



American Society
of Hand Therapists™

Maximizing Functional Outcomes after Flexor Tendon Repair

Presented by

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ASHT International Committee
Virtual Education Series

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Disclosure: I DO NOT have a financial relationship with any commercial interest.



Issues today are the same as they were 75 years ago:

Tendon adhesions

Loss of motion (both in flexion
and extension)

Tendon gapping (can lead to
increased scar, weaker tendon &
insufficient excursion)

Risk of rupture



What's Trending/
Hot Topics
(Tang 2018)

- Surgical technique changes
- Shorter splints
- Wrist position/wrist inclusion
- Decreasing MP flexion in splint
- Early AROM/Out of splint AROM
- Relative motion flexion splinting

(Chung 2017)



Experience

Evidence

Clinical
Judgement

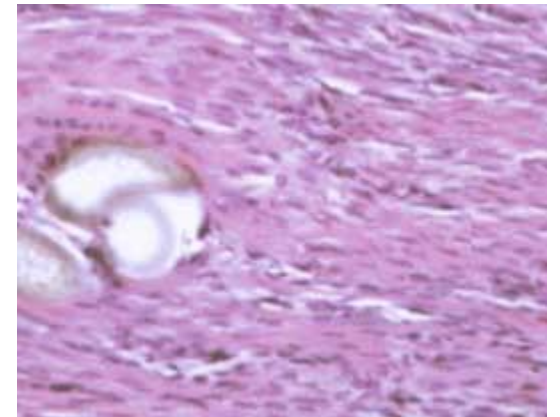
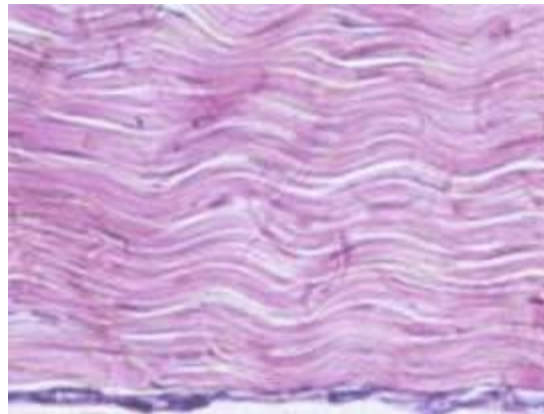
TREATMENT PLAN

Phases of Healing

Inflammatory (0-1 week)

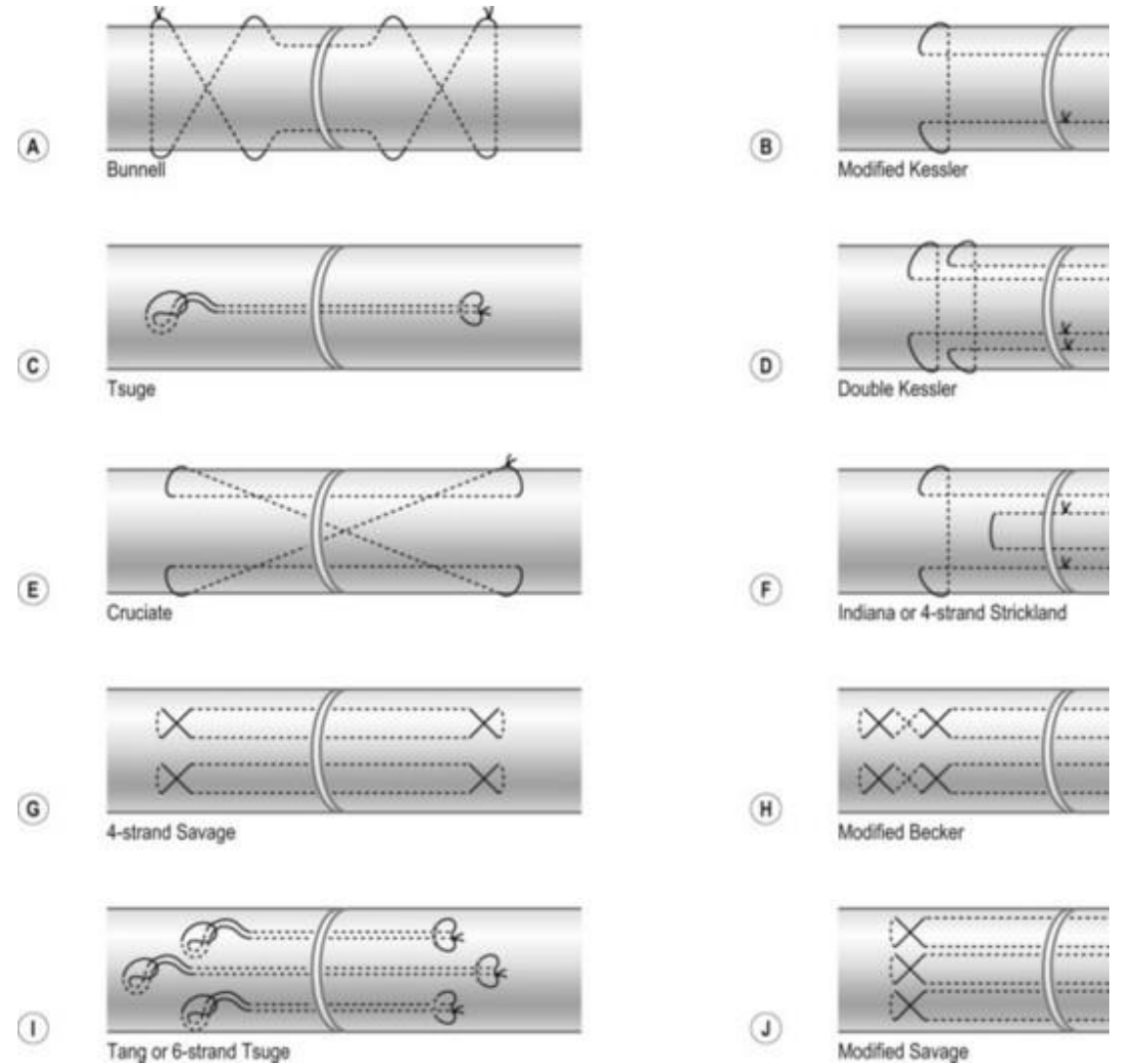
Fibroplasia/proliferative phase (1-6 weeks)

Remodeling (around 4 weeks)



Surgical techniques and terminology

- Type of repair
- How many strands
- Peripheral suture?
- Pulley venting?



Rehabilitation Goals

Increase passive joint motion

Increase tendon glide w/ lowest force
(incremental controlled stress)

Decrease edema

Prevent adhesions, gapping, rupture

Patient education

Post-op Options

Immobilization

Early Passive Motion (EPM)

- tendon “buckle” vs. true gliding?

Early Active Motion (EAM)

- Goal: Increase glide, Decrease work of Flexion
- Tenodesis: most amount of glide (3.5 mm), least amount of tension compared to other motions (*Savage 1988; Lieber et al, 1996*)

A vertical rectangular image on the left side of the slide, framed in white. It shows a dense array of parallel, wavy blue lines that represent collagen fibers under a microscope. The lines are more distinct in the foreground and become more blurred towards the top.

Benefits of Early Motion

Tendon adhesions decreased if tendon allowed 3 mm of glide (*Duran et al, 1976*)

Increased nutrition to the tendons via synovial diffusion (*Amadio, Jaeger & Hunter, 1990*)

Reduces inflammation

Encourages collagen fiber alignment

Early Passive Mobilization: 1970's



- Based on work of Kleinert (1967) and Duran & Houser (1975)
- 3-5 mm glide sufficient to prevent adhesions
- Modified Duran: DBS: wrist 30 deg, MPs 70. Passive flexion, active extension to roof of splint.
- Kleinert: DBS, digits held in flexion with rubber bands. Passive flexion, IP extension against rubber band resistance



Early Active Mobilization

With EPM, tendency for tendon to “buckle” – how much glide actually occurring?

Goal: Increase glide, Decrease work of Flexion

Tenodesis: most amount of glide (3.5 mm), least amount of tension compared to other motions (*Savage 1988; Lieber et al, 1996*)

Terminology varies: should look for “true active flexion” (*Nieduski 2019*)

St. John Protocol: “Move it but don’t use it”



POST-OP	SPLINT	EXERCISE
Day 4	DBS wrist neutral to 45 deg ext, MPs 30 deg flex, IPs straight	True active flexion, 1/3 to 1/2 fist (in splint) Active IP extension w MP flexed
2-4 weeks	Manchester short splint, blocking wrist to 45 deg ext	Active synergistic AROM in splint Increase active fist: 1/2 - 2/3
4-6 weeks		Work towards full fist by week 6
6-8 weeks	-Short splint D/Ced -Can initiate pm ext splinting if flexion contracture -RMFS daytime if needed	Start to use hand for light activity

Early Passive-Partial Active Flexion Protocol

(Tang 2021)

Update to the Nantong Protocol: “wrist position unimportant”

Full passive flexion 10-30 cycles

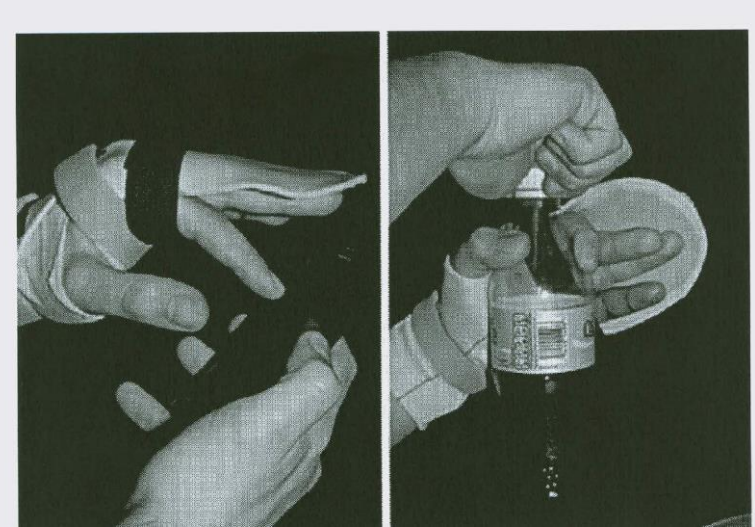
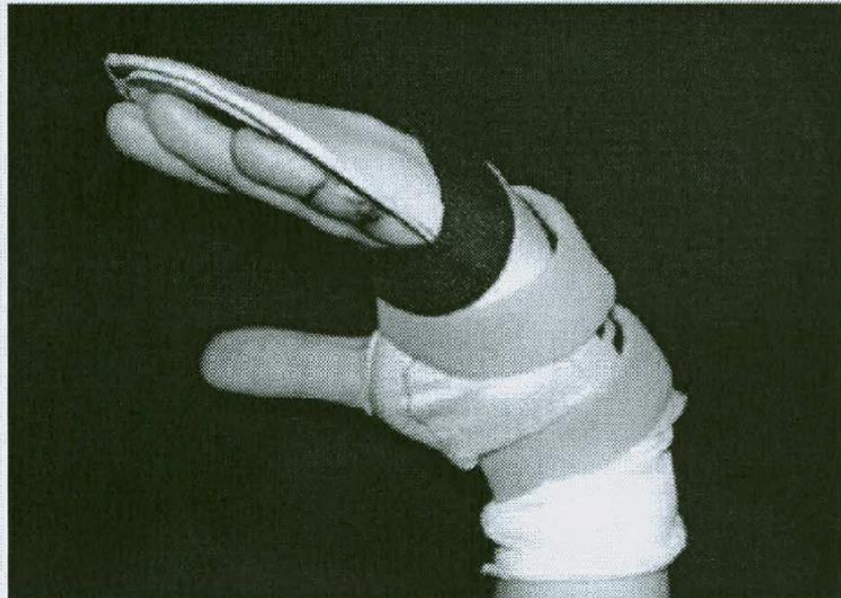
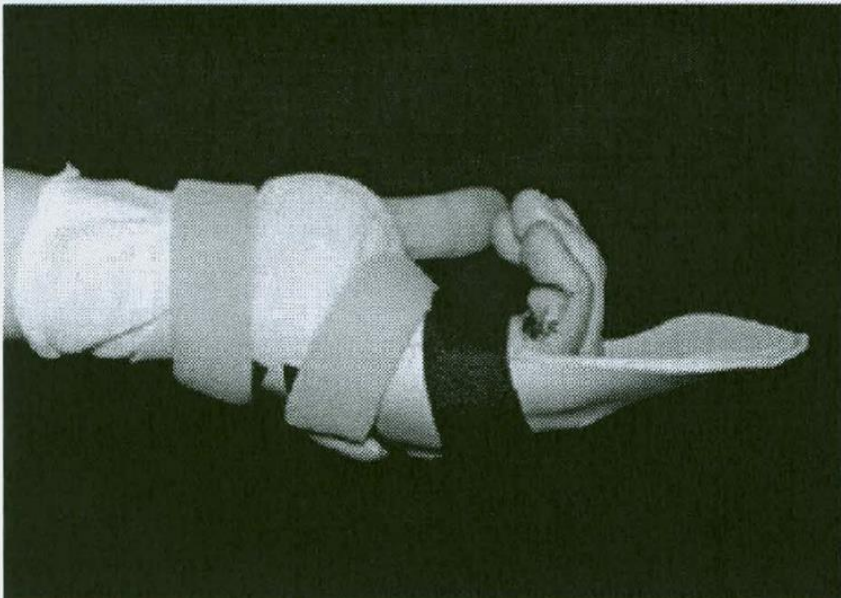
EAM ½ fist or within comfortable range: “point of comfortable resistance”

40-80 cycles of AROM minimum of 4x/day: recommends setting a timer for 15 minutes

Manchester Splint (Wong & Peck, 2014)

Wrist: extension to 45 deg is optimal position to dec forces from extensors (MAMTT) (Evans & Thompson 1993)

MPs: flexed to 30 deg: excessive MP flexion will bias motion to PIPs, forcing DIP to flex at end range





Relative Motion Splinting

- Relies on “quadrifida effect” of 1 muscle belly/4 tendons for FDP
- Affected digit placed in relative flexion compared to unaffected digits
- Limits tension placed on repair site/decreased elongation of FDP
- Encourages active PIP extension/↓rate of PIP flexion contractures
- Functional hand use is allowed earlier: “move it, and (progressively) use it”

Work of Flexion

Work required of repaired tendon to actively flex

Force going through repair site can't exceed strength of repair

Will lead to gapping, rupture

Must also take into consideration: edema, scar, joint stiffness, wrist position/extrinsic extensors, bulk of repair

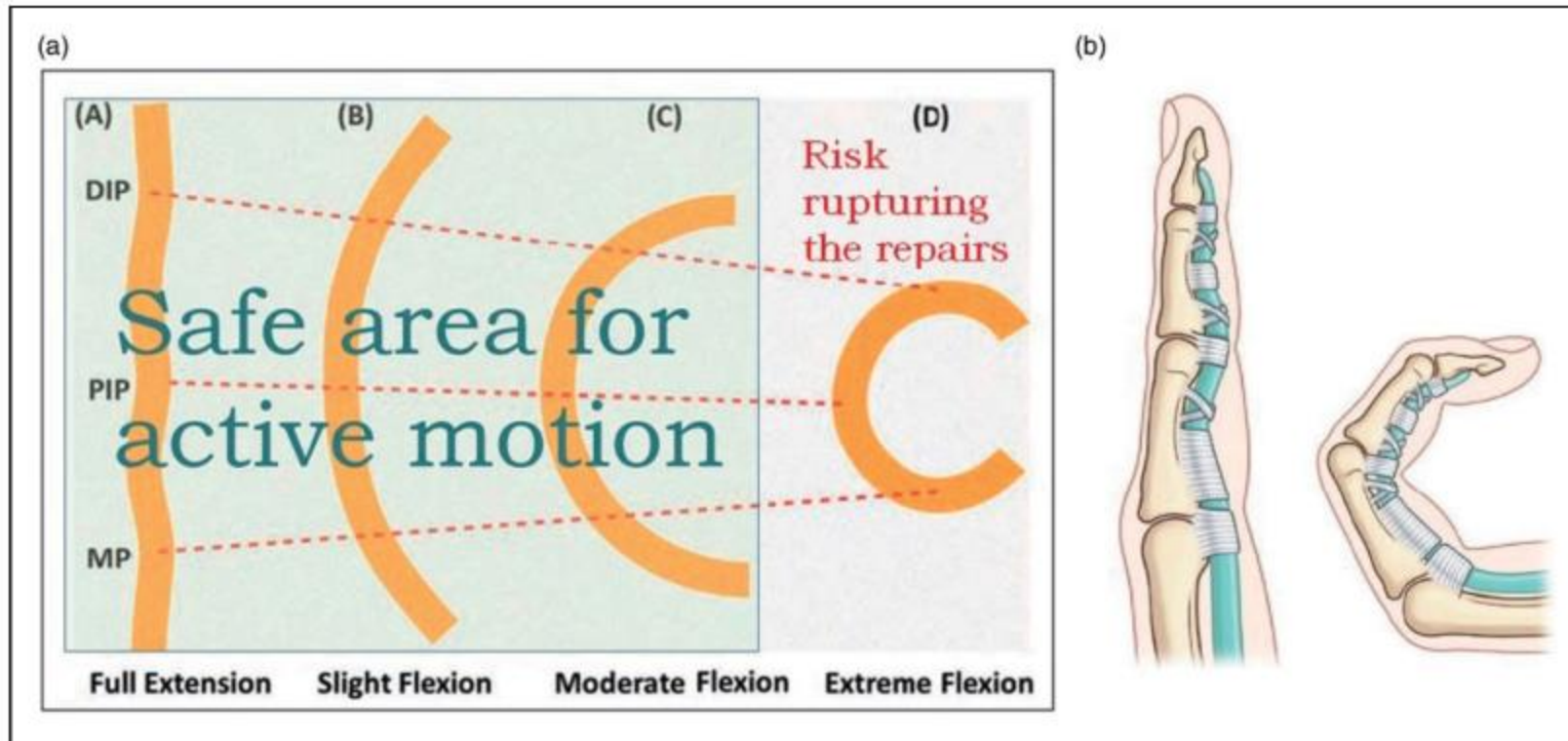


Figure 1. (a) (A) At the full extension of the finger, the tendon shows physiological curves within the digital flexor sheath. (B) When the finger is slightly flexed, the curvature of the tendon is small and smooth. The tendon sustains a small amount of bending force. (C) When the tendon is increasingly flexed, the tendon curvature increases and the bending force increases accordingly. (D) At the extreme of digital flexion, the tendon gliding arc becomes nearly circular, and the tendon is the easiest to disrupt. Therefore, the safe range of active digital motion is from full extension to moderate flexion. (b) Active flexion between two shown positions is in the safe range.
 MP: metacarpophalangeal joint; PIP: proximal interphalangeal joint; DIP: distal interphalangeal joint.

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Forces on the Tendon

- Mean strength of 4 strand repair: 49-85N, 8 strand 82N
- Place/hold: significantly higher forces on FDS with wrist 30 deg flex compared to neutral
- Active flexion: Significantly higher force on FDP w/ full fist
- Isolated FDP/FDS (blocking): Highest forces recorded, FDP
- Tenodesis: mean forces FDP: 2.8N/FDS: 2.7N

(Edsfeldt 2015)

Effects of Edema:

(Cao and Tang)

Moderate edema adds 7N of force

Severe edema adds 9N force

Minimum of 6 reps needed to decrease force, WOF by 30%(?)

NSAIDS: may decrease adhesions, but also may reduce strength of repair (Kulick et al)

Leave the coban on!



When to start therapy?

Ideally: **pre-op** for splint and pt education

- Exercises are initiated pod 3-5
- Edema control as soon as possible
 - Mod/max edema increases resistance
 - coban



Splint

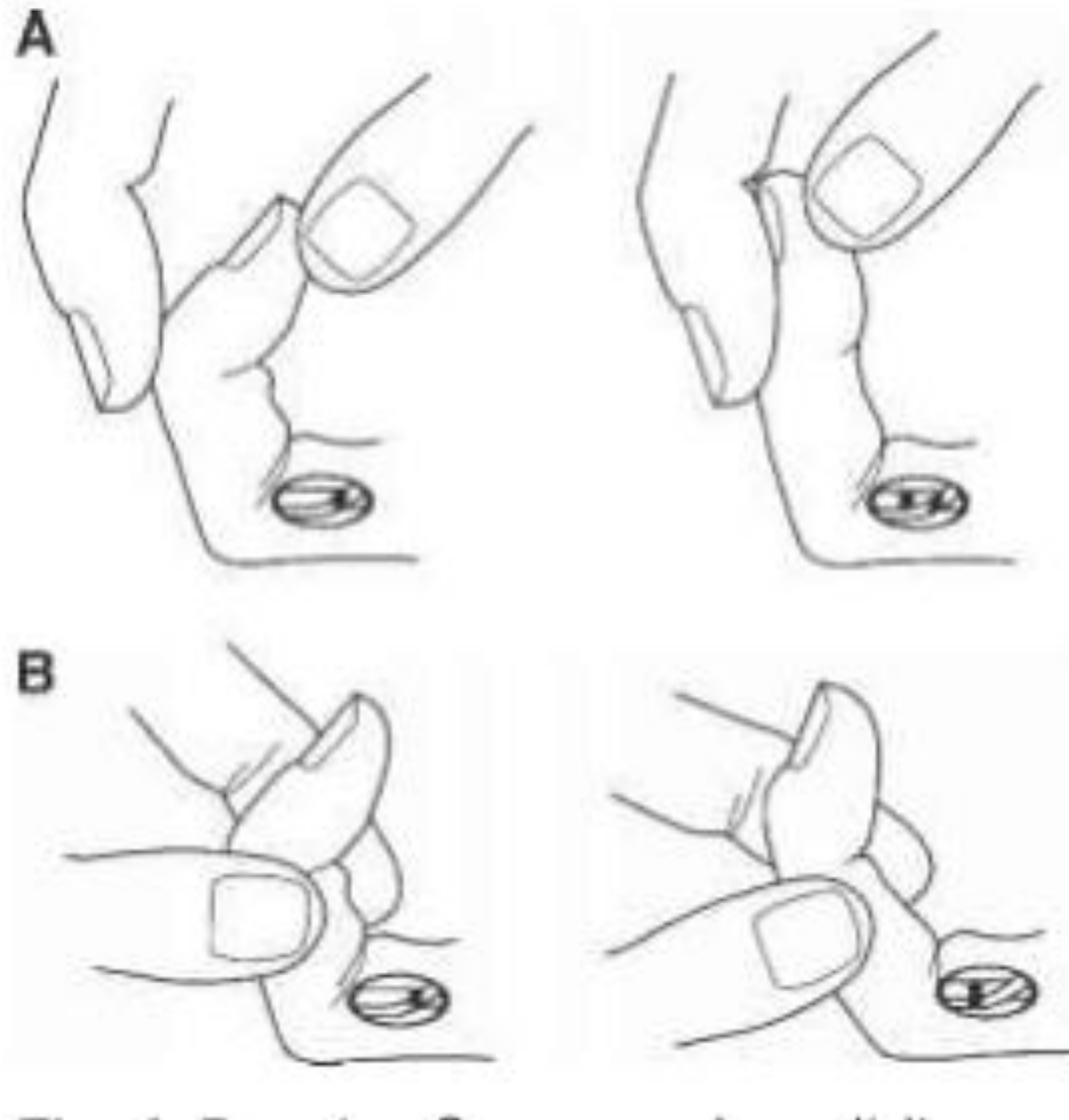
- Wrist: slight ext
- MPs: flexed
- IPs: Splinted straight, but strapped in loosely. IPs unstrapped at night

Home Exercise Program: #1

#1: PROM to affected digits to warm up the joints and decrease friction and the work of flexion (WOF)



Isolated Passive Glide



Home Exercise Program #2:

- True active flexion: 1/3 - 1/2 fist initially, progress to full fist by week 6





Home Exercise Program #3: MP Flexion, Active IP extension

Tenodesis



Exercise frequency

min of 10 reps, 5-6x/day

Should be the last thing
they do before going to bed,
1st thing when they wake up

“Think like a chef”

- DIP: 1mm glide for every 10 deg
- PIP: 1.3 mm for every 10 deg (*McGrouther & Ahmed 1981*)
- Strickland’s Percentage:

Active PIP + DIP flexion minus ext lag

X 100

175 (AAOS norms)



Issues to watch for

Decreased tendon glide/adhesions: active vs passive

Digit “trapping” (can be addressed with buddy strap with foam)

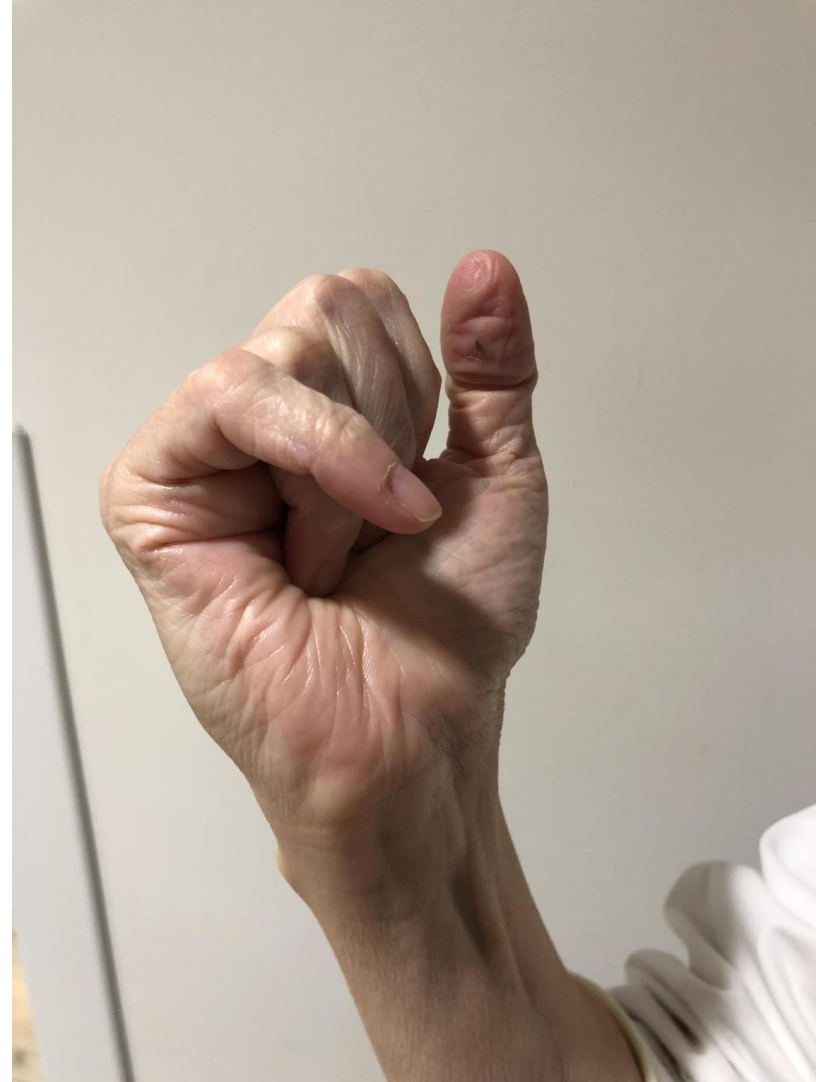
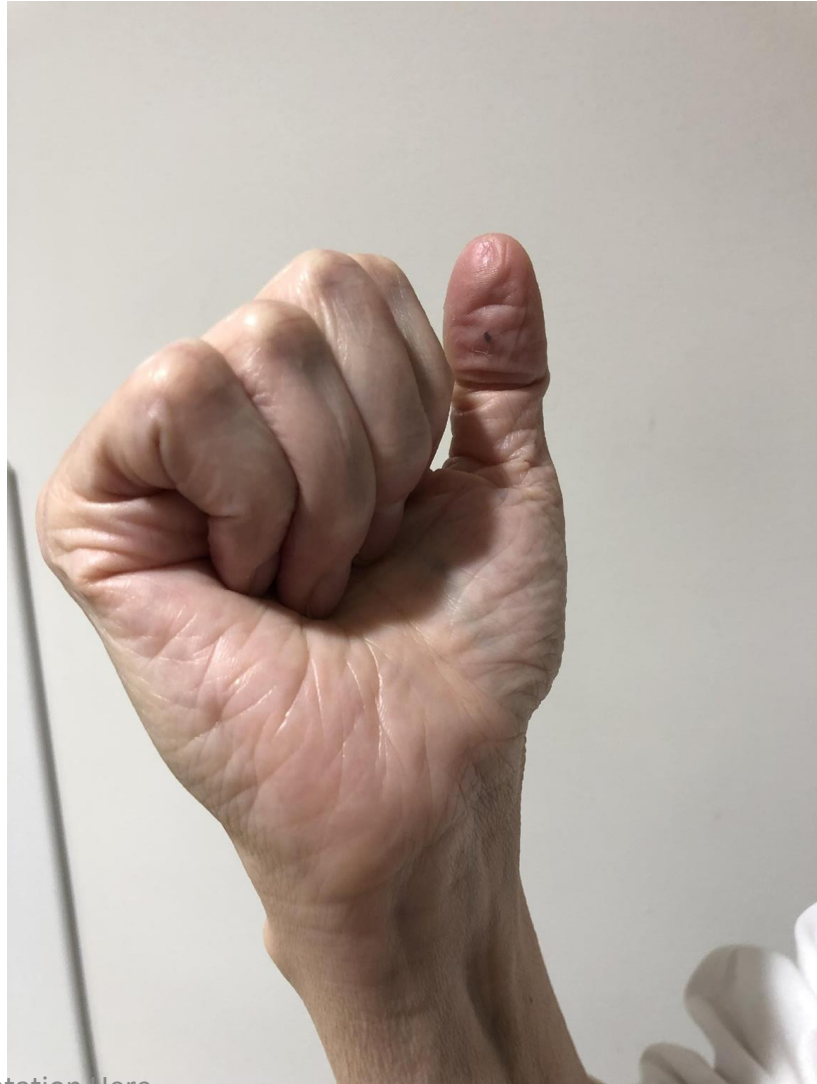
Edema

- Increased joint stiffness
- Increased adhesions

IP flexion contractures

Compensatory motions

Trapping:



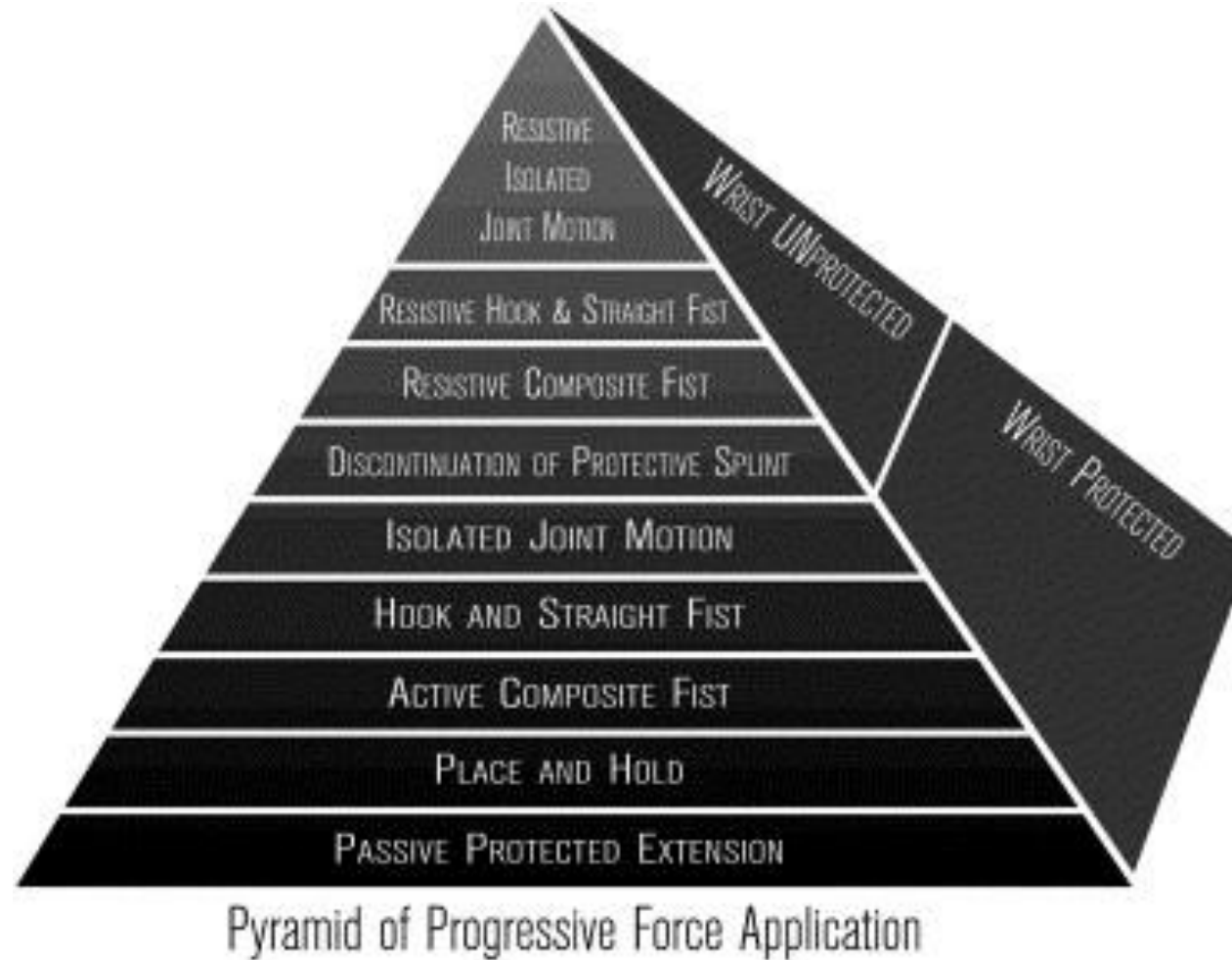


Functional Motions to Increase ROM:

- “Spinning” wine glass
- Manipulating cell phone
- Be Creative!



Clinical Decision Making



- Treatment algorithm based on tissue response (Groth, 2004)

TENDON GLIDING EXERCISES

OPEN PALM



1



DUCK / ROOF TOP



2



STRAIGHT FIST



3

FULL FIST



4



HOOK FIST



5

Blocking exercises: volar or lateral support

(Osanami 2020)

Found to have
decreased WOF with
lateral support

Volar support may
increase tendon
resistance





Splints to gain motion



Adherence to precautions

Up to 67% of patients remove DBS for ADLs or are non-compliant (removing velcro to perform task, etc) (*Sanford 2008; Kaskutas & Powell, 2013*)

Non-compliance associated with increased rupture rate.

Adherence higher in 1st few weeks post-op, then gradually decr over time

Home instruction: what *not* to do, how to modify activity to perform safely

Patient Personality Profile

- The overachiever: “the more I exercise, the faster I’ll recover”
→ increased swelling, gapping, rupture
- High strung: only performs exercises in the presence of the therapist
- Too cool for school: “I don’t really need to wear this splint”
- Uncoordinated: difficulty understanding exercise technique
- Therapist personality profile: Newer or less experienced may be hesitant to advance pt appropriately. Older therapist may be stuck in old ways

FPL

Less research on FPL repair

FPL mechanics inherently different than FDS/FDP

Greatest glide occurs w isolated IP flexion (MP at 0)

IP flexion 35 deg w wrist neutral produces 1.3N force *(Rappoport, 2015)*

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Thank you!

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