Splinting - An adjunct in the management of hypertonicity

Occupational Therapy Department

The Royal Children's Hospital

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Presentation outline

- Muscle alterations due to spasticity
- Approaches to the management of hypertonicity
- Assessment: components and patterns of movement
- Aims of splinting
- Splinting: designs, materials, wearing regime
- MACS – Manual Ability Classification System

Muscle alterations due to spasticity

"Motor control of the wrist and hand is normally balanced by the continual eccentric and concentric contractions of both the extensor and the flexor muscles" Ponten 2008

---Balance---

- In children with spasticity there is deficient motor control:
  - with greater influence of flexors and persistent flexion posturing
  - resulting in shortened muscle fibres and decreased extensibility

---Imbalance---

Muscle alterations due to spasticity

Decreased passive extensibility in muscles is explained by:

- Adhesions between muscles and muscle fibres
  - Reduced use results in fibrotic perimuscular adhesions
- Fewer sarcomeres
  - Reduced use results in fewer sarcomeres, causing shortening of the muscle fibre. Scarcomeres are stretched out and muscle is weaker.
- Intracellular alterations
  - Increased collagen content is present, found to correlate to the severity of spasticity. Spastic single muscle fibres are stiffer than normal single fibres.

Approaches to the management of hypertonicity

Biomechanical

- Maintain active and passive range of movement
- Promote strength and endurance

Neurophysiological, neurodevelopmental

- Inhibit hypertonicity
- Facilitate higher level reactions and normal patterns of movement

Motor Learning approaches

- Conscious control of active movement

Assessment: components

Multiple interacting components to be analysed

- Type and degree of hypertonicity
- Passive movement limitations
- Active patterns of movement
- Weakness
- Sensation
- Pain
- Hand function and performance

- Video is recommended

Assessment: components

Functional activity and participation in daily activities

- Focus on current task performance
- Clarify the goals of child and carers
  E.g. Canadian Occupational Performance Measure

Skill in object manipulation

- Speed
  E.g. Jebsen & Taylor test of hand function, Box & Blocks test of manual dexterity
- Quality of movement
  E.g. Melbourne Assessment of quality of unilateral upper limb movement, Quality of Upper Extremity Skill Test
- Bimanual performance
  E.g. Assisting Hand Assessment

Assessment: components

Biomechanical components

- Hypertonicity
- Joint contracture
- Soft tissue contracture

Severity of tone

- E.g. Modified Ashworth, Tardieu scale

Joint range of motion

- E.g. Goniometry

Assessment: Patterns of Movement

Example 1: Hyperextension of thumb MCPJ when opening hand for grasp

- Adductor Pollicis & 1st Dorsal Interosseous hypertonicity +/- shortness (CMC adduction)
- Abductor Pollicis Brevis is then ineffective on CMCJ & Extensor Pollicis Brevis or Extensor Pollicis Longus impact on MCPJ (resulting in hyperextension)
- Flexor Pollicis Longus hypertonicity + Adductor Pollicis hypertonicity (Z-deformity with MCPJ hyperextension)

Assessment: Patterns of Movement

Example 2: Wrist flexes with grasp attempts – *explanations:*

Contracture

- wrist joint flexion contracture
- wrist flexor muscle shortness
- finger flexor muscle shortness (wrist flexion needed for finger extension)

Hypertonicity

- wrist flexor hypertonicity with finger flexion
- finger flexor hypertonicity (flexes wrist with finger flexion)

Weakness

- wrist extensors (unable to stabilise wrist with finger flexion)
- finger extensors (utilises tenodesis to assist)

Various combinations

Aims of splinting

Establishing the clinical aims of splinting requires an awareness of the interplay between multiple components including tone, contracture, movement patterns, weaknesses/strengths, functional use and structures requiring protection.

Aims of Splinting: Literature Review

- Prevention of muscle & soft tissue contractures
- Prevention of joint deformity
- Maintenance of joint integrity
- Maintenance of active or passive ROM gains achieved by other techniques (casting, surgery, botox)
- Maintenance of muscular balance
- Reduction of hypertonicity
- Positioning of the limb to enable functional use
- Pain and oedema management
- To enable improved hygiene management
- Maintenance of acceptable appearance/to enhance cosmesis

Splint types: Thermoplastic

- Low intensity stretch for reduction of hypertonicity & reversal of posture resulting from hypertonicity
- Low intensity stretch for prevention or reduction of contracture
- Maintain joint alignment, especially arches

Splint types: Palmar Resting Splints

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Indications:

- Moderate to severe hypertonicity at rest and/or activity
- Risk of contracture development/progression
- Joint pain

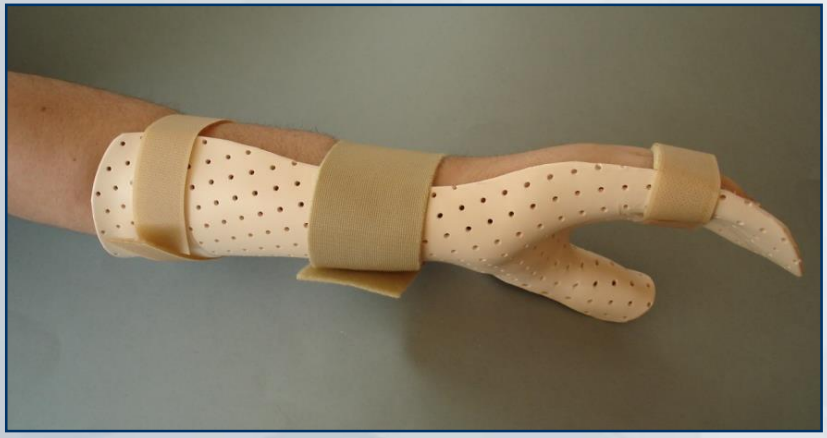
Contraindications:

- Severe contracture

Aims:

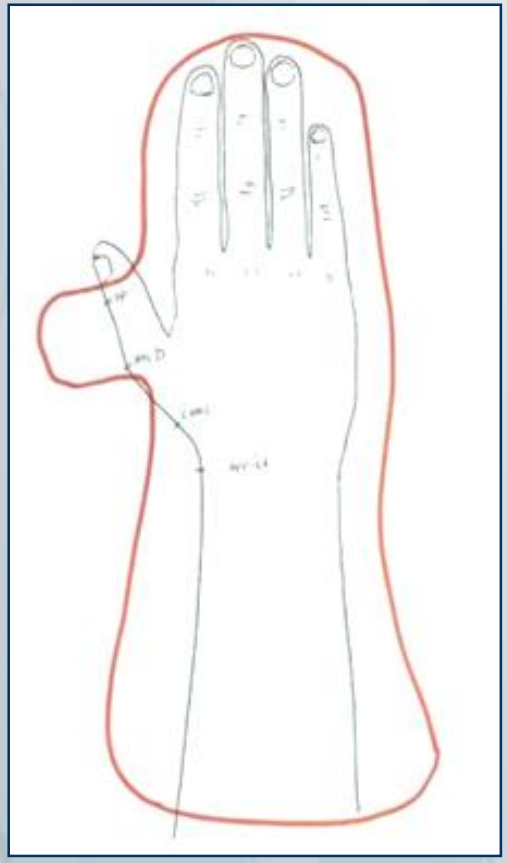
- Reduce hypertonicity
- Maintain soft tissue length
- Maintain joint alignment

Splint types: Palmar Resting Splints



Splint types: Palmar Resting Splints

Preferred design



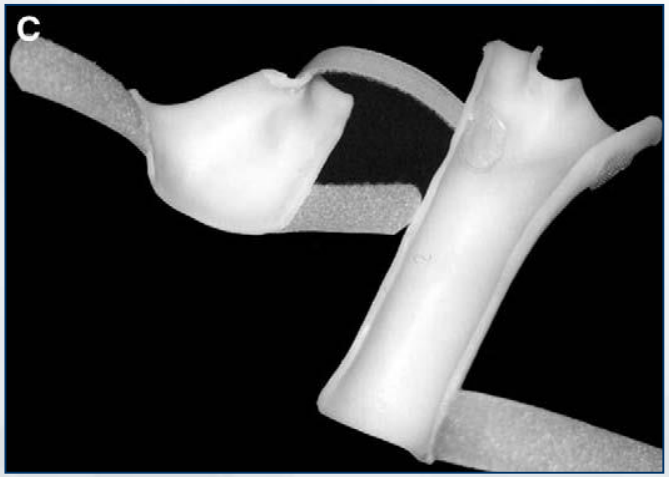
Preferred material

3.2mm Sansplint
3.2mm Ezeform

Poor support

To maximise the support of the thumb and overall strength of the splint, avoid the design above. The cut can weaken the mid point of the splint

Splint types: Volar-Dorsal designs



Judith Wilton, Hand Splinting:
Principles of design and fabrication.

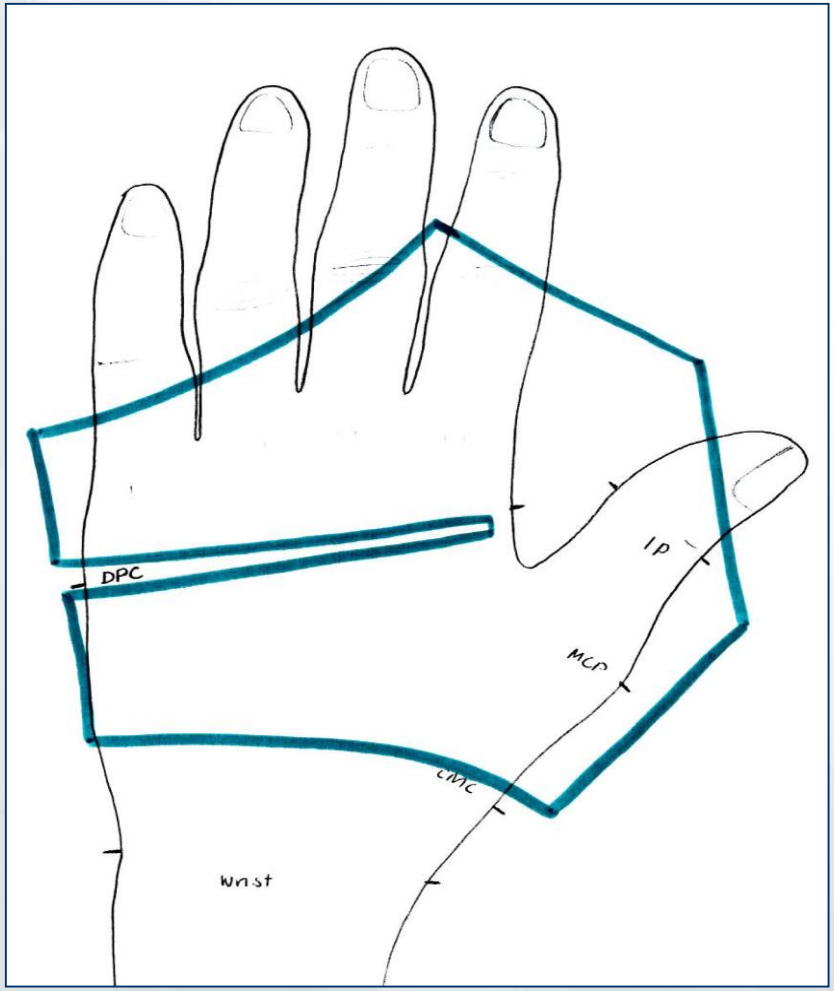
Splint types: Functional hand splints

- Rigid for immobilisation/stability or non-rigid for support
- Maintain joint alignment, including arches for mechanical advantage
- Promote active use of the upper limb where available
- May be used as assistive device for performance of an activity/functional retraining

Splint types: Short thumb spica

Materials

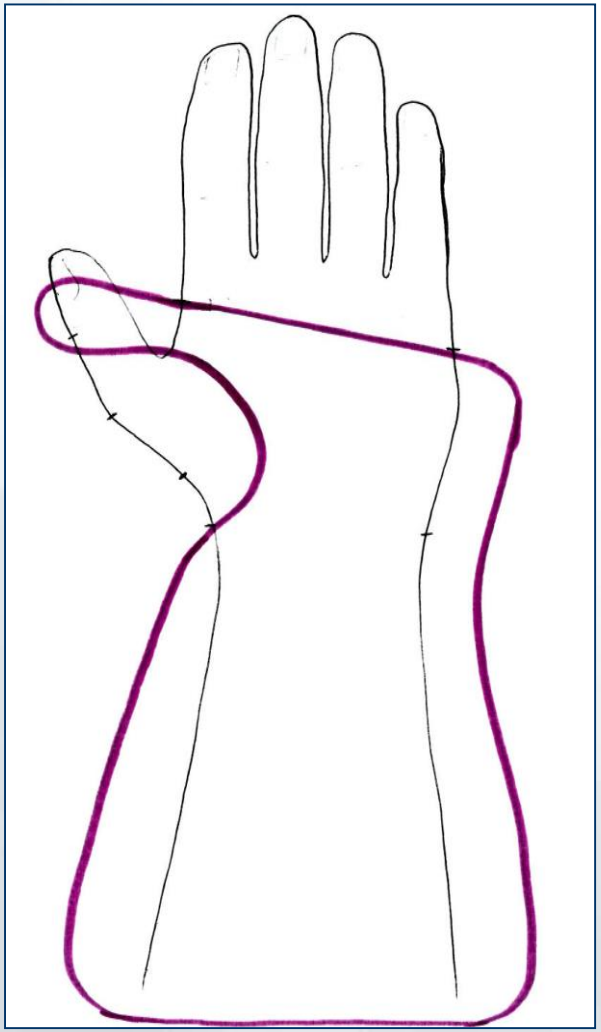
- Orfit
- Aquaplast
- Polyflex



Splint types: Wrist extension

Materials

- Ezeform
- Sansplint



Splint types: Wrist extension

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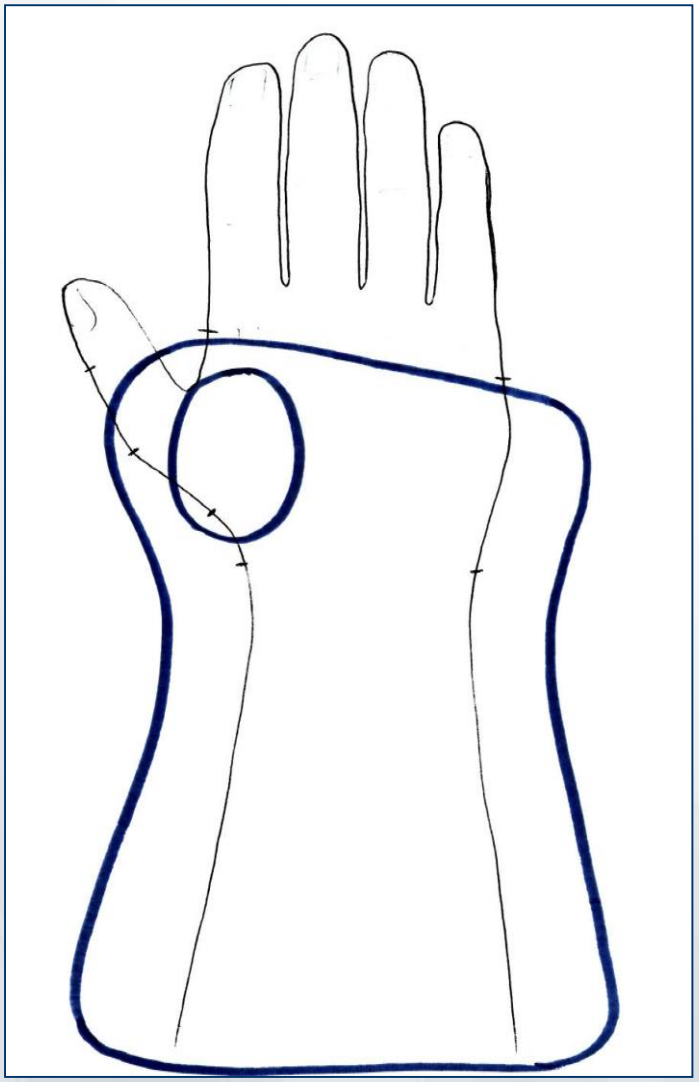
Materials

- Ezeform
- Sansplint



Splint types: Wrist extension

Materials

- Ezeform
- Sansplint
- Polyflex

Splint types: Semi-Dynamic Functional Splints

- Non-rigid
- Neoprene, lycra, foam
- Usually circumferential
- Intrinsic elasticity for passive repositioning
- Provide resistance to extremes of movement
- Provide support to joints not stability
- Useful for mild to moderate hypertonicity

Pattern available from RCH

Splint types: Maintaining skin integrity

- Liners
- NuStim Wrap
- Curash Powder

Consider other materials:

- Soft elbow splints
- Rolled up bandage
- Palm protector modified

Splint types: Strapping

- Prevent movement in splint if aiming to reduce hypertonicity or correct contracture
- Prevent splint from migrating distally
- Allow mobility in joints not included
- Avoid excess pressure over bony prominences
- Broader area = greater comfort

Splint types: Tips and tricks

- The longer the lever arm, the less force required
- Contours add strength
- The broader the area of pressure, the greater the comfort
- Determine position BEFORE starting splint
- Oppose deforming forces
- BALANCE

Splint types: Tips and tricks

- Mould one joint at a time (then part re-dip & remould)
- Use wraps or bandages as a second pair of hands
- Watch for hyperextension
  - Thumb MCPJ
  - PIPJ's
- Finger dividers – thermoplastic, sponge, Otoform K
- Be mindful of maintaining first web space and arches

Splint Wearing Schedules: Reducing Hypertonicity

- Continuous low-load stretch to hypertonic muscles
- Regular removal to encourage antagonist muscle use
- Night splinting alone is not adequate

Mild

(hypertonicity on activity)

- Splint for short periods when active

Moderate to Severe

(hypertonicity at rest)

- Splint for longer periods

Splint Wearing Schedules: Managing Contracture

<u>To prevent contracture</u>

- Continuous low-load stretch for several hours
- Reversal of hypertonic posture
- Night splinting is appropriate

<u>To reduce contracture</u>

- Long periods of continuous low-load stretch – day & night
- Regular adjustment required as length is achieved
- Serial casting is appropriate

Splint Wearing Schedules: Improving Hand Function

- Apply splint for particular activities
- Used as an adjunct to functional retraining during therapy (such as after surgery, Botox or casting)

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Manual Ability Classification System for Children with Cerebral Palsy 4-18 years

MACS - levels I and II

MACS I: Handles objects easily and successfully
MACS II: … with reduced quality and/or speed of achievement

Functional difficulties:

- Increased tone on activity
- Muscle imbalance on activity
- Possible joint instability
- Decreased co-ordination and quality of prehension
- Reduced sensory perception

Clinical aims:

- Reduce hypertonicity after activity
- Improve muscle balance on activity
- Joint stabilisation
- Improve patterns of prehension
- Increase strength and endurance

Goal for manual skills:

Improved speed and quality of performance in activities

Splinting:

Functional splints (neoprene, lycra, taping, thermoplastic)

Copely and Kuipers 1999
Eliasson and Burtner 2009

MACS levels III and IV

MACS III: Handles objects with difficulty; needs help
MACS IV: Handles limited selection in adapted situations

Functional Difficulties:

- Tone increased at rest and on activity.
- Possible soft tissue contracture
- Possible joint changes
- Limited voluntary movement
- Possible sensory neglect

Clinical Aims:

- Reduce hypertonicity
- Prevent contracture increase
- Improve position for function (including management of hygiene & dressing tasks for carers)
- Reduce pain
- Improve skin integrity

Goal for manual skills:
Independence in selected activities using strategies and adaptations

Splinting
Functional splints (thermoplastic) and resting splint at night for contracture risk

Copely and Kuipers 1999
Eliasson and Burtner 2009

MACS level V

MACS V: Does not handle objects; severely limited ability to perform simple actions

Functional Difficulties:

- Tone increased at rest
- Soft tissue contracture
- Joint changes
- Absence/limitation of voluntary movement
- Pain
- Sensory disturbance
- Skin maceration risk

Clinical Aims:

- Reduce hypertonicity after activity
- Improve muscle balance on activity
- Joint stabilisation
- Improve patterns of prehension
- Increase strength and endurance

Goal for manual skill:

Meaningful actions where possible

Splinting

Functional splints (thermoplastic) and resting splint at night for contracture risk

Copely and Kuipers 1999
Eliasson and Burtner 2009

Presenting Problems: Activity Limitations

- MACS II & III:
  - Weakened grip and reduced hand function

- MACS IV & V
  - Difficulty accessing assistive technologies
  - Skin hygiene problems
  - Difficulty dressing
    - eg. threading arm through sleeve

References of interest:

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Occupational Therapy Department
The Royal Children's Hospital
Flemington Road
Parkville 3052
Phone (03) 9345 9300

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