An Evidence-Based Videotaped Running Biomechanics Analysis

Richard B. Souza, PT, PhD, ATC, CSCS[a,b,c,*]

KEYWORDS

• Biomechanics • Running • Motion analysis • Form • Injuries • Observational
• Video analysis

KEY POINTS

- Running biomechanics play an important role in the development of injuries in recreationally active individuals.
- Performing a systematic video-based running biomechanics analysis rooted in the current evidence on running injuries can allow the clinician to develop a treatment strategy.
- The current literature has not risen to the level of proven injury prevention, suggesting that recommendations for modification of running form in uninjured runners would not be evidence based.
- When the patient presentation and physical examination findings are in agreement with abnormalities observed in a biomechanics running analysis, it serves as a potential for intervention.

INTRODUCTION

Running is an extremely common form of exercise, whether recreational or competitive. However, running injuries are also quite common. In particular, running injuries such as patellofemoral pain, iliotibial band syndrome, and stress fractures to the tibia and metatarsals have been identified as highly prevalent in runners.[1] Although causative factors of running injuries are undoubtedly multifactorial, most agree that running biomechanics play a key role in injury development.

Disclosure Statement: Dr R.B. Souza has a financial relationship with SportzPeak, Inc, a sports wellness company.
[a] Department of Physical Therapy and Rehabilitation Science, University of California, San Francisco, 185 Berry Street, Suite 350, San Francisco, CA 94107, USA; [b] Department of Radiology and Biomedical Imaging, University of California, San Francisco, 185 Berry Street, Suite 350, San Francisco, CA 94107, USA; [c] Department of Orthopaedic Surgery, University of California, San Francisco, 185 Berry Street, Suite 350, San Francisco, CA 94107, USA
* 185 Berry Street, Suite 350, San Francisco, CA 94107.
E-mail address: richard.souza@ucsf.edu

Phys Med Rehabil Clin N Am 27 (2016) 217–236
http://dx.doi.org/10.1016/j.pmr.2015.08.006 **pmr.theclinics.com**
1047-9651/16/$ – see front matter

Numerous recent studies have identified abnormal biomechanics in persons with specific running injuries.[2–5] However, the vast majority of these studies used advanced technological methods, which are expensive and uncommon in standard clinical practice. Although some variables associated with running injuries require high-tech equipment, such as instrumented treadmills and 3-dimensional (3D) motion capture systems, many of the kinematic abnormalities identified in runners with injuries can be measured using a simple 2-dimensional (2D) video-based running analysis using readily available and fairly inexpensive tools.

The objective of this article is to provide a framework for a systematic video-based running biomechanics analysis plan based on the current evidence on running injuries. Although some of the proposed variables of interest will have an impact on running performance, the primary focus of this analysis plan is to identify biomechanical factors related to common injuries in runners. Furthermore, there are many other factors that may be related or even causative for injuries while running, including training errors, current health status (ie, recent injury), and/or structural abnormalities (ie, leg length discrepancy, pes planus foot deformity etc).[6,7] However, the focus of this review is restricted to running kinematics, particularly those in the sagittal and frontal plane, which may be easily viewed with standard 2D video. A running biomechanics analysis should be an integral component of the evaluation, either for the injured runner or for screening for injury prevention, to complement a physical examination and thorough history.

ANALYSIS SETUP

Treadmill Setup

Although some studies have identified small differences in treadmill running when compared with overground running, these differences have mostly been associated with muscle activation patterns and joint forces.[8,9] In general, kinematic patterns during treadmill running are very similar to those observed during overground running.[10–12] As such, performing a video-based analysis of joint kinematics while running on a treadmill should provide valuable insight into running kinematics during overground running and is more practical for performing this evaluation.

Running velocity affects lower extremity kinematics.[13] Therefore, matching treadmill speed to a similar speed at which an injured runner experiences symptoms should be accommodated if possible. When evaluating a symptom-free runner, 1 strategy that can be used is to set the treadmill speed to match the running velocity of the runner when performing a “long run,” which is a common term used for the longest distance run in the recent past. The rationale for selecting this speed is that if runners are demonstrating abnormal biomechanics while performing longer runs, these faults will accumulate over the longer exercise period and may contribute to running injuries.

Cameras

Many high-definition cameras are available at varying price points. Both image resolution and temporal resolution should be considered when selecting cameras for video-based movement analysis. Many video cameras have excellent image resolution, but are limited to 30 frames per second. Cameras with higher frame rates (eg, $\geq$120 Hz) can provide cleaner images that are easier to evaluate and more appropriate for the evaluation of running kinematics. More recently released smartphones and tablets can be adjusted to acquire video at high frame rates and provide adequate video for this purpose.