Tuesday, 12:30 – 2:00, B1

Orthopaedic Management of Cerebral Palsy Patients for the Non-Orthopaedist

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Objectives:

1. Identify effective methods for the practical application of concepts related to improving the delivery of services for persons with developmental disabilities
2. Identify advances in clinical assessment and management of selected healthcare issues related to persons with developmental disabilities

Notes:

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Cerebral Palsy

- STATIC encephalopathy to the immature developing brain that may be due to anoxic or hypoxic brain injury
- Diagnosis made OVER TIME

Overview

- Basic Orthotic Management
- Spasticity Management
- General Orthopaedic Concerns

Orthotics

Orthotics

- Main goals:
  - Ambulatory- improve and maintain efficient gait, +/- deformity prevention
  - Non-ambulatory- prevention of spinal/hip deformity, improve sitting posture

Orthotics

- Wrist Hand Orthosis
- Hensinger Collar
- ThoracoLumbar Spinal Orthosis (TLSO)
- SupraMalleolar Orthosis (SMO)
- Floor Reaction Ankle Foot Orthosis (AFO)
- Hinged AFO
- Solid AFO
- UCBL Orthosis
- Other

Wrist Hand Orthosis

- Hand Positioning
- Thumb in Palm deformity
- Prevent Wrist/Finger flexion contractures
- Can assist in motor control functions

Hensinger Collar

- Head Support
- Foam Collar around jaw and occiput
- Improves breathing, eating, swallowing, social interaction

TLSO

- For positional purposes
  - Improved sitting
  - Head and upper extremity postural control
- Have not been found to stop scoliosis progression in CP, but may *slow* progression
- Miller et al- no impact on scoliosis curve, shape, or rate of progression
- Morris et al- No evidence brace effects pulmonary function

Floor Reaction AFO

- Anterior trimline to proximal tibia
- Locks ankle and RESISTS ankle dorsiflexion
- Helps correct CROUCH from weak plantar flexion
- Rogozinski et al- improved knee extension in stance
  - Best when knee/hip flexion contracture ≤10°

Hinged AFO

- Posterior trimline captures malleoli and posterior half of calf
- Controls excess ankle plantar flexion in swing and midstance

Solid AFO

- Workhorse of CP orthotics
- Posterior trimline extends to or above proximal tibia
- Foot plate can be extended and used to control foot
- Used to LOCK ankle in plantigrade position
- Controls plantarflexion in swing
- Increases stride length and thus gait velocity
- Can aid in sit to stand maneuvers in diplegics
- Brehm et al- found AFO use in quadriplegics decreased energy expenditure (not in hemi- or diplegics)

Posterior Leaf Spring Orthosis

- Posterior trimline to proximal third of calf
- Distal third more flexible allowing accomodative dorsiflexion
- Benefits:
  - Control excess ankle plantar flexion in swing
  - Allow ankle dorsiflexion in midstance
  - Dynamic spring-like effect in terminal stance

Nighttime Stretching AFO

Roosterboot®

Courtesy of Pediatric Orthotic Specialists

- For moderate gastroc or soleus contractures
- Continuous stretch when limb in static position

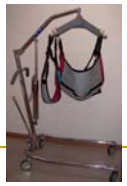
SMO

- Captures and controls hindfoot
- Trimline over malleoli
- No ANKLE control
- Mild & passively correctable foot deformities
- Control excess forefoot supination and pronation

UCBL

- Controls hindfoot and midfoot alignment
- Trimlines below malleoli
- Mild and correctable foot deformities
- Not useful for gait deviations

Other Assistive Devices



Bracing

- When to Start?

Questions

Spasticity Management

Spasticity Management

- Oral Medications
- Botulinum Injections
- Selective Dorsal Rhizotomy
- Baclofen Pump
- Physical Therapy

Goals

- Maximize active function
- Ease care
- Prevent secondary problems
  - Pain
  - Joint subluxation
  - Contractures

Spasticity

- Definition (Taskforce on Childhood Motor Disorders):
  - Hypertonia in which one or both of the following signs are present:
    1) Resistance to externally imposed movement increases with increasing speed of stretch and varies with the direction of joint movements
    2) Resistance to externally imposed movement rises rapidly above a threshold speed of joint angle

Modified Ashworth Scale for grading Spasticity

Grade	Description
0	No increase in muscle tone
1	Slight increase in muscle tone, manifested by a catch and release, or by minimal resistance at the end of the range of motion when the affected part(s) is moved in flexion or extension
2	Slight increase in muscle tone, manifested by a catch, followed by minimal resistance throughout the remainder (less than half) of the range of movement (ROM)
3	More marked increase in muscle tone through most of ROM, but affected part(s) easily moved
4	Considerable increase in muscle tone, passive movement difficult
5	Affected part(s) rigid in flexion and extension

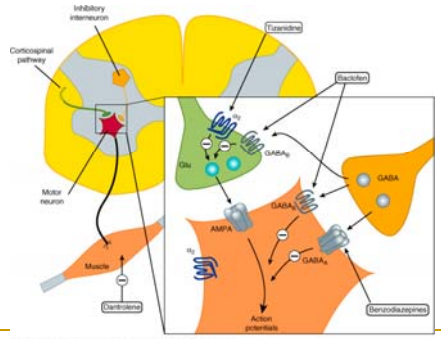
Oral Agents

- Baclofen
  - GABA-B agonist
  - Can cause confusion/sedation
- Tizanidine
  - Central α-2 noradrenergic agonist
  - Shown to reduce tonic stretch reflexes

Oral Agents

- Diazepam
  - Benzodiazepine (activates GABA)
  - Reduces muscle spasm
  - Nighttime use (sedation)
- Dantrolene
  - Inhibits intracellular calcium release and thus muscle firing
  - Causes global weakness, highly sedating, possible hepatotoxicity

Anti-Spasticity Meds



Botulimum Injection

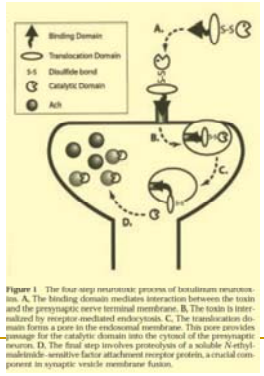


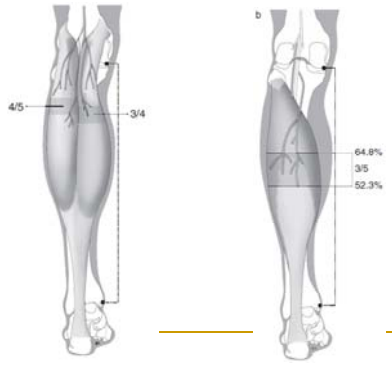
Figure 1 The four-step neurotoxic process of botulinum neurotoxins. A, The binding domain mediates interaction between the toxin and the presynaptic nerve terminal membrane. B, The toxin is internalized by receptor-mediated endocytosis. C, The translocation domain forms a pore in the endosomal membrane. This pore provides passage for the catalytic domain into the cytosol of the presynaptic neuron. D, The final step involves proteolysis of a soluble *N*-ethylmaleimide–sensitive factor attachment receptor protein, a crucial component in synaptic vesicle membrane fusion.

Reference: Delgado MR. Botulinum neurotoxin type A. *JAAOS* 2003;11:291-4.

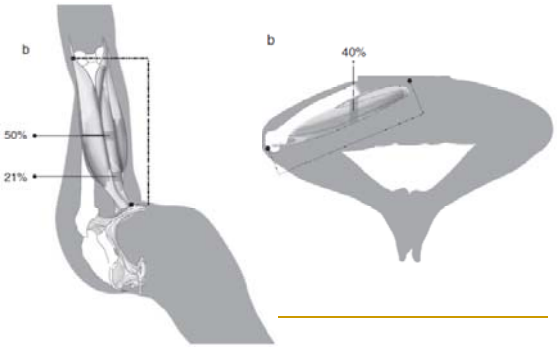
Botulinum Toxin

- Effect lasts approximately 3 months
- If injected < 3 months, antibodies will develop and lead to ↓ effect

Botox Injection



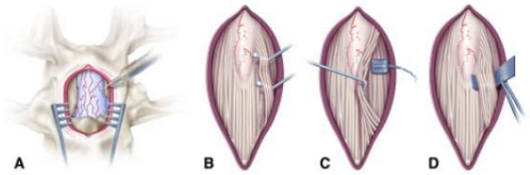
Botox Injection



Botulinum Toxin

- Ryll et al- Use of botulinum toxin and regular PT improves walking in children w/ CP
- Russman et al and Glanzman- serial casting along w/ botulinum toxin A injection improved range in equinus over injection alone
- Molenaers et al- botulinum toxin A injections delayed and reduced frequency of surgical procedures in CP patients

Selective Dorsal Rhizotomy



- Moderate to Severe Spasticity
- Extensive and Intense PT post-op
- Classic pt: spastic diplegia, voluntary motor control, no fixed contractures, able to walk
- Has been used often in non-ambulatory pts as well
- Farmer et al- Can improve GMFCS level, decrease spasticity, improved LE ROM, control of spastic hip subluxation, and decreased need for add'l ortho procedures
- Nordmark et al- permanently reduces spasticity without major negative side effects in combo with physiotherapy, providing functional benefits 5 years post-op
- Can predispose to long-term spinal deformities

Baclofen Pump

- Tunneled catheter from reservoir that directly pumps Baclofen to spinal cord
- Limits side effects of PO administration
- Good for upper and lower spasticity
- Good in athetoid pts

Role of Physical Therapist

- Help to determine *impairments*:
  - Impacting child's function
  - Affecting ability to participate in home & community activities
  - Resulting in secondary musculoskeletal deformities

Physical Therapy

- Goals:
  - Develop strength
  - Maintain ROM
  - Improve coordination

Physical Therapy

- Regular stretching of all affected limbs
  - Impaired movement creates compensatory strategies which minimizes joint movement and leads to potential contractures
- Multiple methods:
  - Regular exercise program
  - Horseback therapy (hippotherapy)
  - Biofeedback
  - Electrical stimulation
- Strength training
  - Can improve gait parameters

Physical Therapy

- Bower et al- found intensive therapy NOT superior to normal amount PT children already receiving
- Weindling et al- no evidence that additional PT affected motor function, developmental status, or adaptive function
- Christiansen et al- found no difference in Gross Motor Function Measure in patients undergoing either intermittent or continuous PT programs
- Shurtleff et al- Hippotherapy for 12 weeks improved trunk and head stability as well as upper extremity reaching and targeting

Orthopaedic Surgery

- When all other interventions have failed
- Delay until gait is mature
- Single Event Multi-Level Surgery (SEMLS)

Questions

General Orthopaedic Concerns

General Orthopaedic Concerns

- Specific Patient Types
  - Hemiplegia
  - Diplegia
  - Quadriplegia
- Wheelchair/Seating Evaluation
- Bone Density
- Standing Frames
- Patient Function
- Gait Analysis
- Post-operative Rehabilitation

Hemiplegia

- Finger/Wrist flexion contractures
- Cavovarus feet
- Equinus Gait
- Crouch Gait

health-7.com/imgs/17/2154.jpg

www.pediatric-orthopedics.com/.../Var01a.jpg

Diplegia

- Multi-level Contractures
- Crouch Gait
- Stiff Knee Gait
- Scissoring Gait
- Equinus
- Equinoplanovalgus Deformity

Courtesy of The Indian Orthopaedic Journal

Quadriplegia

- Scoliosis
- Hip Subluxation/Dislocation
- Pressure Sores
- Foot Deformities

Wheelchair/Seating Evaluation

- Important to maintain wheelchair
- Should be performed for maintenance
- Should be performed if pressure sores develop
- Should be performed after surgical intervention (seating)

Bone Density

- Important point in screening for CP pts, especially those with greater involvement
- Anti-convulsants (Phenytoin, Valproic acid) decrease bone density
- Measured differently than in healthy patients- distal femur
- Ko et al- risk factors for femur fracture (non-ambulatory pts) include weight for age and recent post-op immobilization
- Wren et al- bone density decreased even in ambulatory and higher functioning pts
  - Non-ambulatory pts higher deficits in spine and femur
  - Ambulatory pts higher deficits in tibia

Osteopenia/Osteoporosis Treatment

- Increased Weight bearing and physical activity (Wren et al)
- Improved nutrition, including Vitamin D and Calcium supplementation (Wren et al, Fehlings et al)
  - Vitamin D- 800 to 1000 IU per day (Fehlings et al)
  - Calcium- 1300 mg per day (ages 9 to 18) (AAP)
- Bisphosphanates
  - Paksu et al- PO alendronate effective treatment for osteopenia in CP pts
- Iwasaki et al- found greater increase in bone density in patients receiving both vitamin D and bisphosphanate (risedronate) for >12 months
- Fehlings et al- systematic review found only bisphosphanates were effective at decreasing risk of fragility fractures
  - Recommended for bisphosphanates ONLY AFTER pt has fragility fracture AND after attempt at Vitamin D/Calcium supplementation

Standing Frames

- Gibson et al- caregivers found that transfers and ADLs slightly easier after standing frame use
  - 6 weeks of standing frame use led to significant improvement in hamstring length in non-ambulatory CP pts
- Caulton et al- standing frames increased vertebral BMD but decreased tibial BMD, no decreased fracture risk over usual standing group

Patient Function

- Gross Motor Function Classification System (GMFCS)
  - Most commonly employed system
  - Classifies child's ability in sitting, standing, and walking phases
  - 5 levels
  - Based on age appropriate norms
  - Used to follow long term function, post-intervention or post-operative results

Patient Function

GMFCS	*Description*
Level I	Walks without restrictions; limitation in more advanced gross motor skills
Level II	Walks without assistive devices; limitations are walking outdoors and in the community
Level III	Walks with assistive mobility devices; limitations are walking outdoors and in the community.
Level IV	Self-mobility with limitations; children are transported or use powered mobility outdoors or in the community
Level V	Self-mobility is severely limited even with the use of assistive technology

Patient Function

Gait Analysis

- Very useful tool to assess complex gait patterns in CP patients
- Employ large amount of information through motion capture video, dynamic muscle and joint motion, and static muscle and joint assessment
- Information useful in determining interventions to maintain and/or improve gait
- Molenaers et al- use of gait analysis increased age of first orthopaedic procedures

www.rehabpub.com/.../2008-08/2008-08_03-01.jpg

Post-operative Rehabilitation

- Important after SEMLS
- Often necessitates inpatient rehabilitation hospital admission
- Gupta et al- CP patients with good trunk control and static lower limb contractures can be made ambulant following SEMLS and rehab
- Seniorou et al- intense physiotherapy for 6 weeks post-SEMLS demonstrated significant improvement in muscle strength, gait, and function

Questions

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Thank You

- Mike Thompson
- Vicki Terry

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