Overview of the 3D Gait System

3D Gait is the world’s first and only 3-dimensional (3D) motion capture system designed for a clinical setting. Dr. Reed Ferber, the founder and Chief Scientific Officer of Gait Analysis Systems Inc, began the research and development of 3D Gait in 2004 and saw the first System installed in 2010. Currently, 20 private physiotherapy and chiropractic clinics use 3D Gait and we have 8 academic research partners around the world contributing to the continuous research and development of our world-class approach to injury prevention and assessment.

The heart of 3D Gait is the world’s largest database of scientific 3D biomechanical walking and running data and clinical injury data. The database is growing every day and currently has over 2000 data points from injured and non-injured walkers and runners who span the spectrum of Olympic to recreational athletes and from 18 to over 80 years of age. Each variable in the database is normally distributed: meaning that the data are evenly distributed around a central point (the mean) in a very regular way, which when plotted will result in a bell curve. Thus, by using the database, we can begin to analyze data in ways that have never been possible. For example, the newest version of software will allow for gender-based comparisons so that the way an individual female runs is now compared to how all females run and a decision on the root cause of the running-related injury is more accurate and specific for each athlete. We can be confident that the 3D biomechanical analysis is valid since the gender-specific databases are also normally distributed and considering that Dr. Ferber published the first research study on gender differences in running mechanics. In the near future, and as the database grows, we will further partition the database based on other individual characteristics such as age categories and athletic skill-level. So a male runner, age 34 years and competing in the Boston marathon can be compared to other male runners, of the same age and also competing at a similar level. The potential is incredible and there is nothing in the world that can provide this type of analysis and level of detailed information!
Our overall approach is to treat every injury and athlete as a puzzle and to base our decisions on the current scientific literature regarding biomechanical factors related to an injury. In our 2009 systematic review\(^2\) of overuse running injuries, we reviewed 283 scientific articles and concluded “one of the main limitations identified was the lack of normative data.” Thus, the idea of a central database is critical to help us establish what is “normal” or “typical” motion and to better understand the root cause of a running injury. Our approach of providing scientific 3D biomechanical data and comparing it to the world’s largest database will allow any practitioner to make an accurate decision regarding which biomechanical variables play a role in their client’s injury and how to prevent future injuries.

At any given 3D Gait location, data from an individual athlete are compared to the database and a scientific analysis of their biomechanical gait patterns is performed. The data are transformed into a “percentile rank” score with a score of 100% indicating the average or ideal movement pattern. Thus, the practitioner can easily identify which areas of the body demonstrate atypical movement patterns and work towards focused rehabilitation. The “Injury Index” score is an overall score that reflects overall gait patterns. How do we know this approach is valid? An average injured runner has an Injury Index score of 42 and a non-injured runner has a score of 65. Most Olympic athletes score with in the 90\(^{th}\) percentile. Thus, our overall approach and percentile rank method is statistically valid and provides valuable data to the practitioner and client in an easy-to-understand manner.

The rest of the report provides detailed graphs of each joint and each side of the body. The practitioner can begin to see how individual gait patterns, and combinations of gait patterns are related to the injury. For one runner, it may be excessive motion; for another, it may be reduced or restricted motion that is the root cause. Only by providing scientific-quality 3D biomechanical data can these complex decisions be made.
The research behind 3D Gait is based on Dr. Ferber's 13 years of research experience, peer-reviewed publications, and research from similar labs around the world. Our team of biomedical engineers, biomechanists, physiotherapists, and clinical scientists all conduct research to help improve our database and software validity and reliability. For example, based on Dr. Ferber’s reliability research publications\textsuperscript{3,4} that determined which biomechanical variables are most reliable from day-to-day and by which techniques, we are confident in the ability to introduce this technology to the world at multiple locations. Most recently, we published the first experimental evidence to understand how increased stride-to-stride movement variability leads to injury\textsuperscript{5} and how effective therapeutic exercise reduces movement variability\textsuperscript{6}. These experiments collectively dispute a 10 year-old theory that had only been investigated through cross-sectional studies. In addition to our work developing a biomechanical model for predicting injury risk in running\textsuperscript{6} we have been working on a consistent line of research to understand the inter-relationship between muscle strength and atypical hip and knee running biomechanics\textsuperscript{2,6,8}. Based on this research, our future work will be focused on neural network approaches to predict running injuries based on gait biomechanical patterns. Already we have made tremendous progress in being able to predict a runner’s age based on their biomechanical patterns\textsuperscript{9}, and in accurately predicting whether a runner is injured, or close to an injury, based on the same neural network approach\textsuperscript{10}. Future software releases will incorporate these state-of-the-art approaches and will transform the type of information one can receive about injury prediction, prevention, and treatment. This transformation of health medicine can only be accomplished because of the world’s largest database of scientific 3D biomechanical walking and running data and clinical injury data.
References
(10 of 36 publications and 67 abstracts shown here. For a full list and to see Dr. Ferber’s CV please visit [www.runninginjuryclinic.com](http://www.runninginjuryclinic.com).


To learn more about 3D Gait visit [www.3dgaitanalysis.com](http://www.3dgaitanalysis.com).