Wisconsin Hand Experience 2024

Unraveling the Mysteries of the Wrist

Splinting Tips and Tricks

Part 1: Splinting Tips and Tricks

Tips and Tricks for Orthotic Fabrication

Saturday May 11, 2024

Emily Altman, PT, DPT, CHT, OCS, CLT-LANA, WCC

Splinting Tips and Tricks

Note: These slides are available electronically on www.handtherapy.com

Go to Wisconsin Hand Experience Tab

This will help you enlarge the pictures as needed in the future

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Plan for Today

- My Vision
- Overview of material
- Demo—Do Mix
- Show and Tell
- Tools and Products
- Lots of Room for Customization of the Experience

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Special Thank You

- Judy Colditz, OT/L, CHT, FAOTA
  - Most powerful influence on my clinical skill development
  - Creativity
  - Interventions based on a deep understanding of anatomy and mechanics
  - Contributed extensively to the material provided here today

3

My Vision

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Products

- Comfortprene (North Coast)
  - Benik is also a good source for neoprene yardage
- Fabrifoam 2" x 18" rolls (Performance Health)
- Fabrifoam Carpal Gard (Performance Health)
- 1" Pajama Elastic (Amazon)
- Leather for cuffs (Tandy Leather)
- Leather shears (Sailrite.com)
- Nymo cord (Performance Health)

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Products

- Aquaplast ProDrape 1/16" Perforated (Performance Health)
- Line Connectors (North Coast)
- Jiffy Rivets (North Coast)
- Metal Bobbins for s/p finger flexion splints (Amazon)
  - Prefer metal because they don't melt
- Distal Radius Fracture Finger Traps (Amazon)
- Velcro Cord Ties (Home Depot)
  - Velcro brand, ONE-WRAP Thin Ties. 8" x ½". 50 ties per package.
  - For pulley rings
- Spandex material (Etsy)
  - Look for 4 way stretch

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Products

- 3M Microfoam tape to cushion edges
  - Edge of IP free splint at volar PIP joint
- 3M Micropore-S
  - Silicone tape. Effective for scar management

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Products

- Rolyan Adapt-It thermoplastic pellets (Performance Health)
  - Orfit Allfit Thermoplastic pellets (North Coast)
- Digital pad on a strip (Performance)
  - To cushion strap on PIP extension splint
- Keep the little tabs of plastic hook Velcro that the manufacturers use to connect strips of strap within rolls for strap material. They can be sewn to other materials!

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Products

- Polyethylene Gloves
- Coil finger massager
- 3M Microfoam tape
- 3M Blue Silicone tape
- Edema Wear
- Neoprene Seam Tape (North Coast)

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Products

- EdemaWear
  - Compressiondynamics.com
  - Fuzzy Wale Elastic Compression (FWC)

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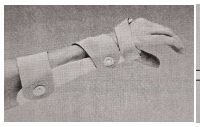
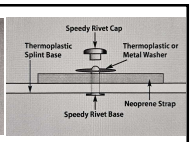
Neoprene

- Thickness
- Various coverings applied
- Gluing: special neoprene glue
- Sewing
  - Difficult to sew greater than 1/8"
  - Use a large needle (100 or 16)
  - Wide zigzag stitch
  - Longer stitch length
  - Use paper towel between material and feed dogs of machine
- Iron-On Seam Tape (North Coast)
  - Pressing cloth between material and iron
  - Top and bottom of seam is strongest way
- Use a thermoplastic "washer" under rivet head when attempting to rivet neoprene to a splint





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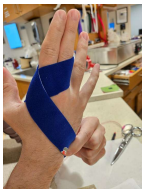

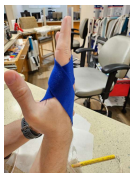

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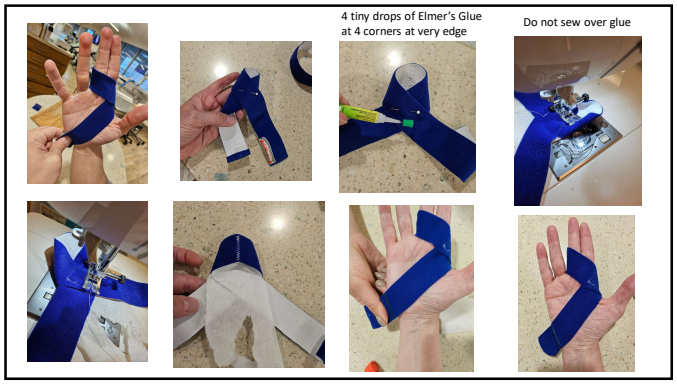

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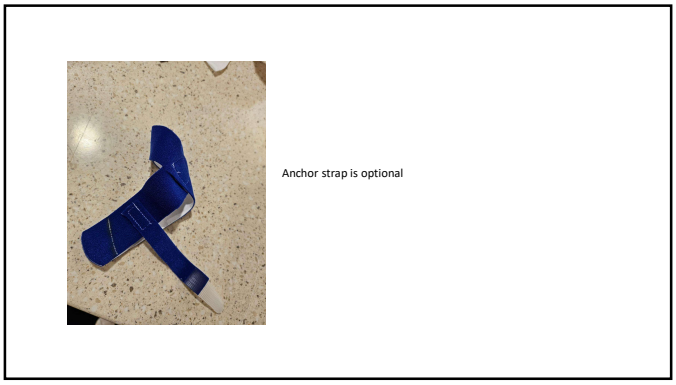

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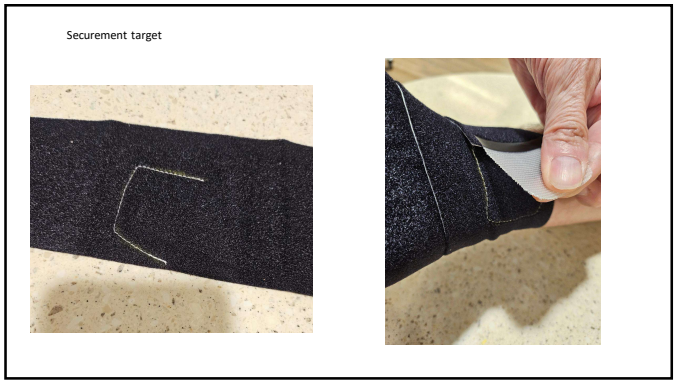

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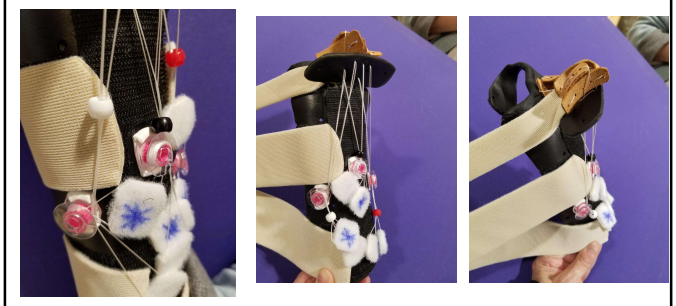

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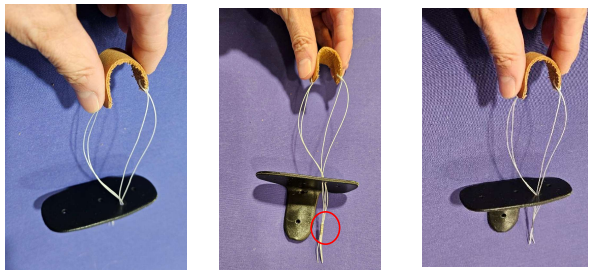

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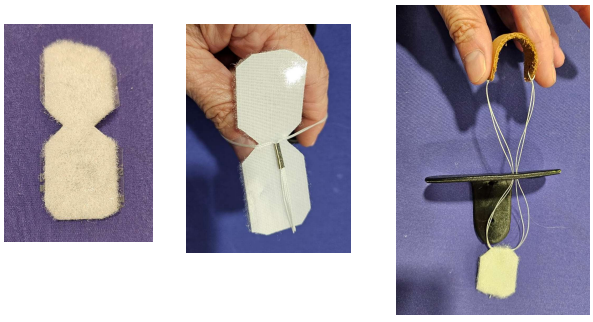

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PIP Free Splints—see detailed handout

Clip on piece for night time. 1/16" aquaplast.

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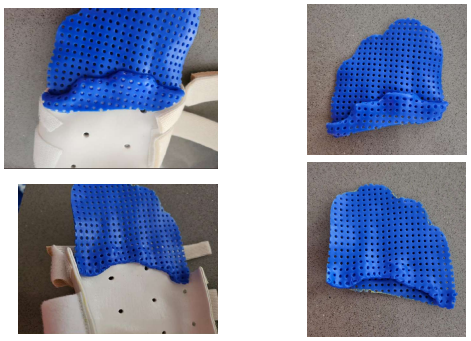

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Foam Filler Strip to create snug fit/control of proximal phalanx

3M Microfoam Tape

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S/P Elbow Flexion Splint

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Night Extension Splint

How to cut "window" in extension splint

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Not ideal

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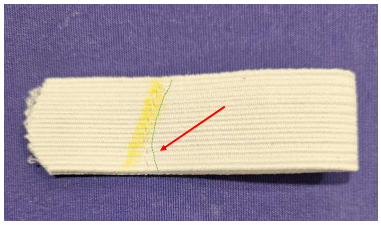
Easy DIP/PIP Strap



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Plaster cast mold for elbow shell fabrication

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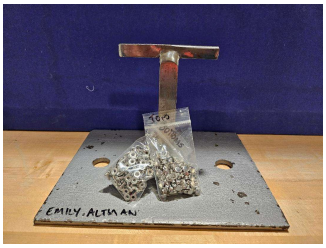
Anvil



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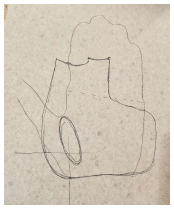
RCL Pattern



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Neoprene Strap for Elbow Night Extension

- Criss cross of static strap reduces stretch of neoprene
- Addition of loop strap material help longevity of strap. Sometimes the Velcro sensitive covering gets fluffy

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METAGRIP® MODIFICATIONS

push

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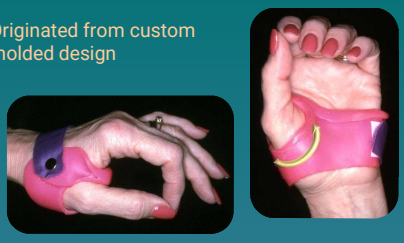
METAGRIP DESIGN RATIONALE

- Originated from custom molded design



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METAGRIP MODIFICATIONS

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METAGRIP MODIFICATIONS

- NOTE:
  - Modifications void the MetaGrip warranty
  - Modified braces cannot be returned or exchanged

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CUTTING & FINISHING

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CUTTING & FINISHING

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HEATING & ROLLING

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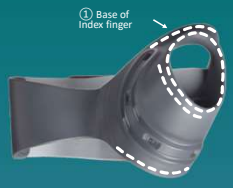
CUTTING and/or ROLLING

- Index side of web
  - To allow full index MP flexion
    - Cut, finish and/or roll



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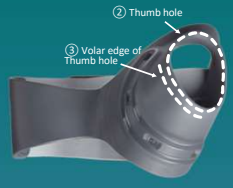
CUTTING and/or ROLLING

- Volar aspect or full thumb hole
  - For larger MP joint
  - Full MP flexion
    - Cut, finish and/or roll



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CUTTING and/or ROLLING

- Base of thumb
  - Relieve edge pressure on bony prominence
    - Roll; cutting NOT recommended

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MP FLEXION BLOCK

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MP EXTENSION BLOCK

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What is the wristable®?

Designed by Judy C. Colditz, OT/L, CHT, FAOTA

How can such a small brace be effective?

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wristable®
Concept
"Carpal Containment"
• Tighten strap with wrist neutral
• As wrist moves, strap "tightens" to "contain" the carpus

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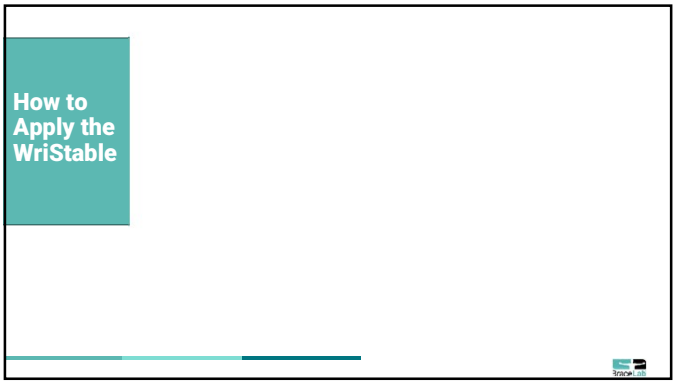
How to Apply the WriStable

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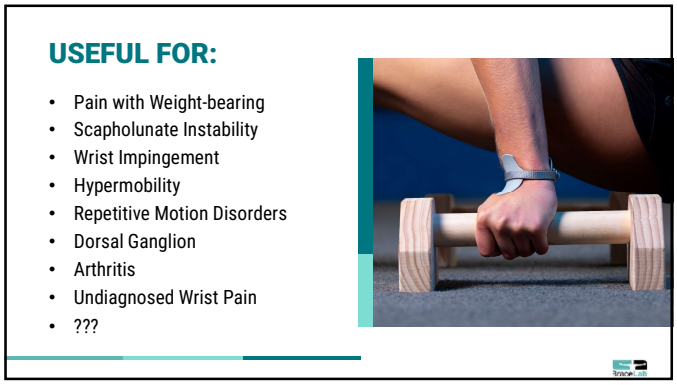
USEFUL FOR:
• Pain with Weight-bearing
• Scapholunate Instability
• Wrist Impingement
• Hypermobility
• Repetitive Motion Disorders
• Dorsal Ganglion
• Arthritis
• Undiagnosed Wrist Pain
• ???

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Wisconsin Hand Experience 2024

Unraveling the Mysteries of the Wrist

Splinting Tips and Tricks

Part 2: Tips and Tricks Outline

Tips and Tricks for Orthotic Fabrication

Saturday May 11, 2024

Emily Altman, PT, DPT, CHT, OCS, CLT-LANA, WCC

NOTE: This handout is available on www.handtherapyhub.com under the tab Wisconsin Hand Experience 24

Reach out anytime: ehpt@aol.com

Tips, Tricks, Pearls, Ideas

Finger

Finger gutter with belly

- Polyform non perforated 1/16”
- Small piece of 50/50 silicone for belly on volar aspect of PIP joint
- Highlighter pen
- 7/8” Surgitube to cover highlighter
- Pattern. Mark location of PIP joint
- Mold over highlighter with 50/50 bump
- Contour radial and ulnar sides just before it fully cures
- Silicone corn protector dots (mini) to mitigate pressure on dorsal PIP joint. Slip it onto the ½” strap material
- Open toe for splint so there is room as PIP joint extends

Custom light compression finger tube

- Pattern
    - Paper towel to exact circumference of finger, exact shape of finger.
        - Pinch paper material around finger
        - At top of finger, fold to one side, finger press, fold to the other side, finger press. Cut along fold lines. Check pattern. It should cover the shape of the finger, no extra.
    - Use pattern to cut out piece of Spandex using a rotary cutter. Scissors are tough to use on Spandex.
    - Sew a ¼” seam allowance and…it works! (For all you sewists, I know, there was no seam allowance in my pattern. But, this is how near perfect compression is achieved! Trust!
        - If you do not have a straight stitch option for your throat plate, I recommend moving the needle to the right to bring it close to one side of the needle hole and close to the right side of the presser foot. Spandex has a tendency to be drawn down into the machine.
        - Avoid starting the seam at the very edge of the material. Start in a bit.
    - Can sew a second seam if it is not tight enough
    - Trim excess with rotary cutter
- Tip! Make a Spandex tube OVER a belly gutter splint! A fantastic way to gently coax out a PIP flexion contracture.

Buddy Tubes

- Pattern
    - Paper towel to exact circumference of finger, exact shape of finger
    - Cut out of spandex using a rotary cutter. Scissors do not cut spandex well
- Sew two together down the center longitudinally. Right sides together. Sometimes hard to tell which is right side. Don't worry. Doesn't really matter.
- Close each of the two tubes with a ¼" seam (see above Finger Tube for helpful hints)
- Sew another seam if increased tightness is needed

Pulley Ring

- Velcro brand cord ties. ONE-WRAP Thin Ties. 8" x ½". 50 Ties per package.
- Apply to finger proximal phalanx
- Closure on the dorsal side of the finger
- Mark mid point on volar side
- Apply a strip of 1/16" polyform all the way around the tie at the level of the mid point mark you just made.
- The width of this "reinforcement area" should be slightly narrower than the finger's width
- Create a slight bend in the polyform piece to follow the contour of the finger
- Trim excess of cord tie
    - Dealer's choice whether to wrap around one more time or just cut it just distal to the loop through closure. I generally do not wrap it around again. It gets a bit bulky.

Index Finger RCL Challenge

- Often ask for a radial gutter. Often hand based, include index and middle, IPs free, MPs in slight flexion
- This is a challenge because the very act of molding it pushes the MP joint ulnarly
- Consider making a volar hand based splint using 1/8" polyform
    - Using a thumb hole instead of a tab helps improve splint mechanics for this one.
    - Mold splint in 2 steps
        - Palm and thumb and volar up to the IP joints (which are free). Leave the radial and ulnar edges FLAT. Totally flat. No edge from MP joint level distal.
            - Apply straps. Usually (1) a loop through strap from the thumb ring, under the pisiform and around to the volar ulnar border; (2) a dorsal strap at the MP joint level; Third strap later.
        - Put splint on. Apply 2 straps. Position index and middle fingers in perfect alignment (maybe even a touch of persuasion radially) Draw a line radial to the index finger along the proximal phalanx. Dip the radial border into the water to exactly that line. No further. Bend up that radial edge exactly at the line. Trim the height of that radial wall to the correct height. Trim the ulnar edge of the splint that is just ulnar to the proximal phalanx of the middle finger just a tiny bit narrower. This way, the strap that attaches there and crosses dorsally over the proximal phalanges of index and middle will snuggly hold the two finger against the precisely placed radial edge that you just made.
- This geometry is precise because you are stably holding the index and middle fingers in a precise position relative to the base portion of the splint.

Index Finger RCL (Step by step can be found in slides)

- Fabrifoam Figure 8 Strap (2" x 18" roll, cut in half lengthwise)
- Measure estimated length necessary
- Cut almost all the way across strip at mid point. Cut out a 30-40 degree wedge of material
- Bring edges of "dart" together, place while, non-skid side down on a piece of paper towel and sew a side zig zag stitch to approximate the two edges. Slightly lengthen stitch from standard default
- Place on patient. Determine where straps will criss cross each other at the level of the MP joint radially. Like a breast cancer ribbon. It will look like a diamond-ish shape. Carefully pin the position of that cross over.
- Apply a small dot of Elmer's School Glue to each corner of the diamond. Right at the very edge. Using a pressing cloth and a low temperature iron, dry the glue (this is quick).
- Using paper towel again between the feed dogs of the machine and the white non-skid of the fabrifoam, sew a seam along the box shape of the criss cross overlap. Stay inside of where the glue was placed. No good to sew through glue that might not be fully dry. Rip away paper towel.
- Place on patient. See where two straps need to be sewn together on the ulnar border of the hand. This line will be an oblique line across the strip. Get this right!! It is important for fit and control. Sew this seam.
- You can be done here. However, if you want to add a strap to keep the hand portion of the strap from slipping distally, you can add a thin strap that goes from volar palm, under thumb to dorsal palm. See picture.

RA Ulnar Deviation Correction

- Challenging
- Consider using thermoplastic beads (Performance Health and North Coast)
- Soften a scant ½ cup of them.
    - Place beads in a piece of paper towel and lower into the water. Once they are in the water just a bit, they stick together and don't float apart all over the splint pan. Squeeze them into a ball and then a flat, thick pancake. Return to water to fully soften it.
- Initially mold to your hand.
    - Make the material about 2.5 inches wide (rectangle-ish) and about ½ inch thick
    - Widen your fingers apart
    - Lay the material from mid-palm to proximal to the PIP joints
    - Aggressively buckle the material up into the webspaces of your hand
        - You are creating distinct slivers of material at the webspaces at the bases of the fingers
    - Squeeze your fingers back together. Mold, mold, mold…adjust
    - There is PLENTY of time
    - You can trim easily where you see material that excessive
    - Before it is set, put it on your patient and get final mold from their fingers/hand
    - Use distal radius fracture traction finger traps to align properly. Good trick.
- Sew a neoprene sleeve with a simple hole for the thumb. Seam is on ulnar side. This will secure the molded piece to their hand.

Soft Separators For Aligning Digits

- Use loop strap. North Coast Cushion Strap works well.
- Fold up about an inch of strap (becomes 1/2" high when folded) and stitch. Take care that "loop" side is on the inside of the fold. Important because you will be securing this soft piece to hook Velcro on the inside of the splint
- Repeat about ¾" down the strap. ¾ " is an estimate of the width of the finger
- Repeat one more time to create 3 "loops"
- Tip: Measure the location of loops 2 and 3 on the patient. It is deceiving sometimes. If loops aren't in the right place, it does not work well.
- Tip: You can slip a small piece of 1/16" splint material in the loops to increase rigidity
- These soft separators are underpowered for severe deformities.

Static Progressive Finger Flexion (refer to pictures in slide presentation and demo that I brought)

- I have stopped attempting composite finger cuffs. Nothing against it. Fine to do. But I prefer managing deficits at each joint separately. And I am not too concerned about chasing DIP flexion as a primary offense.
- One cuff to manage MP flexion, one cuff to manage DIP flexion
- Base splint is a wrist splint
- Create a platform to allow for multiple holes for stringing cuffs
- Create leather cuffs with holes punch on either end
- Nymo cord with 2 loop throughs for the two holes
- Alternate strategy when multiple fingers are involved. See slides. Punch 4 small holes in leather cuff, longitudinally. 2 at the very ends of the cuff and 2 that are about ¼" apart at the center for the cuff. Thread one piece of Nymo cord through the 4 holes starting outside to inside at one end and ending inside to outside at the other end. This techniques simply reduced the number of treads when multiple finger and multiple joints (eg, DIP and MP) are involved
- Line connectors to connect thread of cuff
- Sticky back loop tabs
- Can thread the reins of the two cuffs of each finger through a pony bead to help control and organize the threads!
- Use bobbins to secure each reins for DIP and MP of each finger
- Extra bobbin for temporary "parking" if needed, as you progressively flex MP and PIP of each finger. What happens is the patient positions the MP joint, then the PIP joint and then the MP joint needs to be adjusted. The extra bobbin allows easier adjustments.

RMO

- Flat coffee stirrer to hold extension/flexion differential. Can also use 2 long handled wooden cotton tipped applicators
- Material choices
    - Orficast tape. Two layers
    - 1/16" polyform, 1.5" length, fold over, cut lengthwise along open edge to create smooth edge
- Trick: Place the material as distally as you can (volar or dorsal depending on RME or RMF) on the finger you are trying to impact. This means as close the to PIP joint as you can.
- Trick: If helpful, add a small U-shaped trough to hold the isolated finger securely when making the RME splint

- Trick: If helpful, you do not need to fully complete the ring around the supporting digits. Sometimes this is helpful in the presence of large PIP joints.

Thumb

Judy Colditz Thumb CMC joint splint
- 1/8" Poly form. Non perforated vs performated.
- Pattern (see article from Judy Colditz later in handout)

Modifications of Comfort Cool Thumb Spicas
- Too tight thumb tube
  - Use Rotary Punch and punch holes in it. Many.
- Wrap around is too short
  - Add strip of neoprene
    - Use a Zig Zag stitch (set a bit wider than default and lengthen stitch length)
    - Butt the edges together and zig zag stitch goes from one side of seam to the other. Flush final product
    - Can add strip of non sticky back hook Velcro to new extension if needed. Best solution is to remove the existing one (use seam ripper to remove) and resew to extension. The reason this is best is because if you don't move the existing one from its location, it will be exposed and will annoy the patient.
- Wrap around is too long
  - Add a strip of non sticky back hook Velcro right next to the existing one. You can leave the existing one.
- The "Plus" sizes (Small Plus, Medium Plus, Large Plus)
  - For some reason, without fail, there is too much material in the web space and it appears bunchy and poorly fitting. Just cut a crescent shape of material away right at the webspace and it will fit perfectly.

Modifications to Metagrip splint
- #12 scalpel for skiving and trimming
- Leather shears for cutting
- Heat gun for shaping. Takes a lot of heat
- Dremel tool with grinding attachment for smoothing

Benik Radial Nerve Splints (701 and 703)
- Great splint, but loops around fingers can be improved
- Get rid of structure for finger loops that comes with the splint
- Find which end of the outrigger devices (4 of them) has more soft material at the end
- Punch a small hole in that soft material area
- Measure length needed to get around finger at level of the PIP joint and add a generous ½"
- Cut ½ inch width straps to that length (loop strap)
- Punch small hole in each end of the lengths of strap
- Attach loop of strap to end of outrigger device using a jiffy rivet (small size)
  - Two ends of strap overlap and go on the TOP, non hook Velcro side of the outrigger device. Rivet goes through outrigger and two layers of loop strap
  - Loop side to finger as it is softer!

- Additional tip. Place outrigger devices further distally than you might think. Bend them up a bit at a point just distal to where they adhere to the splint. Augments extension assist.

Wrist

Wristable Splint
- Visit exhibit
- Encourage sizing kit. Super helpful.

Clever clip on extension for extensor tendon/MP arthroplasty splint
- Base split is a forearm based splint, MP 0, IPs free (my preference is polyform 1/8")
- Aquaplast extension
    - Start "outside"
    - Fold to "inside"
    - Extend up
    - Create a trough that clips onto the end for night time use

Elbow

"In The Air" Posterior Elbow Shell
- Life saver for children and for painful acutely injured elbows

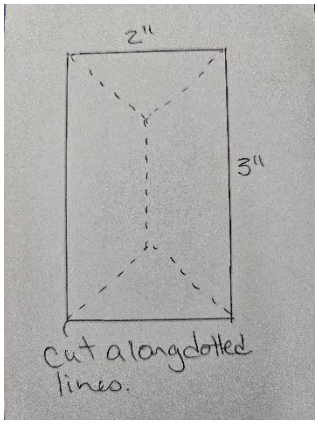
Comfort Cool Elbow Support Modification
- Sew a dart in the forearm side to improve conformity of sleeve

Use a half cast as a mold
- Create a plaster of Paris mold of an average elbow at various angles (90 and 110 are good)

Static Progressive Elbow Flexion Splint
- See detailed instructions in separate handout

Night Extension Splint with slight dynamic/static progressive component
- EZ Form: generally a width of 6 or 7 inches is fine
- Length: measure distance from location of proximal edge to antecubital fossa, then from antecubital fossa to location of distal edge. Measurement is usually around 15 inches and the upper arm measurement is usually 1 inch shorter than the forearm measurement.
- Draw splint measurements on material: do not need precision.
    - In general, upper arm (to antecubital fossa line) is 6 inches wide. From there it narrows to 4 inches wide at distal end. For very large or very small arms, minor changes may be needed. Keep it simple
    - At the level of the antecubital fossa, draw a rectangle right at the midline of the splint, measuring 2" wide x 3" long.
    - Within the rectangle, draw the design in picture (see below) and cut along the dotted lines
    - Trim 2 points and middle edges to make neat
    - Put entire splint in the water to soften
    - Draw back the two pointed triangles from the rectangle and touch the tips down above and below the rectangular area

    - Draw back the two longitudinal panels (trapezoid shape) and touch just the edges down to the sides of the splint.
    - Both of the above maneuvers involve a slight bit of "stretching" before tacking down. This makes it so the four corners of the rectangle are rounded, no right angle corners. Right angle corners are weak and prone to breaking. Also, when you simply tack down the tips of the triangles and the edges of the trapezoids, you create a slightly tube-like structure which is very strong.
    - Avoid a rectangle that is too big or too small
    - Molding
        - Position patient in supine with towel roll under distal humerus
        - Soften splint
        - Apply to anterior surface of arm. Forearm is in neutral rotation
        - It is critical that the "side bars" of the splint (the medial and lateral parts of the splint at the level of the elbow joint, the borders of the rectangle) are turned 90 degrees to the anterior surface of the arm/splint. Otherwise it doesn't work. This takes careful attention
        - Mold the splint with room under the splint. This a challenging because you are guessing. Think that you are folding the splint in the shape the arm will be when it moves into more extension. You are NOT creating a bubble over the antecubital fossa. This does not work. You are lifting the middle part of the splint up. The greatest depth of space between the splint and the arm will be at the level of the antecubital fossa. Space diminishes as it goes proximally and distally.
- Use Velcro Brand Stretch Loop 2" width. North Coast NC12148 125
    - Cut a cross wise slit about 1.5" from one end of the strap
    - Starting about 2-3 inches from that slit, sew a piece of NON sticky back hook Velcro to the fuzzier side of the strap. Use a zig zag stitch, go slowly as you are sewing plastic.
    - Loop this strap around the lateral bar of splint in such a way that the hook Velcro piece will end up facing away from the patient.
    - Strap goes from this loop through attachment, posteriorly at the olecranon, threads INSIDE the medial bar of the splint, around the bar and back to secure on the piece of hook Velcro that you sewed to the strap!
    - Respect wounds!
    - Can also use a wide piece of 1/8" neoprene posteriorly (instead of above described strap) to hold elbow up into the splint. I reserve this for the challenging cases



IP Blocking Splint (see detailed handout) (see example that I brought here)

- MP in Extension, IPs free
- See in hand based exercise splint
- See in forearm based splint following MP arthroplasty
    - See clip on extension piece for night time positioning
        - Aquaplast

Easy DIP PIP strap

- 6" strip of 1" wide pajama elastic
- Mid point of strip to dorsal aspect of proximal phalanx
- Loop around flexed PIP and DIP with ends coming together on the dorsal aspect of distal phalanx
- Draw oblique line cross-wise at the perfect level for a slight stretch.
- Sew with straight stitch along line, creating a loop
- Leave some length on the tails beyond the seam line. This is a tab used to pull the loop on
- Be clever and sew a tiny curve in the seam where the tip of the finger can tuck in. Nice for comfort.

Delta Cast Splints

- Use of Delta Cast Conformable polyester cast tape to create a removable splint
- See two detailed handouts for lots of information and step by step instructions for commonly fabricated, work horse hand therapy splints

Sewing

- Do not sew through sticky back hook or loop or anything
- Do not sew where you have used glue
- When sewing Fabrifoam, white foam side goes down and use paper between white foam and feed dogs of the machine
- Change your needle fairly frequently. It is often forgotten
- Service your machine with some regularity

Random Ideas

- For PIP flexion contractures, use a plastic deli gloves (polyethylene gloves) over paraffin wax. Apply LMB spring splint and heat before treatment
- For PIP flexion contractures, use distal radius finger trap traction device to create traction at PIP joint. Direction of traction needs to be perpendicular to treatment plane (determined by concave of the joint (base of middle phalanx)

Wisconsin Hand Experience 2024

Unraveling the Mysteries of the Wrist

Splinting Tips and Tricks

Part 3: The Biomechanics of a Thumb CMC Splint

Tips and Tricks for Orthotic Fabrication

Saturday May 11, 2024

Emily Altman, PT, DPT, CHT, OCS, CLT-LANA, WCC

The Biomechanics of a Thumb Carpometacarpal Immobilization Splint:

Design and Fitting

Judy C. Colditz, OTR/L, CHT, FAOTA
Hand Therapy Consultant
HandLab (a division of RHRC, Inc.)
Raleigh, North Carolina

ABSTRACT: Splinting for the common osteoarthritis of the carpometacarpal (CMC) joint of the thumb is infrequently described in the literature, but the few splints that are described include one or both adjacent joints. This paper describes the design and biomechanics of a custom-molded thumb CMC immobilization splint that excludes the thumb metacarpophalangeal and wrist joints. The problem of the imbalance of extrinsic extensor/abductor forces against the intrinsic flexor/adductor forces is described. The accompanying weakening of the thumb CMC capsule allows dorsal shifting of the proximal end of the metacarpal, producing pain. The splint described in this paper 1) prevents motion of the first metacarpal in relation to the other metacarpals, 2) prevents tilting (flexion) of the first metacarpal during pinch, and 3) allows unrestricted thumb metacarpal and wrist joint motion. Attention to detail during construction is required for an accurate pattern, precise positioning of the CMC joint during molding, accurate molding around the first metacarpal, and well-distributed pressure. This design may also be used for protection following thumb CMC arthroplasty or thumb CMC sprain or strain and as a base for thumb metacarpophalangeal and/or interphalangeal mobilization splinting.
J HAND THER. 13:228–235, 2000.

The thumb trapeziometacarpal joint, also called the thumb carpometacarpal (CMC) joint, is the most common site in the upper extremity for surgery due to disabling osteoarthritis.[1] Osteoarthritis of the thumb CMC joint is particularly prevalent in postmenopausal women,[2,3] many of whom already have normal laxity of this joint.[1] Osteoarthritis causes increased laxity of the thumb CMC joint capsule, creating a common clinical compliant of pain with resisted thumb motion, particularly forceful pinching.

Most surgeons and therapists writing about treatment of the painful thumb CMC joint use immobilization splinting as a part of conservative treatment. Only one recent article looks at the effectiveness of thumb CMC immobilization splinting.[4] Descriptions of the splint designs recommended as part of the nonsurgical treatment, if included at all, are usually vague.[3,5–7] The few splints that are illlustrated or specifically described usually include one or both adjacent joints.[1,4,8]

Poor patient compliance and limitation of hand function in the splint are listed as detriments to thumb CMC joint immobilization splinting.[1,6,7,9,10] It is assumed that authors are using splints that include at least one and often both adjacent joints. Therefore, the reason for poor compliance and limited hand function may be related to the number of immobilized joints.

Immobilization of the thumb metacarpophalangeal joint robs the hand of the valuable flexion, extension, and radial and ulnar deviation of that joint. Immobilization of the wrist demands greater range of proximal joints, making function more demanding. The choice for the patient is often compliance with immobilization vs. functional use.

This paper describes the design and biomechanics of a custom-molded thermoplastic splint that leaves the

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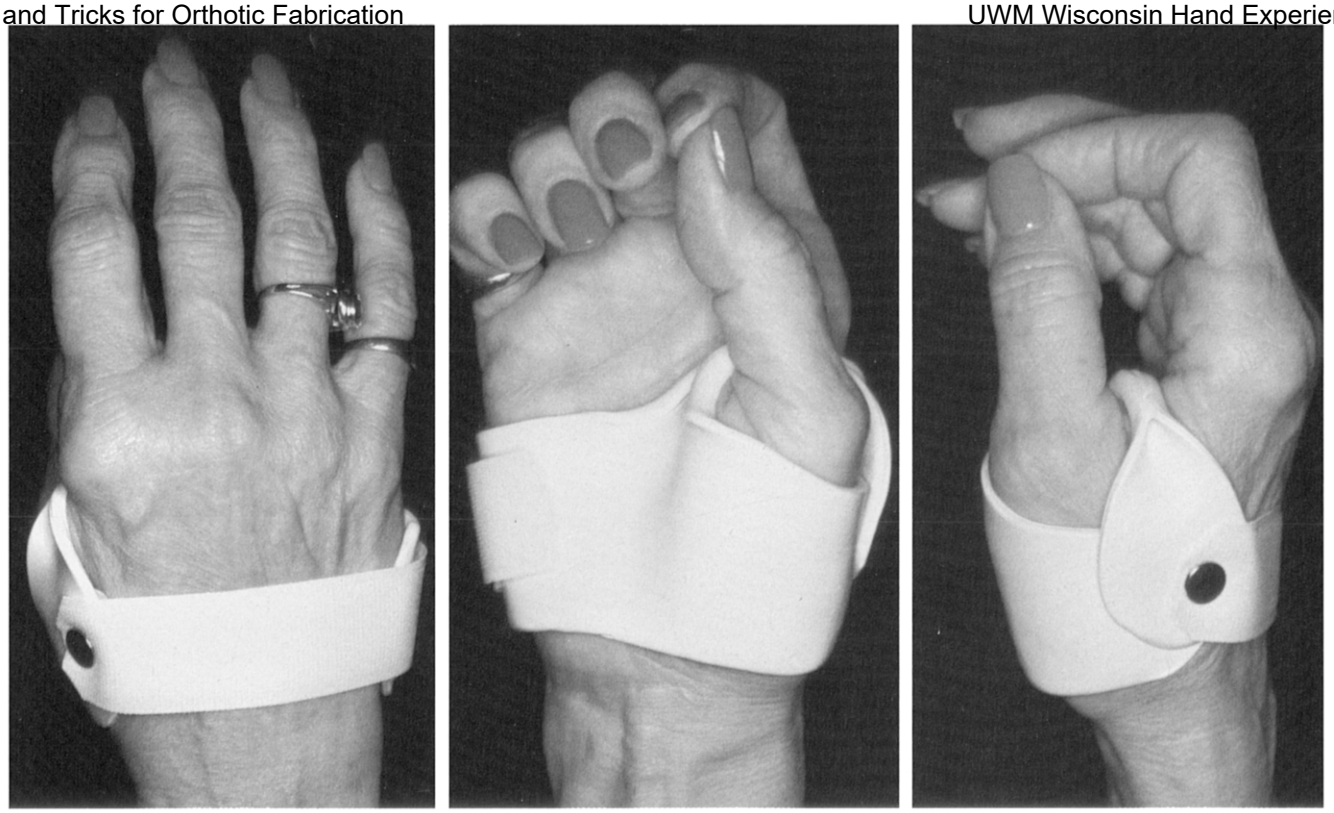

FIGURE 1. *Dorsal* (left), *palmar* (middle), *and radial* (right) *views of small thumb CMC immobilization splint made of 1/8-inch-thick thermoplastic splinting material.*

thumb metacarpophalangeal and wrist joints unrestricted (Figure 1). The only limitation of function with this splint is when a flat palm is needed (as in pushing up off the floor with the palm, wiping a flat surface, or carrying a tray overhead). With this small splint patients report absent or diminished pain with resisted thumb motions. Since the splint does not impede other joint function, this design may provide an effective alternative to larger, more restrictive splints, thereby increasing compliance.

This small splint has previously been illustrated in the literature,[11] but its pattern, biomechanics, and construction methods have not been described. Although many experienced clinicians contend that a splint must cross the wrist to adequately stabilize the CMC joint, the author's experience is that patients with isolated CMC arthritis (who have no associated scaphotrapezial arthritis) receive symptomatic relief with this splint.

PRINCIPLES

It is the author's hypothesis that the muscles crossing the joint create an imbalance of forces as the weaker dorsal protion of the thumb CMC capsule allows excessive motion. The splint is designed to prevent the motion that is hypothesized to create pain during pinch.

There are four intrinsic thenar muscles: the adductor pollicis (AP), the flexor pollicis brevis (FPB), the opponens pollicis (OP), and the abductor pollicis brevis (APB) (Figure 2). The FPB flexes the first metacarpal across the palm, and the APB pulls the metacarpal into palmar abduction. The OP and the AP are larger than the FPB and APB, with the OP inserting along the length of the first metacarpal and the AP originating along the length of the third metacarpal. The AP brings the first metacarpal toward the second metacarpal. The OP rotates the first metacarpal as the entire thumb reaches toward a fingertip.[12] All these muscles contract to stabilize the thumb CMC and metacarpophalangeal joints

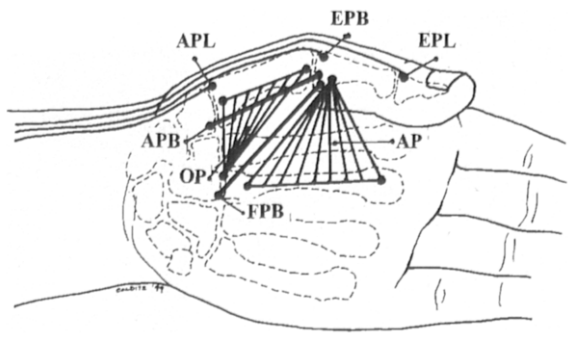

FIGURE 2. *Schematic drawing showing the efficient line of pull of the thenar muscles compared with the less efficient line of pull of the extrinsic extensor and abductor muscles. APB indicates abductor pollicis brevis; EPB, extensor pollicis brevis; EPL, extensor pollicis longus; APB, abductor pollicis brevis; OP, opponens pollicis; FPB, flexor pollicis brevis; AP, adductor pollicis.*

during pinch so that the force of the flexor pollicis longus can be transmitted distally. Because the insertion of the AP, FPB, and APB are distal to the thumb metacarpophalangeal joint, these muscles have a long moment arm to effect CMC joint motion. In addition, the long insertion of the OP on the first metacarpal allows this muscle to effectively move the CMC joint.

The antagonist muscles, however, are extrinsic muscles with weaker mechanical advantage (Figure 2). Originating on the radius and the ulna in the forearm, the abductor pollicis longus (APL) inserts on the base of the first metacarpal. Because the tendon insertion is close to the axis of the joint, it provides little mechanical advantage for extension at the CMC joint.

The extensor pollicis brevis (EPB) originates on the interosseus membrane and the radius in the forearm and inserts just beyond the thumb metacarpophalangeal joint into the base of the thumb proximal phalanx. It primarily extends the thumb metacarpophalangeal joint and secondarily extends/abducts the thumb CMC joint. Only when the metacarpophalangeal joint of the thumb is fully extended does it then effectively act on the CMC joint. The extensor pollicis longus (EPL) originates in the forearm from the interosseus membrane and the ulna, inserting at the base of the distal phalanx. Crossing over all three thumb joints, the EPL can assist in CMC joint extension only after it has exhausted its excursion at the other joints.

Therefore, the APL, EPB, and EPL muscles are relatively inefficient extensors and abductors at the CMC joint, in contrast to the more efficient intrinsic thenar muscles that primarily flex and adduct/abduct the thumb CMC joint. With three of the four thenar muscles (the FPB, OP, and AP) pulling the first metacarpal head toward the palm (into flexion), the balance of motion at the thumb CMC appears to the author to be loaded toward flexion (Figure 2).

As osteoarthritis develops, the already slack capsule of the thumb CMC joint becomes attenuated. Pellegrini[1] describes the shift of the distal attachment of the stabilizing volar beak ligament distally on the metacarpal as eburnation of the articular surfaces progresses. He states: "This shift...compromise[s the beak ligament's] mechanical efficiency in checking dorsal migration of the metacarpal on [the] trapezium during dynamic flexion-adduction of the thumb." The weaker dorsal fibers of the trapeziometacarpal capsule allow the base of the first metacarpal to sublux dorsally. As the intrinsic thenar muscles pull on the distal end of the first metacarpal, it flexes forward, levering the metacarpal. Therefore it is postulated that during pinch, when the thenar muscles contract, the first metacarpal tilts; i.e., the distal end moves toward the palm and the proximal end shifts dorsally. It is this shift of motion, although perhaps slight, that appears to create pain. This splint appears to prevent the first metacarpal tilting motion, controlling pain during thumb use.

RATIONALE

Immobilization of the Thumb Metacarpotrapezial Joint

Splints that immobilize the thumb metacarpophalangeal or the wrist joint (or both) in addition to the thumb CMC joint effectively eliminate pain at the thumb CMC joint.[1,4] The difficulty in effectively immobilizing the first metacarpal without including other joints is the inability to mold splinting material circumferentially around the first metacarpal. This design uses the stability of the adjacent immobile second and third metacarpals as the anchor for the first metacarpal. In other words, motion of the first metacarpal in relation to the other metacarpals is prevented. The thumb CMC joint is stabilized in a position of palmar abduction so that fingertip and lateral pinch is unimpeded.

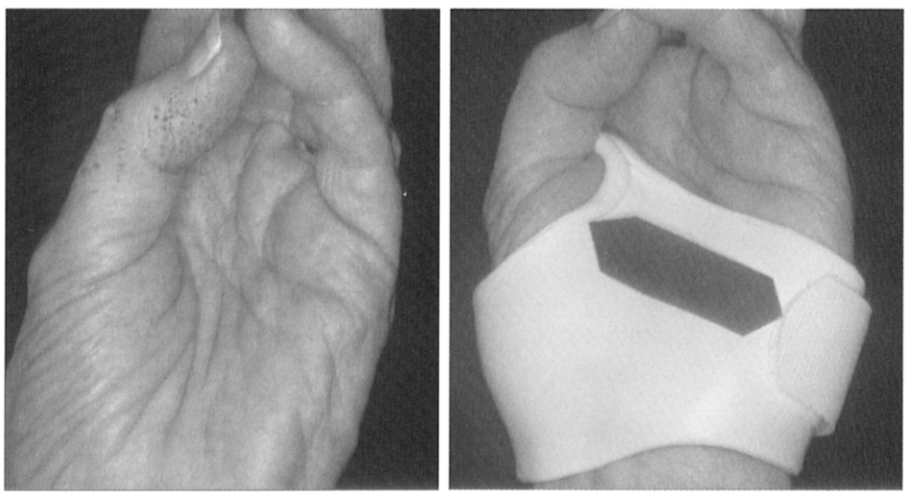

FIGURE 3. Left, *During opposition, the distal end of the first metacarpal flexes toward the fifth metacarpal.* Right, *With the thumb CMC immobilization splint in place, the first metacarpal is stabilized and flexion occurs at the distal joints.*

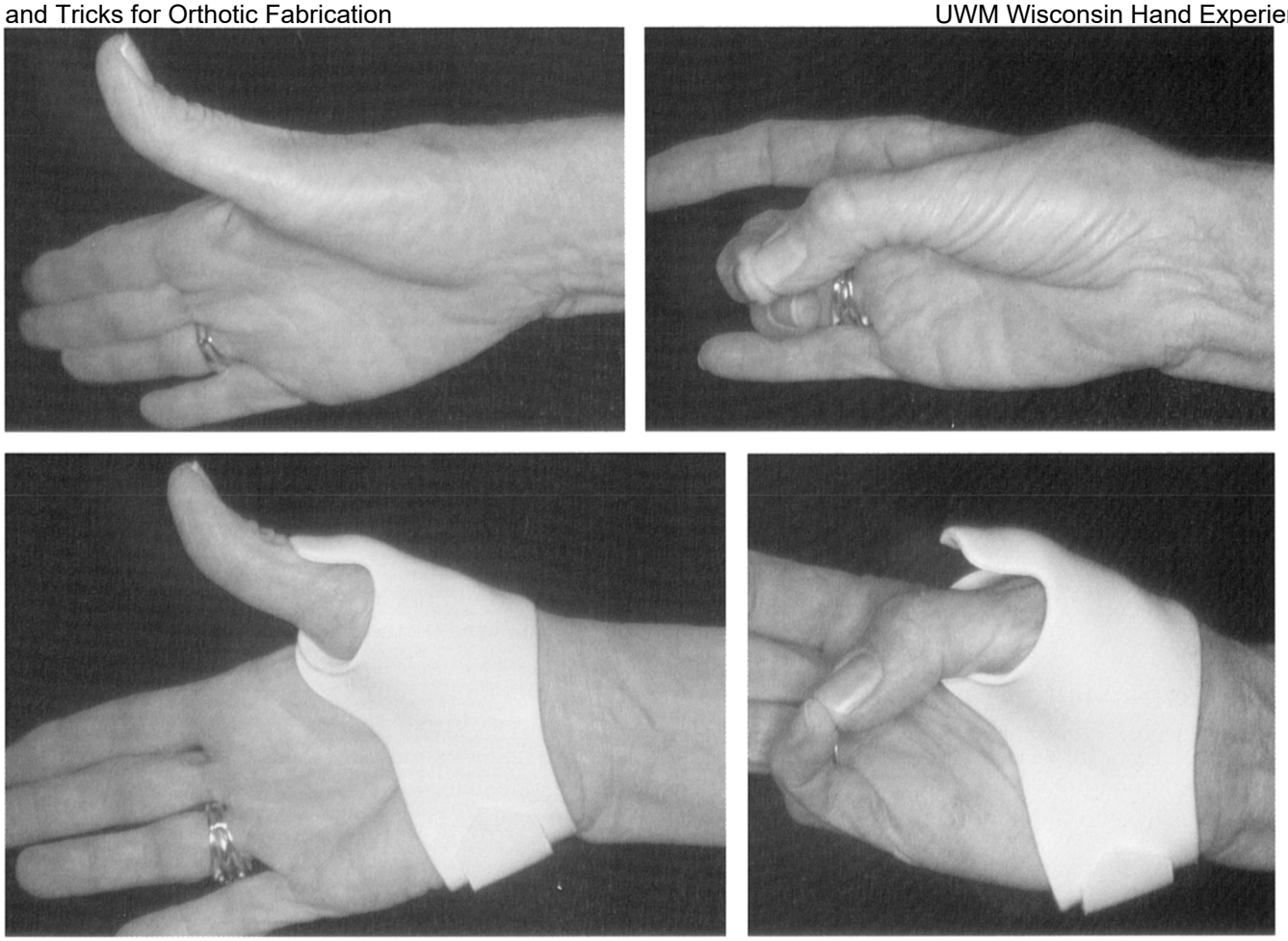

FIGURE 4. *Patient with dorsally subluxed thumb CMC joint shows thumb metacarpophalangeal hyperextension during attempted thumb extension* (top left) *and lack of thumb metacarpophalangeal flexion during active flexion* (top right). *The small CMC immobilization splint with a dorsal block changes the pattern of motion by preventing hyperextension of the metacarpophalangeal joint during extension of the thumb* (bottom left) *and blocking thumb CMC flexion* (bottom right), *thereby demanding more motion at the thumb interphalangeal and metacarpophalangeal joints.*

Prevention of First Metacarpal Tilting

The rigid splint material molded across the palm creates a strut. This strut prevents the distal end of the metacarpal from tilting toward the ulnar border of the hand during pinch (Figure 3). Motion of the CMC joint is blocked, and the flexion force can only be transmitted more distally across the metacarpophalangeal and interphalangeal joints. The strut is effective because of thenar muscle contraction. With the rigid splinting material in the palm, the thenar muscles cannot expand out toward the environment as they contract. Their expansion force is directed backward toward the first metacarpal, stabilizing it. This muscle contraction supports the distal end of the metacarpal from flexing forward. This pseudohydraulic environment of muscle contraction within a closed space is recognized as the primary principle behind long bone fracture stabilization with functional fracture braces.[13–16]

As the thumb CMC joint subluxes dorsally, the mechanics of the thumb are altered, changing the balance of forces that cross the thumb metacarpophalangeal joint. A modified pull on the thumb metacarpophalangeal joint creates secondary problems of imbalance at this joint.[3] Subluxation of the thumb CMC joint may lead to secondary radial deviation deformity of the thumb metacarpophalangeal joint due to an adduction contracture of the first metacarpal. Alternatively, a hyperextension deformity of the thumb metacarpophalangeal joint may develop as the flexion/adduction of the first metacarpal[17] allows a straighter line of pull of the extensor pollicis brevis and extensor pollicis longus (see Figure 2 and Figure 4, *top left*).

Early stabilization of the thumb CMC joint with the small CMC immobilization splint allows maintenance of the normal mechanics across the metacarpophalangeal joint. If the imbalance has already begun, an extension of the CMC splint dorsally over the thumb metacarpophalangeal joint to block it in mild flexion can alter the pattern of motion during pinch, slowing a further progression of this deformity (Figure 4).

One criticism is that this design deprives the palm of tactile input. It is the activities of daily living

FIGURE 5. The small thumb CMC immobilization splint does not impede fingering or pinching activities, such as playing a stringed instrument.

requiring pinch that primarily cause symptoms at the thumb CMC joint.[1] Since this splint leaves the critical digital sensory input unimpeded, it does not impair pinching, fingering, or handling activities (Figure 5). It may also be used without impairing most gripping activities.

OBSERVATIONS

The smaller any splint, the more difficult it is to make accurately. This small and seemingly simple splint requires finesse and attention to detail to be successful in controlling thumb CMC pain. Not all patients can be helped with this CMC splint, but to maximize the probability of symptom reduction, attention to detail in construction of this splint is necessary. The successful stabilization of the thumb CMC joint with this splint design is dependent on 1) an accurate pattern, 2) precise positioning of the CMC joint during molding, 3) accurate molding to support the first metacarpal out of a position of flexion at the distal end, and 4) attention to detail so that pressure is well distributed.

Accurate Pattern

To effectively immobilize the first metacarpal in a position of palmar abduction, the splint pattern must accommodate the first metacarpal position. In palmar abduction, the metacarpal lies in a plane at a 90° angle to the plane of the palm (the plane of the stable second and third metacarpals.) It is the angle of the large flange of the Y-shaped pattern† that allows precise molding around the first metacarpal in palmar abduction (Figure 6). When therapists are taught this design, the flanges are frequently drawn with undesirable angles in the initial pattern. This results in difficulty with proper positioning of the first metacarpal, and the splint then does not provide adequate support.

Precise Positioning of the CMC Joint During Molding

After the pattern is drawn and traced on the thermoplastic material, the material is heated and cut. While the patient's elbow is stabilized on a work surface, the patient is instructed to touch the tip of the thumb to the tip of the index finger in a relaxed position. This position will ensure that the patient can comfortably reach the fingertips with the thumb. The patient should not actively pinch while the splint is being molded. If the thenar muscles are contracted during molding, there will be too much space inside the splint for the muscles to successfully stabilize the metacarpal during pinch.

The fingers should be relaxed in flexion with the wrist in extension. This position creates the natural transverse metacarpal arch that should be incorporated into the splint.

Accurate Molding to Support the First Metacarpal

As the thermoplastic material is cooling and becoming firm, gentle pressure to mold the splint should be applied over the thenar muscles palmarly and over the proximal end of the first metacarpal

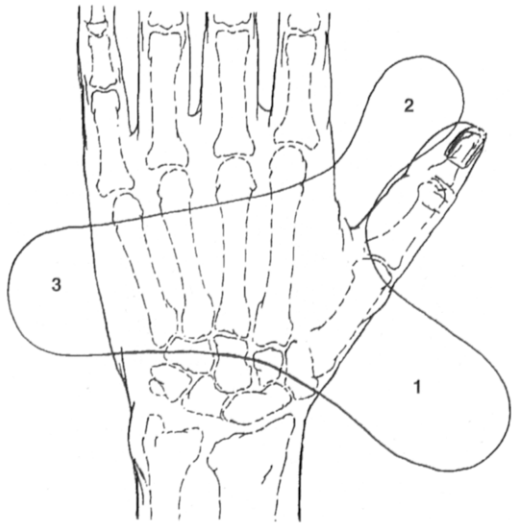

FIGURE 6. The pattern for the thumb CMC splint is Y-shaped. Flange 1 is angled and wraps around the first metacarpal when it is in a position of palmar abduction. The throat of flange 2 is rolled prior to placing it through the thumb web space. Flange 3 wraps around the ulnar border of the hand.

†This CMC pattern is available in pre-cut, sized thermoplastic splinting kits from North Coast Medical, Inc., Morgan Hill, California.

dorsoradially (Figure 7). The therapist must actually compress the thenar muscles slightly with the splinting material, with specific molding distally on the palmar piece to prevent the first metacarpal from tilting forward. Care must be taken not to push the metacarpal into so much extension that fingertip pinch becomes difficult or impossible. Attention must also be given to ensuring that the palmar edge of the splint is well below the thumb metacarpophalangeal joint, allowing full metacarpophalangeal flexion. The therapist must be observant, to make the splint long enough that it stabilizes the distal end of the metacarpal but not so long that it impedes thumb metacarpophalangeal flexion.

Pressure over the proximal end of the dorsoradial aspect of the first metacarpal should be minimal. The goal is to conform the splinting material snugly around the entire thumb base, not to apply force to attempt reduction of the dorsally subluxed metacarpal base. It appears to be the prevention of motion at this joint during pinch that reduces pain, not the ability of the splint to reduce the subluxation. Pressure that attempts to reduce the joint can actually exacerbate the pain.[3]

Even patients with grossly dislocated CMC joints can receive benefit from this CMC immobilization splint, because it is the elimination of motion at this joint and not the alignment of the joint that reduces pain. Although such an application of a splint would not in any way remediate the problem, the support the splint provides during thumb use has consistently been reported by patients to reduce pain.

After molding, the strap is attached with a rapid rivet on the overlapping flanges on the dorsoradial aspect of the splint. The rivet serves to hold the two overlapped flanges securely together. If a rivet is not used for the strap attachment, the therapist should bond these two flanges together before applying a strap.

When the completed splint is applied, the patient should be instructed to push the splint down fully on the thumb so that it is seated over the thenar area with full contact. Splints that are quickly applied without this downward pressure may be loose and may provide inadequate stabilization even with precision molding.

Distribution of Pressure Areas

There are three areas in which care must be taken during molding, so that the splint fits comfortably: the dorsoradial aspect of the base of the first metacarpal, the first web space, and over the dorsum of the second metacarpal.

When the splint is molded and counter-pressure to the dorsoradial aspect of the CMC joint is applied, care must be taken so that the edge of the splint does not press on the area (see Figure 1, *middle* and *right*). This area is often enlarged, with underlying osteophytes,

FIGURE 7. Gentle pressure is applied over the distal end of the first metacarpal palmarly and over the proximal end of the metacarpal dorsoradially as the thermoplastic material hardens.

and pressure from the splint edge may be uncomfortable. There is a fine line between the splint being long enough to cover the metacarpal length and yet short enough to allow unimpeded wrist motion.

If the base of the metacarpal is dorsally subluxed or dislocated significantly, the bony prominence of the base may poorly tolerate pressure. At times, gel padding may be needed if counter-pressure over this area is to be tolerated. Patients often state that they feel the splint should cover the entire radial aspect of the wrist, since there is referred pain proximal to the thumb CMC joint. Even though patients often request that the splint extend over the radial aspect of the wrist, it is the author's experience that the shorter design adequately alleviates symptoms.

If the splint is pulled tightly through the first web space during molding, radial deviation of the thumb metacarpophalangeal joint and extension of the index finger will cause the web skin to rub against the splint, and comfortable wear of the splint is diminished. Prior to application of the warm splinting material, the web area of the splint should be rolled to form a circle (see Figure 1, *right*, and flange 2 on Figure 6). Rolling strengthens this part of the splint while minimizing bulk in the first web space. While the patient holds the index and thumb fingertips touching (without pinching), the splint material is gently brought through the first web. As the material begins to harden, the curled material is lifted away from the first web skin so that the material and skin do not touch. The first web skin should not rub against the splint when the patient holds a large object with full extension and radial deviation of the thumb metacarpophalangeal joint.

The ulnar border of the splint ends just as the splinting material begins to wrap dorsally (see Figure 1, *left*). Pressure is well distributed over the abductor digiti quinti muscle belly. If the ulnar border extends too far dorsally, application and removal of the splint

FIGURE 8. The CMC immobilization splint serves as an effective base to stabilize the first metacarpal when force is being applied to more distal joints. In this example, concurrent force to flex the metacarpophalangeal and interphalangeal joints of the thumb is applied to increase distal excursion of the extensor pollicis longus, which is adherent over the first metacarpal where it was lacerated.

can be both painful and difficult for the patient.

On the radial border of the splint dorsally (Figure 1, *left* and *right*), the dorsal edge of the splint ends just before the second metacarpal. There is little subcutaneous tissue padding in this area, and as the strap is pulled firmly across the dorsum of the hand the radial edge may press on the second metacarpal, causing exquisite pain. Attention to this potential problem can prevent unnecessary discomfort and increase compliance.

On completion of the splint, ask the patient to pinch both with and without the splint on. If the patient cannot immediately appreciate a reduction of pain with pinch with the splint on, the splint should be remolded to better stabilize the first metacarpal.

Patients who have just received an injection in the thumb CMC joint will not be able to provide this feedback, and the temporary enlargement of the joint from the injection will cause the splint to fit poorly in a few days. In such cases fitting of the splint should be delayed for a few days or the patient scheduled to return for remolding of the splint.

Material Recommendation

Thermoplastic splinting materials with memory require constant pressure to ensure a conforming fit while the material cools. Because there are numerous small areas of this splint that require precise positioning simultaneously, it is recommended that materials with a strong memory be avoided. The constant pushing necessary for molding these materials prevents the accuracy of definitive molding. It is also questionable whether splints made of thermoplastic splinting material thinner than 1/8 inch provide adequate stabilization.

Recommended Wear

There is little information in the literature regarding suggested wearing schedules for CMC immobilization splints to reduce painful symptoms of osteoarthritis. When included, instructions for wear vary from continuous wear for three to four weeks[4] to intermittent wear when the joint is painful.[5]

Many patients present for medical intervention following an episode of overuse that has caused the trapeziometacarpal joint to become inflamed. The small splint described here should initially be worn full-time for a period of two to three weeks (with removal for skin care only). Following this period of full-time immobilization, the splint is worn to prevent irritation of the joint with repetitive thumb use or to reduce symptoms after such irritation has occurred. Most patients choose to wear the splint routinely at night and are encouraged to do so. The most important time to wear the splint is during activities that cause pain at the CMC joint, and patients are instructed to do so.

Numerous patients have elected to use the splint in this manner over a number of years to control symptoms rather than undergo an arthroplasty procedure. Unlike most splints applied to joints, this CMC splint cannot be worn too long or too much. The problem at the thumb CMC joint is one of excessive motion. It would be ideal if the splint were worn enough for the joint to "stiffen" and have greater stability.

A patient will eagerly wear the splint only if it is molded correctly, with attention to detail for precise support and positioning and avoidance of painful pressure areas. When the splint is correctly molded, patients report an immediate elimination or reduction of thumb CMC pain with pinch.

Use of this Design Following Thumb CMC Arthroplasty, Sprain, or Strain

The small splint design described here may be fitted to patients who have had CMC arthroplasty, after the initial immobilization has been discontinued and edema has subsided. This splint allows the patient functional use of the thumb while protecting the healing thumb CMC capsule. Since the patient contracts the thenar muscles in the splint during pinch with the CMC joint in a desirable position, this splint prepares the patient for effective weaning from external support. For patients who sustain a sprain or strain injury to the

thumb CMC joint, this small splint allows continuing use of the hand while protecting the healing capsule.

Use as a Base Design for Other Thumb Problems

The CMC immobilization design is useful to stabilize the first metacarpal while immobilizing the thumb metacarpophalangeal joint, or while mobilizing the thumb metacarpophalangeal and/or interphalangeal joints. To immobilize or restrict thumb metacarpophalangeal motion following ligamentous injuries, the pattern can be extended to include the metacarpophalangeal joint. This makes a removable thumb metacarpophalangeal immobilization splint that protects the thumb metacarpophalangeal from external force without including the wrist joint. Outriggers may be added to the CMC immobilization splint to provide a pull to either the thumb metacarpophalangeal and/or interphalangeal joint (Figure 8). Since the base design adequately stabilizes the first metacarpal, the force of the pull is efficiently directed to the more distal joints.

CONCLUSION

This splint design has been used for more than 20 years with isolated trapeziometacarpal arthritis. Many patients have returned for replacement splints as old splints have become brittle and have broken. It appears that thumb CMC pain can successfully be controlled without including other joints, if care is taken with positioning and molding. Immediate reduction or elimination of pain with pinch must be reported by the patient to ensure that the splint has been molded correctly. If remolding of the splint cannot achieve reduction or elimination of pain with pinch, inclusion of either the thumb metacarpophalangeal joint or the wrist, or both, may be necessary to control symptoms.

With splinting being recognized as part of routine initial care for the frequently occurring thumb CMC osteoarthritis, hand therapists are often required to construct custom-made thumb CMC immobilization splints. This small splint, designed by the author, can be completed in 15 minutes or less by a therapist experienced in its design and fitting. Because the small size of the splint allows unrestricted use of adjacent joints, it is a cost-effective, efficient treatment option for those patients who elect to postpone or exclude surgical reconstruction for thumb CMC joint pain.

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Wisconsin Hand Experience 2024

Unraveling the Mysteries of the Wrist

Splinting Tips and Tricks

Part 4: Thumb CMC Immobilization Splint

(Judy Colditz, OTR/L,CHT, FAOTA)

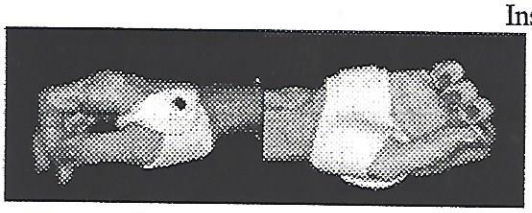
Tips and Tricks for Orthotic Fabrication

Saturday May 11, 2024

Emily Altman, PT, DPT, CHT, OCS, CLT-LANA, WCC

THUMB CMC IMMOBILIZATION SPLINT: Small thumb OA Splint

Designed by: Judy C. Colditz, OTR/L, CHT, FAOTA
Instructions by: Judy C. Colditz, OTR/L, CHT, FAOTA

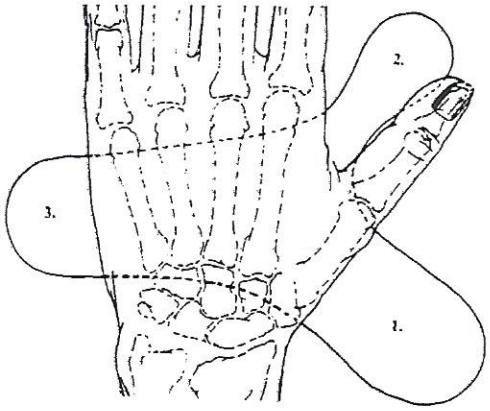


Indications

To immobilize the thumb CMC joint for patients with isolated CMC arthritis who have no associated scaphotrapezial arthritis.

Concept

Use a precisely molded splint to prevent CMC motion during pinching splint.



allows up motion

pseudo hydraulic

Pattern

Note: Precut, sized blanks available from North Coast Medical, Inc.

Preferred Materials: *1/8 inch non-perforated material with minimal memory*

Construction Sequence

NOTE: This splint must be precisely fitted during molding to successfully stabilize the thumb CMC joint.

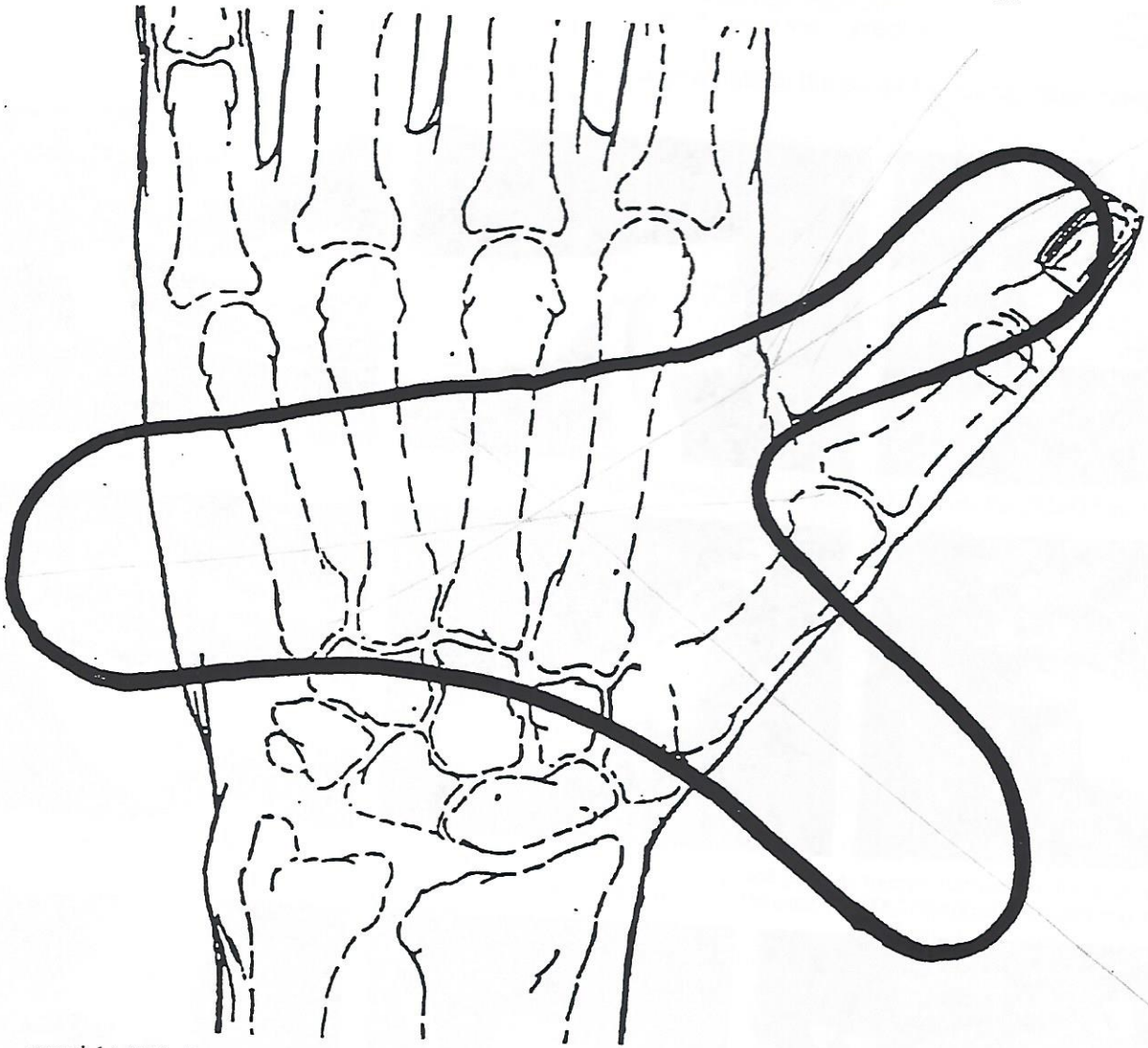
1. Stabilize the patient's elbow on a work surface and have them gently touch the thumb to the index finger. THE PATIENT MUST NOT PINCH. The fingers should be in relaxed flexion with the wrist in extension.
2. Before molding the splint on the hand, roll the neck of the smallest flange to make a complete circle. Place this rolled area gently through the thumb web.
3. As the splinting material becomes firm, apply firm pressure directly over the thenar muscles and mold accurately over the dorso-radial aspect. NOTE: Do not push the first metacarpal into extension
4. Assure the distal edge of the splint is low enough to allow full MP flexion but not so short that it does not adequately stabilize the thumb metacarpal.
5. Trim the ulnar border so it ends just after it has gone around the fifth metacarpal.
6. Assure the radial edge of the splint does not press on the second metacarpal and the proximal end does not impede full wrist motion.
7. Apply the loop strap through both layers on the radial aspect with a rapid rivet.
8. If the patient does not report a reduction of pain with pinch with the splint, remold the splint for better fit.
9. Instruct the patient to apply the splint by firmly pushing it down so there is full contact with the thenar area.

Pattern for CMC Immobilization Splint

Judy C. Colditz, OTR/L, CHT, FAOTA

The critical shape of the pattern is the "Y" shape which allows it to conform to the first metacarpal. Assure the three "prongs" of the pattern are long enough so the radial ones overlap each other. If they are too long the splint is difficult to apply and remove.

Remember: Have the patient *GENTLY* hold an "O" shape with the index and thumb but ***NOT PINCH*** when molding the splint. Apply pressure to the distal aspect of the first metacarpal, supporting it into a position of extension. If after molding this splint the pain with pinch at the CMC joint is not eliminated, REMOLD the splint!!!!!!!!!!!



Wisconsin Hand Experience 2024

Unraveling the Mysteries of the Wrist

Splinting Tips and Tricks

Part 5: Metacarpal Phalangeal Joint Blocking Splints

Tips and Tricks for Orthotic Fabrication

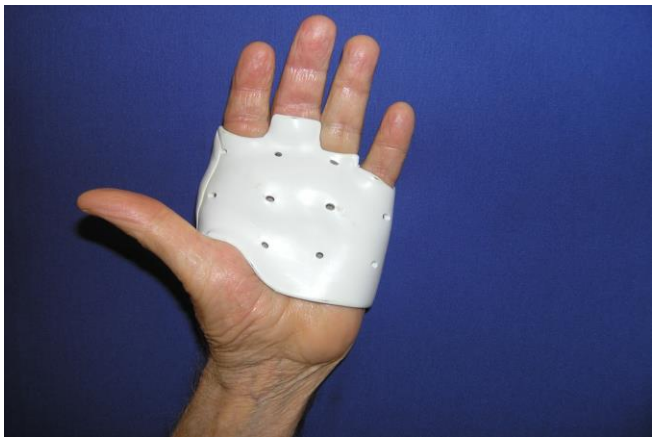
Saturday May 11, 2024

Emily Altman, PT, DPT, CHT, OCS, CLT-LANA, WCC

HOSPITAL FOR SPECIAL SURGERY

Smart Design

The Art of Splinting



Metacarpal Phalangeal Joint Blocking Splints

Hand Based MP Blocking Splint

Materials, Tools and Hardware

- 1/8" thermoplastic with minimum to moderate resistance to stretch, such as Polyform® or TailorSplint®
- Sticky back Velcro® hook (optional)
- Cushion or loop strap material (optional)
- Cotton stockinette

Diagnoses

- Intrinsic tightness or joint stiffness in the digits secondary to:
  - Distal radius fracture
  - Metacarpal or phalangeal fracture
  - Hand multi-trauma
  - Arthritis
  - Stiff hand
- Promotion of differential FDS/FDP tendon gliding after flexor tendon repair/reconstruction

Instructions for Splint Fabrication

The purpose of this splint is to facilitate flexion of the interphalangeal (IP) joints while blocking the metacarpal phalangeal (MP) joints. This splint is primarily used for therapeutic exercise. Below are step-by-step instructions for fabricating a hand based MP joint blocking splint.

1. Trace hand and draw pattern as shown.
2. The volar portion of the pattern has concrete landmarks and is therefore relatively easy to draw. The dorsal extension is not easy to visualize. Make a broad guess at it when you draw the pattern and then mark it on the patient and trim [see splint pattern].
3. Be generous with the height of the dorsal piece. It is not a problem if the dorsal edge is higher than the PIP joints. It is a problem if it is lower because you lose mechanical control of the proximal phalanx when the material is too short dorsally.
4. Indicate on your pattern the following landmarks:
   - Wrist crease on the ulnar side of the hand
   - PIP joint lines of digits II-V
   - First web space
5. Cut the pattern out and test on the patient to ensure a proper fit. Adjust as necessary.
6. Place a piece of stockinette on the patient's hand.
7. Reheat the thermoplastic material in preparation for molding the splint.
8. Align splint on palmar side of hand. Wrap the material through the first web space and over the dorsal aspect of the hand. Overlap the thermoplastic material on the ulnar side of the hand. While molding the splint take great care to contour to all digit web spaces palmarly while

maintaining MP joint extension. The splint must conform fully to proximal phalanges of digits II-V while allowing full PIP joint flexion.

9. Allow thermoplastic material to fully cool. Pop open overlapped portion of the thermoplastic material on the ulnar side of the hand.
10. Create Velcro closure or permanently bond thermoplastic material on the ulnar side of the splint.

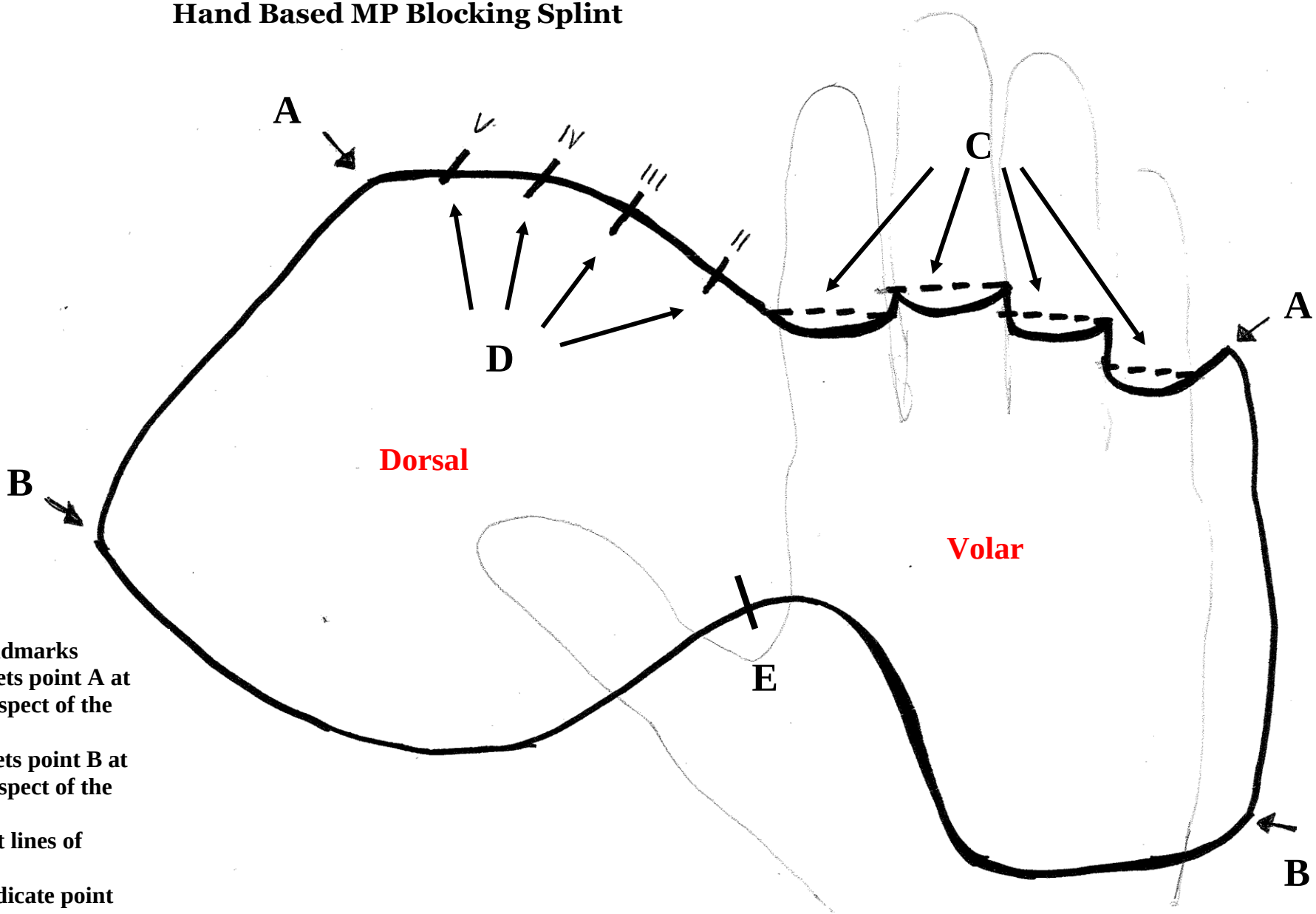
Helpful Hints

- Excellent conformity is crucial for strict control of the MP joint in extension.
- Maintain the MP joints in full extension during the molding process. A second set of hands can be useful to achieve proper positioning.
- Splint must permit full PIP motion
- The splint can be bonded shut on the ulnar aspect or an overlapping closure with a strap can be created if fluctuating edema is an issue or if room is needed for donning/doffing.
- Attempt to create comfortable, distinct “troughs” for each digit (II-V).
- It is possible to make this splint as two separate pieces (dorsal and volar) that you later fuse together into one piece. If you mold it this way, mold the volar piece first, holding the MP joints in maximum allowable extension. Allow piece to become firm. Then mold the dorsal piece while the volar piece is on the hand. Bond the radial and ulnar edges, or bond just the radial edge if an opening is necessary to permit don/doff.

Photographs of completed hand based MP blocking splints

Splint Pattern

Hand Based MP Blocking Splint



Landmarks

Point A meets point A at the radial aspect of the hand

Point B meets point B at the radial aspect of the hand

C: PIP joint lines of II-V

D: Lines indicate point area of splint that will lie over dorsal aspect of digits II-V

E: Thumb web space

Forearm Based MP Blocking Splint- Interphalangeal Joints Free

Materials

- 1/8" thermoplastic with minimum to moderate resistance to stretch, such as Polyform® or TailorSplint®
- Sticky back Velcro® hook
- Loop or cushion strap
- Cotton stockinette

Diagnoses

- Extensor tendon repair proximal to the MP joint (protocols and surgeon preference vary widely on this)
- Tendon transfer to EDC
- Metacarpal phalangeal (MP) joint arthroplasty
    - NOTE: This splint is made along with volar extension piece that includes the IP joints and holds them in extension at night. This becomes a removable piece. The volar extension piece is also an option for the other diagnoses if PIP flexion contractures are a concern.

Instructions for Splint Fabrication

The purpose of this splint is to support the wrist and MP joints in extension while allowing full IP joint flexion. Below are step-by-step instructions for fabricating a forearm based MP joint blocking splint.

1. Position the patient's hand and forearm on a piece of paper towel palm down. Trace the forearm, thumb and index and small finger borders.
2. Indicate on your pattern the following landmarks:
    - Wrist crease
    - PIP joint lines of digits II-V
    - Web space
    - 2/3 the length of the forearm
3. When drawing the distal portion of be sure to draw your lines just below the PIP joint line to allow full PIP joint flexion.
4. The finished splint should cover 2/3 the length of the forearm and 2/3 of the width of the forearm along the radial and ulnar borders, so take this into account when drawing the pattern. Once the forearm is traced, add about 1 inch or less on either side on the pattern – this can be adjusted as needed to accommodate the height of the forearm. If the sides of the splint come up too high, the straps will not be able to securely hold the splint in place. If the sides are too low, there will be a loss of structural integrity.
    - The forearm is conical in shape and the pattern needs be wider towards the bottom of the splint
5. Cut the pattern out and test on the patient to ensure a proper fit. Adjust as necessary.
6. Place a piece of stockinette on the patient's forearm.

7. Trace the pattern on a piece of thermoplastic material, heat the material and cut out the pattern. It is nice to cut along the inside of the lines so that the pencil marks do not show on the splint.
8. Once the pattern is cut out and the thermoplastic material is still warm, roll the edges of the splint along the thenar eminence and web space back approximately ¼". Rolling the edge of the splint away from the patient increases comfort and tolerance to wearing the splint. When rolling the splint material, be sure to roll toward the proper side (away from the patient) because it is very difficult to fix the splint if the edge is rolled incorrectly.
9. Place the patient's forearm in supinated position with the wrist and dorsum of the hand supported by a small towel roll. This position will allow gravity to assist you in molding the splint and allows for easier control of the thermoplastic material.
10. If the patient is unable to fully supinate the forearm you can mold the splint with the elbow propped up on the table with the wrist in a slightly extended position. An ace wrap can be used to help mold the forearm portion of the splint while you work on the hand portion of the splint.
    - Be sure not to wrap the ace wrap too tight (it will leave an imprint on the thermoplastic material and the edges of the splint will bother the patient).
    - Leave the ace wrap in place long enough for the thermoplastic material to set but remember that the portion of the splint that was wrapped with the ace wrap will need some more time to cool.
11. While molding the splint take great care to contour the material to each digit web space palmarly and maintain full MP joint extension. The splint must conform fully to proximal phalanges of digits II-V and permit clearance for full PIP joint flexion.
11. Typical strapping configuration for this splint includes: one strap across the proximal phalanges, one strap across the MP joints, one strap from the tab to the ulnar side of the hand and two straps across the forearm portion of the splint

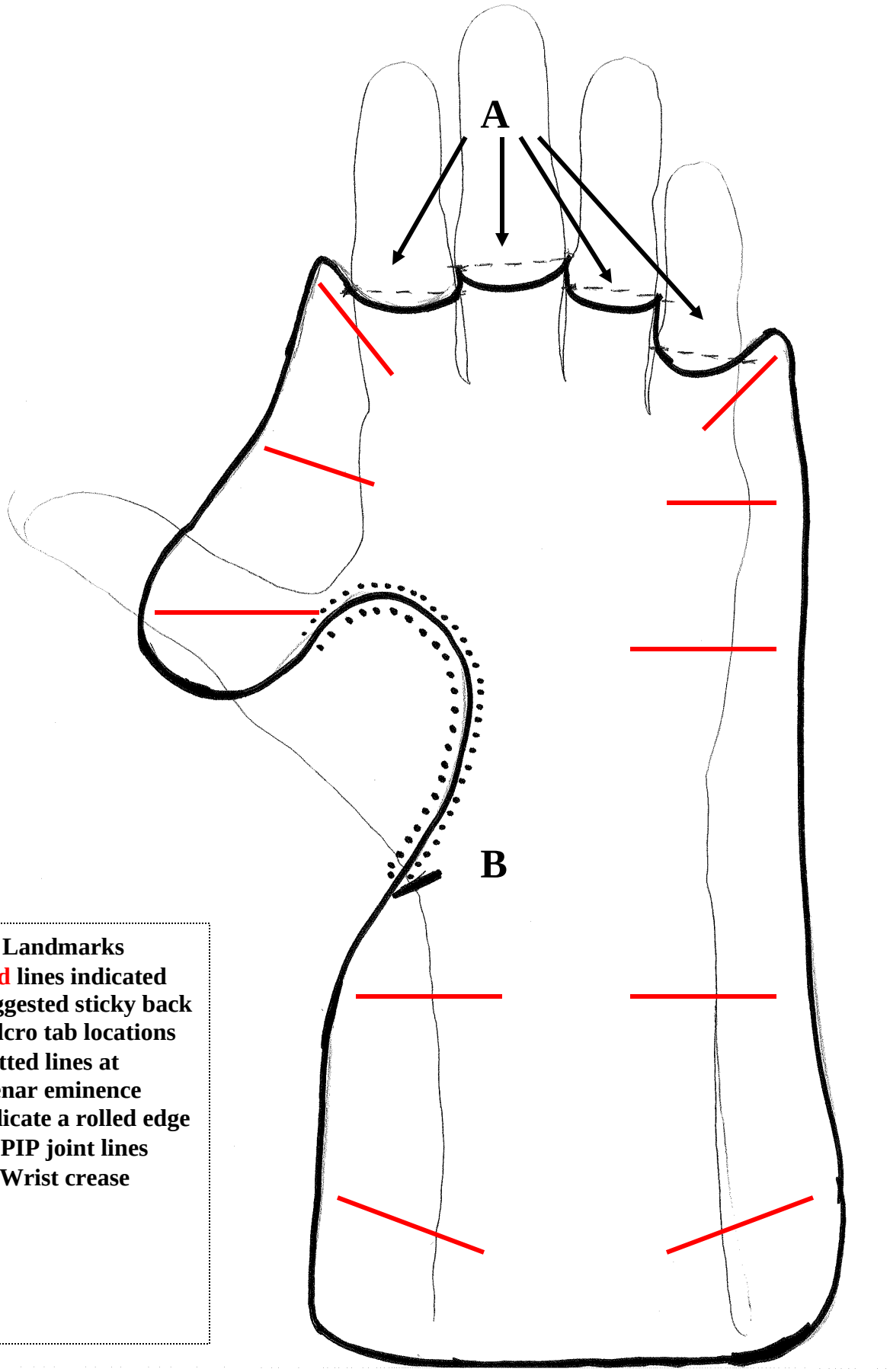
Helpful Hints

- Splint must permit full PIP joint motion.
- Excellent conformity is critical for strict control of the MP joint in extension.
- Maintain the MP joints in full extension during the molding process. A second set of hands can be helpful.
- Dorsal strapping must effectively control the strong tendency of the MP joints to flex. Foam padding under the straps can help control motion.





Splint Pattern
Forearm Based MP Blocking Splint-IPs Free



Landmarks

- **Red lines indicated suggested sticky back Velcro tab locations**
- **Dotted lines at thenar eminence indicate a rolled edge**
- **A: PIP joint lines**
- **B: Wrist crease**

Wisconsin Hand Experience 2024

Unraveling the Mysteries of the Wrist

Splinting Tips and Tricks

Part 6: Static Progressive Elbow Flexion Splint

Tips and Tricks for Orthotic Fabrication

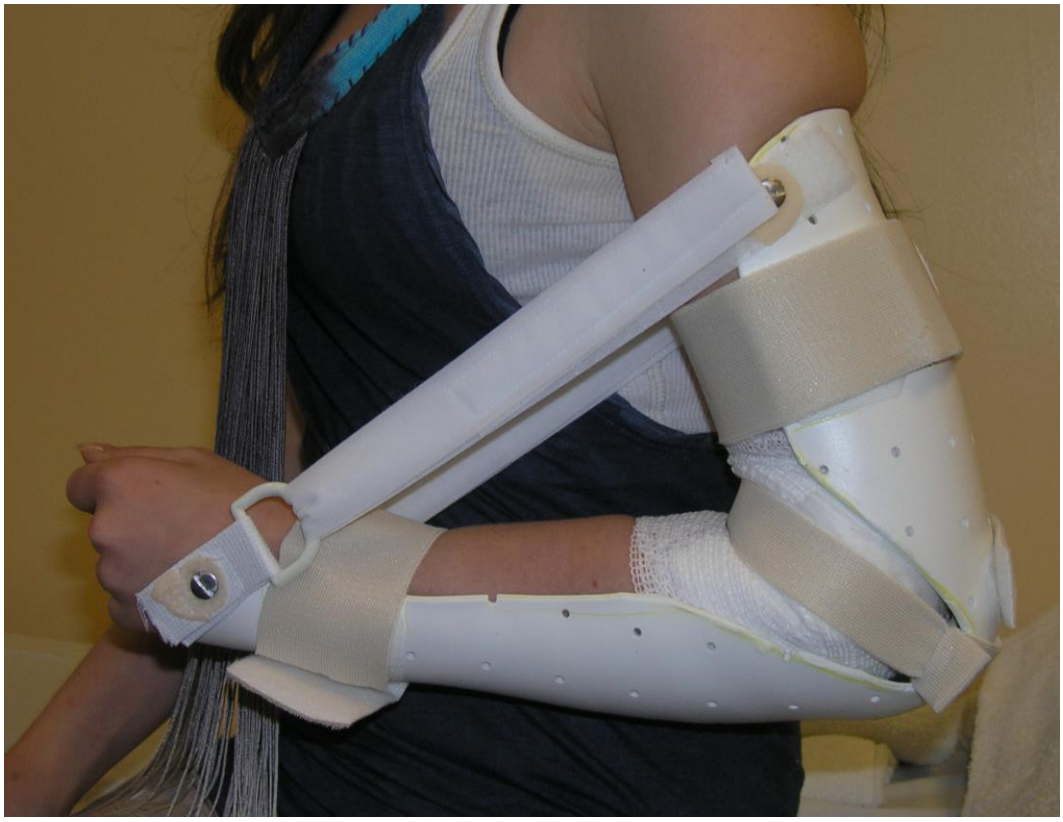
Saturday May 11, 2024

Emily Altman, PT, DPT, CHT, OCS, CLT-LANA, WCC

HOSPITAL FOR SPECIAL SURGERY

Smart Design

The Art of Splinting



Static Progressive Elbow Flexion Splint

Emily Altman, PT, DPT, CHT, OCS, CLT-LANA, WCC

Static Progressive Elbow Flexion Splint

Tools, Hardware and Materials

- 1/8" thickness thermoplastic material, such as Ezeform® perforated
- 1" squares (x 4) of 1/16" thickness thermoplastic such as Orfit™
- Strong scissors / heavy duty shears for cutting hard thermoplastic
- Creating holes in thermoplastic:
    1. Dremel Cordless Rotary Tool
       MiniMite 750-02, 4.8 Volts, two-speed
       Purchase separately:
           Dremel #4486: Dremel Chuck
           Dremel Accessory #628D: 7 piece drill bit set 1/32-1/8. Use the 1/8 drill bit for holes needed for screw rivets attachment
    2. Deluxe Revolving Hole Punch
    3. Samson All-Purpose Hole Punch
        - Comes with 1/8" Die Set, however the ¼" Die Set (A371-18) is very useful to have. This is purchased separately.
- 4 pairs of aluminum screw rivets
- 1" Plastic D-Rings, x 2
- 1" Stainless Steel D-Rings, x 2
- 1" Webbing (cotton or nylon)
- 1" non-sticky back loop Velcro®
- 1" non-sticky back hook Velcro®
- 2" loop strap material
- 1" loop strap material
- 2" sticky back hook Velcro®
- 1" sticky back hook Velcro®
- Foam (such as Polycushion® or other similar product)
- Cotton Stockinette

Diagnoses

- Soft tissue or elbow joint stiffness resulting in decreased elbow flexion secondary to:
    - Radial head fracture
    - Proximal ulna fracture
    - Distal humerus fracture
    - Contracture release of the elbow
    - Elbow dislocation

Instructions for Splint Fabrication

The purpose of this static progressive splint is to increase elbow flexion range of motion (ROM) following surgery or trauma. The splint is fabricated to gradually gain elbow flexion. Below are step-by-step instructions for fabricating a static progressive elbow flexion splint.

1. The easiest position to mold the splint is with the patient in supine with the shoulder in 90° of flexion and the elbow in maximum available flexion. Alternatively, the patient may be seated with the shoulder slightly abducted.
2. The following measurements are taken:
    - The width of the upper arm (A)
    - The length from the axillary crease to the olecranon process (B)
    - The length from the olecranon process to the distal palmar crease on the ulnar aspect of the hand (C)
    - The width of the ulnar side of the hand at the distal palmar crease (D)
3. Using the measurements you've taken, draw the splint directly onto the thermoplastic material or on a piece of paper towel. If you are comfortable with the pattern, you may chose to forgo drawing a pattern on paper towel and use your measurements to draw the splint directly onto the thermoplastic material. The splint pattern looks somewhat like a rectangle on top (from just proximal to the axilla down to the olecranon) and a cone on the bottom (from the olecranon to the distal palmar crease).
4. Proximally the splint should be lower on the medial side to clear the axilla and should extend higher laterally to ensure proper support (E). The thenar eminence and distal palmar crease must be cleared to allow full digit and thumb motion (F).
5. If you draw the pattern on a piece of paper towel, cut it out and test it on the patient to ensure a good fit.
6. Heat the material and cut the splint out.
7. Place a long piece of stockinette over the entire arm from the distal palmar crease to the top of the brachium.
8. Pad the ulnar head and if necessary the proximal edge of the splint with 1/8" foam. Once you have placed the foam over the area(s) you are padding, place a small piece of stockinette over the padding to prevent it from sticking to the thermoplastic material while you mold the splint.
9. Position patient in supine as described in step one. Place material on posterior aspect of arm and forearm. Check that the material is aligned properly proximo-distally and medio-laterally.
10. Pinch the material at the elbow to make a mitered corner. <u>DO NOT pinch-and-fold or cut-and-fold the corner as is done for the standard posterior elbow shell</u>. Simply leave the material pinched. Allow material to harden. See picture 1.
11. Remove splint from patient. <u>Dip just the corner of the splint that will sit over the olecranon process in the splint pan water</u>. Allow the splint to fill with water to soften just the corner of the splint.
12. Once the material is soft, place a towel over your fist and sculpt a bubble in the splint. Continue to shape until the material hardens. It is necessary to increase space around the olecranon because as the elbow flexes, the length of the posterior surface of the arm increases. The bubble that is sculpted over the olecranon allows the splint to accommodate that increase and continue to fit through the range of elbow flexion.
13. Using a strong pair of scissors or heavy duty shears, cut the 2 folded corners on the splint so that only a narrow bridge of material (about 3" wide) connects

the brachium to the forearm. This will destabilize the splint and allow the forearm piece to move toward the brachium piece. See picture 2.

14. Dry heat 2 1" squares of Orfit™ and apply to one end of each length of 1" non-sticky back Velcro® loop strap. Punch a hole through the Orfit™ and the strap material. The Orfit™ serves as a reinforcement to the webbing. It will ensure that the webbing does not pull away from the screw rivet.
15. Sew a 4" piece of non-sticky back Velcro® hook to the other end of the length (about 15") of 1" Velcro® loop.
16. Dry heat the remaining 2 1" squares of Orfit™ and apply to one end of each length of 1" webbing. Punch a hole through both ends of the webbing. This webbing piece is used to attach the D-ring to the splint at the wrist.
17. Punch 4 holes in the splint: 2 at the proximal end (medial and lateral) and 2 at the distal end (near the wrist, medial and lateral). A Dremel drill can also be used to drill the 4 holes into the splint.
18. Use screw rivets to secure the Orfit™ end of the Velcro® loop to the proximal end of the splint. One medially, one laterally.
19. Use screw rivets to secure the short length of webbing (in the form of a loop, with a D-ring on it) to the distal end of the splint. One medially, one laterally. See pictures 3 and 4.
20. It is important that your strapping choices hold the arm into the splint so the static progressive forces imparted by the Velcro® loop straps are able to effectively bend the elbow. There must be a strap right at the elbow joint line, holding the elbow into the bend of the splint. We recommend a loop-through attachment of one end of this strap to the narrow bridge of material and a regular sticky-back hook Velcro® attachment at the other end of this strap. Two 2" straps across the upper arm, two 2" straps across the forearm and one 1" strap through the thumb web space will adequately hold the arm in the splint.
20. Pull the hook Velcro® ends of the loop Velcro® straps through the D-ring (one medial and one lateral) and adjust tension. *See picture 5.*

Helpful Hints

- Including the wrist in this splint increases the length of the lever-arm of the forearm segment and improves patient comfort.
- As the patient makes progress regaining elbow flexion range of motion, the tension strap can easily be adjusted. Simply apply a new 1" square of dry-heated Orfit™ a few inches down the strap, punch a new hole, unscrew the rivet, resecure through the new hole and trim off the old hole and Orfit™ piece.
- Reinforcing strapping material with a piece of dry-heated Orfit™ prevents tearing of the strap material under stress.
- When punching a hole in cloth (i.e. webbing or other strap material), sandwich a scrap of 1/16" thermoplastic splint material between the cloth material and the anvil side of the punch mechanism. The cloth material is pinched between the cutting device and the thermoplastic (which also gets cut) and a clean hole is cut in the cloth material.

Line of Pull

While the line of pull is not at a perfect 90° angle to either the upper arm or the forearm, it is not terrible and it gets closer to 90° as the elbow flexes more! Remember that the unwanted sheer component of the force vector pulls the elbow out of the corner of the splint…hence the importance of the strap right at the joint line.

Why static progressive splints? Why not dynamic splints?

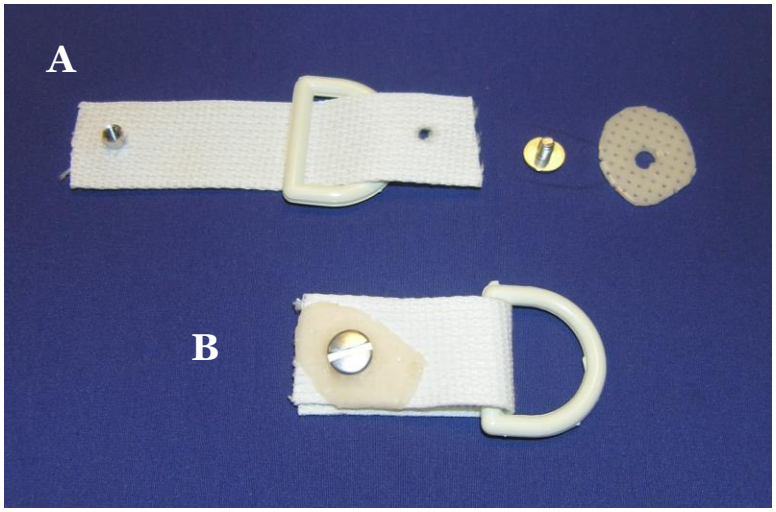
The elbow joint is known to be very sensitive to trauma and surgery. The joint capsule and other soft tissues surrounding the joint react to trauma and surgery with a powerful fibrosis response. The application of a constant, unrelenting, dynamic force can be irritating to the tissues and can trigger an inflammatory reaction. Provoking such a response is to be avoided. With the application of a static progressive force, the soft tissues are able to accommodate to the initial force and gently elongate before additional force is applied in a gradual fashion.

How does a static progressive elbow flexion splint compare to a prefabricated static progressive elbow flexion splint?

The problem with a prefabricated static progressive elbow flexion and extension splint is that one-size-fits-none. A well-made custom fabricated static progressive elbow flexion splint will definitely deliver more effective forces at the elbow. As a prefabricated splint is “cranked” into more and more flexion, the brace tends to shift posteriorly and the axis of rotation of the brace falls posterior to the axis of rotation of the elbow. This is due in part to the fact that the two anterior straps on the splint that are just proximal and just distal to the elbow joint line have to be removed because they bunch up as the elbow flexes. So, it becomes difficult to hold the elbow into the splint. As the prefabricated splint falls more and more posterior with increasing elbow flexion angles, the flexion angle of the splint will be more than the elbow joint itself. Eventually, the prefabricated splint will be in maximum flexion, but the elbow joint will still have range of motion to capture. There are some clever and creative modifications that can be made to prefabricated static progressive splints to improve the mechanics, but a custom splint is superior.

Picture 1. Pinched corners

Picture 2. Splint material over olecranon bubbled out and pinched corners cut away



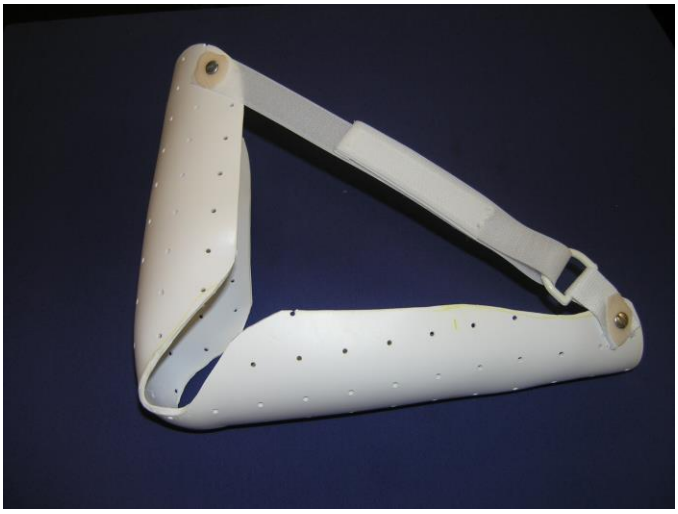
Picture 3. A.Webbing, D-ring, screw rivets and Orfit™ reinforcer before attachment to the thermoplastic material. B. Webbing, D-ring, screw rivets and Orfit™ reinforcer assembled.

NOTE: Instead of webbing, we now use a strip of 1" Orficast tape looped through the Dring (as webbing is looped through in B to the left). Press firmly together. Round the square edge with scissors, punch a hole and your tab for the Dring is done and strong! Much easier.

Pro Tip:
Do not cut away pinched corners until the D-ring and strap device are all attached. This way, the side straps are set to the correct length for the elbow's most flexed position and they are equal. Also, the splint wiggles around less. Use heavy duty shears to cut the pinched bits off. Line rough edge with an adhesive fleece edger.

NOTE: Important!
In this picture, the placement of the distal Dring on the forearm piece is not correct. It should be attached more proximally on the forearm. Ideally, the distance between the point of the elbow and the hole for the start of the strap at the proximal humerus and the distance between the point of the elbow and the attachment of the Dring should be EQUAL!

Picture 4. Webbing, D-ring, screw rivets and Orfit™ reinforcer attached to splint and static progression flexion loop strap with Orfit™ reinforcer and hook strap sewn in.



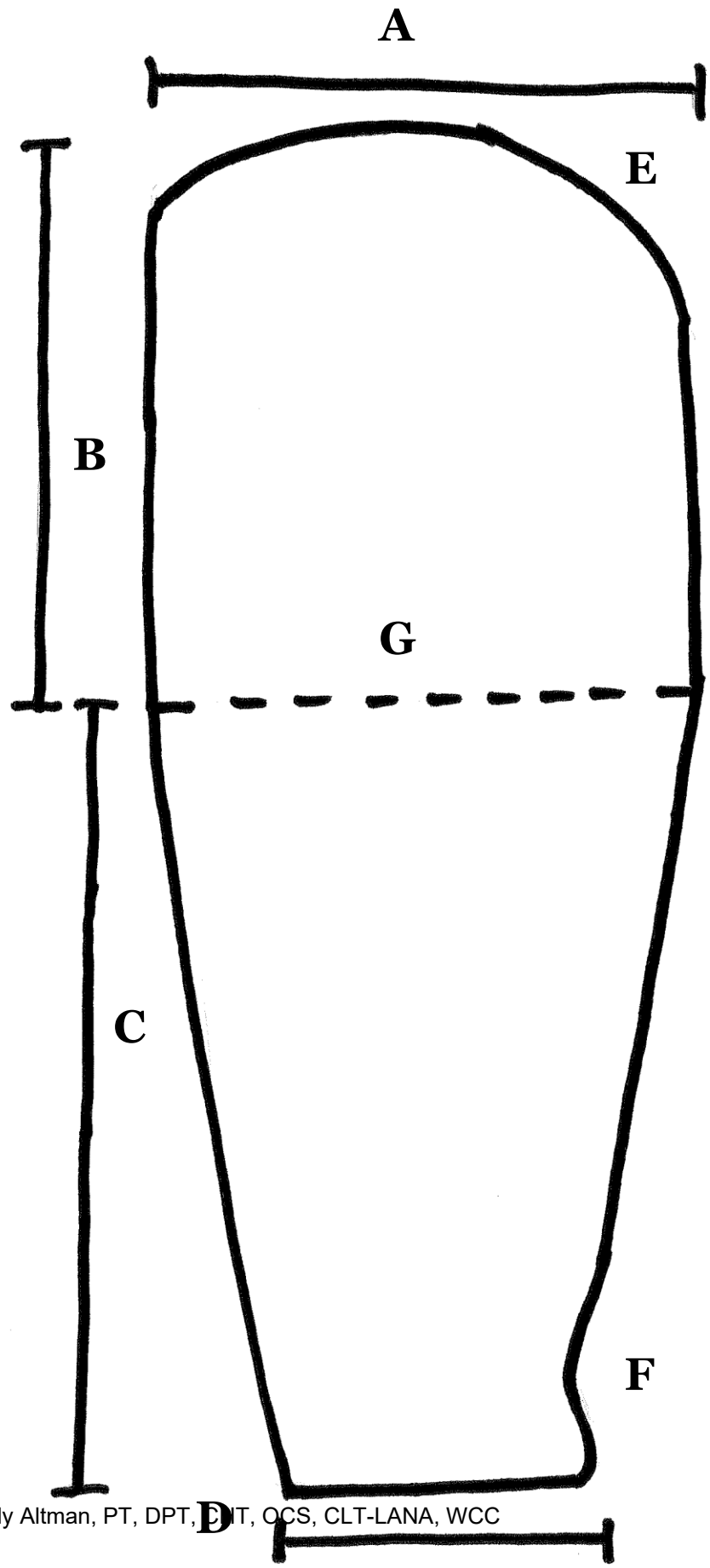
Picture 5. Static progressive flexion strap attached to splint.

Note: As the patient makes progress, simply punch a new hole in the strap at the proximal end.

You could also sew hook Velcro to the proximal end of the strap, but then the distal end become a little flimsy. Dealer's choice.

Pro tip: Make the humeral length of the splint as long as you can (without impinging in axilla). This will maximize the mechanics of the splint.

Splint Pattern
Static Progressive Elbow Flexion



Landmarks

A: Generous ½ of upper arm circumference **6+"**
B: Proximal edge of splint to olecranon process **9"**
C: Olecranon to distal palmar crease (or just proximal to MC heads) **12"**
D: Volar 3rd MC to dorsal 3rd MC via ulnar aspect of hand **4"**
E: Mild shaping for axilla.
F: Shaping for thenar eminence
G: Elbow joint line

Note: Measurements in red represent reasonable numbers for the participants of this course. Use as a guideline!

Wisconsin Hand Experience 2024

Unraveling the Mysteries of the Wrist

Splinting Tips and Tricks

Part 7: Delta Cast Fabrication Directions

Tips and Tricks for Orthotic Fabrication

Saturday May 11, 2024

Emily Altman, PT, DPT, CHT, OCS, CLT-LANA, WCC

Delta Cast®

Wrist Splint

Thumb Spica

Elbow Shell

Sugar Tong/Munster Splint

Delta Cast Basics

Delta Cast Conformable Polyester Cast Tape is an easy-to-use, fiberglass-*free* cast tape that produces versatile, lightweight and strong casts. When fabricated as described below, the casts can be cut off with scissors. Cast saws should not be used with this material.

Prepare Items:

- **Bucket of water**
- **Roll(s) of cast tape**
- **Inexpensive bandage scissors (for cutting wet cast tape, sticky back Velcro, fleece edger, etc)**
- **Cast scissors: 8" Clean Cut™ (for cutting dry cast material only). Take good care of these!**
- **Zip Stick (cast removal aid/plastic cutting stick)**
- **Terry-Net™ Stockinette**
- **Terry-Net™ adhesive terry cloth/foam padding**
- **Terry-Net™ adhesive felt padding**
- **Terry-Net™ adhesive fleece edger**
- **Sticky back hook Velcro**
    - **The sticky back hook Velcro manufactured by BSN Medical is preferable**
- **Stretch loop strapping (BSN brand)**
    - **The sticky back hook Velcro manufactured by BSN Medical is preferable**
    - **Standard non-stretch strapping can also be used very effectively**
- **Gloves**
- **Towel**
- **Gown to protect patient and clothing, if necessary**

Things to Keep in Mind:

- **Use inexpensive bandage scissors to cut wet cast tape and sticky materials.**
- **Use special, expensive BSN black and gold scissors (8" Clean Cut Scissors) for cutting *dry* cast material ONLY. Item number 28230.**
- **BSN 6" Clean Cut Scissors are useful. They have pointed tips so use with care. Item number 28235.**
- **We occasionally use heavy duty shears to cut the cast AFTER it has been removed from the patient: Sammons Preston 5599-88-11 Kretzer Heavy Duty Shears.**
- **Cold water slows curing rate (conversely, warm water speeds curing rate).**
- **Dipping roll of cast tape without squeezing slows curing rate (conversely, squeezing roll speeds curing rate). There is no need to squeeze the roll after submersion.**
- **Purple gloves of yore:**
    - **Special purple gloves used to be required when using the polyester cast tape. They are no longer required. Regular gloves found in the clinic can be used.**

- **Explain to patient that the cast may feel warm and a bit tight during application.**
- **Tension the material as you roll the cast.**
- **Overlap about 50 %.**
- **1 layer: very flimsy**
- **2 layers: good rigidity, cut-able**
- **3 layers: very rigid, hard to cut**
- **4 layers: totally solid, impossible to cut**
- **Do NOT forget to place the cutting stick (you will do this once and then never again!).**
- **Use clinical judgment when deciding where to place the extra layers for reinforcement and rigidity.**
- **For smaller, more delicate splints, you can use a wide (at least 2") strip of webbing material instead of the Zip Stick.**
- **Cutting open a Delta Cast splint can be made easier by gently squeezing it together on either side of the cutting line. This lifts the cast away from the skin and reduces pressure.**
- **Avoid putting foam where you will be cutting.**
- **Avoid excessive layers of cast material where you will be cutting. Plan ahead.**
- **Use one long piece of sticky back Velcro per strap and heat the adhesive with heat gun prior to applying to splint.**
- **Strap ends should pull from the middle of the piece of sticky back Velcro. This reduces pull-off of sticky-back Velcro pieces.**
- **If you apply the sticky back Velcro strips to splint before applying fleece edger, the edge of the Velcro can be placed under the fleece edger to improve adherence.**
- **Applying the fleece edger can be tricky. Un-spool a significant length of edger out of the box to make it easier to work with. Peel about 1" of paper backing off and apply to edge of splint. Allow about ½ the width to fit on the outside of the splint and the other ½ will be folded over to fit on the inside of the splint. Peel paper off slowly as you simultaneously apply the edger to the splint. If you peel off all of the paper first, it will curl and stick to itself, creating a mess. Cut the tape where there is still paper attached, otherwise it will stick to the scissors.**
- **Sometimes skin can be pinched along the splint closure area. Mold a thin strip of 1/16" thermoplastic splint material to the skin in the area where the splint closes. The splint then closes over the thermoplastic piece, functioning like a tongue in a shoe.**
- **Plan ahead!!**
- **Be creative!!**
- **Wear a protective gown until you are confident in your skills. The resin of the cast tape does not come out of clothing.**
- **Protect the clothing of the patient.**
- **Use Goo Gone® Painter's Pal (silver-colored spray bottle) to clean black & gold scissors. Spray the scissors and leave overnight in a sealed container (it smells a bit). You can also use powerful, industrial adhesive stripper used for**

removing adhesive from existing linoleum floors. This is a dangerous chemical so use with care and caution.

- **A note on "Cutters" vs "Stretchers". In the fabrication of the wrist and thumb spica orthoses you will notice that we demonstrate the technique of cutting into the cast tape to accommodate the thumb. It is possible to use a "Figure 8" rolling technique with some stretching through the web space to create the cast. We encourage people to try different techniques to accomplish their desired end result!**

Order from skin to outer layer:

- **Skin**
- **Cutting stick (slip under AFTER applying stockinette)**
- **BSN Stockinette (2" for wrist, 3" for adult elbows)**
- **Foam padding for bony prominences**
- **Double check that cutting stick is in!!**
- **Cast tape for reinforcement strut**
- **Cast tape for splint**
- **Estimates: One roll of 2" or 3" cast tape for forearm splints; for elbows, use 2 rolls of 3" or one roll of 3" and one roll of 2".**

Visit www.handtherapyhub.com and click on Delta Cast Pictures to see some creative splints made with Delta Cast®

Delta Cast Wrist Splint

1. **Slip Surgitube on thumb to protect from resin (optional).**
2. **Snip a tiny hole in Terry-Net sleeve for thumb. Hole should be no less than 4" from distal end of sleeve. Sleeve will shorten as it is stretched over arm so cut a generous overall length. (Figure 1)**
3. **Slip 2" sleeve of Terry-Net on forearm.**
4. **Piece of foam to ulnar head. (Figure 2)**
5. **Place Zip Stick through thumb hole along radial border of arm. (Figure 3)**
6. **Don gloves.**
7. **Open a roll of 3" BSN Delta Cast Polyester Cast Tape.**
8. **Cut a 6" piece off the end. Fold in half length-wise. This is your reinforcing strut for the volar aspect of the wrist splint. (Figure 4)**
9. **Submerge roll of 3" cast material in water. Do not squeeze. Remove and gently blot on towel.**
10. **Begin to roll cast at wrist crease. (Figure 5)**
11. **Second layer at wrist crease. (Figure 6)**
12. **Begin first layer of palmar portion. Cut tape to accommodate thumb. (Figures 7 & 8)**
13. **Begin second layer of palmar portion. (Figure 9)**
14. **Complete 2nd layer of palmar portion. Then angle down to begin forearm portion of cast. (Figure 10)**
15. **Create forearm portion with 50% overlaps. (Figure 11)**
16. **Complete forearm portion. Proximal edge should be 2 layers thick. (Figure 12)**
17. **Cut tape, discard excess portion of rolled cast tape.**
18. **Shape splint as desired.**
19. **Rub surface of material with wet gloves.**
20. **Allow material to dry and set (about 5 minutes).**
21. **Remove gloves.**
22. **Draw shape of splint and cutting line. Use Sharpie® pen. (Figures 13, 14, 15)**
23. **Using special black and gold scissors, cut along plastic cutting stick. (Figure 16)**
24. **Using special black and gold scissors, trim excess off proximal end of splint, cut along previously drawn lines to create final shape of splint. (Figure 17, 18)**
25. **Apply fleece edger to cut edges of the splint. (Figures 19, 20)**
26. **Affix sticky back Velcro strips. (Figure 21)**
27. **Apply straps. (Figure 22)**
28. **Completed splint. (Figures 23, 24)**

Notes:

- **Keep gloves moist during fabrication.**
- **Add a 1" wide collar of folded regular stockinette material just proximal to metacarpal heads, under Terry Net sleeve. This will create more room in this area of the splint to increase ease of don/doff. Prominent metacarpal heads can make don/doff difficult.**
- **Distal opening of splint (at distal palmar crease) should slant obliquely (radial to ulnar). This permits full flexion of II-V at the MCP joints and increases the area of the opening, allowing easier don/doff of splint.**

Illustrations

Figure 1:
Stockinette sleeve, surgitube to protect thumb from resin, cutting stick on radial aspect of the forearm, foam padding on ulnar head

Figure 3
Cutting stick

Figure 2
Foam padding on ulnar head

Figure 4
2-layer reinforcing strip

Figure 5
Begin to roll cast

Figure 6
Second layer at wrist crease

Figure 7
Begin first layer of palmar portion. Cut into tape to accommodate thumb.

Figure 8
Stretch through webspace

Figure 9
Begin second layer of palmar portion

Figure 10
Complete 2nd layer of palmar portion and angle down to forearm area.

Figure 11
Begin forearm portion with 50% overlaps

Figure 12
Complete forearm portion. Cut tape. Discard extra material.

Figure 13
Draw shape of splint

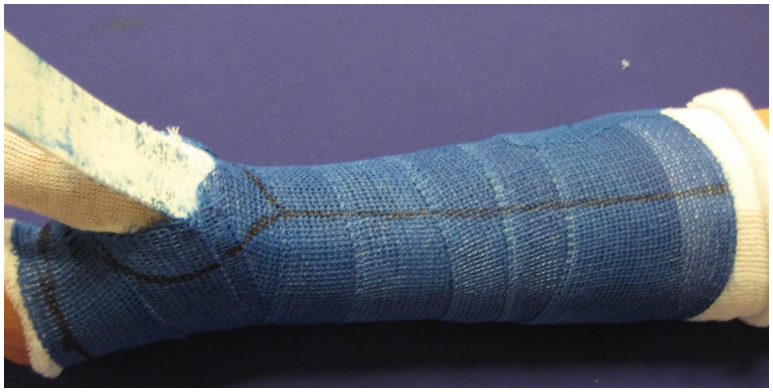


Figure 14
Draw guide line along cutting stick

Figure 15
Draw shape of splint

Figure 16
Cut cast along cutting stick

Figure 17
Trim excess off proximal edge

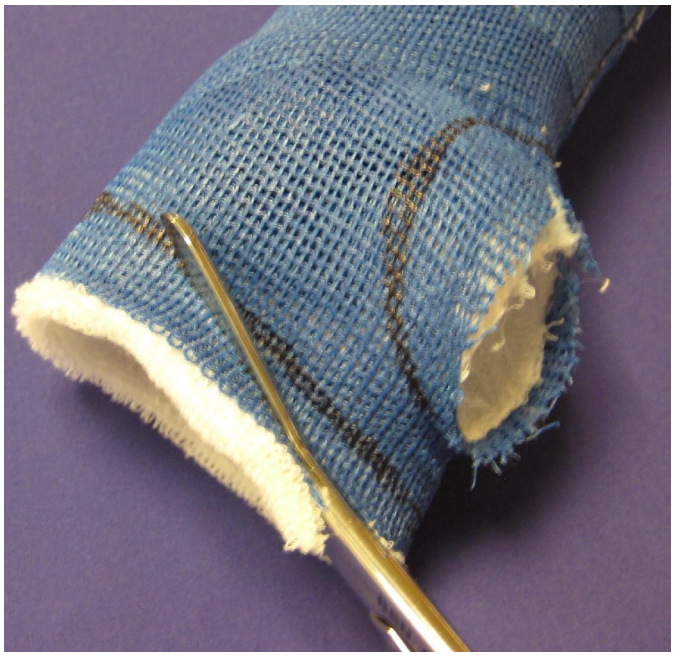


Figure 18
Trim along line on distal end of splint

Figure 19
Apply fleece edger to cut edges of the splint.

Figure 20

Figure 21
Apply sticky back Velcro pieces. Complete fleece edging.

Figure 22
Apply straps

Figure 23
Completed splint

Figure 24
Completed splint

Delta Cast Thumb Spica

1. **Slip thumb spica stockinette onto hand. (Figure 1)**
2. **Cut excess thumb length to just shorter than thumb tip. (Figures 1-3)**
3. **Mark thumb IP joint line volarly and dorsally. (Figures 1-2)**
4. **Cut into the thumb cuff as shown. (Figure 2)**
5. **Place plastic Zip Stick on dorsal aspect of forearm. (Figure 3)**
6. **Foam padding to dorsal thumb and ulnar head. (Figures 2-3)**
7. **Don gloves.**
8. **Open a roll of 2" BSN Delta Cast Polyester Cast Tape.**
9. **Cut an 8" piece off the end. Fold in half . Create a taper at the folded end. This is your reinforcing strut for the dorsal side of the thumb and radial forearm. (Figures 4-5)**
10. **Submerge the roll of cast tape in water. Remove and gently blot on towel. Do not squeeze.**
11. **Begin to roll cast at the level of the carpal tunnel. The tape starts on the ulnar side of the wrist. Complete one loop. Then angle up to the thumb. (Figures 6-8)**
12. **Cut into the tape from proximal to distal to permit fit through the web space. Circle the thumb once, stopping at the cut that you made in step 4. (Figures 9-10)**
13. **Fold down the cuff. The leading portion of the tape with slide through the cut in the cuff. You will again need to cut into the tape to allow the second round of the thumb to fit through the web space. (Figure 11) Note: some clinicians prefer to stretch the tape through the web space instead of cutting the tape. This is a personal preference/decision.**
14. **Complete second round of thumb.**
15. **Then circle the distal ends of the metacarpals twice. You will again need to cut into the tape at the web space. (Figures 12-13)**
16. **Once the thumb and hand are complete, begin spiral down the forearm to the elbow. Overlap should be about 2/3. (Figure 14)**
17. **Once you have reached the desired length, cut the tape and discard the unused portion. Remember that the end of the splint needs to have 2 layers for stability. (Figure 15)**
18. **Shape splint as desired.**
19. **Allow material to dry and set.**
20. **Draw outline of splint with Sharpie®.** (Figures 15-16)
21. **Using black and gold scissors, cut along the cutting stick. (Figure 17)**
22. **Using black and gold scissors, trim all edges of the splint to the desired shape. (Figure 19)**
23. **Apply fleece edger to the cut edges of the splint.**
24. **Affix velco strips.**
25. **Apply strap material**
26. **Splint is complete.**

Illustrations

Figure 1. Stockinette, Zip Stick, IP joint line marked volarly, foam padding to thumb and ulnar head

Figures 2 & 3. Cut into cuff of thumb sleeve, foam padding, Zip Stick

Figures 4 & 5. Creation and placement of reinforcing strip

Figure 6. Begin roll at ulnar side of wrist. Unroll in direction of the arrow. Complete one loop.

Figures 7 & 8. In next loop, angle up to the thumb, cut into the tape to permit fit through web space

Figures 9 & 10. Circle the thumb. Lay the edges of the cut down on either side of the web space. Cut into tape again to prepare for second pass through web space

Figure 11. Before the second loop of the thumb, fold thumb sleeve down over the edge of cast material, permitting the tape to come through the cut that you made in the thumb sleeve. Secure the folded cuff with the second loop of cast material around the thumb

Figure 12. After completing second loop of the thumb, create two loops at the distal metacarpal level. Again, cut into the tape, as shown, to permit fit through web space. Lay the cut edges of the tape (V's) down on either side of the web space.

Figure 13. Complete second loop around distal metacarpals level, including cut for web space.

Figure 14. Continue down forearm, overlapping by about 2/3

Figure 15. Cut tape at desired length. Mark distal edge of splint

Figure 16. Mark cutting line on dorsal aspect of the forearm. Mark distal edge of the splint

Figure 17 & 18. Cut along cutting line, over Zip Stick. Remove splint from hand.

Figure 19. Trim to desired shape, place sticky-back, hook Velcro tabs. Fleece edge as described in the wrist splint section.

Delta Cast Elbow Shell

1. **Gown to protect patient's clothing.**
2. **Cut desired length of 3" Terry-Net sleeve. Snip small hole in sleeve for the thumb. Leave at least 4" between the hole and the end of the sleeve.**
3. **Use Surgitube thumb sleeve to protect the patient's thumb from the resin if desired.**
4. **Slip sleeve on patient's arm.**
5. **Place foam as shown to ulnar head, olecranon, medial/lateral epicondyle. (Figures 2-4)**
6. **Place Zip Stick anteriorly as shown. (Figure 2)**
7. **Open a roll of 3" BSN Delta Cast Polyester Cast Tape.**
8. **Create a 3-4 layer posterior strut. (Figure 5)**
9. **Submerge roll of cast material in water. Do not squeeze. Remove and gently blot on towel.**
10. **Begin to roll cast at the proximal end. (Figure 6)**
11. **Overlap about 50%.**
12. **As you approach the elbow joint (positioned at 90°), be sure to debulk the cast tape by cutting into it from both sides in the spot where it crossed the cutting stick. If you do not do this, too much cast material will be layered in this area and you will not be able to cut it off. (Figures 7-10)**
13. **Start a new roll of cast tape when the first one runs out.**
14. **Once you are past the bend of the elbow, proceed normally with 50% overlap. (Figure 11)**
15. **Wrap all the way down to the level of the metacarpal heads, cutting into the tape as needed to accommodate the thumb (same technique that was used for the wrist splint). (Figures 12-13)**
16. **When splint is complete, cut tape and discard excess portion of rolled cast tape.**
17. **Shape splint as desired.**
18. **Rub surface of material with wet gloves.**
19. **Allow material to dry and set.**
20. **Remove gloves.**
21. **Using a Sharpie® draw shape of splint and cutting line. (Figure 16)**
22. **Cut along cutting line. (Figures 16-17)**
23. **Take great care to stay on the cutting stick and be careful at the antecubital fossa.**
24. **Remove splint. (Figure 18)**
25. **Trim distal and proximal edges in same fashion as wrist splint and thumb spica and shape the anterior opening. We recommend creating a corner at the bend in the elbow (See Finishing Pictures).**
26. **Place sticky-back Velcro tabs.**
27. **Apply fleece edger. See special tips in the Illustrations section below.**
28. **Apply strap straps.**

Illustrations

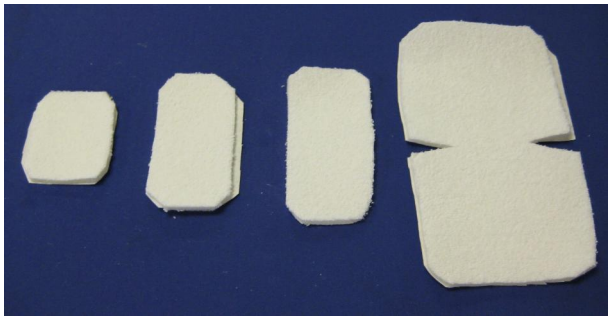


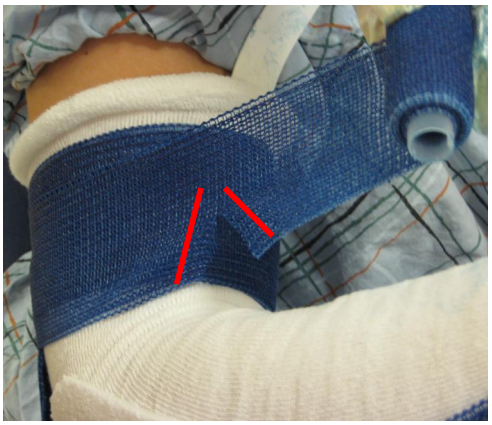
Figure 1. Prepare foam pieces for elbow splint. Left to Right: ulnar head, lateral elbow, medial elbow, posterior elbow

Figure 2. Stockinette sleeve with small hole for thumb, Zip Stick placed anteriorly.

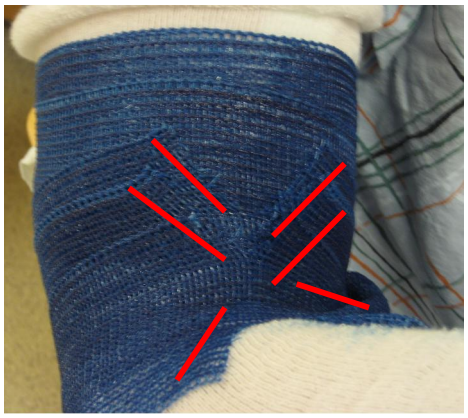
Figures 2, 3 & 4. Foam padding at ulnar head, olecranon, medial epicondyle, lateral epicondyle.

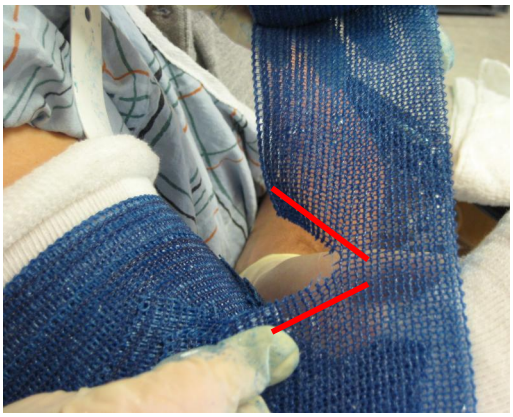
Figure 5. Posterior, reinforcing strut. 3-4 layers. Avoid excessive pressure holding distal end of strut. It can become a pressure point inside the splint.

Figure 6. Begin circumferential rolling of splint at proximal end of splint. Make sure edge has two layers. Overlap about ½ to 2/3.



Figures 7 & 8. VERY IMPORTANT: You must cut into the tape on one or both sides at the point where it crosses the anterior elbow at the bend of the elbow. You will be cutting into many loops. If you do not, there will be far too much material to cut through. The more you cut, the happier you will be.





Figures 9 & 10. More views of debulking cuts. Material splays over cutting strip.

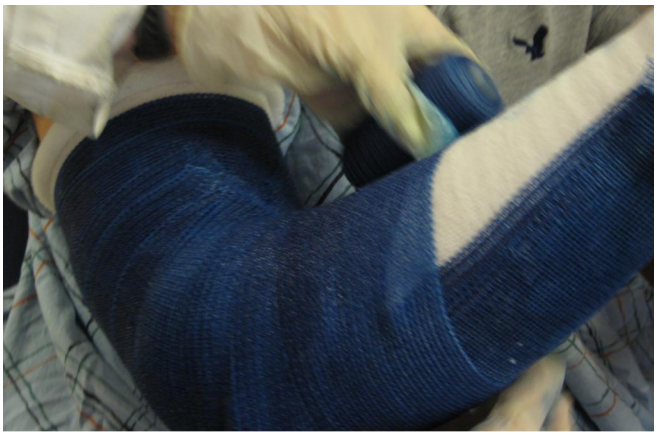
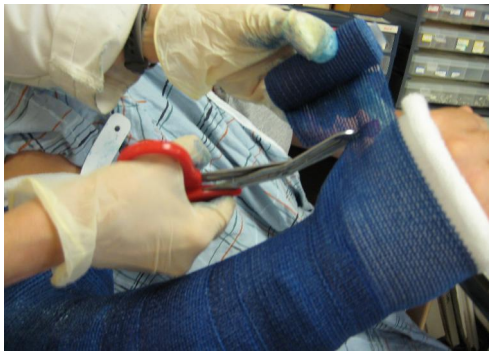


Figure 11. Continue rolling in standard fashion toward the hand. Overlapping ½ to 2/3. Avoid too much material over cutting stick!



Figures 12 & 13. Two loops around the metacarpal level of the hand, cutting into the tape to accommodate the web space. This is exactly the same technique as was used for the distal end of the wrist splint.

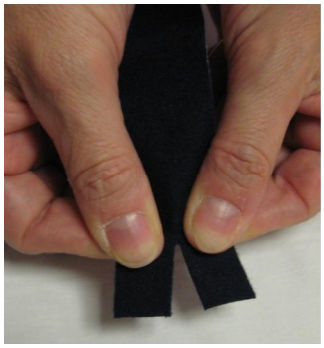
Figures 14 & 15. Cut tape when splint is complete. Discard excess. Shape as needed. Rub entire splint with wet gloves.

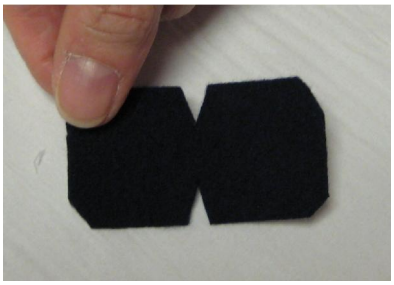
Figure 16. Draw cutting line with Sharpie and cut splint.

Figure 17. Exercise great care at the antecubital fossa.

Figure 18. Remove splint from patient once cut is complete. Draw preferred shape of splint with a sharpie and cut final shape with black and gold scissors. This is done is exactly the same fashion as the thumb spica and wrist splint.

Figures below: special tips for fleece edging elbow splint.
Begin edging at corner formed at the bend in the elbow. Cut into the end of the fleece tape and apply as shown. Continue edging as usual. End at opposite crease and finish with similar fishtail split. Then start edging in the other direction in the same manner. Further reinforce the medial and lateral corners with an extra short piece of edging as shown. Apply sticky-back hook Velcro pieces as usual and apply straps.





Note 90° corner at the medial and lateral aspects at the bend in the elbow. Provides wide opening for don/doff.

Delta Cast Sugar Tong/Munster Splint

1. Gown to protect patient's clothing.
2. Cut desired length of 3" Terry-Net sleeve. Snip small hole in sleeve for the thumb. Leave at least 4" between the hole and the end of the sleeve.
3. Use Surgitube thumb sleeve to protect the patient's thumb from the resin if desired. (Figure 1)
4. Place 4-layer ring of 2" stockinette just proximal to metacarpal heads if desired. This will loosen the fit of the cast around MCPs and ease don/doff. (Figure 1)
5. Slip stockinette sleeve on patient's arm.
6. Place foam as shown to ulnar head and distal humerus. (Figures 2 & 3))
7. Place Zip Stick anteriorly as shown. (Figure 4)
8. Open a roll of 2" BSN Delta Cast Polyester Cast Tape.
9. Create a 2-3 layer strut. (Figure 5)
10. Submerge roll of cast material in water. Do not squeeze. Remove and gently blot on towel.
11. While patient holds reinforcing strut, create a figure-of-8 (x2) around the elbow joint, with the cross at the antecubital fossa. (Figure 6)
12. Then begin spiral toward the hand. (Figures 7 & 8)
13. Overlap about 2/3.
14. Start second roll when first roll runs out. This will be a 3" roll of tape. (Figures 9 & 10)
15. As you approach the hand, cut into the tape to accommodate the thumb (same technique as used in the wrist splint and the posterior elbow shell). (Figures 11-13)
16. When splint is complete, cut tape and discard excess portion of rolled cast tape. (Figure 14)
17. Shape splint as desired.
18. Rub surface of material with wet gloves.
19. Allow material to dry and set.
20. Remove gloves.
21. Using a Sharpie® draw shape of splint and cutting line. (Figure 15 & 16)
22. Cut along cutting line. (Figure 17)
23. Take great care to stay on the cutting stick and be careful at the antecubital fossa.
24. Remove splint. (Figure 18)
25. Trim edges of the splint to create final shape. (Figures 19-28)
26. Place sticky-back Velcro tabs. (Figure 29)
27. Apply fleece edger. (Figures 30-35)
28. Apply straps

Figure 1. Prepare and protect hand.

Figure 2. Sleeve and foam.

Figure 3. Distal humeral foam

Figure 4. Insert Zip Stick. Mark base of thumb/radiocarpal joint

Figure 5. Place reinforcing strut.

Figure 6. Create 2-layer figure-of-8. Cross at antecubital fossa. See schematic on last page.

Figure 7. Begin spiral toward hand. Overlap 2/3.

Figure 8. Continue toward hand.

Figure 9. End of first roll of cast tape.

Figure 10. Begin 3” roll.

Figure 11. Cut tape to accommodate thumb

Figures 12 & 13. Cutting tape to accommodate thumb.

Figure 14. Rolling is done.

Figure 15. Draw outline final splint.

Figure 16. Draw edges of splint.

Figure 17. Cut along cutting line and stick.

Figure 18. Cutting is complete. Carefully remove from patient.

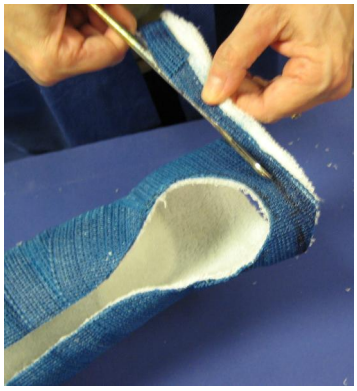
Figure 19. Trim and shape.

Figures 20-28 (below)
Trim and shape splint edges.

Radial Opening

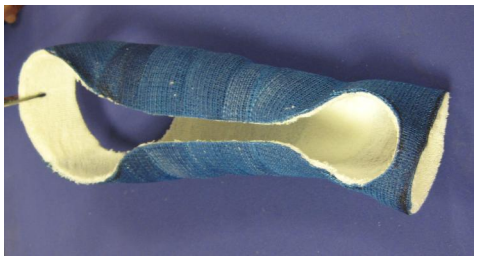
Thumb Opening

Metacarpal Head Opening



Metacarpal Head Opening

Olecranon Opening



Final Shape

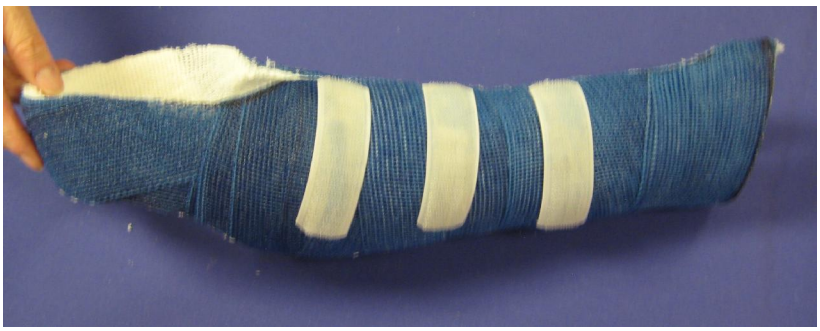


Figure 29. Apply sticky back hook Velcro tabs for straps. Apply to dorsal side.

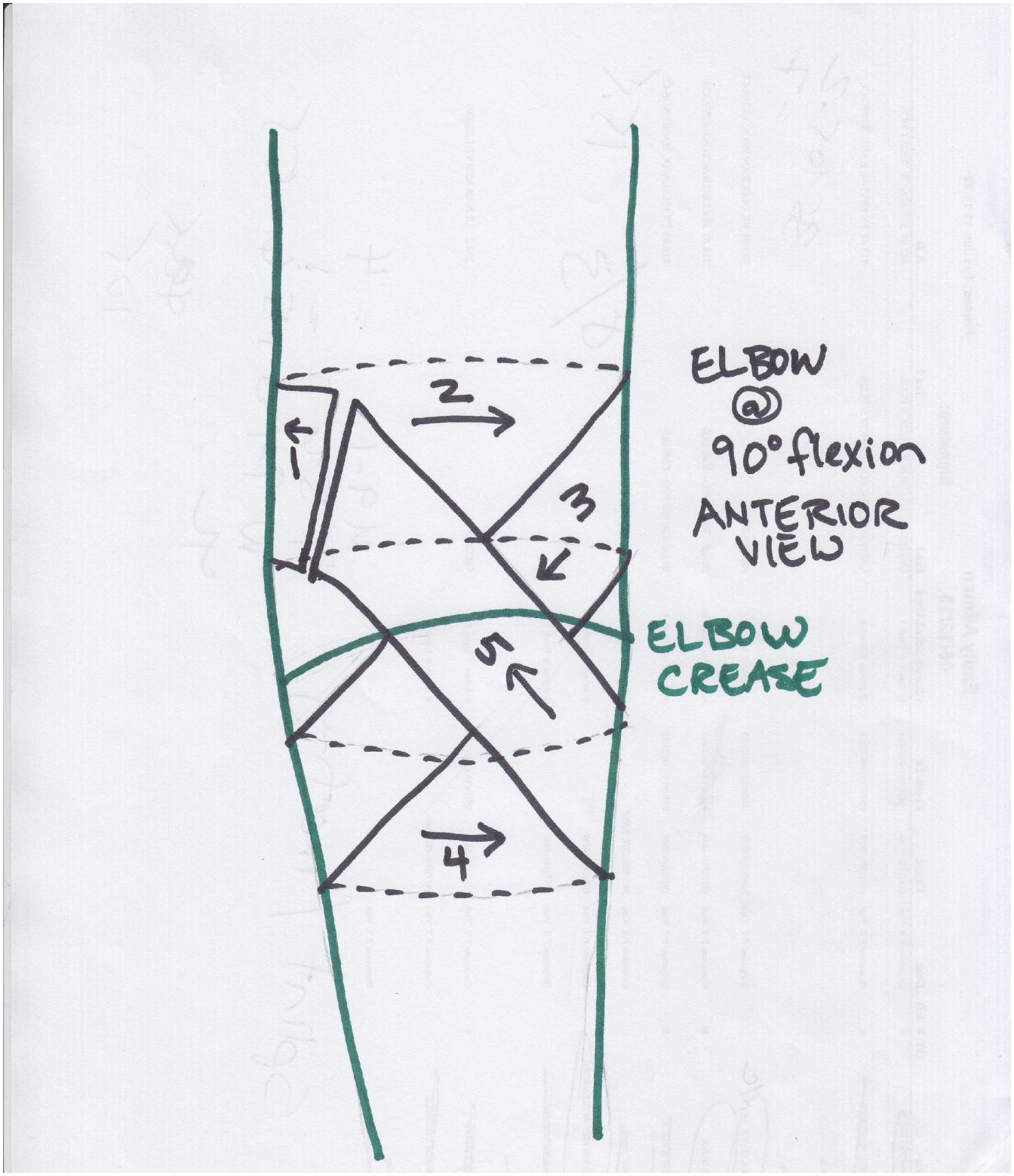
Figures 30-35 (below) Apply fleece edger.

Olecranon Opening

Metacarpal Head Opening

Splint is DONE!

Schematic of Figure-of-8 at elbow.



Wisconsin Hand Experience 2024

Unraveling the Mysteries of the Wrist

Splinting Tips and Tricks

Part 8: Delta Cast Fabrication Cheat Sheet

Tips and Tricks for Orthotic Fabrication

Saturday May 11, 2024

Emily Altman, PT, DPT, CHT, OCS, CLT-LANA, WCC

Quick Cheat Sheet

Prepare your items:

- Stockinette sleeve
- Padding (on top of stockinette)
    - Becomes part of the splint
    - Ulnar head
    - Olecranon
- Relief (under stockinette)
    - Is not part of the splint
    - Stockinette band at metacarpal heads for wrist splint
    - Piece of putty in a plastic bag over ulnar head
- Zip stick
- Inexpensive bandage scissors
- Expensive Black and Gold scissors
- Gloves
- Water
- Protect patient's clothing

Plan your strategy. Mentally review.

Do not open the package of cast tape until you are completely ready to wrap.

No need to squeeze cast tape after immersing in water.

Slight stretch as you apply cast tape. Overlap about 2/3.

1/16" thermoplastic piece, dry-heated and pressed into areas that need a patch or reinforcement.

Debulk areas that you will need to cut (eg, antecubital fossa, radial styloid).

Layers of material. 1 is flimsy, 2 is firm, 3 is very rigid, 4 is extremely rigid and very difficult to cut with scissors. Finished edge of splints should have at least 2 layers.

DO NOT use black and gold scissors on wet cast material or sticky back velcro hook. Use inexpensive bandage scissors.

Be generous with the length of your strips of sticky back hook Velcro (often 4-5 inches). Heat before applying. Apply with pressure.

One end of the sticky back hook Velcro piece should be under the fleece edge.

If strap is side-to-side (not circumferential), you must secure the pull-off edge. Use a small piece of 1/16" thermoplastic or melt (deactivate) the hooks of the Velcro on the pull-off edge. Circumferential strapping is preferred.

Fleece edging:

- Think: center of the adhesive side goes on the raw, cut edge of the splint. Then fold edges to the inside and outside.
- Apply fleece from left to right if right-handed. Right thumb continuously peels the paper backing off as you move along.
- Working area is very short. Peel open only very short segments of the fleece edger at a time. Coordinate left and right hand actions. Right is peeling, left is securing.
- Cut the fleece edger while it is still attached to the paper backing.
- In plane concavity-*larger radius of curvature* (eg, thenar semi-circle of wrist splint)
    - Loose placement. No tension.
- In plane concavity-*very small radius of curvature or corner* (eg, elbow crease of posterior elbow shell)
    - Consider starting and stopping edging at the point of the corner
- In plane convexity/corner (eg, proximal edge of wrist splint or thumb spica where bivalve cut meets finished proximal edge)
    - Stretch around corner (about 1" on either side of corner)
- Out of plane convexity-*small radius of curvature* (splint is bowing out toward you. eg, wrist splint as it wraps around small finger metacarpal)
    - Apply fleece edger to outside of splint (half the width) around the entire curve. Then fold entire portion to the inside.
- Out of plane convexity-*larger radius of curvature* (eg, proximal edge of wrist splint)
    - Regular application method works well
- In tight situations consider starting and stopping tape to finish the edge or trimming the width of the fleece edger.
- Snip triangular buckles that sometimes occur around 90° corners/curves. Small cast scissors can be helpful

Static versus elastic strapping: Static tends to wear better.

Trick for cleaning black and gold scissors:
Put scissors warm splint pan for a minute or so. Remove and immediately place in container of ice for a minute or so. Remove and use a towel and thumb nail to easily clean off hardened cast resin from scissors, paying close attention to scissor blade edges.