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Conservative Contracture Remediation for the Upper Extremity Series

Part 2 - Elbow

Ellie Pong DPT, MOTR/L

• This course series will explore conservative treatment combinations including modalities, Botulinum toxin injections, dynamic and static splinting, and hands-on soft tissue and joint mobilization for patients with soft tissue and joint contractures of the upper extremity. Neurological and orthopedic-caused contractures will be addressed separately.

• The series consists of three courses: The Shoulder Complex; The Elbow; and The Wrist and Hand.
Learner Outcomes

As a result of this course, participants will be able to:

1) ...identify the joint and soft tissue structures of the elbow that are commonly problematic in neurological and orthopedic contractures

2) ...recognize in post-course testing, best combined use of conservative treatments including modalities, splinting, hands-on manual treatments, and Botulinum toxin injection guidance to treat patients with contractures of the elbow.

3) ...discuss and later incorporate into the participant's daily practice, evidence-based conservative treatments as well as those pending clinical trials which have demonstrated successful use in the clinic for these impairments.

The Stiff Elbow

• When considering treatments for a patient who has elbow stiffness, a consideration of the tissue status is very important.
  – Normal tissue, non-fibrous or scarring, tightened from simple non-use.
  – Fibrous tissue from scar formed in normal healing process.
  – Fibrous tissue from burn scarring with superficial and deep tissue contracture.
  – Bony tissue from unknown reactive tissue pathology.
  – Hypertonic contractile tissue with contracture of both muscle and tendon.
  – Hypotonic tissue with contracture due to gravity, muscle unable to maintain normal anatomical positioning.
The Stiff Elbow

- Elbow stiffness can be caused by pathologies requiring highly specialized treatments outside of the scope of this course, such as burn scarring, upper limb lymphedema, or pediatric upper limb dysfunction after brachial plexus birth injury.
- We will address more generalized causes today, yet provide specific treatment examples.

The Stiff Elbow

- Normal tissue, non-fibrous or scarring, tightened from simple non-use.
  - After an injury such as fracture of the clavicle, the arm is kept in a sling for close to 6 weeks.
  - Many tissues are tightened as a result, especially the biceps brachii.
  - The actual structures of the humeroulnar and proximal radioulnar joints are not in a healing mode.
  - Stretching is not painful, although some discomfort may be present, and the biceps tends to be a very reactive muscle.
  - Joint mobilizations will be more general due to less-specific structural restrictions.
The Stiff Elbow

• Fibrous tissue from scar formed in normal healing process.
  – After elbow surgery such as distal biceps tendon repair, patient is restricted in active use of the elbow.
  – Passive range is limited at first, gradually increasing.
  – Meanwhile, in the natural healing process, scar develops in the healing tissues.
  – Our stretching and mobilizations must not disrupt the repair, and they must avoid engendering an excessive scar healing response by their aggression. Specific techniques will address specific tissues.

The Stiff Elbow

• Bony tissue from unknown reactive tissue pathology.
  – In the elbow, this occurs with heterotopic ossification of the elbow.
  – Stages of pathology with resulting tissue differences must be considered.
  – We must avoid increasing the body’s reactivity and engendering a prolonged or exacerbated response to pain or tissue trauma.
The Stiff Elbow

• Hypertonic contractile tissue with contracture of both muscle and tendon.
• Hypotonic tissue with contracture due to gravity, muscle unable to maintain normal anatomical positioning.
  – Now the situation is extremely complex. A myriad of relationships between hypertonic and hypotonic restrictions must be considered.
  – No matter what we do to the tissue, the tone will not permanently change to normal; therefore, there will always be likelihood of redevelopment of contracture.

Anatomical Considerations

a. Coracobrachialis
b. Biceps brachii
c. Brachialis
d. Supinator
e. Pronator Teres
f. Triceps brachii
Biomechanical Considerations

- In any contracture, there will be (at the very least) an imbalance of short, tight structures and lengthened, often weakened, structures.
- Pathological structures may be contractile and/or non-contractile.
- The very basics of the biomechanical alterations then lead us to a two part harmony of lengthening and strengthening to restore “normal” joint movement.
Biomechanical Considerations

• In contractures of the elbow, we must consider alterations in all joints of the elbow.

• At times it appears that treatments focus on the humeroulnar joint without regard for proximal radioulnar and humeroradial joint alterations.

Biomechanical Considerations

• Elbow musculature considerations:
  – Muscles that move shoulder and elbow
  – Muscles that mainly move only the elbow
  – Muscles that move elbow and forearm
  – Even muscles that move shoulder, elbow, and forearm
    • Consider the biceps, which provides 60% of supination strength (Schmidt et al., 2014), in addition to elbow flexion and shoulder flexion (primary movements).
Biomechanical Considerations

• As we explore treatments for the stiff elbow then, we must consider both the passive limitations (tightened tissue) and the dynamic limitations (muscle weakness, altered kinematics producing blocks to movement).

• Let us begin with a review of general elbow contracture treatments.

General Elbow Contracture Treatments

• A general order of treatment:
  – Physically warm the tissue
    • Exercise or moist heat
  – Long positional stretching
    • Relax tissues to full length potential
  – Soft tissue work, manual stretching
  – Joint mobilization
  – Functional activity, strengthening
  – Splinting at home, at rest
General Shoulder Contracture Treatments

• Physically warm the tissue
  – Exercise or moist heat
    • You want to avoid beginning the session with pain
    • If the patient is unable to perform a warming exercise, such as pulleys or UBE (arm bike) without pain, then moist heat is a better choice.
    • If using moist heat, position the patient comfortably and direct the heat at the specific limited structure
      – Supine, bolster under knees, pillow under head but not shoulders, towel pad full length of arm if needed; sidelying is also possible
      – If sitting, prop arm on a pillow

General Elbow Contracture Treatments

• In the elbow, there are restrictions of joint structures that will benefit from joint mobilization; however, many times the joint itself is not contracted.
• The muscles are often responsible for the contracture of the elbow, especially the biceps.
  – What are some reasons for this?
General Elbow Contracture Treatments

- Long positional stretching
  - Relax tissues to full length potential
  - These will of course depend upon the area of restriction and the patient’s position tolerance.

General Elbow Contracture Treatments

- Stretching
  - Must relax tissues to full length potential
  - Let’s consider some less effective stretches:
General Elbow Contracture Treatments

• Stretching
  – Less effective stretches:

General Elbow Contracture Treatments

• Stretching
  – Less effective stretches:
General Elbow Contracture Treatments

• Long positional stretches
  – Biceps stretch, hooklying on foam roller:

For this stretch to work, a small bolster or towel roll must be inserted under the distal humerus, providing a fulcrum for elbow extension

General Elbow Contracture Treatments

• Long positional stretches
  – Triceps stretch, sidelying, with a strap, soft splint, or towel belt
  – The other end is secured under the resting arm.
General Elbow Contracture Treatments

• Long positional stretches
  – Same triceps stretch, with a soft splint worn
  – Can be made for the clinic to use
  – Requires foam 1” straps and foam 2” or > straps
  – Velcro or buckles, make sure it is secure

General Elbow Contracture Treatments

• Long positional stretches
  – Stretch to improve elbow flexion
  – Not all patients will benefit
  – Must have enough flexion present for mechanical advantage
    • Have to weight-bear over the joint
    • Must be allowed to put weight/force through the joint
General Elbow Contracture Treatments

• Soft tissue work, manual stretching
  – Many techniques are available, some can be very painful
  – Consider carefully the role that increased pain may play in increasing muscle tension, patient guarding, inability to reach true end range
  – A deep comfortable massage of the muscles that is not painful appears to engender both tissue and subjective relaxation.

General Elbow Contracture Treatments

• Soft tissue work
  – Myofascial release, cross-friction, massage
  – Example: **cubital tunnel soft tissue extensibility** (Patla, 2002, p. 66)
    • Therapist uses both thumbs to sweep along the flexor and extensor margins in the cubital fossa (Patla, 2002)
General Elbow Contracture Treatments

• Cubital tunnel soft tissue extensibility

Image adapted with changes by the author to the original from https://resultsphysiotherapy.com/wp-content/uploads/2014/12/0444.jpg

General Elbow Contracture Treatments

• Passive range of motion and manual stretch techniques.
  – Example: **Short head biceps stretch in two stages** (Patla, 2002)
  – Therapist stabilizes through the coracoid process
  – Stage 1: Therapist performs a passive shoulder external rotation with one hand until the coracoid process moves anteriorly into the stabilizing hand (Patla, 2002).
General Elbow Contracture Treatments

• Short head biceps stretch in two stages

General Elbow Contracture Treatments

• Short head biceps stretch in two stages (Patla, 2002)
  – Therapist maintains Stage 1 with ER and coracoid process stabilization (Patla, 2002).
  – Stage 2: Therapist performs a passive elbow extension with pronation; the coracoid process should again be felt to push anteriorly into the therapist’s stabilizing thumb (Patla, 2002).
General Elbow Contracture Treatments

• Short head biceps stretch in Stage 2:

- Specific manual muscle stretching
  - Example: **Long head of biceps stretch** (Patla, 2002).
  - Therapist stabilizes acromion with one hand
  - Therapist positions and maintains GH joint in full extension with 30-40 degrees abduction and forearm in pronation.
  - Therapist moves elbow into extension until resistance is felt, holds stretch (Patla, 2002).
General Elbow Contracture Treatments

- Long head of biceps stretch (Patla, 2002).

General Elbow Contracture Treatments

- Joint Mobilizations

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General Elbow Contracture Treatments

• Joint Mobilizations

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General Elbow Contracture Treatments

• Joint Mobilizations: **distraction of the ulna**
  - Therapist’s forearm produces a caudal force from her finger placement on the patient’s ulna.
  - The line of force is 45 degrees from perpendicular in the anterior direction.
  - Therapist must take up the muscle slack before providing the joint mobilization.
    • (Magee, 2008, p. 385; Patla & Paris, 2000, p. 111)
General Elbow Contracture Treatments

• Joint Mobilizations: cephalic movement of radius (Patla & Paris, 2000, p. 113)
  • Therapist stabilizes by grasp of the posterior distal humerus and posterior proximal ulna, cupping the posterior-medial joint aspect.
  • Therapist’s other hand provides manipulation with her thenar eminence to the patient’s thenar eminence contact, Sawmiller’s grip. Maintains patient’s wrist in extension.
  • Force is directed from therapist’s forearm in cephalic direction through thenar eminence contact, compress and rotate.
General Elbow Contracture Treatments

- Joint Mobilizations: **caudal movement of radius** (Patla & Paris, 2000, p. 114)
- Therapist stabilizes with a grasp of the patient’s anterior-distal humerus.
- Manipulation is given by therapist’s other hand contacting the patient’s distal radius in a golfer’s grip.
- Therapist’s forearm and hand provides a downward (caudal) force on the radius.
- Oscillation may be added, and movement of joint to end range extension may be combined.
General Elbow Contracture Treatments

- Joint Mobilizations: **Outward roll of radius and ulna, distal** (Patla & Paris, 2000, p. 100)
- Patient sits with forearm supported in supination on table.
- Therapist uses the thenar eminence of each hand to contact the patient’s distal radius and ulna.
- Force is provided through these contacts in volar and outward directions from the midline of the patient’s forearm.
General Elbow Contracture Treatments

- Joint Mobilizations: **Anterior glide of radial head** (Patla & Paris, 2000, p. 112)
- Therapist stabilizes with a grasp around the patient’s distal humerus.
- Therapist provides mobilization through contact of thumb against posterior surface of radial head, while fingers are positioned on the anterior myofascial plane.
- Therapist thumb pad contact to deliver anteriorly directed mobilization of the radial head.

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General Elbow Contracture Treatments

- Joint Mobilizations: **Anterior glide of radial head** (Patla & Paris, 2000, p. 114)
General Elbow Contracture Treatments

- Joint Mobilizations: **Posterior glide of radial head** (Patla & Paris, 2000, p. 112)
  - Therapist stabilizes with a grasp around the patient’s distal humerus.
  - Therapist positions pad of thumb against posterior surface of the patient’s radial head, while her fingers provide mobilization force through their position on the anterior myofascial plane.
  - Therapist provides a posterior directed force against the radial head via the contact of her fingers.

General Elbow Contracture Treatments

General Elbow Contracture Treatments

• Joint Mobilizations: Palpating the radial head (Patla & Paris, 2000, p. 112)

![Image of joint mobilization technique]

General Elbow Contracture Treatments

• Joint Mobilizations: Alternate contact for posterior glide of radial head (Patla & Paris, 2000)

![Image of joint mobilization technique with posterior glide indication]
General Elbow Contracture Treatments

- Joint Mobilizations: **Dorsal glide of the radius on the ulna** (Patla & Paris, 2000, p. 99)
- Patient is sitting with forearm in neutral, supported on table.
- Therapist stabilizes with an underhand grasp of the patient’s distal ulna and lateral side of the carpals.
- Therapist contacts the volar-distal surface of the radius with her proximal palm, while her finger pads contact the dorsal-distal aspect of the radius. **KEEP OFF THE ULNA!**
- Mobilization is given through the palm contact on the volar radius in the dorsal direction.
General Elbow Contracture Treatments

- Strengthening of weak antagonists
  - May enhance with Functional Electric Stimulation
  - Think about how we use our hand and arm functionally; we do not make just one movement at a time
    - For the elbow, consider FES with elbow flexion and supination
    - For the elbow, consider FES with elbow extension and pronation
    - Or a combination with shoulder and hand with the functional activity

General Elbow Contracture Treatments

- FES functional example:
  - FES with elbow flexion and supination – picking up a spoon, bringing to mouth
  - Return motion FES with elbow extension and pronation, placing spoon on table

- Two channels, placed on direction of difficulty
  - Ch 1: motor point of biceps; Ch 2: belly of supinator
  - Ch 1: distal aspect of triceps; Ch 2: belly of pronator teres
General Elbow Contracture Treatments

- FES example:

At all times, remember that transfer of training is often poor.

Remember human task motivation for functional activity versus lifting a free weight.

Use functional activities and movements when possible.
General Elbow Contracture Treatments

• Splinting Considerations
  – Botulinum toxin focal injections to force relaxation, improving tolerance to splinting and stretching
  – Dynamic and static splinting
    • Pros and cons, specific applications

• Reminder of tissue mechanics we hope to achieve with splinting:
  – “Connective tissue is capable of being stretched after it shortens because of its viscoelastic nature. Under tension, it can respond by reaching either an elastic or plastic deformation state. In elastic deformation, tissue reverts to its original length after a force is removed; however, when tissue is plastically deformed, it will maintain a newly elongated length after removal of the force” (Ulrich et al., 2010, p. 196-197).
Splinting Tools

- Treatment – Dynamic Splinting
- Let us discuss some common errors in utilization of dynamic splinting.
  - Contracture must be not due to bony block.
  - Relaxation of the tissue in a lengthened position must be present for “creep” to occur.
  - This cannot be achieved if the splint pressure is too great as to produce pain.
    - Tissue will simply become painful and reactive, so the patient will carry it in shortened position defensively.

Splinting Tools

- Treatment – Splints providing creep-based loading to obtain plastic deformation of soft tissue
- Force is constant and applied over time.
  - Hours
- Displacement varies
- Low load with prolonged stretch
- (Ulrich et al, 2010)
Splinting Tools

- Treatment – Splints providing creep-based loading

- [YouTube video](https://youtu.be/3-_WVe7a3h4) on how to apply and wear pron sup Dynasplint
Splinting Tools

- Treatment – Splints providing stress-relaxation loading to obtain plastic deformation of soft tissue
- Force varies over time
- Displacement is constant
- “Stress relaxation principles can be further applied in the therapeutic technique of static progressive stretch. Static progressive stretch is defined as incremental, periodic application of stress relaxation where the force applied changes over time as the tissue accommodates” (Ulrich et al., 2010, p. 197).

Splinting Tools

- Treatment – Splints providing stress-relaxation loading
Splinting Tools

• Treatment – Other splinting kits and custom

Splinting Tools

• Treatment – Other splinting kits and custom
• Static Progressive Splint #2: 3-Point Design
Splinting Tools

- Treatment – Other splinting kits and custom
- **Dynamic Elbow Flexion Splint Kit**
  - [https://www.ncmedical.com/item_604.html](https://www.ncmedical.com/item_604.html)

Splinting Tools

- Treatment – Yes, there is a CPM for the elbow!
- **Continuous Passive Movement for Elbow**
  - [http://www.diamondathletic.com/product;cat,21;item,1111;Continuous-Passive-Motion-Units-&-Dynamic-Splints-E2-Elbow-CPM-Unit#](http://www.diamondathletic.com/product;cat,21;item,1111;Continuous-Passive-Motion-Units-&-Dynamic-Splints-E2-Elbow-CPM-Unit#)
Neurological Elbow Contractures

• Now we will discuss treatment options for elbow contractures caused by a neurological pathology.
• We have gone into great detail already regarding order of treatment as well as specific treatments, and these still apply with a few important differences.

Neurological Elbow Contractures

• Problem:
  – Hypertonic muscles prevent effective stretching in a relaxed, fully lengthened position of the muscle fibers.
  – Interventions, whether surgical lengthening or sessions of botox, stretching of the hypertonic agonist and strengthening of the weak antagonists, yield temporary results.
  – The cause of the problem, in the brain, remains…and will continue to re-shorten the tissue.
Neurological Elbow Contractures

• Does this mean that we should not try to intervene, because we know it will be only temporary?
  – No. But we do need to make it clear to the patient and/or caregivers that what we provide will most often be temporary improvement, and may be repeated.
  – Quality of life is the benefit here, whether for active use of the arm, or for ease to the caregiver and patient in dressing and other assisted or dependent activities of daily living (Lam et al., 2012).

Neurological Elbow Contractures

• Distinguish between the function of the extremity and the function of the individual.
  – We think of active function and passive function of the extremity. These terms refer to the expected outcomes for a limb but do not indicate the outcome for the person as a whole. Surgical releases of an arm contracted in a flexed and internally rotated position in a hemiplegic patient often allows the person to become independent in dressing even though the arm itself remains nonfunctional” (Keenan & Mehta, 2004, p. 144).
Neurological Elbow Contractures

• Treatment of patients with contractures of the elbow and forearm due to neurological causes may include stretching and strengthening enhanced by dynamic splinting and botulinum toxin injection.
• This is an even more useful combination when applied here versus orthopedic contracture.
  – Why?

Neurological Elbow Contractures

• Currently, large double-blind, randomised, placebo-controlled studies are focused on proving that the use of botox in the upper extremity for the neurologically impaired patient population is safe (Gracies et al., 2015).
Neurological Elbow Contractures

• Considerations:
  – For dynamic splinting and manual stretching to be effective, the tissues must be able to attain a fully lengthened position, or a true end range.
  – The muscle must be relaxed to achieve this.
  – Careful and selective use of botulinum toxin can assist to provide a temporarily relaxed muscle.

Neurological Elbow Contractures

• Considerations:
  – Important! Leave enough for function!
  – Example: hypertonicity in elbow flexors, elbow flexion contracture
  – Use botox injection in specific elbow flexors but not all three of them. Assess what the patient is using for function, then choose.
    • Biceps
    • Brachialis
    • Brachioradialis
Neurological Elbow Contractures

• Think about targeting injections into motor points for best results:
  – “A reference line was defined as a line connecting the coracoid process with the lateral epicondyle of the humerus. The location of the motor points of the biceps brachii and brachialis muscles was identified in reference to the reference line. The motor point of the biceps brachii muscle was found to be approximately half of the reference line. In the brachialis muscle, the location of the motor point was 70% of the reference line from the coracoid process and 2 cm medial to the line” (Park et al., 2007, p. 459)

Neurological Elbow Contractures

• Caution: “In a neurologically impaired patient it is frequently difficult to distinguish between the many potential causes of limited joint motion” (Keenan & Mehta, 2004, p. 149).
  – “…increased muscle tone, a myostatic contracture, the presence of periarticular HO, an undetected fracture or dislocation, joint subluxation, pain, or the lack of patient cooperation secondary to diminished cognition” (Keenan & Mehta, 2004, p. 149).
Neurological Elbow Contractures

– Consider our previous FES example, and adjust for neurological cause:

– Spoon to mouth – biceps and supinator
  • Initiated with elbow flexion, Channel 1 ON
  • Then refined with supination, Channel 2 ON
  • Pause, then Channel 1 OFF with Channel 2 remaining ON
  • Pause, then Channel 2 OFF
  • RELAX ARM
  • REST

Neurological Elbow Contractures

• Considerations for FES with neurological muscle weakness:
  – Time needed for full contraction of muscle is longer
  – Time needed for full muscle relaxation is longer
  – Fatigue is earlier
  – Therefore, longer ramp times are needed with longer rest times in between and fewer repetitions before lengthy rest period.
Neurological Elbow Contractures

• Motor points are important for successful FES as well:
  – Just as identification and utilization of correct motor points were demonstrated important in injection earlier, they also produce best effects in FES, with the greatest response at least discomfort to the patient (Forrester & Petrofsky, 2004).

Neurological Elbow Contractures

– Is there supportive evidence for use of FES on the elbow to treat neurological elbow contractures?
– Meadmore and associates (2014) have demonstrated positive results in the application of FES to three muscle groups in the upper limb to complete goal-oriented movements to facilitate functional motor recovery post-stroke.
– “During each session FES was applied to the anterior deltoid, triceps, and wrist/finger extensors to assist performance of functional tasks with real-objects, including closing a drawer and pressing a light switch” (Meadmore et al., 2014, p. 105).
Neurological Elbow Contractures

– Supportive evidence for use of FES to treat neurological elbow contractures?
– Why not just use as one would a cane?
  • “However, FES may cause strong involuntary muscle contractions and can be painful for patient” (Maciejasz et al., 2014p. 17 of 29 in pdf).

Neurological Elbow Contractures

• What about dynamic and other splinting?
  – The splints I featured earlier can be used.
  – I strongly recommend using only with concurrent botox injection.
  – Bulky – remember the supination splint cage?
  – I find the use of dynamic splints more reasonable for neurological contractures of the wrist and hand, as less of the total arm is restrained by the device as for an elbow splint.
Neurological Elbow Contractures

• What about other presentations? What about other patterns?
• The strategy is the same:
  – Identify the major players restricting functional use of the elbow and entire arm.
  – Target these muscles with your lengthening and relaxing treatments as we just discussed.
  – Strengthen the weak antagonists.
  – Be respectful of bony or painful joint limitations.
  – Recognize that function does not require a standardized “full” range of motion.

Summary

• Although the elbow and forearm are treated by some as a largely ignored joint, we have more tools now than ever before to treat its contractures, regardless of the cause or type.
• This course has explored in detail general elbow contracture treatment as well as treatment for contractures due to neurological pathology.
• In each case, important considerations are the state of the tissue, limitations imposed by the causative pathology, and each patient’s personal goals for functional use of his/her arm.
Learner Outcomes

As a result of this course, participants will be able to:

1) ...identify the joint and soft tissue structures of the elbow that are commonly problematic in neurological and orthopedic contractures

2) ...recognize in post-course testing, best combined use of conservative treatments including modalities, splinting, hands-on manual treatments, and Botulinum toxin injection guidance to treat patients with contractures of the elbow.

3) ...discuss and later incorporate into the participant's daily practice, evidence-based conservative treatments as well as those pending clinical trials which have demonstrated successful use in the clinic for these impairments.

References

References


Questions and Answers:

**Point of Contact:**
Please feel free to email me with any additional questions or discussion of this course. Thank you for your time and attention!

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