REBUILDING & RENOVATING POST STROKE SPASTICITY

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OBJECTIVES:

- Identify patient at risk for post stroke spasticity
- Identify patient with post stroke spasticity
- Determine when patient needs post stroke spasticity management
- Understand consequences of post stroke spasticity
- General understanding of management strategies including
  - Therapy
  - Pharmacologic
  - Minimally invasive
  - Invasive
  - Surgical
WHAT IS POST STROKE SPASTICITY?

- **Spasticity:**
  - Velocity dependent increase in resistance to passive range of motion
  - Involuntary contractions of synergistic muscles
  - Component of upper motor neuron syndrome
CONSEQUENCES OF POST STROKE SPASTICITY

- Gait abnormalities
- Problems with arm use
- Increased pain
- Joint contractures
- Reduced quality of life
INCIDENCE OF POST STROKE SPASTICITY

- 3-12 months post stroke
  - 63%

Predictors of PSS:
- Lesions in the brain stem
- Hemorrhagic stroke
- Younger age
- Severe paresis
- Hemi-hypesthesia at stroke onset
MEASURING SPASTICITY

· Monitor effectiveness of treatments

· PSS an assessment should include:
  · Measure of passive stretch
  · Volitional movement
  · Active/passive function

· Multiple measures:
  · Modified Ashworth Scale, Tardieu Scale, Electrophysiological tests (H-reflex, H/M ratio), Carer Burden Scale, Composite Functional Index, Disability Assessment Scale
MEASURING SPASTICITY

Modified Ashworth Scale

- Most commonly used clinical measure
- Simple
- Measures resistance to passive stretch
- Limited by poor inter-rater reliability
# Measuring Spasticity

- Modified Ashworth Scale

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No increase in muscle tone</td>
</tr>
<tr>
<td>1</td>
<td>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</td>
</tr>
<tr>
<td>1+</td>
<td>Slight increase in muscle tone, manifested by a catch, followed by minimal resistance throughout the remainder (less than half) of the ROM*</td>
</tr>
<tr>
<td>2</td>
<td>More marked increase in muscle tone through most of the ROM, but affected part(s) easily moved</td>
</tr>
<tr>
<td>3</td>
<td>Considerable increase in muscle tone, passive movement difficult</td>
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</table>
COMMON POSTURES IN SPASTICITY

**Pronated flexed elbow**
- Biceps brachii
- Brachialis
- Brachioradialis
- Pronator teres

**Flexed fingers**
- Flexor digitorum profundus
- Flexor digitorum superficialis
- Interossei
- Lumbricals
COMMON POSTURES IN SPASTICITY

**Thumb in palm**
- Adductor pollicis brevis
- Adductor pollicis
- Flexor pollicis brevis
- Flexor pollicis longus
- Opponens pollicis

**Flexed wrist**
- Flexor carpi radialis
- Flexor carpi ulnaris
- Flexor digitorum profundus
- Flexor digitorum superficialis
- Flexor pollicis longus
- Palmaris longus
COMMON POSTURES IN SPASTICITY

Supinated flexed elbow

- Biceps brachii
- Brachialis
- Brachioradialis
COMMON POSTURES IN SPASTICITY

**Flexed ankle**
- Flexor digitorum longus
- Flexor hallucis longus
- Gastrocnemius
- Soleus

**Flexed Toes**
- Flexor digitorum longus
- Flexor digiti minimi brevis
- Flexor digitorum brevis
- Flexor hallucis longus
- Proximal and distal interphalangeal joints
- Flexor hallucis brevis
COMMON POSTURES IN SPASTICITY

Inverted/supinated foot

- Tibialis anterior
- Tibialis posterior
Examples of functional limitations

- **Adducted, internally rotated shoulder**
  - Limit overhead reaching
  - Difficulty bathing, cleaning underarms

- **Spasticity in wrist and finger flexors**
  - Interferes with grasp and release
  - Writing, eating
  - Fitting hand in to arm holes of shirts
  - Skin breakdown and nail bed infections
POST STROKE SPASTICITY MANAGEMENT

Examples of functional limitations

- **Equinovarus foot**
  - Inability foot flat during stance phase of gait
  - Instability
  - Knee pain due to excessive recurvatum when ankle plantar

- **Hip adductor spasticity**
  - Difficulty with perineal care and toileting
  - Scissor gait
Is presence of PSS an indication to treat?

- No
- May not always have a negative impact
- Sometimes can aid in functional tasks
  - Knee extensor tone used for standing, transfers
  - Preserve muscle bulk
  - Slow development of osteoporosis
When do you treat PSS?
- disabling or problematic
GOAL

- Reduce muscle hypertonia
- Improve post stroke function and well-being
- Active and passive
  - **ACTIVE** - To improve ability to perform tasks by the patient
  - **PASSIVE** - To improve ability to perform tasks for the patient
- **Example**
  - Treatment EF spasticity
    - Facilitate hygiene and prevent contractures (passive)
    - Improve limb movement (active)
POST STROKE SPASTICITY MANAGEMENT

PSS TREATMENT OPTIONS

- Rehab techniques
- Pharmacological management
- Neurolysis
- Botulinum Neurotoxins
- Intrathecal Baclofen Therapy
- Surgical Intervention
POST STROKE SPASTICITY MANAGEMENT

REHAB TECHNIQUES

Combo of techniques needed for functional improvements

- **Potentiate medication**
  - Neuromuscular electrical stimulation after BoNT injections

- **Restore biomechanics**
  - Stretching – continuous over short ballistic
    - Orthotics
    - Serial casting – also effective in conjunction with botox
  - Heat/cold application
  - Cryotherapy
  - U/S, short wave diathermy, microwave irradiation, transcutaneous electrical nerve stimulation
REHAB TECHNOQUES

- Improve motor control
  - Body weight–supported treadmill training
  - Robot-assisted
  - Functional electrical stimulation - applying a small electrical stimulus to nerves of the arms and legs during physical therapy
- TMS
- TCDS
POST STROKE SPASTICITY MANAGEMENT

REHAB TECHNIQUES

• **Strengthen weak muscles**
  • Resistance training
  • Aquatic therapy

• **Integrate into functional tasks**
  • Constraint-induced movement therapy
  • Neural prosthesis

• **Improve endurance**
  • Aquatic therapy
  • Treadmill exercises
  • Circuit training

• **Others**
  • Electroacupuncture
  • Biofeedback
  • Physical modalities (US, Vibration, thermotherapy)
POST STROKE SPASTICITY MANAGEMENT

- **Pharmacological Treatments**
  - Generalized spasticity
  - Focal spasticity
  - Choice depends on severity, anatomic distribution, comorbidities, cost
Pharmacological Treatments

GENERALIZED SPASTICITY

- MC treatment are oral medications
- MC oral meds
  - Baclofen (Lioresal)
  - Dantrolene (Dantrium)
  - Tizanidine (Zanaflex)
Pharmocological Treatments

- **Baclofen** – potentiates inhibitory neurotransmitter GABA
  - Mean half life 3.5 hours
  - Liver metabolized, renal excreted
  - Side effects
    - Sedation, fatigue, dizziness, lowered seizure threshold
  - Dosing:
    - Start 5-10 mg bid to tid
    - usually increased by 5-10 mg per week
    - 80 mg usually max dose per day
    - Withdrawal sx if rapid cessation
Pharmocological Treatments

- **Tizanidine** - predominately an alpha-2 agonist thus decreases presynaptic activity of excitatory interneurons
  - Chemically similar to clonidine
  - Peak plasma levels at 1 hour
  - Half life 2.5 hours
  - Liver metabolized, renal excreted
  - Side effects: sedation, dizziness, hypotension, nausea, dry mouth
  - Dosing:
    - Start 1-4 mg qhs
    - Typical max 36 mg per day
POST STROKE SPASTICITY MANAGEMENT

Pharmacological Treatments

- **Dantrolene** - only antispasticity treatment that acts primarily on the **peripheral muscle** rather than central neurotransmitter. Works by inhibiting Ca release from the sarcoplasmic reticulum during muscle contraction
  - Half life 15 hours
  - Dosing:
    - Start 25 mg bid
    - Increase by 25-50 mg per day per week
    - Common max dose 400 mg per day

- **Hepatotoxicity** - Requires lab monitoring
- Other side effects: weakness, nausea, diarrhea, paresthesias
Pharmocological Treatments

OTHER AGENTS for spasticity

- Gabapentin (Neurontin)
- Tiagabine (Gabitril)
- Diazepam (Valium)
- Clonidine (Catapres)

Central acting muscle relaxants:

- MC used to treat painful MSK conditions rather than spasticity
- Cyclobenzaprine (Flexeril), Carisoprodol (Soma), Methocarbamol (Robaxin), Metaxalone (Skelaxin)
POST STROKE SPASTICITY MANAGEMENT

Pharmacological Treatments

If patient temporarily cannot take oral
  ∙ Diazepam and Dantrolene have IV formulations
  ∙ IV Diazepam can be used for Baclofen withdrawal
  ∙ Conidine has a transdermal patch
POST STROKE SPASTICITY MANAGEMENT

NEUROLYSIS

- Treat **focal spasticity**
- Local injection of phenol and or alcohol – works by denaturing proteins of neural structures
- Sometimes used in combo with botox
- **Irreversible**
- MC medial popliteal blocks in kids with foot deformities and obturator nerve blocks for scissoring gait, to improve sitting posture and ease with perineal hygiene
- Adverse effects:
  - *Post injection dysesthesia*, localized swelling, excessive weakness
**Botulinum Neurotoxins**

- Focal spasticity
- Inhibits release of acetylcholine at the NM junction – thus inhibiting muscle contraction
- Blockade is permanent but,
  - Effects are reversible b/c of nerve sprouting and muscle reinnervation
- Must be used in conjunction with physiotherapy to obtain maximum benefit
- Injected directly into targeted muscle
- 10-14 days for visible effect
- Repeat every 3 months
- Most notable improvements in passive functions (hygiene, dressing)
POST STROKE SPASTICITY MANAGEMENT

Botulinum Neurotoxins

- Advantages over oral
  - target specificity
  - Better adverse event profiles
  - Non sedating

- Advantage over Neurolysis
  - Technically less challenging to perform
  - Less complications

- Disadvantages
  - Expensive
  - Often have to have tried and failed other treatment options
Botulinum Neurotoxins

- Can be done in the office
- ID muscles causing symptoms/postures
  - Anatomical localization
  - EMG
  - E-stim
- Isolate most problematic muscles
- Determine dose of botox to use
  - 100unit vials
  - Dilution: 100 units/2 ml preservative free 0.9% sodium chloride
  - Lowest recommended starting dose – no more than 50 units per site initially
  - Max 400 units in 3 month interval
MUSCLES APPROVED FOR BOTOX INJECTION IN THE UPPER EXT

RECOMMENDED DOSES

- **Biceps Brachi**: 100-200 units divided in 4 sites
- **Flexor Pollicis Longus**: 20 units in 1 site
- **Adductor Pollicis**: 20 units in 1 site
- **Flexor Carpi Radialis**: 12.5-50 units in 1 site
- **Flexor Carpi Ulnaris**: 12.5-50 units in 1 site
- **Flexor Digitorum Profundus**: 30-50 units in 1 site
- **Flexor Digitorum Superficialis**: 30-50 units in 1 site
POST STROKE SPASTICITY MANAGEMENT

BOTOX
Muscles approved for Botox injection in the LOWER EXT

- **Tibialis Anterior**
- **Gastrocnemius (medial head)**
  - (75 Units divided in 3 sites)
- **Fibularis Longus**
- **Soleus (hidden)**
  - (75 Units divided in 3 sites)
- **Extensor Digitorum Longus**
- **Extensor Hallucis Longus**
  - (hidden)

- **Gastrocnemius (lateral head)**
  - (75 Units divided in 3 sites)
- **Tibialis Posterior (hidden)**
- **Soleus (hidden)**
  - (75 Units divided in 3 sites)
- **Flexor Hallucis Longus**
  - (hidden)
  - (50 Units divided in 2 sites)
- **Flexor Digitorum Longus**
  - (50 Units divided in 2 sites)
- **Fibularis Longus**

* indicates muscles in the lower extensor compartment with a dose of 75 units and divided into 3 sites, except for **Soleus**, which is divided into 2 sites.
POST STROKE SPASTICITY MANAGEMENT

Examples of functional limitations
- Adducted, internally rotated shoulder
- Spasticity in wrist and finger flexors
- Find out what is most impairing to the patient

Muscles to inject
- Shoulder adductor - Pectoralis major
- Elbow Flexor - Biceps
- Pronator teres
- Wrist Flexors
- Finger Flexors
## Aggregate Postures

<table>
<thead>
<tr>
<th>Aggregate Postures</th>
<th>Typical Starting Dose</th>
<th>Total Maximum Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equinovarus foot, flexed toes</td>
<td>400</td>
<td>600</td>
</tr>
<tr>
<td>Extended knee, plantar flexed foot/ankle</td>
<td>400</td>
<td>600</td>
</tr>
<tr>
<td>Plantar flexed foot/ankle, flexed toes</td>
<td>300</td>
<td>500</td>
</tr>
</tbody>
</table>

*POST STROKE SPASTICITY MANAGEMENT*
INTRATHECAL BACLOFEN THERAPY

- **Regional or generalized PSS** recalcitrant to oral meds or injection therapy
- Concentration of GABA receptors in the lumbar spinal cord allows very small dosages of baclofen to be effective without causing any systemic side effects
- Programmable pump is implanted into the abdomen, from where a catheter conveys the baclofen into the intrathecal space
- Consider as early as 3-6 months post stroke
  - If spasticity is causing significant functional impact and hindering progress in rehab
POST STROKE SPASTICITY MANAGEMENT

INTRATHECAL BACLOFEN THERAPY

- Side effects
  - Similar to oral but less frequent due to lower intrathecal dose needed
  - Procedure related, device related, surgical infection, pump malfunction, catheter interruption
- Best for LE spasticity but can be used for UE spasticity
- A trial using a bolus dose of baclofen through a lumbar puncture needle
- Significant commitment from patient, not only during the trial and implant phase but also for the ongoing maintenance of regular refills and replacements
- Used in <1% of stroke patients
  - Cost, surgical risk, less effective in UE, need for management post placement and limited providers
Surgical intervention

- Patients with PSS complicated by muscle or tendon shortening
- Limited success with less invasive procedures
- Most common cases
  - Split anterior tibial tendon transfer and tendon Achilles lengthening for spastic equinovarus foot
  - Tendon transfer of the Brachioradialis to extensor digitorum communis
  - Tendon lengthening of the flexor pollicis longus
  - Release of flexor pronator tendons
Take away
• Early identification is key
• Focal treatment is better
• Referral to PM&R or Neurology early