Use of motion analysis to assess non-gait related movements

Upper Extremity

Challenges

- Non-cyclical movement
- Many degrees of freedom
- Complex movements
- Large envelope of motion
- No/few standardized protocols

Need for Standardization

Definition and description of protocols

- Segments of interest – shoulder, elbow, wrist, forearm, hand, thumb
- Biomechanical models – UE -Rab (2002), scapular -Karduna (2001), wrist biomechanical (Hillstrom, 2014,
- Coordinate systems
- Marker set-up (Carpinella 2006, Baker 2007)
- Functional movements and activities

Motion Capture Techniques

- 2-D – video capture (Dartfish), electrogoniometry
- 3-D – Electromagnetic systems, passive marker, video/digital based, markerless, cyberglove
- EMG – static vs dynamic, surface vs fine wire

Purpose

1. Clinical Service
   - Inform pre-operative surgery
   - Document baseline/progress
   - Measure effect of therapeutic/surgical intervention
     a. CP hand and UE
     b. Congenital BP
     c. Congenital hand anomalies
     d. Tetraplegia
   - Kinematics of reach to grasp
     o Phases of reach – reach, grasp, transport, release
     o Grasp – aperture, hand shaping to object shape/size

2. Research

Provide quantitative kinematic/kinetic data for variety of biomechanical and clinical questions
CP reach and grasp

- Pediatric Upper Limb Motion Index -PULMI (Butler, 2009)
- Arm Profile Score -APS (Jaspers, 2011)

Relationship between upper extremity posture and gait

- Upper Limb Deficits during Gait in CP
  a. Decreased elbow and shoulder ROM in hCP with increased elbow flexion (Riad 2011),
  b. Decreased arm swing in CP (Meyns 2011).

- Improvement in lower limb kinematics following UE limb improvements
  a. in adult hemiplegia
    i. Botox – increased gait speed, (Esquenazi, 2008)
    ii. increased stride time, (Hirsch 2005)
  b. In CP
    i. CIMT (Coker, 2010)

- Clinical correlation between changes in arm posture and gait asymmetry
  a. stroke – increased muscle activity with decreased arm movement (Stephenson 2010)

- No change in upper limb with ankle foot orthosis in CP (Schweizer, 2014)

- Simulated stiff elbow study (Trehan, 2014)
  a. Decreased velocity in stiff elbow conditions
  b. Increased stride length

References


Kuhtz-Buschbeck JP, Jing B. Activity of upper limb muscles during human walking. J.Electromyogr.Kinesiol. 2012 Apr;22(2)


