Relationship between hamstring length & spasticity & knee extension during gait in children with CP

Leanne Johnston[1 2]
Suad Alanzi [2], Pauline Watter [2]
Robyn Grote [2 3] & Teresa Phillips[3]

[1] Cerebral Palsy League of Queensland
[2] University of Queensland
[3] Queensland Children's Gait Laboratory

Gait abnormalities in CP

Primary impairments *(Damiano etal 2006, Johnson etal 97, Stout 2006)*

- Muscle spasticity
- Muscle shortening / contracture
- Decreased muscle strength
- Poor selective motor control
- Agonist-antagonist muscle imbalance
- Joint stiffness
- Skeletal deformities
- Sensory deficits

Gait abnormalities in CP

Gait limitations…

- Kinematic
  - *– joint excursion, limb motion, inter-limb coordination*
- Kinetic
  - *– forces and powers*
- Temporospatial
  - *– walking speed, cadence, step length*
- Effort
  - *- Energy consumption, endurance*

→ Functional limitations

Gait abnormalities in CP

Poor knee extension

Most common gait abnormality in spastic type CP
(Butler et al, 1992; Gage, 1991; Perry, 1989; Winters et al, 1987).

- ↓ knee ext during stance and terminal swing &
- ↓ knee excursion during the gait cycle *(Johnson et al, 1997)*
- ↓ knee joint angular velocities *(Damiano et al., 1995, Tuzson et al., 2003)*
- ↓ stride length *(Cooney et al., 2006, Rodda and Graham, 2001)*
- transition from equinus to crouch pattern *(Rodda and Graham, 2001)*

Relationship with primary impairments

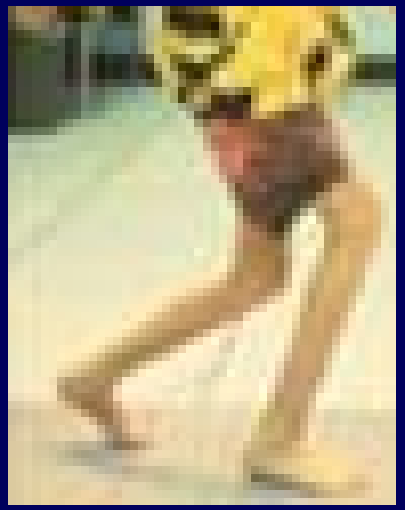
- Seen in conjunction with decreased popliteal angle due to increased hamstring spasticity and/or contracture

DDx guides management

Dependent on nature, severity, progress & prognosis of the relative contributions from:

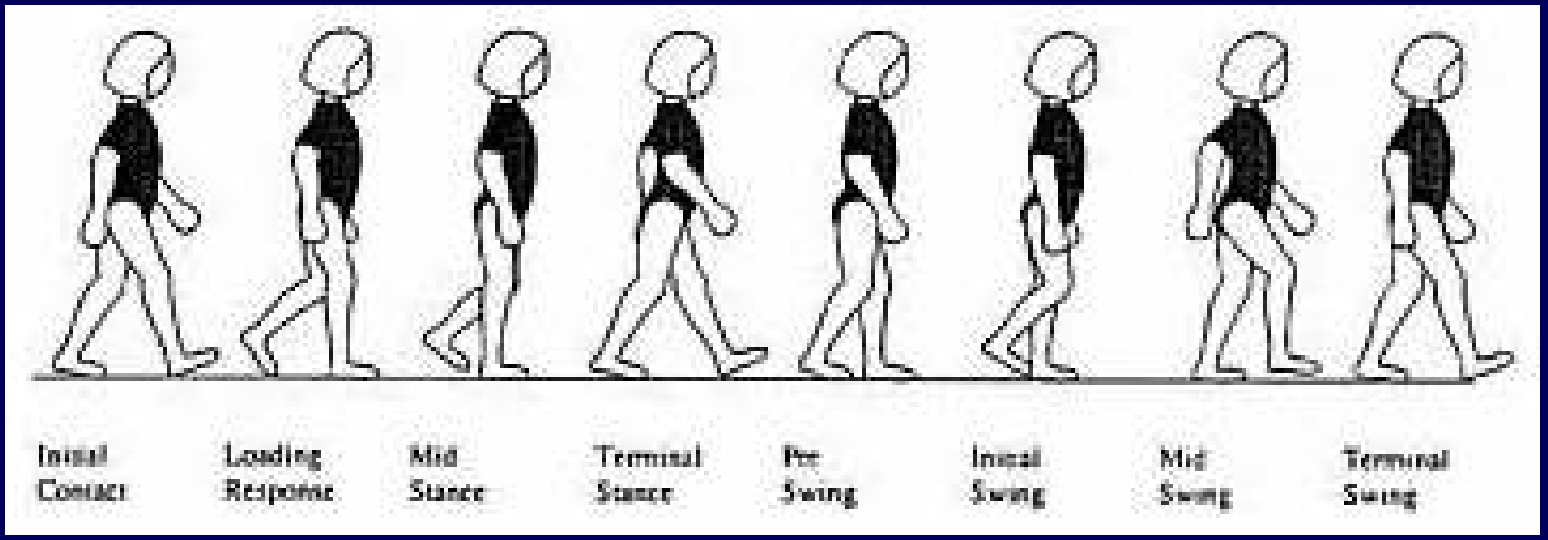
- Musculoskeletal causes (e.g. contracture)
  → Orthopaedic surgery

- Neurological causes (e.g. spasticity)
  → Botulinum toxin, SDR, ITB



Research question

To determine the relationship between *knee extension* during stance and swing phases of gait and *hamstring length and spasticity* in children with cerebral palsy.



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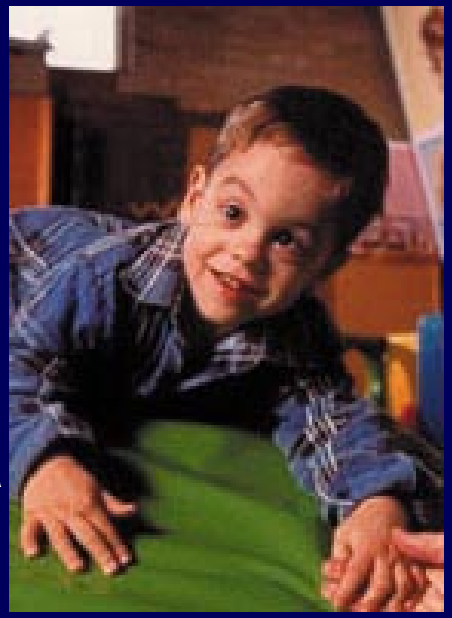
METHOD

Participants



- 19 children (12 boys)
- Aged 3 years or older
  (μ=128.5 ± 39.4m; range=55-216m)
- Data for 29 legs affected by spastic hypertonia

- Inclusion criteria
  - Attending for 3DGA at the QCGL
  - Diagnosis of Cerebral Palsy (10 diplegia, 9 hemiplegia)
  - Informed parental consent
  - At least 5 reliable gait traces

- Exclusion criteria
  - Any bony or soft tissue surgery
  - Botulinum toxin or serial casting in the previous 12months
    (10 none; 8 BTXA; 11 BTXA+casting >12m prior to study)
  - Behavioural problems precluding the ability to walk reliably

Musculoskeletal measures

Retrospective review

- Musculoskeletal data routinely collected as part of 3DGA at the QCGL

Clinical musculoskeletal assessment for gait

(Gibson et al, 2005)

- Straight leg raise
- Popliteal angle

Modified Tardieu *(Boyd and Grahame, 199*

- Spasticity – hamstrings

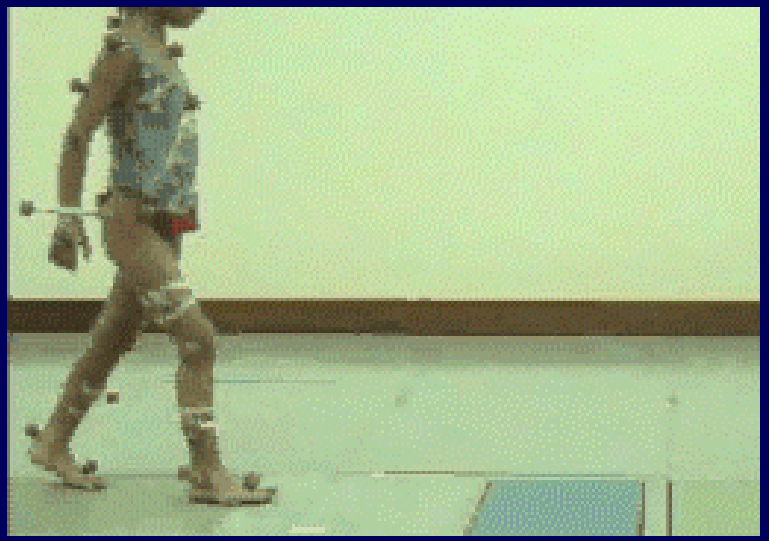
Gait Measures

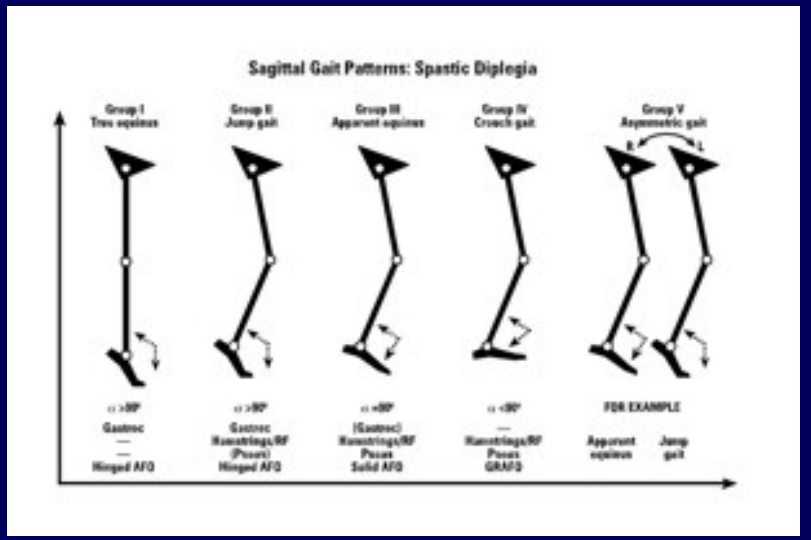
Retrospective review

- 3-dimensional gait analysis (3DGA) - gold standard for clinical gait analysis *(Harris & Wertsch, 1994)*

- Bare-foot walking routinely collected at the QCGL

- Sagittal kinematics → knee flexion/extension position at initial contact, mid-stance and terminal swing during gait





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RESULTS

Results – kinematics

Spearman's correlations

- Increased hamstring *spasticity*
  - Decreased extension at terminal swing (r=0.453, p=0.014)
  - Decreased extension at midstance
  - Not correlated with extension at initial contact
- Decreased hamstring *length* related to:
  - Decreased knee extension in all phases
    - Initial Contact (p=0.001)
    - Mid-stance (p=0.004)
    - Terminal Swing (p=0.0001)
- No differences between males and females

Results – temporospatial

Spearman's correlations

- Increased hamstring *spasticity*
  - Smaller step length (p=0.045)
  - not related to velocity (p=0.293)
- Decreased hamstring *length*
  - Popliteal → no effect on temporospatial parameters
  - SLR → decreased step length (p=0.01)
  - SLR → decreased % stance phase (p= 0.021).
- No differences between males and females

Discussion - kinematics

Swing phase

Findings support suggestion by *Damiano (2006)* and *Sutherland and Davids (1993)* that failure to achieve full knee extension at terminal swing may be due hamstring spasticity, leading to a shortened step and therefore a decreased step/stride length

Stance phase

Lower correlation between spasticity and knee angle at mid-stance, supports the idea from *Sutherland and Davids (1993)* that mid- & late stance extension is controlled by competence of the quadriceps muscles with the assistance of the plantar flexors

Function

Perry (1992) suggests that hamstring contracture of 15º results in an inadequate gait cycle characterized by limited knee extension in swing and stance.

Conclusions & recommendation

During gait in children with CP,

↓ hamstring length & ↑ spasticity….

- are related to a shorter step length
- but have differential effects on gait phases

Swing

- is affected by both hamstring spasticity and length

Stance

- is primarily affected by hamstring length

Assessment should include evaluation of factors that limit achievement of active knee extension (i.e. quadriceps strength)

For more information:

Dr Leanne Johnston

Clinical Research Manager

Cerebral Palsy League of Queensland

ljohnston@cplqld.org.au

Honorary Lecturer

Division of Physiotherapy

University of Queensland

l.johnston@shrs.uq.edu.au