SCAR MANAGEMENT AFTER TRAUMA/SURGERY (OR BONEY INVOLVEMENT) OF THE HAND AND UPPER EXTREMITY: PRINCIPALS FOR IMPROVING FUNCTIONAL OUTCOMES

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I. Phases of Soft Tissue Healing-Intervention

A. Inflammatory Phase: Immobilizing splint or sling may be used to protect tissue (2 days to 1 week).

B. Fibroblastic Phase: Splint or device may be used to allow protected mobility. This allows the healing tissue to strengthen while minimizing the negative effects of scar adhesion with the surrounding tissue. Passive Range of Motion is provided in the direction of the injury (Active concentric movement is minimized so as not to disrupt the repair). Light resistance or dynamic pulleys may be used in the direction away from the injury. This will allow eccentric recruitment of the injured tissue and helps improve the tensile strength of the repair. Active assisted and place and hold exercise are graduated to active and resisted exercise by the end of the phase (up to 8 weeks post surgery). Pressure applications may help to control scar development.

C. Maturation Phase: Healing tissue is strong; however, there may be hypertrophic scar due to tissue density (increased molecular bonds) and disorganized collagen fibers. Splint or device may be used to provide low load stretch (static progressive splint or serial casting). This would coincide with manual soft tissue and joint mobilization along with progressive strengthening and activity.

Note: During the Fibroblastic phase, it is important to initiate controlled movement as soon as possible. Protocols are established for various injuries and surgical repairs. Frequency of therapy will depend on the patient's pain levels and/or ability to comply with a home exercise program to provide early gliding of the tissues. Frequency may also be governed by the size of the involved joints.

During the late Fibroblastic and Maturation Phase, therapy should be more frequent (depending on patient compliance) and it should be progressive. The emphasis is on specific adaptation to imposed demand (SAID). Respect should be given to pain so as not to disrupt the healing tissue or develop a secondary inflammatory response (which will perpetuate the scarring effect). NSAIDS and physical agents may be necessary to control inflammation. Manual therapy is a very important intervention during this phase to reestablish joint balance and muscle length-tension. Again, care should be taken not to be too aggressive. The requirement for aggressive manual therapy should be minimized by the proper implementation of movement during the 2^{nd} phase of healing. The patient's compliance with a home exercise program for flexibility and gradual strengthening is very important.

All research indicates a direct correlation with total end-range time (TERT) and the effect of lengthening tissue and scar modeling.

***Heat Modalities versus Cold Modalities**

Heat can be applied through moist packs, paraffin or continuous frequency Ultrasound. Heat preparation before tissue stretch helps to move the patient through the second of the three phases of stretch (elastic, visco-elastic and plastic deformation or scar modeling) by lowering the viscosity of the tissue. Heat can also have an anesthetizing effect on the tissue and can promote relaxation. Care should be exercised with heat when there is an active inflammatory process.

Cold (or non-thermal modalities such as electrical stimulation or pulsed frequency ultrasound) can be used specifically to cool tissue after manual intervention or exercise. Collagen fibers tend to contract as they cool so application of Cold Pack to the lengthened tissue may help to facilitate scar modeling in the lengthened state.

II. Phases of Bone Fracture Healing

A. "Movers" versus "Resters"

Fractures that are closed and relatively non-displaced and stable can be managed by protection without reduction or immobilization. Fractures that are non-displaced but are unstable require immobilization such as a cast or fracture brace. Open reduction is required when bone fragments cannot be approximated through closed reduction alone and internal fixation devices are then used.

With immobilization by cast there is slight movement of the fracture sight and immature woven bone or external callous forms first as the bone consolidates and remodels. When external callous forms first, more healing time is required.

With internal fixation, direct healing occurs and may be faster depending on the nature of the fracture and the number of fragments.

Fracture Healing estimated time tables according to Apley and Solomon (1994)

Phase	Upper Limb	Lower Limb
Callus Visible	2 – 3 weeks	2 – 3 weeks
Union	4 – 6 weeks	8 – 12 weeks
Consolidation	6 – 8 weeks	12 – 16 weeks

B. Immobilization or Early Mobilization

Early mobilization treatment programs have specific focused protocols which govern timing, type and quantity of desired movement. Advancement is determined by the stability of the fracture and radiographic indication of fracture healing. Any immobilizing device should be monitored for signs of adverse response such as constriction of circulation or skin breakdown. Hinged splinting may be used to allow some restricted movement of a joint. Care must be taken to preserve joint function above and below the fracture site. Muscle co-contraction of the muscles isometrically across the fracture site is encouraged to facilitate circulation and bone healing.

C. Early Consolidation

Therapy begins to focus on active use of the effected limb. Active therapy may include specific resistance training as well as activities and tasks designed to remediate the muscles of the injured region. There is continued focus on edema control and soft tissue management in the adjacent regions. If there are changes in body posture or compensatory movement patterns these must be addressed. Adherent or hypertrophic scar should be treated as previously described. Increased Muscular activity will help with edema control and the scar modeling.

D. The Final phase

Once we have good primary healing, Physical or Occupational Therapy in orthopedic rehabilitation should include activities to reintegrate the injured extremity to the body scheme and to condition the individual for specific Activities of Daily Living, Instrumental Activities of Daily Living and Vocational Tasks. This allows intrinsic recovery of function and neurological relearning. Whole body exercise and activity should be incorporated to reverse any deconditioning that occurred during the convalescent period. Sufficient data may be gleaned from the measurement of function and performance during this time in the program.