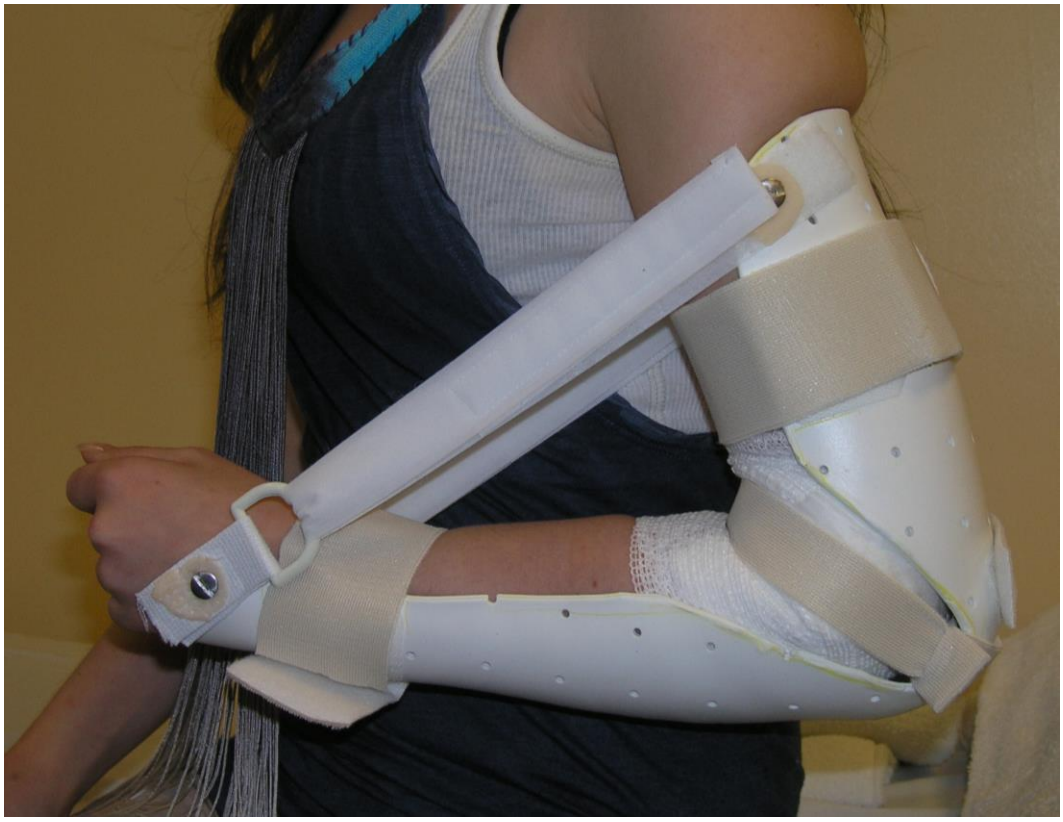
HOSPITAL FOR SPECIAL SURGERY

Smart Design

The Art of Splinting



Static Progressive Elbow Flexion Splint

Hand Therapy Center • Rehabilitation Department • Hospital for Special Surgery
535 East 70th Street New York, NY 10021

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?

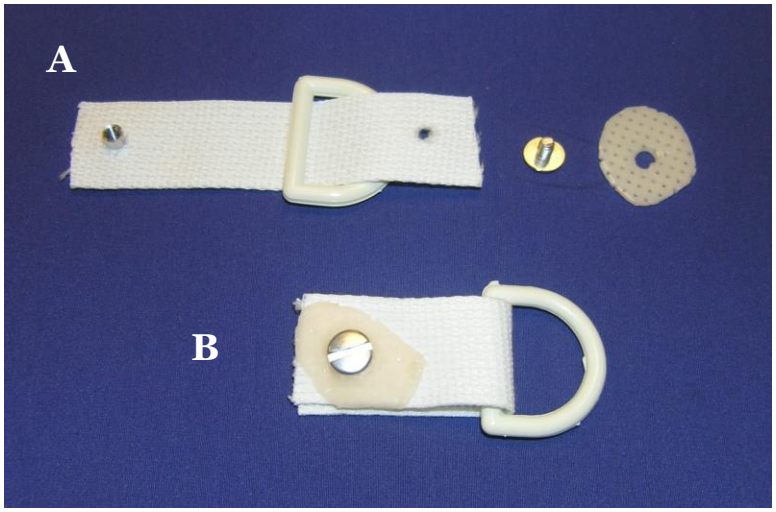
The elbow joint is known to be very sensitive to trauma and surgery. The joint capsule and other soft tissues surrounding the joint react to trauma and surgery with a powerful fibrosis response. The application of a constant, unrelenting, dynamic force can be irritating to the tissues and can trigger 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

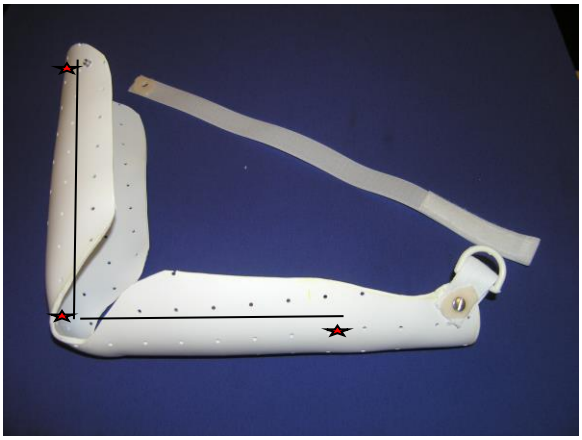
Picture 2. Splint material over olecranon bubbled out and pinched corners cut away



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.

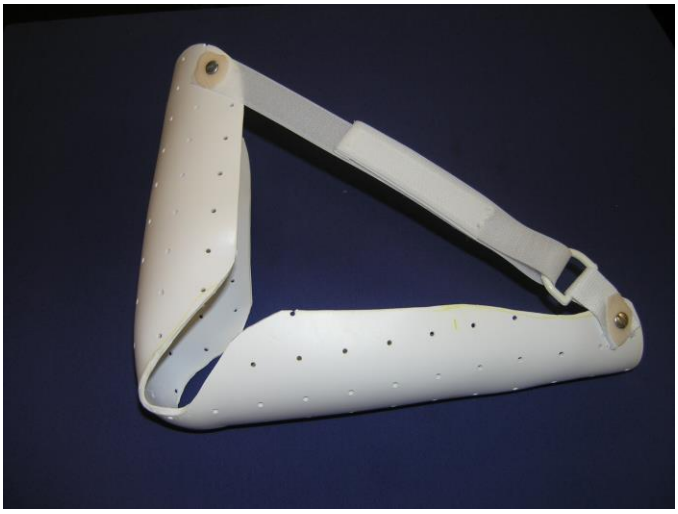
NOTE: Instead of webbing, we now use a strip of 1" Orficast tape looped through the Dring (as webbing is looped through in B to the left). Press firmly together. Round the square edge with scissors, punch a hole and your tab for the Dring is done and strong! Much easier.

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.



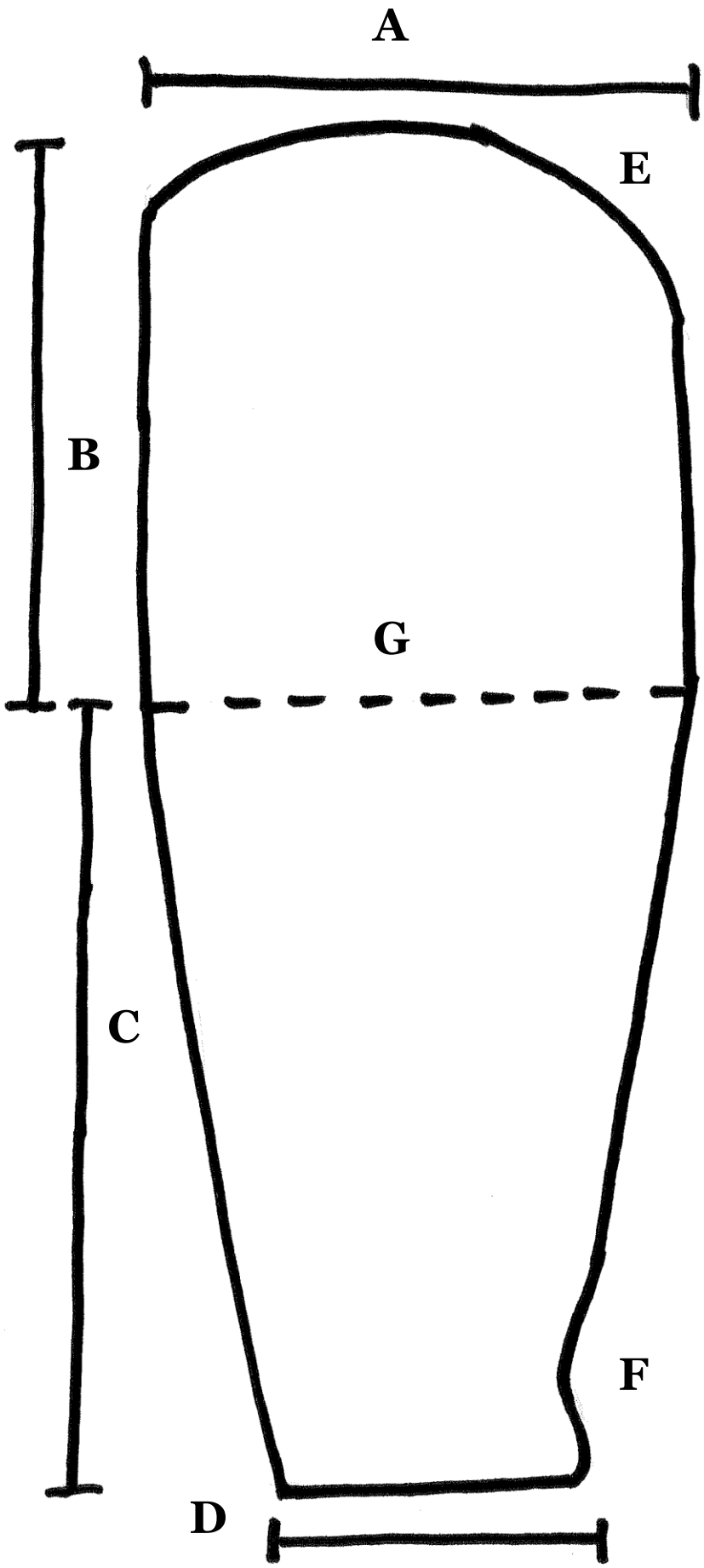
Picture 5. Static progressive flexion strap attached to splint.

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!