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Principal component models of knee kinematics and kinetics: Normal vs. pathological gait patterns

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Abstract

Gait data were collected on a group of 29 asymptomatic elderly subjects to describe knee joint kinematics and kinetics as measured by the three components of the bone-on-bone forces, net reaction moments and relative knee angles. Each of these gait measures were considered separately in the development of Principal Component Models (PCMs) to describe the variation of the normal subjects throughout the gait cycle. The statistical similarity of patients' gait curves (waveforms) to the pattern of normal subjects' gait waveforms was assessed using the PCMs. The PCMs consider data from the entire gait cycle and detect statistically significant waveform shapes using measures of distance from normal. Osteoarthritic patients were selected from a clinical study of pre-operative and post-operative unicompartmental arthroplasty. Three cases were chosen to demonstrate the PCMs application on a waveform-by-waveform basis. In addition, the overall assessment of three patients as indicated by eight kinematic and kinetic gait measures was performed. The outcome measured by the PCMs was shown to agree with the clinical results as measured by the Knee Society Score. The PCMs were able to quantify the difference from normal with statistical significance and the structure of the models allowed for interpretation in terms of portions of the gait cycle.

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Keywords: Principal component analysis; Statistics; Gait analysis; Knee kinematics and kinetics; Unicompartmental knee arthroplasty

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