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The Veterinary Journal 178 (2008) 165–176
The Veterinary Journal
www.elsevier.com/locate/tvjl

Review

Recent developments in canine locomotor analysis: A review

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Accepted 15 January 2008

Abstract

Subjective evaluation of canine gait has been used for many years. However, our ability to perceive minute details during the gait cycle can be difficult and in some respects impossible even for the most talented gait specialist. The evolution of computer technology in computer assisted gait analysis over the past 20 years has improved the ability to quantitatively define temporospatial gait characteristics. These technological advances and new developments in methodological approaches have assisted researchers and clinicians in gaining a better understanding of canine locomotion. The use of kinematic and kinetic analysis has been validated as a useful tool in veterinary medicine. This paper is an overview of the kinematic and kinetic analytical techniques of the last decade.
Published by Elsevier Ltd.

Keywords: Locomotion analysis; Kinematic; Kinetic; Electromyography; Treadmill; Force plate; Motion analysis

Introduction

Objective measures of musculoskeletal function have been around since the late 1800s. Historically, clinical methods of gait analysis have been rapidly evolving for the past 40 years (Brown, 1986; Decamp, 1997; McDowell, 1964). Gait analysis evolution has created new sampling and analysis powers that have enabled clinicians and researchers to accurately and efficiently explore the canine gait cycle. In the last 25 years, technological advances in computer assisted gait analysis have aided our ability to quantitatively define temporospatial gait characteristics. This has assisted researchers and clinicians in gaining a better understanding of canine locomotion. With the ongoing advancement of computer technology, biomechanists have been able to develop systems that integrate methodologies using three-dimensional (3D) kinematic (motion) analysis (i.e. includes analysis of the third coordinate axis), kinetic (forces) analysis, and electromyography (EMG) all at the same time in the same system.

Subjective evaluation of canine gait has been used for many years. However, our ability to perceive minute details during the gait cycle can be very difficult and in some respects impossible even for the most talented gait specialist. During a subjective evaluation, a clinician is only able to perceive a few kinematic variables at a time, but a modern kinematic or kinetic analysis system can capture, analyze, and store hundreds of observations per second. Unfortunately, a human cannot perceive the minuscule fractions of canine gait such as rotation about the stifle at rear paw take off. These fractions of gait have to be analyzed with two-dimensional (2D) and 3D kinematic analysis systems. A human has the ability to view an animal in motion, but does not have the capabilities to observe the forces involved in gait and identify specific neuromuscular activity. Therefore, we must employ and are limited to our different gait analysis tools. The purpose of this paper is to provide a comprehensive overview of the recent advancements in canine locomotor analysis during the past 10 years and identify future areas of research.

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1090-0233/$ - see front matter Published by Elsevier Ltd.
doi:10.1016/j.tvjl.2008.01.009

faces in relation to the extreme biomechanical factors (e.g. movement strategies and traction) experienced by the dog during competition.

Conclusions

In considering an overview of the analytical techniques of the past 10 years, we have discussed kinematic analytical systems such as analog-based systems, digital optoelectronic systems, and kinetic measurement systems such as force plates, pressure mats, and strain gauges. In addition, we have also covered finite element models, inverse dynamics analysis, neuromuscular measurement systems, and treadmill gait analysis. The use of kinematic analysis and force plates has been validated as a useful tool in veterinary medicine, although more research needs to be conducted to determine in which situations kinematic and/or kinetic analysis should be used. All of the above listed technologies are applicable to most areas of locomotion research, whereas only certain aspects of these technologies are applicable to the practicing veterinarian. Some of the more in-depth analysis tools such as finite element analysis and inverse dynamics are not currently practical analytical tools for practicing veterinarians but these technologies are practical in the research setting.

Of the current biomechanical technologies, a 2D computer assisted videographic gait analysis system has the most relevance to the general practitioner. Although a 2D analysis is limited in the amount of information ascertained, its ease of use allows it to be used by a greater number of general practitioners. The more specialized practices or research laboratories are more proficient at handling the complexity of a 3D system. Videographic data can be collected at almost any selected location and does not need a specialized gait path with an imbedded force plate. There are many basic computer assisted videographic gait analysis systems that are less expensive then most force plate systems. In addition, videographic systems can output a videographic presentation that is better understood by the client then most kinetic systems which output complex graphical kinetic data.

Biomechanical data can be used by everyone but not everyone can afford or be trained to use these tools of analysis. The technology is underutilized by the veterinary community. There is not any formal training (e.g. the curriculum of radiology) for veterinarians on the use of and interpretation of biomechanical data. Therefore, many do not understand their capabilities. The technology is growing in popularity and more specialized practices and institutions are employing biomechanical analysis in their clinical routines and research. Whatever the scope of the biomechanical research or clinical evaluations may be, the quantitative ability of kinematic and kinetic hardware and software has aided our exploration of canine locomotion and led to new developments in veterinary medical technology. With these new developments we have increased our ability to understand and quantify the kinematics and kinetics of intricate parts of the canine gait.

Conflict of interest statement

None of the authors of this paper has a financial or personal relationship with other people or organisations that could inappropriately influence or bias the content of the paper.

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