

Clinical Gait Analysis

Initial Impressions of Specks

Dr Alison Richardson
Specialist Physiotherapist

Dr Benjamin Cox
Clinical Scientist

Anderson Gait Analysis Laboratory
December 11th 2008



Overview

- What is clinical gait analysis (CGA)?
- Measurement of gait kinematics
 - Three-dimensional gait analysis
 - Biomechanical modelling
- Limitations of current methods of CGA
 - Modelling errors
 - Practical constraints
- Preliminary validation work using Orient devices for motion capture
- Proposed future applications and benefits

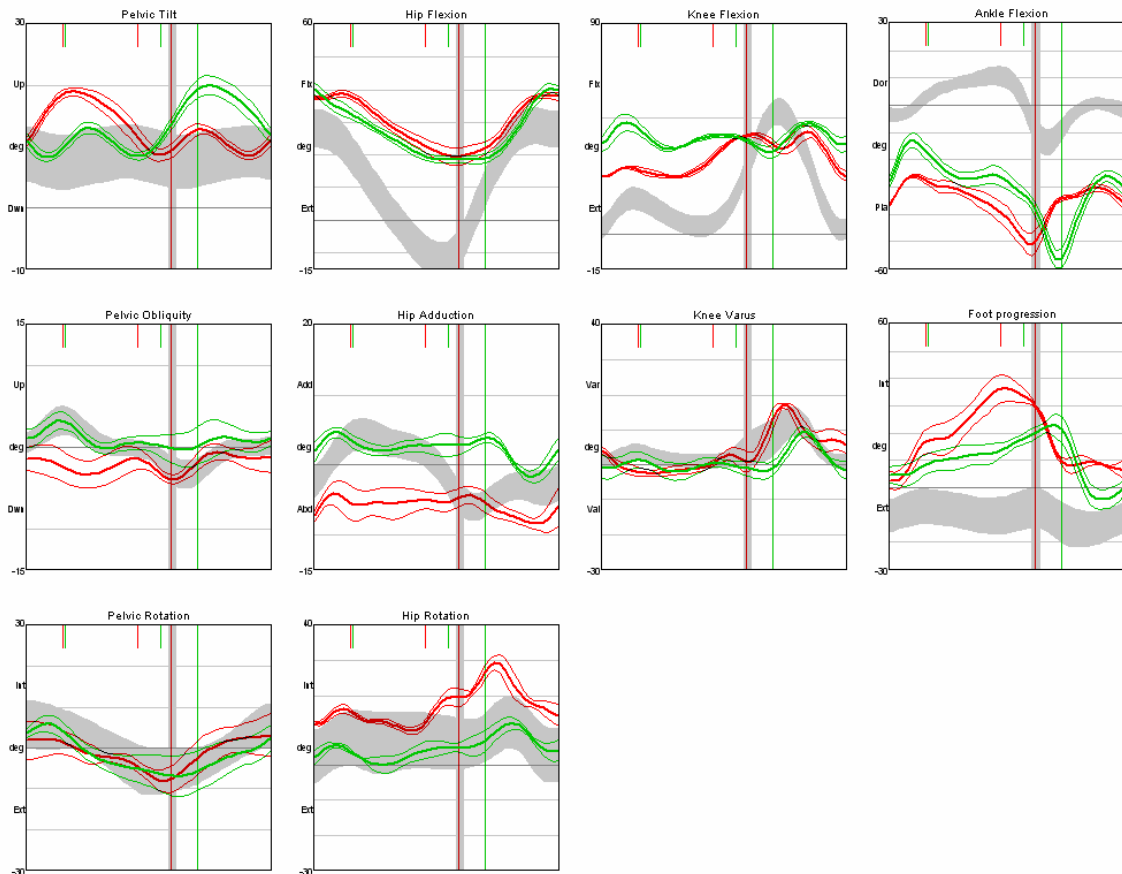


What is clinical gait analysis?

- Brief observation to sophisticated measurement
- Various approaches and concepts
 - Podiatry
 - Physiotherapy
 - Prosthetics
 - Cerebral palsy
- Objective theoretical principles
- Data collection
- Subjective interpretations
- Anderson Gait Analysis Laboratory (NHS)



What is clinical gait analysis?



Measurement of kinematics

- Description of gait in terms of angles, displacements, velocities and accelerations
- Measurement techniques
 - Video
 - Subjective scoring methods
 - Electrogoniometer (potentiometer, strain gauge)
 - Rely on accurate alignment
 - 2D (sagittal plane) measurement
 - Relative motion between adjacent body segments



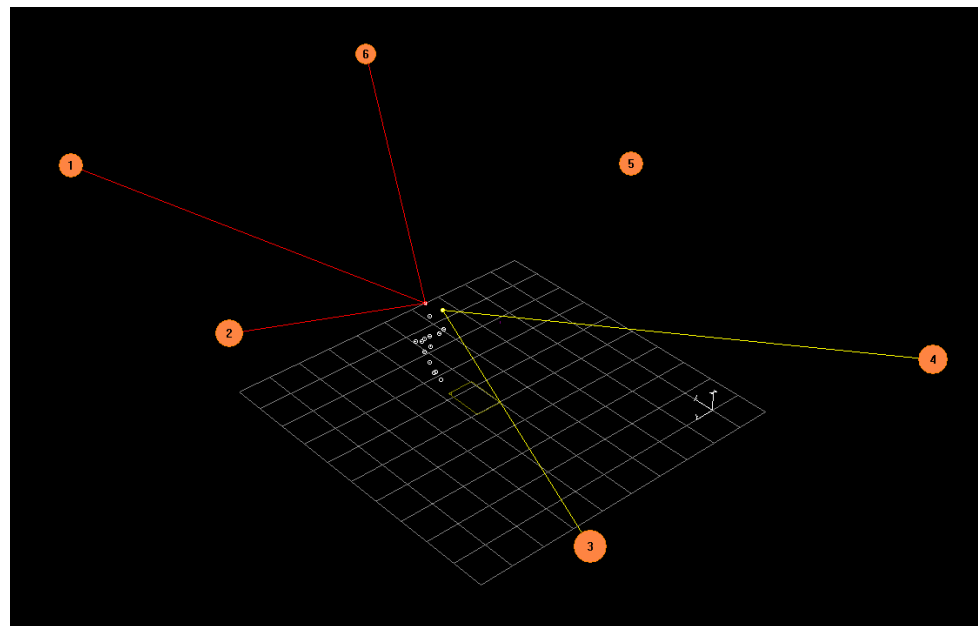
Measurement of kinematics

- Absolute measurement techniques
 - Optical
 - Vicon Motion Systems, Qualisys, CODA
 - Electromagnetic
 - FasTrak, MotionStar Wireless
 - Ultrasonic
 - Zebris
 - Inertial
 - Orient, POET, xSense



Three-dimensional gait analysis

- Track images from two or more cameras
- Points used to reconstruct original 3D trajectories



Three-dimensional gait analysis

- Track images from two or more cameras
- Points used to reconstruct original 3D trajectories
- Volume calibration
- Typical accuracy ± 0.1 % of capture volume
- Anderson gait analysis laboratory
 - 6 IR cameras (12.5 mm lens)
 - 100 Hz, 1.3 million pixel resolution, 64 analogue
 - £50k



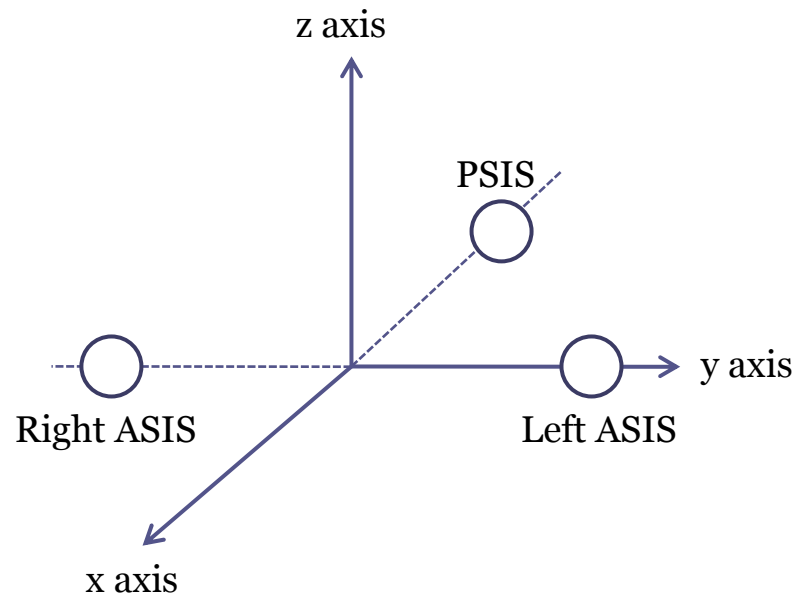
Biomechanical model

- Three markers per body segment
 - Markers on joints define two adjacent segments
- Modified Helen Hayes model
 - 3D axis system for each segment
 - Flexion/extension (sagittal plane angles)
 - Abduction/adduction (coronal plane angles)
 - Internal/external rotation (transverse plane angles)



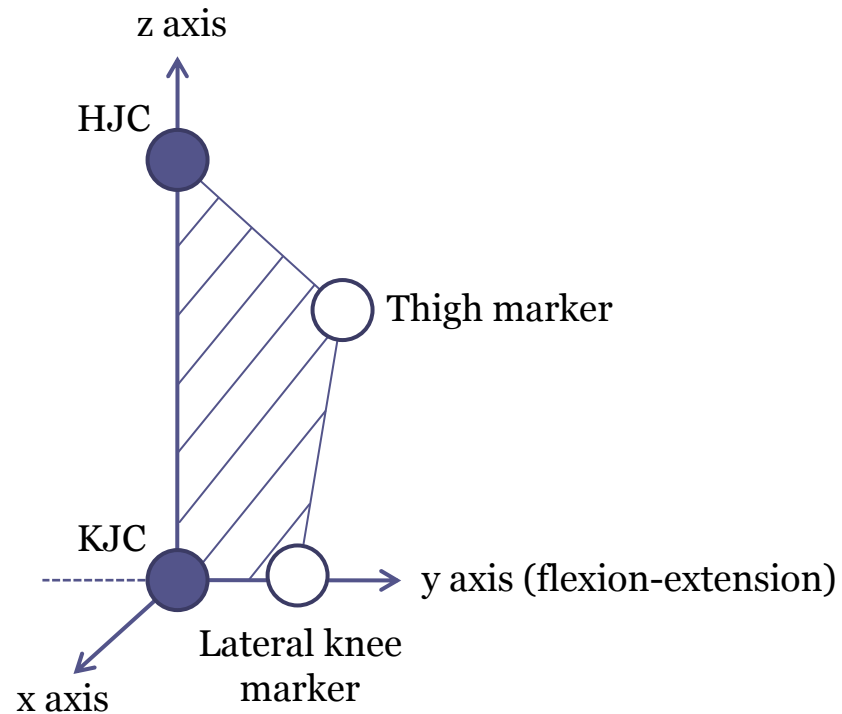
Biomechanical model

- Pelvis segment



Biomechanical model

- Thigh segment



Biomechanical model

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 - Internal/external rotation (transverse plane angles)
 - Euler angle sequence
 - y, x, z (Davis *et al.* 1991)
 - Different sequences usually clinically insignificant



Limitations of current methods of CGA

- **Modelling errors**
 - Centre of knee rotation
 - Marker placement
 - Soft tissue movement
 - Euler angle sequence
 - Foot modelling



Limitations of current methods of CGA

- Practical data collection constraints
 - Artificial capture environment
 - Snapshot analysis
 - Restricted activities
 - Specialist staff
 - Intrusive
 - Expensive



Preliminary validation work using Orient devices for motion capture

- Vicon analysis of three normal adults at Anderson Gait Analysis Laboratory
 - Simultaneous lower body motion capture
 - Technical problems with system integration and Orient devices
 - Vicon segment position data analysed retrospectively
- Ongoing validation work using Qualisys optical motion capture system (Dept. Sports Science)
- Step tracking



Proposed future applications

- Activity monitoring
 - activPAL (20 g, 53 x 35 x 7 mm, 7+ days battery)
 - Collaborative study University of Strathclyde
 - Orient devices may provide an indication of the quality of detected movement, i.e. measurement of 2D or 3D kinematics



Proposed future applications

- **Prosthetics**
 - Limitations of optical motion capture systems, i.e. joint anatomy
 - Pistoning at socket and prosthetic components for shock absorption
 - Active patient group
 - Monitoring progress from limb fitting to optimum function
 - Objective component prescription



Potential benefits of Specks for CGA

- Address limitations of current optical motion capture methods
- Provide objective measure of functional ability in every day environments
- Provide ongoing monitoring
- Increase national service capacity
- Reduce assessment costs



Questions?

