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 457, and was one of the co-requisite labs, KIN 458, during the Fall 2009 semester term. 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 this paper, are 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, distances, and velocities, 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 requiring strict instructions.
- The videotape was improved requiring strict instructions onto the Dartfish Motion Analysis computer software.
- The performance was critically analyzed by utilizing the drawing tools (see pictures below).
- Conclusions were drawn by applying biomechanical principles and personal knowledge of weight training kinesiology (see comments beneath pictures).
- Results were provided to the performer by utilizing the drawing tools to illustrate errors and producing a DVD media book.

Abstract

During the Fall 2009 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 Analyser Software. In 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 selecting two subjects, who performed the squat in the best of their ability. The subjects were instructed to wear existing kit and were instructed to raise their knees and to lower their knees and shoulders until visible. To ensure accurate measurements, strict standards were followed during video recording. A camera, containing a MiniDV cassette tape, was set up to a tripod and set up in a position where it was perpendicular in the plane of movement, allowing the subject to move from the camera (as possible), and least to all movements. Therefore, the subject then instructed to stand holding a scaling grid, which is an object of known width which allowed the software to calculate distances, and was recorded for ten seconds. Three 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 spinal columns of the subject were selected for an extensive and thorough movement analysis. Strengths and weaknesses of the movement were analyzed and illustrated in the study. The booths allowed the investigator to both quantify and qualify the correct and incorrect movements. The investigator utilized knowledge of physics and biomechanical principles to analyze and provide conclusions to the various phases of the movement. For clarification of the recommendations, pictures were drawn with the Dartfish software and text was added to further explain both the corrections and phases. The investigator 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 performers’ movements than with the known error of video clipping and allowed him to evaluate the performance using a computerized data base. It also allowed him to provide more detailed feedback for improvement to the subjects. The above images were used to publish 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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