Upper limb orthosis

Uot-BME

5th Level Biomechnaics and Bioinstruments

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Introduction

Mechanical device- anatomical and functional position

Orthos – to correct or maintain straight

Any externally device used to modify structural and functional characteristics of the neuromuscular skeletal system

Physiotherapist + orthotist

Orthosis

Categorized :

- Upper limb orthosis
- Trunk orthosis
- Lower limb orthosis

Objectives of upper limb orthosis:

1) Protection :

- stabilization

- Dynamic control

2) Correction

3) Assistance

To immobilize a body part to promote tissue healing

Prevent	Prevent contractures
Increase	Increase ROM
Correct	Correct deformities
Strengthen	Strengthen muscles
Reduce	Reduce tone
Reduce	Reduce pain
Restrict	Restrict motion to prevent harmful postures

Nomenclature :

On basis of

- joint they cover
- the function they provide
- condition they treat
- by appearance
- name of the person who designed them

Mainly three systems:

1) International Organization for Standards(ISO) which gives anatomic region wise names

2) 1992, American Society of Hand Therapists published ASHT splint classification system (SCS) which gives function and body part wise.

In that, numbering system – ‘type’

3) McKee and Morgan

Common name	ASHT splint classification system	IOS	McKee and Morgan
Humeral fracture brace	Non articular splints- humerus	Not applicable	Circumferential non-articular humerus stabilizing
Tennis elbow splints or brace	45 degree elbow flexion immobilization type 1[1]	Shoulder- elbow – wrist – hand orthosis	Circumferential non-articular proximal forearm strap
Duran splint, post operative flexor tendon splint	Wrist and finger flexion immobilization; type 0[4]	WHO	Dorsal forearm based static MCP-IP protective flexion and MCP extension blocking orthosis
Thumb spica splint	Thumb MCP extension immobilization type 2[3]	WHFO	Volar forearm- based static wrist thumb orthosis

Classification :

On basis of anatomical regions:

- Shoulder and arm orthosis
- Elbow orthosis
- Wrist orthosis
- Hand orthosis

Based on function

- Supportive
- Functional
- Corrective
- Protective
- Prevent substitution of function
- Prevent weight bearing
- Relief of pain

Based on design

- non-articular
- Static
- Serial static
- Static motion-blocking
- Static progressive
- Dynamic
- Dynamic motion-blocking
- Dynamic traction splints
- Tenodesis
- Continuous passive motion orthoses
- Adaptive or functional usage

Biomechanics of orthosis

External force + moments on body

Internal forces

Mainly 4 biomechanical principles:

1) Control of moment across a joint
2) Control of normal forces across a joint
3) Control of axial forces across a joint
4) Control of action of ground reaction force

General principles:

- Uses of force
- Limitation of movements-pain
- Correcting the mobile deformities
- Fixed deformity
- Adjustability
- Pressure reduction
- Heat
- Weight
- Maintenance and cleaning
- Application
- Sensation
- Gravity
- Comfort
- Cosmesis

Special principles:

1) Principle of Jordan
2) May assist with residual motor power or substitute for absent motor power
3) Prehension force must be adequate
4) Only one action
5) Operation of electrically powered orthosis
6) Tactile sensation

Assessment :

Subjective assessment:

- Comprehension
- Complaints – pain, performance, appearance
- Previous orthotic experiences
- Gadget tolerance
- The goals
- Economic consideration

OBJECTIVE ASSESSMENT:

-Type of paralysis and prognosis

-Limb alignment

-Joint range

-Muscle power

-Coordination and spasticity

-Sensory status

-Skin

-Manual dexterity

-Vision

-Other disabilities

Description of orthoses:

1) **Calvicular orthoses:**

Regional name: shoulder orthosis

Common names: figure of four harness, clavicular brace/ harness

Functions	Indications
- Restrict motion to promote tissue healing	Clavicular fractures
- Improve posture	- Forward shoulder posture - TOS
- Reduced scapular myofascial pain	- Cumulative trauma disorder
- Increase/maintain PROM	- Pectoral contractures

Materials :

- Webbing straps
- Padding and velcro
- Prefabricated orthoses often used.

Placement :

- Material goes over clavicles, under arms and crosses over high thoracic spinous processes.

Biomechanical efficacy:

- Restrict movement of the clavicle and to some extent inhibit scapular protraction while allowing free movement at the GH joint.

2) **Arm sling**

Regional name: shoulder orthosis

Common names:

figure of eight slings

universal sling

Nothern ring sling

Cuff sling

Hemi sling

Orthopaedic sling

Flail arm sling

Homemade Bandanna- Type sling

Glenohumeral support

Hook hemiharness

Rolyan hemi Arm sling(vertical arm sling)

Functions	indications
- Immobilize to promote tissue healing	- AC joint injury - Scapular, humeral fractures - PO shoulder repair/arthroplasty - PO tendon,artery, or nerve repairs - Rotator cuff injury - Bicipital tendinitis
- Prevent overstretching of GH musculature/ligaments	- Brachial plexus lesion
- Decreased shoulder pain related to arm distraction and shoulder-hand syndrome	- Upper motor neuron lesion: hemiparesis with subluxation
- Keep hand and forearm elevated to reduce oedema	

Placement :

Most slings support the forearm with the elbow flexed, shoulder internally rotated and arm adducted.

- The Rolyan hemi arm sling supports the humerus and allows the elbow and forearm to be free by using a humeral cuff with figure of eight suspension.

- The hook hemiharness has two humeral cuffs connected by a posterior yoke and abduct each arm slightly while allowing the elbow and forearm to be free.

Biomechanical efficacy :

- Slings may be static or dynamic.

- Dynamic slings use elastic straps and are designed to allow some motion of the forearm while supporting the arm.

- The wrist should be supported by the sling to prevent wrist drop if there is distal weakness.

- Hand should be higher than the elbow to decrease the oedema.

- Care must be taken to mobilize the shoulder SOS possible to prevent adhesive capsulitis.

Materials :

- Cloth
- Webbing
- Elastic
- Metal ring/ fastners
- Velcro
- Prefabricated slings are often used.

Contraindications:

- Slings have fallen over out of favour with a neurodevelopment treatment approach to UMN lesion because they are thought to encourage flexion synergy, increase flexor tone, and promote contractures.

- The Rolyan hemi arm slings or the hook hemiharness may not approximate the GH joint in a large patient.

3) **Arm abduction orthosis:**

- Regional name: shoulder elbow wrist hand orthosis

- Common name: airplane splint

Functions	Indications
- Immobilize to promote tissue healing	- Axilary burns - Post operative shoulder fusion - Post operative scar release - Shoulder dislocation
- Increase PROM by soft tissue elongation via low load prolonged stretch(serial static splinting)	- Burns - contractures

Placement :

- Medial arm and lateral trunk with weight of arm borne primarily on the iliac crest or lateral trunk.

- May be one piece or separate waist piece with arm attachment.

Biomechanical efficacy:

- The shoulder should be positioned in abduction with the degree determined by pathology.

- Care should be taken not to overstretch skin, nerves or vascular structure.

Material :

- Casting

- Thermoplastic

-Metal

-Pillow

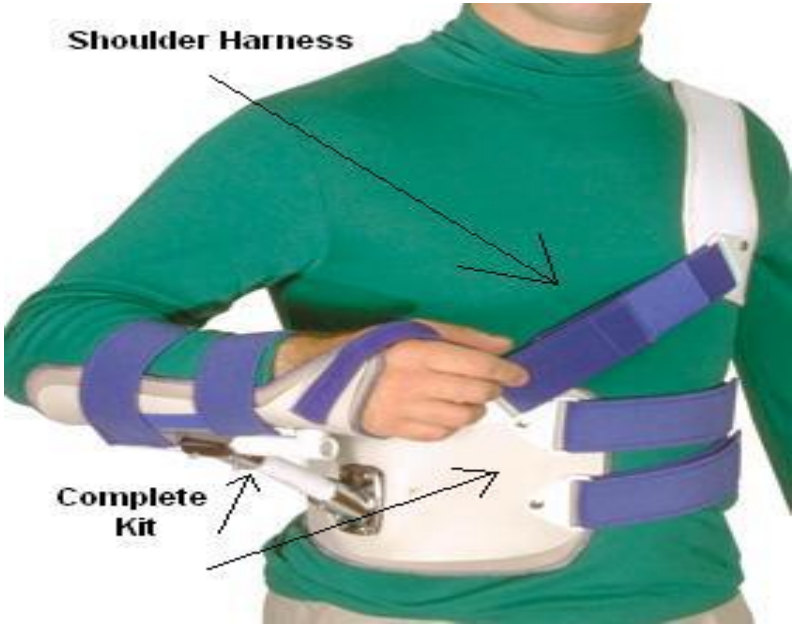
- Padding

- Strapping

- Velcro

Functional arm orthosis

Arm suspension sling – deltoid aid



Balanced forearm orthosis- gun slinger

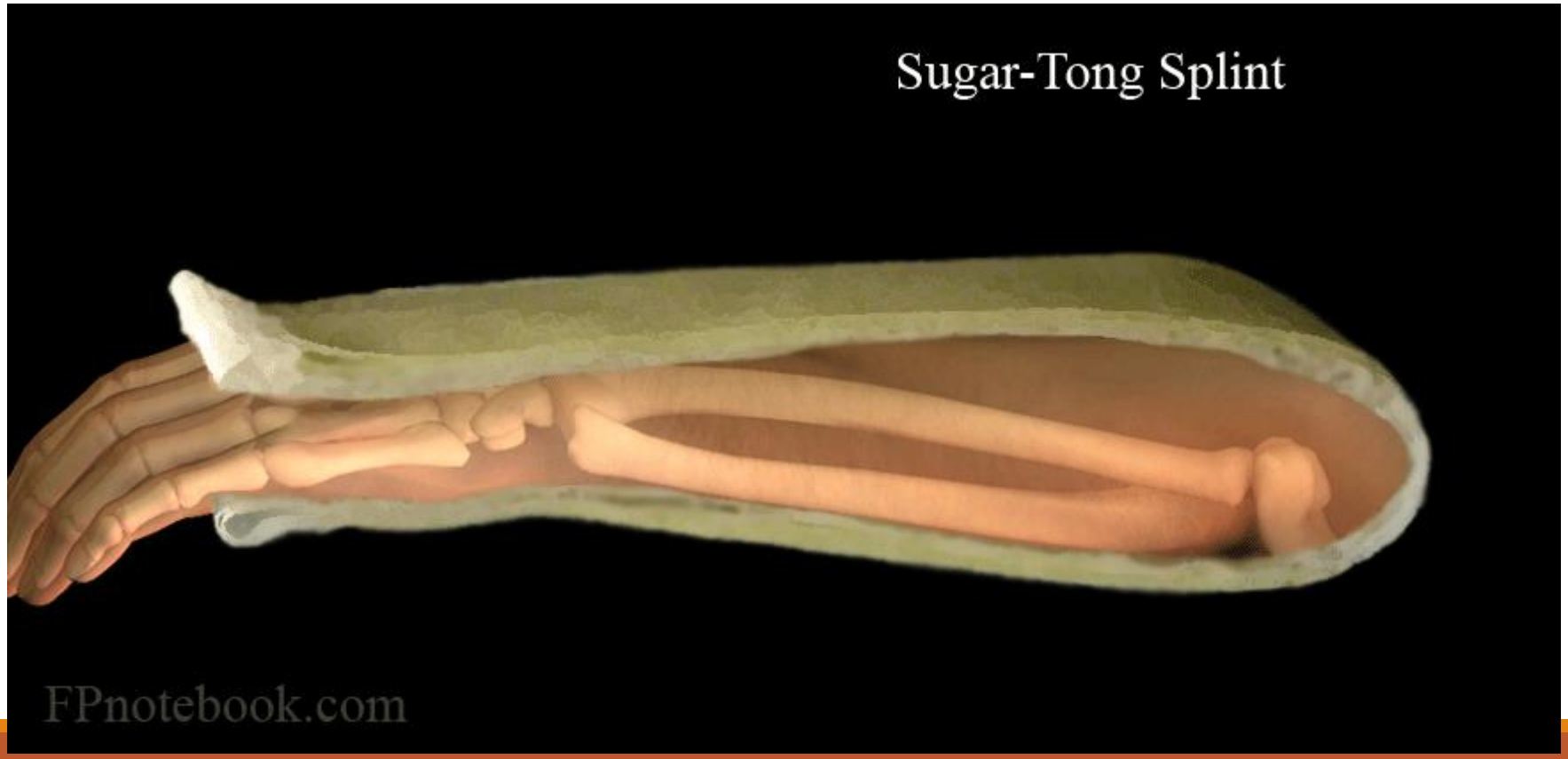
Arm supports- wheelchair arm trough

Nonarticular fracture orthosis- humeral fracture brace

4) **Elbow- forearm wrist othosis:**

Regional name : elbow wrist hand orthosis

Common name: sugar-tong splint



Functions	Indications
- Immobilize elbow/forearm/wrist to promote tissue healing	- CTD - Forearm fractures - Post operative elbow arthroplasty - Post operative ulnar nerve transposition

• **Placement :**

- Circumferential with elbow in 90^0 of flexion and forearm/wrist in neutral.

• **Biomechanical efficacy:**

- Orthosis should totally restrict elbow, wrist and forearm AROM yet should allow full active use of all digits.

• **Materials :**

- Thermoplastics
- Strapping
- Velcro

5) **Elbow or wrist mobilization orthoses:**

Regional name: elbow orthoses or wrist orthoses

Common name:

- Dynamic elbow
- Wrist flexion/extension splint
- Dynasplint
- Ultraflex splint
- Static progressive splint
- Phoenix wrist hinge
- Turn buckle splint

Biomechanical efficacy:

- In most cases, the thumb should be positioned in palmar abduction so that three jaw chuck prehension is easily achieved , unless pathology dictates otherwise.
- Material should not restrict motion of digits 2-5.

Materials :

rigid: thermoplastics, metal, strapping, velcro, casting, padding

Flexible: neoprene, elastics, fabric, leather, strapping, velcro

8) Ring orthosis :

Regional name: finger orthosis

Common name:

- Silver ring splint
- Swan neck splint
- Figure eight splint
- PIP hyperextension block splint
- Murphy ring splint
- Boutonnaire splint
- Pulley ring
- PIP extension stop

Functions	Indications
Block PIP/DIP hyperextension but allow normal IP flexion /extension	Arthritis Swan neck deformity PIP/DIP volar palte injury
Prevent overstretching of PIP/DIP volar plate	
Prevent further deformity	
Immobilize PIP in extension (DIP free)	arthritis
Prevent deformity	Boutonniere deformity
Prevent bowstring of flexor tendons	A2 pulley injury(annular pulley for flexor tendon located on volar surface of proximal phalanx)
Protect reconstruction/ allow dynamic motion, without immobilizing finger	Post operative pulley repair

Biomechanical efficacy:

- Rings are custom fitted and worn at all time.

swan neck splint:

- Prevent IP hyperextension via three points of pressure but allows full IP flexion.

- Lateral or distal supports may be added for stability.

boutonniere splint:

- Immobilize the IP in extension via three points of pressure. Needs to remove several times in a day.