Motion Analysis for the Neurologist

Warren Marks, MD

Cook Children's Health Foundation Endowed Chair in Neurosciences

Medical Director, Neurorehabilitation, Neuromuscular and Movement Disorders Programs

Medical Director, Motion Analysis Laboratory

warren.marks@cookchildrens.org

www.cookchildrens.org/neuro

Movement

"an elegant interplay of neuronal discharges, with changes in pattern, frequency, and synchronization, as well as feedback from other brain regions." Abnormal movements result from an imbalance between positive and negative actions.

Comella & Shannon, Continuum, June 2004

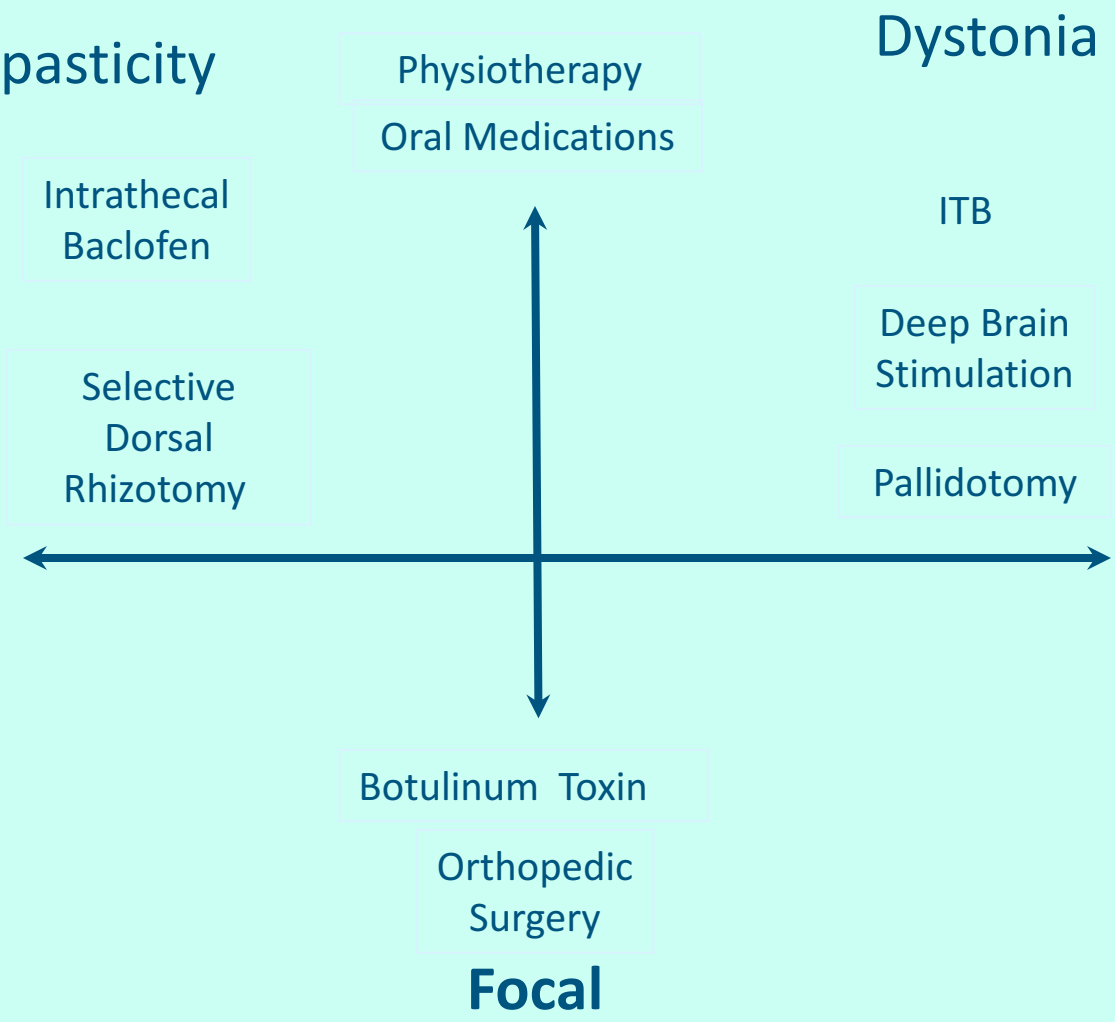
CookChildren's

Common referrals

- Ambulatory patient
- Cerebral palsy
- Abnormal gait pattern
- Boney malignment
- Foot deformities
- Intervention (Surgical) planning

Cook Children's

Data Guides Treatment



Modified from Graham et al (2000)

Gait Analysis: Clinical Information

- Strength
- Tone
- Joint movement
- Orthopedic alignment
- Foot pressure (static and dynamic)

Motion Analysis Lab

- Examination
- Tone classification
- Movement
- Kinetics
- Kinematics
- Plantar pressures
- Upper extremity
- Energy expenditure (Oxygen consumption)

Comprehensive measurements of muscle tone and strength, joint movement, boney alignment and energy expenditure gives us a objective evaluation of movement

CookChildren's

Motion Analysis: Diagnostics

- Gait
  - Independent/supported
  - Intervention planning
- Upper extremity
  - Intervention planning
    - Tone management (botulinum toxin)
- Neuromuscular
  - Oxygen consumption/therapy monitoring
  - Orthopedic planning

Motion Analysis

- Examination
- Tone classification
- Movement
- Kinetics
- Kinematics
- Plantar pressures
- Upper extremity
- Energy expenditure (Oxygen consumption)

Comprehensive measurements of muscle tone and strength, joint movement, boney alignment and energy expenditure gives us aa objective evaluation of movement

CookChildren's

GMFCS - ambulation

I: Walk and climb stairs; running with decreased speed, balance, or coordination.
II: Limited walking on uneven surfaces.
III: Walk with ambulation device; W/C for long distance.
IV: Power chair for long-distance.
V: Restricted voluntary motor control; limitations in all areas of motor function.

Children with CP of every severity level by GMFCS often have both spasticity and dystonia

MACS – upper extremity

I: Handles most objects easily and successfully
II: Handles most objects but with slower speed or dexterity
III: Handle objects with difficulty; needs help; modified activities.
IV: Handles limited number of easily managed objects; constant supervision
V: Total assist

Hypertonia

Spasticity

- Velocity dependent resistance
- Uniplanar
- Hyper-reflexia

- Ashworth
- Tardieu

Dystonia

- Non velocity dependent

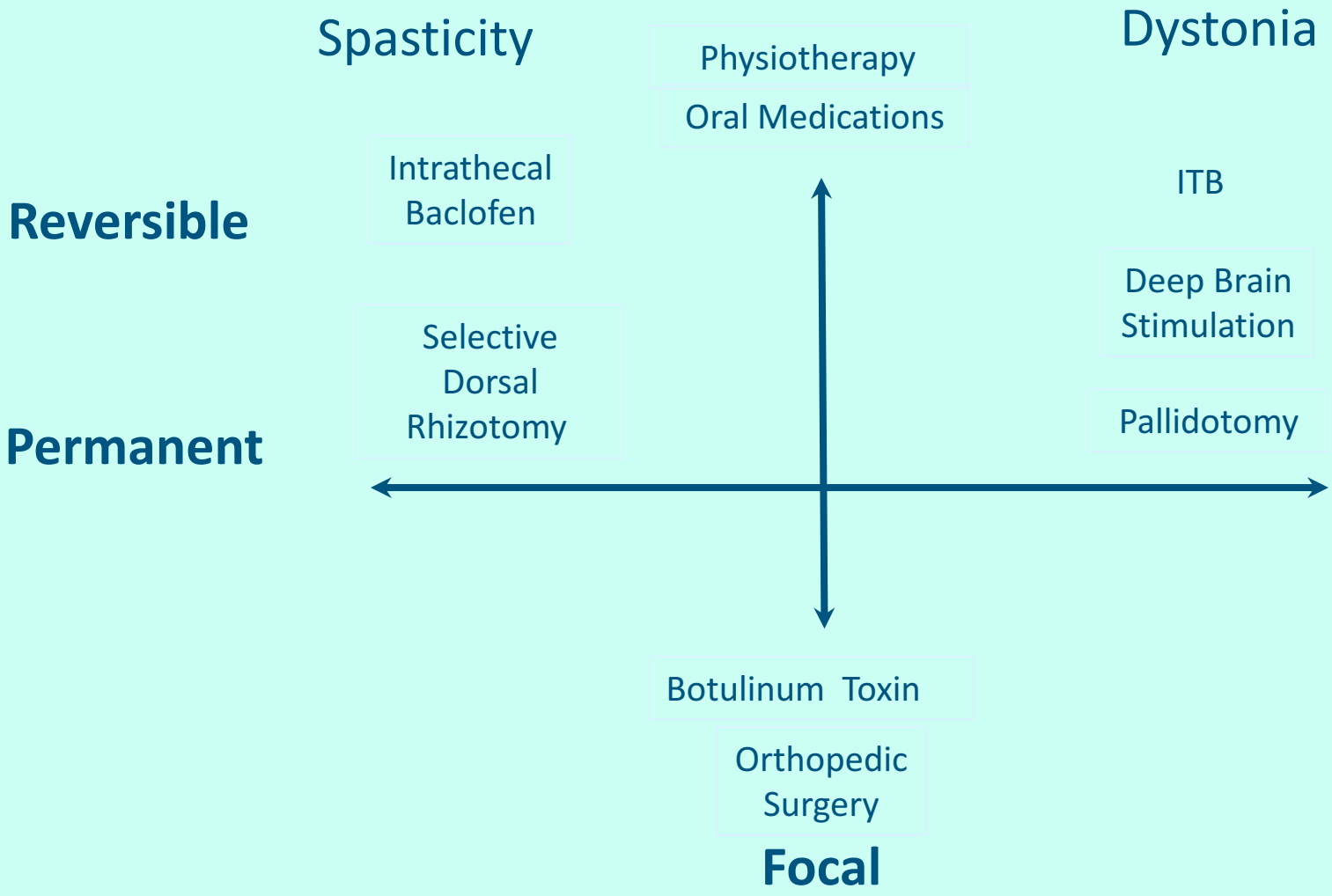
- Multiplanar
- Reflexes variable

- Burke-Fahn-Marsden
- Barry Albright

Hypertonia Assessment Tool

Increased involuntary movements/postures with tactile stimulus to another body part	Dystonia
Increased involuntary movements or postures with movement if a distal body part	Dystonia
Velocity dependent resistance to stretch	Spasticity
Presence of a spastic catch	Spasticity
Equal resistance to passive stretch during bi-directional movement of a joint	Rigidity
Increased tone with movement of a distal body part	Dystonia
Maintenance of limb position after passive movement	Rigidity

Hypertonia: Treatment Strategy



Modified from Graham et al (2000)

Case: Spastic Diplegia

- 29 week preterm infant
- Spastic diplegia
- GMFCS 3
- HAT – bil LE spasticity ; no dystonia or rigidity

Cook Children's

Selective Dorsal Rhizotomy

- Preterm infant
- PVL
- GMFCS II/III
- Motivated
- Strong family support

Cook Children's

Case: Dystonia

- Healthy, neuro-developmentally normal
- Normal PLD
- Age 10 years – right leg turning in followed by involvement of left leg which became the more severe
- HAT confirms dystonia, no spasticity or rigidity

Case: Dystonia

Pre DBS

- BFM-M = 6.5/120
- BFM-D = 4/30
- BAS = 4/32

- GMFCS = 1

1 months post DBS

- BFM-M = 7/120
- BFM-D = 4/30
- BAS – 5/32

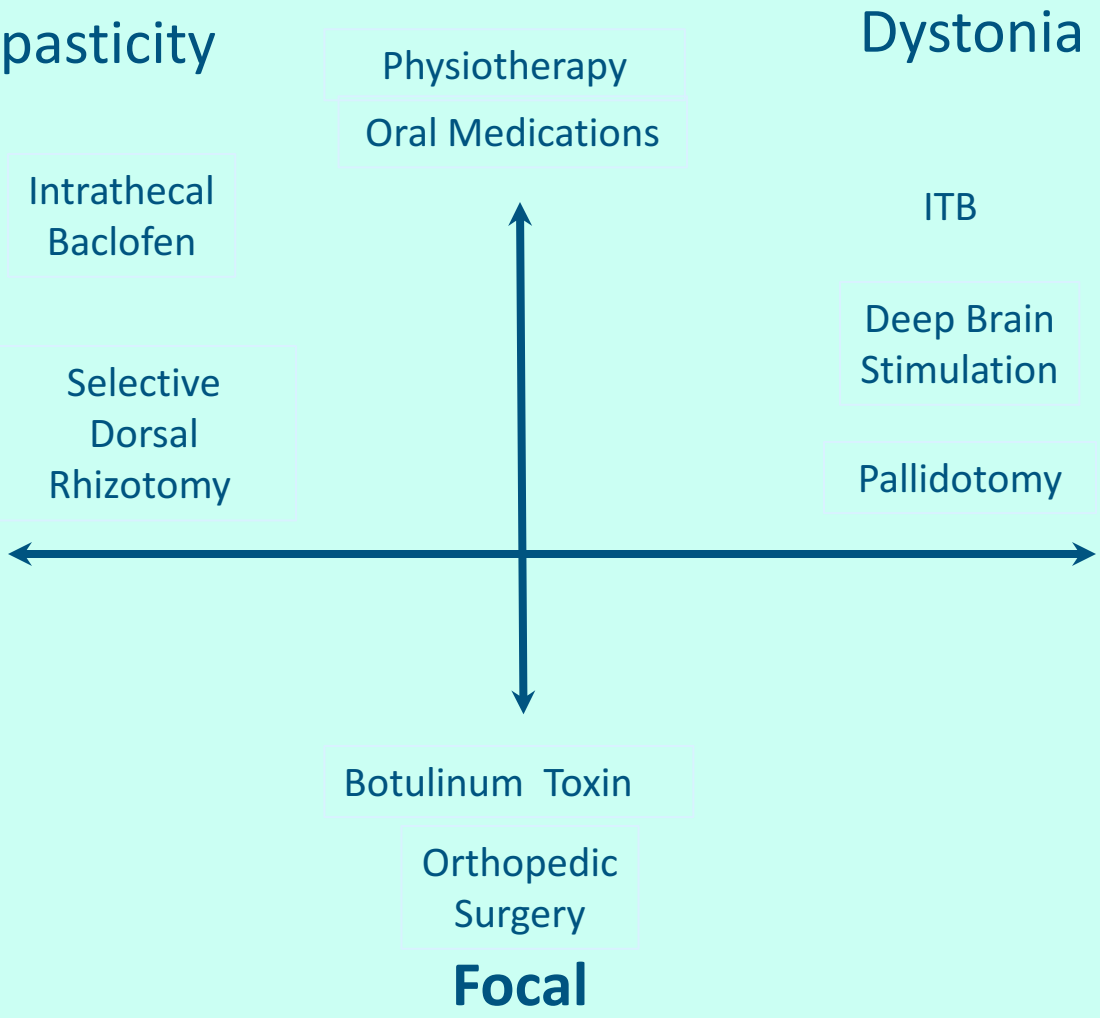
- GMFCS = 1

Cook Children's

Summary

- Motion analysis adds objective measure of tone and movement
  - Classification
    - Spasticity vs dystonia
  - Treatment plan
- Tone then bones

Data Guides Treatment



Modified from Graham et al (2000)

Therapeutic Uses

- Gait training
- Upper extremity dexterity training

Cook Children's

Upper extremity

- Intervention guidance
  - Botulinum, DBS
    - Device control
    - Orthotic management
- Robotics
- Picture of Nirvana

Cook Children's

Future Directions

- Sports
  - Injury prevention
  - Training
  - Rehabilitation
- Picture of Sports set-up

CookChildren's

Epidemic Obesity

- The percentage of children and adolescents affected by obesity has more than tripled since the 1970s.
- Nearly 1 in 5 school age children and young people (6 to 19 years) foot and other
- Boney deformities
- Energy use
- Ability to exercise
- Education and Intervention monitoring
- Foot model

Cook Children's