A Biomechanical Analysis of the Weight Training Squat Using Dartfish Motion Analysis Software

Introduction

Wesley Kephart was enrolled in the course Analysis of Movement, KIN 427, and is one of the co-requisite labs, KIN 427L, during the Fall 2001 semester. His course-long term project, A Biomechanical Analysis of the Weight Training Squat, was completed in the lab portion of the course. This project required the comprehension and utilization of various biomechanical principles which he learned in the lecture portion of the Analysis of Movement class. The biomechanical principles, which are discussed in his paper, were derived from Newton’s Laws of Motion and assist us to understand the forces that produce and affect movement. The unique aspect of this project is that he was able to scientifically analyze the performance of the Weight Training Squat by using the Dartfish Motion Analysis Software, which is the latest and most sophisticated computer video analysis software being used. This software is used by researchers, teachers, coaches, physical therapists, occupational therapists, and sports medicine specialists for detecting errors in a person’s movements, calculating angles, time, distance, and velocity, and for providing feedback to the performer through the utilization of drawing tools and the production of a media book on a DVD. Stephen F. Austin State University is among an elite group of universities in the United States that has this sophisticated equipment.

Methods

A videotape of the weight training squat was created according to strict instructions.

- The video tape was improved, requiring strict instructions into the Dartfish Motion Analysis Program software.
- The performance was subsequently analyzed by utilizing the drawing tools (see picture below).
- Conclusions were drawn by applying biomechanical principles and previous knowledge of weight training kinesiology (see comments below picture).
- Results were provided to the performer utilizing the drawing tools to illustrate errors and producing a DVD media book.

Abstract

During the Fall 2001 semester, Dr. Cole and her graduate assistant David Ware supervised students in a term project in which the students analyzed a movement of their choice using the latest computer version of the Dartfish Motion Analysis Software. This project, a weight training squat was analyzed because it is considered to be the “king of all lifts,” but it is frequently performed incorrectly.

- The biomechanical analysis involved understanding various concepts, who performed the squat in the best of their ability. The subjects were instructed to wear clothing, that was comfortable, and to have their hair and shoulders visible. To ensure accurate measurements, strict standards were followed during videoing: A camera, containing a MiniDV cassette tape, was second to a tripod and set up in a position where it was perpendicular to the plane of movement, while the middle of the range of movement was positioned for maximum clarity (from the actors, possibly, and below to all actions). The subject then instructed to stand, holding a stool, which is an object of known weight which allowed the software to calculate distance, and was recorded for two times. Five trials were recorded per subject with a five second period of recording time before and after the completion of the squat. After the trials were completed, all data were imported into the Dartfish software.

- After a careful review of the data, the qualitative and quantitative data of the subject were selected for an evaluation and thorough movement analysis. Strengths and weaknesses of the movement were analyzed and illustrated by the necessary steps of the software. The tools allowed the investigator to both quantitatively and qualitatively the correct and incorrect movement patterns. Also, the investigators utilized their knowledge of physics and biomechanical principles in analyzing the movements. The software allows an analysis of the various phases of the movement. For clarification of the recommendations, pictures were drawn with the Dartfish software and the text was provided to further explain both the correctness and phases.

The investigators then created a media book at the conclusion of the analysis to present the results and findings in a DVD format. The DVDs made it possible for the subjects to watch their movements with the analysis recommendations, so that they could perform the weight training squat more safely, effectively, and efficiently.

Summary

The Dartfish Motion Analysis Software enabled the investigator to more efficiently view the performer’s movements than with the known error of “trial and error,” and it allowed him to evaluate the performance using a sound scientific basis. It also allowed him to provide more detailed feedback for improvement to the subjects. The above images were used to create a DVD media book, which was then given to the subjects as a permanent resource of the instructions and reasoning of performing the weight training squat in a manner that prevents injury.

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