Orthotic Interventions and Therapy for Upper Extremity Contractures - Elbow
Kristin Valdes OTD, OT, CHT

How much elbow motion do you need?
- A range of motion of 100° (30° to 130°) is required for proper elbow and upper extremity function, and a loss of 50° of motion will result in a functional loss of 80% in activities of daily living

What causes elbow stiffness

Primary causes
- Capsular shrinkage
- Soft tissue contractures determined by an elevated number of myofibroblasts

Secondary causes
- Heterotopic ossification
- Malunions
- Contractures after burn injuries
- Intra-articular cartilage damage
- Free bodies
- Gross osseous incongruence

Intrinsic Sources of Contracture
- Incongruity of Articular Surfaces
- Bony Block or Hardware Block

Extrinsic Sources of Contracture
- Joint Capsule Shortening/Fibrosis
- Adherent Brachialis
- Collateral Ligament Shortening/Fibrosis
Extrinsic Sources of Contracture

- Skin
- Nerve
- Edema
- Muscle-Tendon Unit

Examination of Extrinsic Sources

- Assess Muscle Length of Biceps
- If you have greater elbow extension in forearm pronation, biceps is tight

Examination of Extrinsic Sources

Assess Muscle Length of Triceps

Tightness limits elbow flexion

Who will get a stiff elbow?

- Genetic predisposition and prolonged immobilization have been reliably identified as major risk factors

Treatment options

- Surgery
- Possible contraindications
  - Additional trauma to the joint
  - Neurovascular damage
  - Additional stiffness
- Orthotic Intervention
- The key to this treatment is the viscoelastic nature of connective tissue

Reflections on Mobilizing the Stiff Hand (or elbow) by Ken Flowers

- Joint mobilization
  - This reality of viscoelastic behavior is what dooms stretching techniques (e.g., joint mobilization) to a very limited application in managing joint stiffness.
- Low-grade mobs can mitigate pain and muscle guarding prior to therapeutic exercise.
- High-grade mobs can pre-condition joints in preparation for taking PROM readings.
Tissue Expansion

- Tissue stretches when mobilized but returns to resting length once force is released.
- Tissue expansion describes two types of creep—mechanical creep (stretch), which is elongation because of the elastic nature of tissue and biological creep, which is the generation of new tissue or growth because of metabolic activity.

Dose of Orthotic Application

- Fibroblasts of the connective tissue respond to stress to alter the infrastructure, resulting in lengthened tissue if the dose is adequate.
- Further, the stress dose is a combination of intensity, frequency, and duration.
- Again, orthotic intervention has the advantage of high potential duration and frequency, and even intensity, if needed, by adding dynamic or static progressive forces.

Orthotic Considerations for Articular Cartilage

- Sustained orthotic immobilization without cartilage compression promotes formation of synovial adhesions, especially in an injured joint, which block absorption of nutrients at the surface of the cartilage.
- Thus, restriction of joint mobility should be regarded as undesirable and where possible, joints should be excluded from an orthotic design.

Low-load prolonged stress

- According to Brand when living tissue (such as skin, ligament, joint capsule, or tendon) is held in a slightly lengthened position, within its elastic range (i.e., low load) for a period of hours or days (i.e., prolonged), the fibroblasts will sense the tension and synthesize more collagen, causing growth and optimal remodeling.

Splinting for ROM Deficits

- Low Load Prolonged Stress

Guidelines

- The number of joints restricted by the orthosis should be kept to a minimum.
- Intermittent ROM exercises should be permitted to ensure circulation of nutrient-rich interstitial fluid to tissues and SF to tendons.
- Encourage active muscle contraction to facilitate the return of venous blood and lymph.
Amount of Force—No Pain

- Force should be low enough that the client senses the tension but feels no pain.
- Hepburn suggested the following guidelines for nontraumatic, effective stress applied by a dynamic orthosis:
  1. the stress should not be perceived as a “stretching” force until at least one hour has passed
  2. the client should remain comfortable with the orthosis for up to 12 hours
  3. after its removal, the client should feel no more than a feeling of stiffness or a mild ache, which quickly resolves.

End-range Time and Physiological Tissue Response

- In 1994, Flowers and LaStayo demonstrated that the improvement in ROM is directly proportional to the length of time a joint is held at its end range, which they called total end-range time (TERT).
- Joint Active Systems (JASs), propose that short daily treatment times—one to three 30-minute treatment sessions per day—are effective and produce tissue elongation through stress relaxation.

Static progressive

- Prolonged low intensity stretch encourages increased length of tissue. Tissue adapts and new collagen fibers are laid down in new elongated position.
- Force is adjusted as tissue adapts.

Current Best Evidence Muller et al. 2013

- Effectiveness of bracing in the treatment of nonosseous restriction of elbow mobility: a systematic review and meta-analysis of 13 studies.

- 13 eligible studies, providing data on 14 treated groups in 247 patients. The mean age of these patients was 34.5 ± 10.4 years, and female patients comprised 46% ± 12%.
- The mean duration from the incident to the start of brace treatment was 6.9 ± 5.1 months.
- The mean improvement in range of motion during the course of treatment was 38.4° ± 8.9° (95% confidence interval, 39.5°-41.8°).

- **Flexion gained**
  - The mean gain in flexion was 17° ± 8° (95% CI, 16.2°-18.1°).
  - Dynamic bracing resulted in the largest improvement of range of motion, with an increase of 28° ± 6° (95% CI, 25.1°-29.3°).
  - Static-progressive splints resulted in a slightly lesser improvement, with 17° ± 6° (95% CI, 15.9°-18.7°).
  - Static splints had the least improvement, with 10° ± 6° (95% CI, 8.6°-12.1°).
The mean gain in extension was $23^\circ \pm 8^\circ$ (95% CI, 21.9°-23.9°).

The largest improvement was seen with dynamic splinting, measuring $28^\circ \pm 11^\circ$ (95% CI, 24.7°-30.2°).

Static splinting, with $27^\circ \pm 6^\circ$ (95% CI, 25.6°-29.0°).

SPS, with $19^\circ \pm 9^\circ$ (95% CI, 17.5°-20.2°).

All 3 types of bracing led to significant improvements of range of motion.

Extension gained

Given the favorable outcome and the patient-friendly protocol of treatment 3 times 30 minutes per day in each direction —flexion and extension—SPS is the treatment of choice.

However, our data also support the use of other splinting techniques, and on the basis of this study, there is no obvious superiority of any one treatment based on actual effect size. Thus, if SPS cannot be made available to a patient, dynamic or even static splints are valuable and worthwhile alternatives.

5-30° extension deficits with firm (springy) end feel

20-90° extension deficits with Firm (aka cement) end feel

Flexion from 100-125° Firm (springy) end feel

5-30° extension deficits with firm (springy) end feel

Anterior Serial Static Extension Splint

Belly Gutter Extension Splint

20-90° extension deficits with Firm (aka cement) end feel

Anterior tumbuckle until 20 degrees extension

Green and McCoy (1979)

Flexion from 100-125° Firm (springy) end feel
Flexion $100^\circ$ or less
Two Turnbuckles applied in open position and turned to flex elbow

Splinting for Rotation
- Longitudinal axis for forearm rotation.
- Line of pull is 90 degrees perpendicular to axis

Rotation deficits: Firm end feel
- Colello-Abraham Rotation Splint
- Use either dynamic or static progressive 4 lines of pull
- Addresses both deficits with one splint

Rotation deficits: Firm

Commercial components for rotation splint

Commercial Splints

Splint Wearing Schedule
- Extension splint at night
- Flexion splint during the day
- Prefer one 60 minute session vs. two 30 minute sessions-due to time needed to reach new end range position
Anterior HO Following Immobilization

Treatment Options for HO

- Splinting or Serial Casting
- Medications
  - NSAIDS
  - Biophosphonates
- Radiation
- Surgery (Excision)


Thank You

kav52@drexel.edu