The spastic hand

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Why neuromuscular conditions?

• Complex decision making
• MDT approach
• Often told "nothing can be done"
• Variety of surgical treatments
• Multilevel, tendon transfers, fusions
• Little need for complex/expensive kit

What is spasticity?

Spasticity

• Velocity dependent hypertonia

Corticospinal tract
– Primary pathway of motor neurons
– Not directly affected in spasticity

Rubrospinal tract
– Cyclical, non-voluntary movements

Reticulospinal tract
– Inhibitory function => dec tone
– Eg prevent flexor response to stimuli

Vestibulospinal tract
– Excitatory function to maintain posture/balance

OBPI
FSHD
Stroke hemiplegia
Dystonic CP
Duchenne
MPS
Cerebral palsy
Arthrogryposis
Dystonic CP
Spastic CP
CP hemiplegia
Kennard principle: Activation of unaffected hemisphere

Pathophysiology of neuromuscular conditions

Weakness / Spasticity
Imbalance of forces
Correctable contracture
Fixed contracture
Skeletal deformity

Incidence

- Cerebral palsy
  - Most common physical disability in children
  - 1 in 2000, many living into adulthood

- Incidence of upper limb involvement
  - 82% had some upper limb involvement
  - 69% had reduced motor control
  - 36% had a upper limb contracture
  - Only 12% had seen a specialist for treatment of UL

Upper limb involvement

- 92% Wrist
  - 59 deg flexion
  - 85 deg pronation

- 50% Hand
  - 65% thumb in palm
  - 35% finger deformity

- 77% Elbow
  - 55 deg flexion

Manual Ability Classification System

<table>
<thead>
<tr>
<th>Motor function</th>
<th>Carer</th>
<th>Appearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grasp</td>
<td>Washing</td>
<td>Easy manipulation</td>
</tr>
<tr>
<td>Release</td>
<td>Dressing</td>
<td>Reduced speed</td>
</tr>
<tr>
<td>Dexterity</td>
<td></td>
<td>Needs adaptations</td>
</tr>
<tr>
<td>Mirror movements</td>
<td></td>
<td>Poor despite adaptations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Severe limitations</td>
</tr>
</tbody>
</table>

Nixon et al. Incidence UL involvement in CP British Society Surgery to the Hand. 2011
Gross Motor Functional Classification System

1. Widely used.
2. Observer measured score 1-5.
3. Measure of lower limb function and mobility.
4. Strong correlation to MACS

Differences in management of upper and lower limb spasticity

Lower limb
Closed kinetic chain (Stabilised by ground reaction force)
- Harder to over correct
- Power important

Upper limb
Open kinetic chain (No ground reaction force)
- Very easy to over correct
- Fine motor control important

Decision making factors

Age
- Active control
- Time since injury
- Functional contracture
- Dystonia

Spasticity vs FFD

Age dependent factors

Spasticity
- Growth velocity

Hågglund G. Development of spasticity with age in children with CP. BMC Musculoskelet Disord. 2008

Age

3-7 years
- High spasticity
- Very high risk of over correction

Botox neurectomy

7-12 yrs
- Moderate spasticity
- More growth potential
- Risk of over-correction

Constrained procedure

>13 yrs
- Less spasticity
- Less growth potential

Unconstrained rebalancing

Thumb in palm
Wrist flexion
Elbow flexion

Most disabling

Patterson J. Late deformities following the transfer of FEU to ECRB in children with CP. J Hand Surg Am. 2010


comparison of AbilHand logit scores vs normal
* all p<0.01 MWU
One third of older children have cosmetic concerns

Odds Ratio = 3.1 (1.1 to 8.6), Chi sq= 0.029


Spasticity vs contracture

1. Mild ↑ tone
   Catch <50% ROM
2. Mod ↑ tone
   Catch >50% ROM
3. Severe ↑ tone
   Entire ROM
4. Fixed deformity

Modified Ashworth classification

Spasticity
- Early disease
- Overactive muscle
- Botulinum toxin
- Splinting
- Tendon transfers

Contracture
- Head Injury
- Fibrosis & contracture
- Poor response to botox
- Contracture release
- Joint stabilisation

Is there active control?

No active control
- Joint stabilisation
- Splints, arthrodesis

Active control present
- Joint rebalancing
- Contracture release
- Tendon transfer

Management

Upper motor neuron
- Muscle relaxants, ITB
- Spinal
- Selective dorsal rhizotomy
- Selective peripheral neurotomy
- Botulinum toxin
- Tendon transfer
- Arthrodesis, splints

Hand therapy: CIMT

Isakides L. RCT of upper limb CIMT versus standard care for children with unilateral cerebral palsy. Dev Med Child Neurol. 2015 Jan
Botulinium toxin

- Cochrane review
  – Benefits for 3-6 months
- NICE (2012)
  – Motor function, cosmesis, pain, hygiene
- Role in my practice
  – Diagnose which muscles misfiring
  – Dystonia vs spasticity
  – Buy time in young children
  – Those not suitable for surgery

Selective spinal rhizotomy

- Removes afferent feedback
- Has a place in lower limb spasticity
- Good for generalised reduction in spasticity
- No evidence for specific use in the upper limb

Selective peripheral neurotomy

- Young (4-10 years), high spasticity, good response to botox
- 50% reduction spasticity
- Reduction associated pain
- Improvement in function
- Benefits last up to 5 years

Elbow

- Brachialis aponeurosis
- Biceps lengthening
- + Brachioradialis/elbow capsule
- Outcome at 5 years
  – 50 deg ↑ resting posture
  – 20 deg ↑ active extension
  – 5 deg ↓ active flexion
  – No change supination

Wrist – deforming forces

- Wrist vs finger flexors
- Pronator teres
- Long extensor weakness
Wrist spasticity

- Flexion contracture
- Wrist flexed, fingers flexed
- Wrist flexed, fingers extended
- Fingers flex as wrist extended

Finger flexor spasticity

- Wrist flexed, fingers flexed
- Wrist flexed, fingers extended
- Fingers flex as wrist extended

Wrist flexion deformity

- Fixed flexion contracture
- Proximal row carpectomy
- Wrist fusion

Outcome of 41 wrists
- 98% union, 94% satisfaction
- Disability Assess. Scale from 9.6 to 6.5
- Improvement appearance VAS by 7.9

Hand

- Swan neck deformity: Grasp and release
- Clasp hand: Hand hygiene
- Thumb in palm: Manual dexterity

Thumb in palm - classification

1. MC adduction contracture
   - Adductor Pollicis spasticity
   - MCJ flexion contracture
   - MCJ Instability
2. MCP flexion contracture
   - Floor Pol Brovis spasticity
   - AP & FPB spasticity
   - AP & FPB & IPJ contracture
3. CMCJ Instability
   - AP & FPB spasticity
   - EPL/AFL active
   - PIP spasticity
4. MCPJ and IPJ contracture
   - AP & FPB spasticity
   - FPL spasticity

Wrist flexion deformity

- Active control
- Passively correctable
- FCU => ECRB
- FCU => EDC

Outcome at 17 years
- 90% cosmetic improvement
- 80% functional improvement


Outcome of 41 wrists
- 98% union, 94% satisfaction
- Disability Assess. Scale from 9.6 to 5.5
- Improvement appearance VAS by 7.9

1. PRC + arthrodesis
2. Fractional lengthening
3. FCU to EDC transfer

Swan neck deformity - classification

1. Grasp and release
2. AP & FPB spasticity
3. AP & FPB & IPJ contracture
4. FPL spasticity

Clasp hand - classification

1. Hand hygiene
2. Manual dexterity
3. AP & FPB spasticity
4. EPL/AFL active
Swan neck deformity

- FDS and lumbral spasticity
- Hypermobility

- Central slip release
  - Simple, effective
- Lateral band advancement
  - 40% 5 year recurrence

Acquired brain injury

- Glove and stocking
- Shoulder subluxation
- Skeletally mature
- High anaesthetic risk

- Botulinium toxin

The hemiplegic shoulder

Flaccid paralysis

Spastic paralysis

Inferior subluxation:
Biceps suspension procedure
- Maintains passive ROM

Contractures:
- Soft tissue release
- Post-operative

Therapy / CIMT

Botulinium / neurectomy

rebalancing

Mass anastomosis

Pre-op

Distal FDS release

Proximal FDP release

Post op

Contracture release

- 1st webspace
- Intrinsic/extrinsic release

Joint stabilisation

- MCP joint arthrodesis

Rebalancing

- EPL translocation
- FPL lengthening + BR transfer

Contracture release

- MCP joint arthrodesis

Rebalancing

- EPL translocation
- FPL lengthening + BR transfer
Summary

• Upper limb involvement in CP is common
• Many patients are not referred for treatment
• Cheap and effective treatments are available
• Specialist services are available locally