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CUSTOM ORTHOSES FOR COMMON UPPER EXTREMITY CONDITIONS

Mike Szekeres, PhD, OT Reg (Ont.), CHT

OBJECTIVES

• By the end of the course, the participant will be able to:

  • 1) Describe the important anatomical landmarks or orthosis fabrication for the upper extremity.
  • 2) Recognize basic biomechanics of orthosis fabrication.
  • 3) Identify appropriate orthoses for some of the common conditions seen by hand therapists.
OVERVIEW

- This is a BASIC level course that will cover:
  - Anatomical Considerations
  - Biomechanical Principles
  - Examples of Specific Orthoses that are used for common conditions – including some dynamic and static progressive

ANATOMICAL CONSIDERATIONS

- Bones and Joints
- Muscles – Intrinsic and Extrinsic
- Arches and Creases
- Neurovascular Structures
ANATOMICAL CONSIDERATIONS

- Bones and Joints
- Volar or Dorsal? – Bony Prominences

ANATOMICAL CONSIDERATIONS

- Muscles – Intrinsic and Extrinsic
ANATOMICAL CONSIDERATIONS

- Arches – longitudinal arch, transverse carpal arch, proximal transverse arch
- Creases - distal palmar crease, proximal palmar crease, thenar crease

CREASES OF THE HAND

- An orthosis that crosses the distal and or proximal palmar creases will limit motion at the MP joints
- Here the orthosis clears these creases allowing motion at the MP joints 2-5
- This orthosis also allows thumb ROM by clearing the thenar crease
ANATOMICAL CONSIDERATIONS

- Neurovascular Structures

POSITIONING

- Always think of the purpose of your orthosis – then think of what position each structure needs to be in to achieve that effect!
POSITIONING

• Hands up if you know the "safe" position of the hand after trauma

• Why is this "safe"?

![Image of a hand in a splint]

BIOMECHANICAL PRINCIPLES

• There are several!
  • 3 important ones in this course:

  • 1) Increase area of force application to decrease pressure

  • 2) Provide perpendicular force as able with static progressive and dynamic orthoses to minimize compression and distraction

  • 3) Increase orthosis length to improve mechanical advantage
BIOMECHANICAL PRINCIPLES

• 1) Increase area of force application to decrease pressure

FORCE (F)

• Something causing change in motion of an object
• A push or pull

• F= mass x acceleration

continued™
PRESSURE

- The applied force over an area (P=F/A) or applied force per unit area.
- Pounds/square inch (PSI) or kilograms per square centimeter or in liquids: millimeters of mercury (one PSI is approximately equal to 50 mm Hg).
- “excessive pressure causes tissue injury, including blisters, corns. Calluses, “stone bruises”, ulcers, wounds, and stress fractures...people who have compromised neural systems become even more susceptible to these injuries since they are unable to detect discomfort or pain.”

Houghlum and Bertoli (2012)

<table>
<thead>
<tr>
<th>To decrease the effects of pressure:</th>
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<tbody>
<tr>
<td>Decrease the magnitude of the force</td>
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<tr>
<td>Increase the area of application</td>
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<tr>
<td>Decrease the time of application</td>
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</tbody>
</table>
BIOMECHANICAL PRINCIPLES

• 2) Provide perpendicular force as able with static progressive and dynamic orthoses to minimize compression and distraction
TORQUE

Torque = Force x Distance!!!
BIOMECHANICAL PRINCIPLES

• 3) Increase orthosis length to improve mechanical advantage

MECHANICAL ADVANTAGE

Mechanical Advantage (MA) is the number of times by which a machine can increase or decrease the effort force required for an action. If you know the effort force and the load force, you can determine the mechanical advantage of the mechanism by calculating the following ratio:

\[
\text{Mechanical Advantage} = \frac{\text{Load force (N)}}{\text{Effort force (N)}}
\]
MECHANICAL ADVANTAGE

If the $MA = 1$, then there is no advantage.
If the $MA < 1$, then a large effort force is required to move a smaller load (Class three levers).
If the $MA > 1$, then less effort is required to move a larger load (Class 1 and 2 lever systems).

MA is proportional to the distance from the fulcrum.
So $M2G \times d2$ = gives the torque!
LEVER?

MECHANICAL ADVANTAGE

• Mechanical advantage implies a long resistance arm to get the desired output

• A longer orthosis (2/3 of the forearm is recommended) increases the mechanical advantage of the desired output or wrist immobilization
STATIC PROGRESSIVE FLEXION CUFF

PIP EXTENSION ORTHOSIS
PURPOSE?

- Static - Rest, protect fractures, prevent deformity/contracture, substitute for lost motor function

- Dynamic and Static Progressive – substitute for lost motor function, correct deformity, stretch contractures

- What is the difference between a dynamic and static progressive orthosis?

FINGER GUTTER
HAND BASED THUMB SPICA

FOREARM BASED THUMB SPICA
FOREARM BASED WRIST ORTHOSIS

ANTERIOR ELBOW EXTENSION ORTHOSIS
ORTHHOSES AS ADAPTIVE AIDS

- Orthoses can also be used to improve function – OT at its finest!
- Eg. Wrist Drop

ORTHHOSES AS ADAPTIVE AIDS

- Eg. Claw Deformity
ORTHOSES AS ADAPTIVE AIDS

- If a client has disability, and has specific functional goals, you can get creative!!!
- Ken

ORTHOSES TO MOBILIZE TISSUE

- Serial Static: Applied near the end range and changed after a period of time in the new lengthened position
- Dynamic: create a mobilizing segment using an elastic force
- Static progressive: mobilizing force created by non-dynamic components (Velcro, merit, etc.)
GENERAL RULES

• Should not cause pain

• Provide a low load, prolonged stretch – Thanks Ken Flowers!

• Used in addition to heat stretch

• Force application should be 90 degrees to joint you are trying to mobilize

• Rarely used in acute stages of healing. Used for stiffness once initial injury is healed.

ELBOW EXAMPLES
FOREARM

WRIST
HAND

OBJECTIVES

• By the end of the course, the participant will be able to:

• 1) Recognize anatomical considerations for fabrication of orthoses

• 2) Identify the important biomechanical principles related to orthosis fabrication

• 3) Recognize the appropriate therapy orthoses and their rationale for use with common diagnoses.
THANK YOU

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