Upper Extremity Orthotics

Pathology and Prescription

Heikki Uustal, M.D.
Medical Director, Prosthetic/Orthotic Team

JFK - Johnson Rehab Institute
Upper Extremity Orthotic Goals

- Substitute for absent strength
- Assist for weak muscles
- Support injured or diseased segments by limiting motion or load
- Prevention or correction of deformity
- Attachment of assistive devices
Functional Goal = Prehension

Primary Factors: Thumb opposing fingers
  Effective pinch
  Gross grasp
  Positioning the hand in space
Orthoses are universally named by the joints involved and special features. Unfortunately, many orthoses are named after the inventor or the institution where developed.
Biomechanical Concerns

- 3 Point control concept
- Static vs. dynamic orthosis
- Materials selection
- Force application and tissue tolerance
- Pressure sensitive areas
3 Point Control Concept
Pressure Sensitive Areas of Hand
Pressure-Duration Curve for soft tissue tolerance
Levers and Forces
(longer lever changes the force)
Direction of Force
Finger IP Joint Collateral Ligament Strain

Findings - M-L instability at IP joint
  Tender at IP joint
  Motor and sensory normal

Orthosis - Finger gutter splint with Velcro closure

Alternates - Aluminum/foam splint
Static Finger Orthoses
Static Finger Orthoses
Rheumatoid Arthritis

IP Joints

Findings - “Swan Neck” deformity with hyperextension at PIP and flexion at DIP

“Boutonnière's Deformity” with flexion at PIP and hyperextension at DIP

Orthosis - Metal ring finger orthosis
Finger Ring Orthosis at DIP
Finger IP Joint Contracture

Findings - Flexion contracture at IP joint due to collateral ligament shortening
   Normal motor/sensory
   Normal ROM at MCP

Orthosis - Dynamic springwire finger orthosis

Alternates - “Joint Jacks” and others
Dynamic Finger Orthosis
Springwire Finger Orthosis

MODEL NO. 501

Spring Finger Extension Assist
Dynamic Finger Orthosis
Joint Jack Finger Orthosis
Hand Finger Orthoses
Short Opponens Orthosis

Rancho short opponens hand splint. a, opponens bar; b, C-bar.

Bennett basic hand splint. a, opponens bar; b, C-bar.

Fig. B.20. Thumb distal phalanx extension outrigger.
Plastic Opponens Orthoses
Distal Median Nerve Injury

Findings - Weakness at thumb
  Sensory loss on palmar surface
  Loss of thumb opposition

Orthosis - Short opponens orthosis
Short Opponens Orthosis
Rheumatoid Arthritis
Base of Thumb

Findings - Tender at CMC joint (base of thumb)
  - Synovial thickening
  - Strength normal
  - Sensation normal
  - ROM may be limited by pain

Orthosis - Static plastic thumb spica
Thumb Spica
Dynamic Hand-Finger Orthosis with PIP extension and MCP block
Dynamic Hand-Finger Orthosis with progressive PIP extension
Biomechanical Failures

Clinical problems
1. The more mobile metacarpophalangeal joints are hyperextended.
2. The angle of elastic traction to the proximal phalanges enhances metacarpophalangeal joint hyperextension.
3. The finger cuffs prevent full interphalangeal joint flexion.
4. The uncovered Velcro hook fastener is abrasive to clothing.

Solutions
1. Add a dorsal phalangeal bar to prevent metacarpophalangeal hypertension. NOTE: Classification changes to compound PIP extension splint.
2. Adjust outrigger to provide a 90-degree angle of the elastic traction to middle phalanges.
3. Trim the proximal and distal edges of the finger cuffs to interphalangeal joint flexion.
4. Lengthen the wrist strap to provide full closure.
5. Wrist may need to be immobilized in some instances.
Dynamic Hand-Finger Orthosis for extensor contracture
MCP Joint Contracture

Findings - Extensor contracture at MCP joint

Orthosis - “Knuckle Bender” dynamic hand finger orthosis
Knuckle Bender Orthosis
Rheumatoid Arthritis

MCP Joint

Findings - Subluxation of MCP joints
- Ulnar deviation of fingers
- Synovial thickening of MCP joints
- Limited ROM of MCP
- Normal motor/sensory

Orthosis - Ulnar deviation orthosis for early stage
- Static wrist-hand-finger orthosis for later stage
Ulnar Deviation Orthosis
Wrist-Hand-Finger Orthoses
Severe RA Deformity
Carpal Tunnel Syndrome

Findings - Compression of median nerve
- Incomplete motor / sensory loss at thumb

Orthosis - Wrist – hand orthosis
- “Cock-up splint”
Wrist Cock-up Splint
CVA with Spastic Hemiplegia

Findings - Flexor positioning of wrist and fingers
Motor-voluntary control absent
Sensation absent, edema present
Tone increased

Orthosis - Static wrist-hand-finger orthosis with
wrist in slight extension, MCP’s in flexion, IP’s extended, thumb in opposition
Static Wrist-Hand-Finger Orthosis
Static Wrist-Hand-Finger Orthosis
Dynamic WHFO with PIP Extension for long flexor tendon contracture
Progressive WHFO needs regular follow-up and adjustment
Long Opponens Orthosis
Long Opponens with wrist motion

Fig. 8.12. Wrist extension hinge and elastic extension assist on long opponens hand splint.

Fig. 8.13. Abduction-adduction splint for wrist.
Finger Flexor/Extensor Injury and Repair

Findings - Restrictions on ROM at wrist, MCP and IP joints per surgical protocol

Orthosis - Hybrid wrist-hand-finger orthosis with static stabilization of wrist and limited dynamic control of MCP’s and fingers
Flexor Tendon Repair
Extensor Tendon Repair
Distal Ulnar Nerve Injury

Findings - “Intrinsic Minus” hand with hyperextension at MCP and flexion at IP joints
- Sensory deficit on palmar surface
- Motor deficit of intrinsic muscles

Orthosis – Hybrid Wrist-hand-finger orthosis with MCP block
Hybrid WHFO
Radial Nerve Injury at Elbow

Findings - “Wrist Drop”
- Motor deficit at wrist extensor and finger/thumb extensors
- Sensory deficit at dorsum of hand

Orthosis - Dynamic wrist-hand-finger orthosis with extension assist at wrist and fingers using outriggers and bands
Dynamic WHFO for Radial Nerve Injury
Elbow Contracture

Findings - Flexion or extension contracture at elbow following immobilization for fracture or surgery

Motor and sensory normal

Orthosis - Dynamic elbow orthosis with adjustable tension for stretching
Dynamic or Progressive Static Elbow Orthosis
Humeral Fracture

Findings – Stable, non-displaced humeral shaft fracture

Orthosis – Circumferential splint
Circumferential Humeral Orthosis
Static
Progressive
Elbow
Wrist Hand
Orthosis for
elbow
fracture
Progressive EWHO for Humerus and Radius Fracture
Adjustable ROM Elbow Orthosis for soft tissue injury at the elbow
Shoulder Fracture or Surgery

Findings - Restriction on ROM at gleno-humeral joint per surgical protocol

Orthosis - “Airplane Splint”
Other static shoulder orthoses
Static Shoulder Immobilizer
Static Shoulder Immobilizers

Fig. 8.42. Airplane splint.

GUNSLINGER ORTHOSIS
Elastic Shoulder Stabilizers for gleno-humeral subluxation
Static Scapular Immobilizer for winging of the scapula
Shoulder Orthosis
Elastic Scapular and Glenohumeral Stabilizer
Spinal Cord Injury C₆ Level

Findings – Wrist Extensors Intact
Long Finger Flexors and intrinsics absent

Orthosis - RIC Tenodesis Orthosis
Alternate – Flexor Hinge Orthosis
Tenodesis Effect
Tenodesis Effect
Metal Flexor Hinge Orthosis
Flexor Hinge Orthosis

Fig. 8.38. Shoulder driven flexor hinge splint.
Universal Cuff
Ball-bearing Feeder

Balanced Forearm Orthosis
**Lower Brachial Plexus Injury**

**Findings** -
- Motor deficits at hand and wrist with good strength at elbow/shoulder
- Sensory deficits in hand
- ROM limited due to contracture at hand

**Orthosis** -
- Static wrist-hand-finger orthosis for protection

**Alternate** -
“Prosthosis” using prosthetic terminal device for prehension
Static WHFO for insensate and non-functional hand
Prosthosis
Thank You