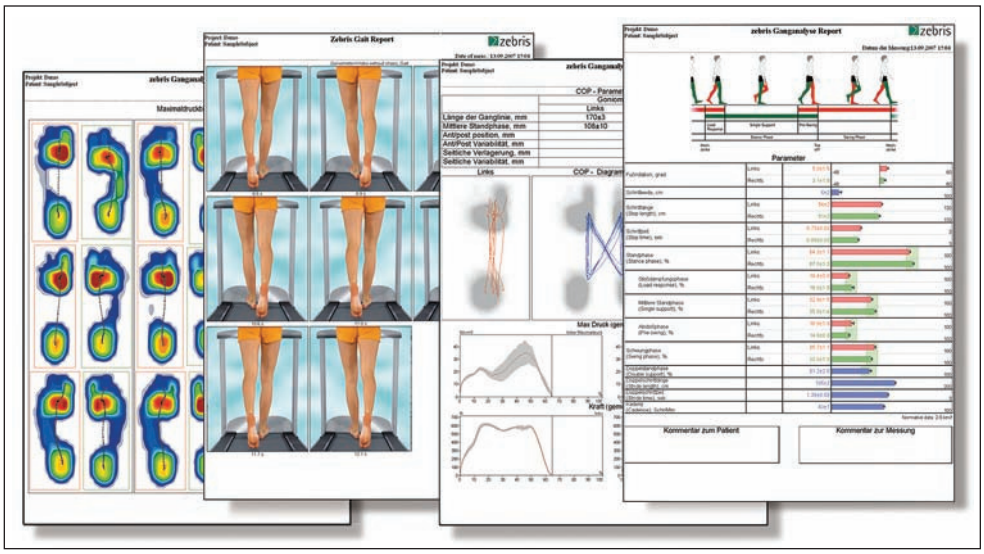

Figure 2.

Gait Symmetries

To look at the most basic of gait symmetries, the "Separate Foot Prints" and "Butterfly Parameter" sections display the left and right gait lines, along with the total COP cyclogram or butterfly chart. Balance and stability can also be shown in this report graphic. Even small changes in patients' lateral or ant/post stability—via changes in shoes, orthotics, lower extremity weaknesses, or even upper body kinematics or vestibular or neurological interventions—can be noted from how tightly the lines are overlaid.

It may also be useful to look at the loading rates for particular portions of the gait cycle. The third section of the auto report highlights the ground force reaction (GFR) curves and overlays them for up to two scenarios. After inserting an orthotic you may see a smoother slope, or a reduced loading rate at initial contact, or vice versa; without an orthotic you may see a steeper slope and you can justify a possible orthotic prescription. You may see a change in the GFR dip at midstance, or more efficient movement through the midfoot, as another example. A perturbation in the preliminary slope of the GFR curve may indicate that there is some aversion in their upper body movement Strengthening or loosening hip and knee movement through strides may reduce such aversions, and you can see this also by noting changes in the path of the composite gait line.

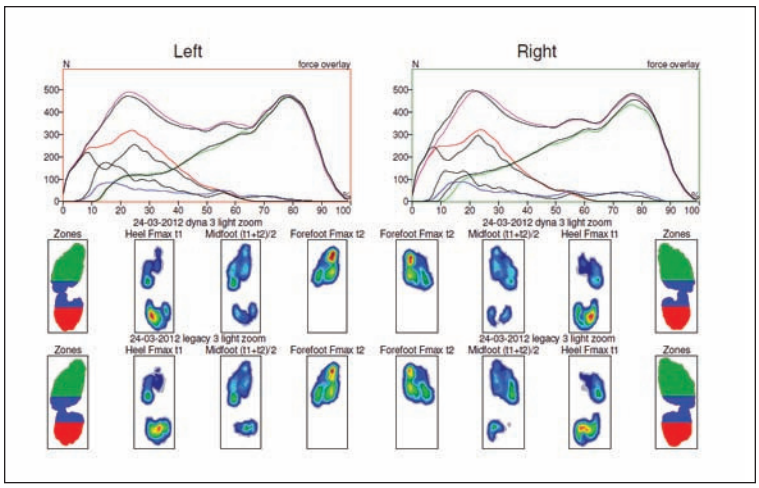

Figure 3.

Specific Foot Segments

The ensuing pages go into more detail on the effects and changes in specific foot segments. If you are aware of an issue like severe varus positioning you can look to the heel segmented graphic to note limited eversion and higher peak pressures [Figure 3]. In the midfoot segmented graphic you can note the increase speed of loading, and in the forefoot segment you can see the slope steepen even more in the medial portion where the first metatarsal head is located, and where contact is made prematurely. You can see changes in these patterns after corrective footwear is provided, with results seen side by side, automatically—thus time is saved. You and your patient are given an even clearer picture of where changes either have or may still need to be made.

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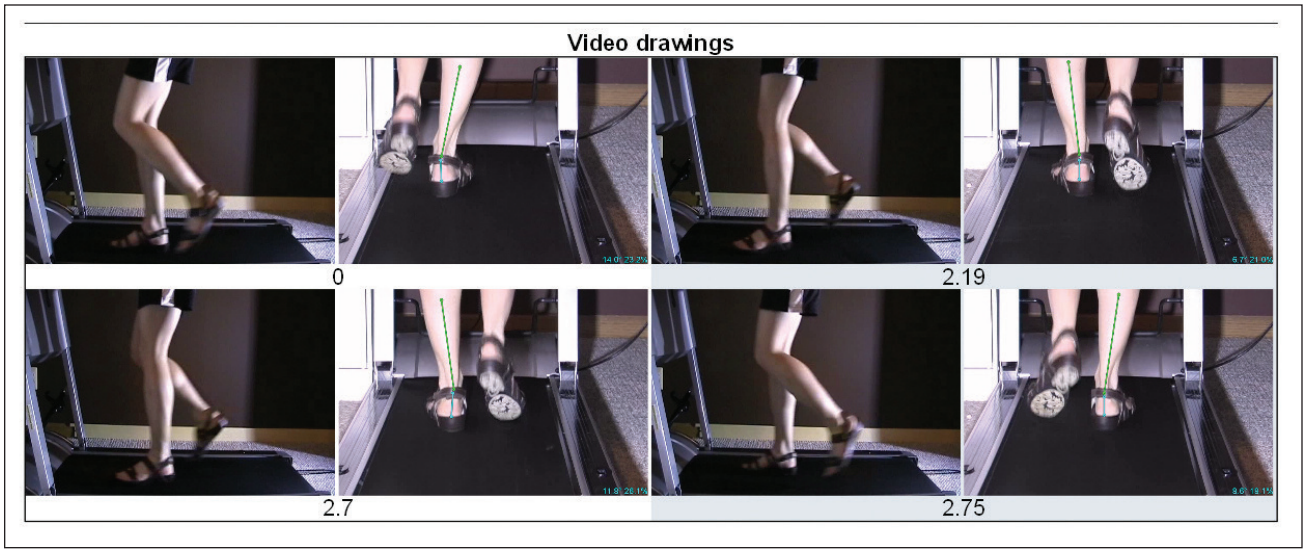

Figure 4.

Video and Kinetics

If video is used in synchrony then there will also be a page where kinetics and kinematic angles are displayed. For example, Figure 4 shows the ankle angles at mid-stance for two different posted orthotics, dynamic and static. These results appear simultaneously with the pressure analysis, all in one easy-to-read report.

As the reports are immediately available, I like to give my patients a copy of the study and suggest that they share it with their primary care physician, orthopedic surgeon, chiropractor and/or physical therapist. It's good for the patient/doctor relationship and good for your referring doctor to know that you possess that level of gait sophistication. The comprehensive software package is windows-based and includes a database with real-time analysis, signal viewer

and report generator. If you choose to, Noraxon has a companion video module for purchase, adding the ability for kinematic examination. This add-on is plug and play. I find slow motion gait analysis to be a great communication tool with colleagues, staff and patients alike.

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Clinical Evaluation

As a practicing podiatrist for nearly 30 years, concentrating in biomechanics, I was asked to evaluate the FDM-T for its kinetic data, ease of use, and patient experience, along with its analytical and comparative capabilities. I used the unit in my office over a period of 4 months with appreciated and reproducible results. I found patients engaged in the process, staff able to perform the basics and referring physicians interested in the results. The FDM-T also was helpful in my decision-making when alteration of a prescribed and dispensed orthotic was necessary. The system worked well with patients but was also powerful enough to be used in the research and development of my dynamic rear foot posting system found in Langer's new line of DynaFlange™ orthotics.

The FDM-T computerized gait analysis system would be a welcome addition to any podiatric office interested in stance and gait analysis, and is particularly useful when seeing patient diagnoses including, but not limited to, short limb syndrome, plantar fasciitis, posterior tibial dysfunction, drop foot, ankle instability, balance issues and a host of arthritities and neuropathies.

Dr. Jay Segel graduated from OCPM in 1983. He moved to Massachusetts and did his residency training at Cambridge City Hospital, a Harvard University teaching affiliate. Jay has been in private practice on Martha's Vineyard for nearly 30 years where he lives with his wife Celine and his children, Kevin, Vikki and Brad.

For more information, visit www.segelpodiatry.com or *circle #158 on the reader service card.*

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