Part 1: COMPONENTS OF A MOTION ANALYSIS TEST

Susan Rethlefsen, PT
Children’s Hospital Los Angeles, Los Angeles, California, USA

1. Purposes of clinical gait analysis (CGA)
   a. Surgical/treatment planning
   b. Bracing assessment

2. Data collected
   a. Kinematics – 3-D joint motion of pelvis, hips, knees and ankles
      i. Allows assessment of motion in 3 planes:
         1. Sagittal – flexion/extension
         2. Coronal – ab/adduction
         3. Transverse – rotation
      ii. Allows visualization of what is difficult to see with
          observational alone, multiple joints moving simultaneously,
          consistency of gait pattern, etc.
          1. Toe walking is often caused by knee flexion at terminal
             swing rather than equinus.¹
          2. In-toeing can originate from the pelvis, femur, tibia, or
             foot.²
      iii. Allows assessment of effect of position of one joint on another
          1. Impact of ankle position on knee and hip motion
             a. Barefoot versus braced comparisons
                i. Does controlling calcaneus improve knee
                   and hip extension in stance?
                ii. Does controlling equinus decrease
                    recurvatum?

   b. Kinetics – Internal joint net moments and powers
      i. Information about factors producing or controlling motion
         1. Describes joints’ response to external moments
            a. Power absorption – eccentric contraction, power
               generation - concentric
               i. Example is dorsiflexor moment with
                  power absorption at loading response

[Diagram of Kinematics Ankle Dorsi/plantarflexion]
ii. Provides additional information to use with kinematics and electromyography in explaining gait deviations

iii. Helpful for evaluating effectiveness of treatment interventions, bracing and assistive devices, for example:
   1. Assessing impact of Botox injections to plantar flexors on ankle mechanics for patients with CP.\(^3\)
   2. Evaluating impact of different styles of AFOs on gait for patients with CP.\(^4,5\)

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\begin{align*}
\text{Ankle Joint Net Moment} \\
\text{Plantar} & \quad 1.5 \\
\text{Dorsi} & \quad 0
\end{align*}
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\begin{align*}
\text{Ankle Power} \\
\text{Generation} & \quad 4 \\
\text{Absorption} & \quad 0
\end{align*}
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c. Electromyography (EMG)
   i. Muscle timing during gait cycle
      1. Surface EMG for large, superficial muscles or muscle groups
      2. Fine wire EMG for specific muscles or deep muscles such as posterior tibialis
   ii. Needed to determine appropriateness of muscle for transfer
      1. Rectus femoris\(^6,7\)
      2. Anterior tibialis vs. posterior tibialis\(^8\)
d. Use of gait analysis data in research
   i. Kinematic, kinetic and EMG data yield objective data, numeric data points for every frame of data collected, can be imported into various post-processing software programs for manipulation and statistical analysis
      1. Advanced measurement tools for research have been developed based on gait data:
         a. Gait indices based on kinematic, kinetic and stride parameters deemed clinically important, yielding a summary score compared to typical gait [Gait Deviation Index (GDI), Gait Profile Score (GPS)]
b. Musculoskeletal modeling – assesses dynamic muscle lengths, effects of muscle contractions on remote joints

ii. Gait data are more reliable than static measures of range of motion and visual gait assessments
1. Intra-rater reliability of 0.73-0.99 for sagittal plane hip, knee and ankle motion, coronal plane hip and pelvic motion. Pelvic tilt, knee varus/valgus, and all transverse plane pelvic, hip, knee and foot positions showed variable reliability (0.24 – 0.72).  
2. Sagittal plane errors typically <4°, and coronal plane errors typically <2°. Greatest errors seen in hip and knee rotation (maximum error 8°).

iii. Prospective – objective nature of data collected make CGA an ideal tool for prospective research studies

iv. Retrospective – Established gait labs often have data from serial gait studies performed on the same subjects over span of many years, using consistent standardized methods.
1. Excellent for longitudinal studies of change in gait patterns over time
2. Studies of outcome of operative or other treatment interventions, long and short term

REFERENCES
