• **Common traumatic local causes of forearm &/or wrist stiffness**
  – Distal radius/forearm/humerus/carpal fracture
  – Other trauma
    o Multiple trauma
    o Tendon injury
    o Ligament injury
    o Infections
    o Burns

• Forearm & Wrist Stiffness
  • Bony malalignment\(^1\,^2\) (Fraser, 2009; Bronstein, 2014)
  • **Soft tissue contracture**
    – Adaptive shortening of
      § Muscle
      § Periarticular tissue
        o Tendon
        o Ligament
        o Joint capsule
      § Skin
    – Changes in articular cartilage
      § Synovial adhesions resulting in tearing, necrosis & ulcerations of cartilage

• **Functional Motion**
  • Forearm
    – Total arc of 100 degrees needed
      § 50 degrees pronation and 50 degrees supination
  • Wrist Flex/Ext
    – Total arc of 45-80 degrees needed in flex/ext
      § Sit to stand weight bearing needed greatest wrist extension (63 degrees)
      § Other tasks required up to
        o 35-40 degrees wrist extension
        o 5-40 degrees wrist flexion
    – Total arc of 25-40 degrees needed in RD/UD
      (Brumfield, 1984; Palmer, 1985; Ryu, 1991; Nordin and Frankel, 2012)\(^3\,^6\)

• **Patient Rated Outcomes**
  • Reduced grip strength, extension, and UD correlated with decreased DASH score (Wilcke, 2007)\(^7\)
  • Increased wrist ROM correlates with better functional outcome as measured by DASH scores (Lucado, 2008)\(^8\)
  • Grip strength deficits associated with lower MHQ scores (Shauver, 2014)\(^9\)

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–Correlation between wrist extension motion and grip force production

•Satisfaction with the physical impairment after DRF improved if 95% of their wrist arc motion is recovered (Chung 2009)¹⁰
  –“Percent of recovery required for patients to be satisfied with their physical impairment is well beyond minimal range of motion requirements to perform specific activities” (MacDermid, 2009)¹¹

•Pain and psychological factors explained more of the variation in disability than wrist motion impairment (Bot, 2012)¹²

•Wrist motion impairments account for less than 40% of total MHQ score (Shauver, 2014)⁹

•Therapy for the stiff wrist/forearm
  •Joint mobilization, supervised exercise and orthotic management can all increase ROM (Michlovitz, 2004)¹³

  •Therapeutic effects of heat and stretch (Nakano, 2012; Bleakley, 2013)¹⁴,¹⁵
    –Sustained ROM increases were reported in stiff joints when heat and stretching were repeated over periods of days or months (Bleakley, 2013)¹⁵

  •Cross-education after DRF (Magnus, 2013)¹⁶

  •Effects of other physical agent or electrotherapeutic modalities in increasing UE ROM – little in the literature

•Orthotic Management for the stiff wrist/forearm
  •McClure, 1994¹⁷
    –The use of splints in the treatment of joint stiffness: biologic rationale and an algorithm for making clinical decisions

  •Flowers, 2002¹⁸
    o Proposed decision hierarchy for splinting the stiff joint

  •Flowers, 1994/2012¹⁹
    o Effect of TERT on PROM

•Dynamic Orthotic Management
  –Elastic or spring-loaded components apply relatively constant force to the joint
  –Total wearing time 6-12 hours per day is typical
    • may be worn while asleep

•Static Progressive Orthotic Management
  –Inelastic components that apply torque to a joint at its end range
  –Joint angle is re-adjusted periodically to keep the tissue positioned at its new length
  –Total wearing time 90 minutes typical (longer for static progressive casting)
• Dynamic Orthotic Management of Forearm/Wrist Stiffness

  • Shah, 2002\textsuperscript{20}
    – Forearm rotation contractures improved 43 degrees with 11 weeks dynamic splint

  • Lee, 2003\textsuperscript{21}
    – Forearm pronation contractures improved 48 degrees with 10 weeks dynamic splint

  • Berner, 2010\textsuperscript{22}
    • Dynamic splinting in wrist extension following DRF
    • Retrospective of 133 patients
    • at night while sleeping for 6-8 hours of continuous wear with increased force application every two weeks
    • Mean Duration 4 weeks (3 to 20)

  • Jongs, et al 2012\textsuperscript{23}
    • Dynamic splints do not reduce contracture following distal radial fracture: a randomised controlled trial.

• Static Progressive Orthotic Management of Forearm/Wrist Stiffness

  • McGrath et al. 2008\textsuperscript{24}
    • 46 patients with posttraumatic or postsurgical wrist stiffness in wrist flex/ext
    • Treated with bidirectional SPS orthosis for avg of 10 weeks (6-28)
    • No difference in ROM gains when early initiation (before 12 weeks) was compared with late initiation (after 12 weeks)
    • 30- to 60-minutes; 1 to 3 times per day
    • 34 degrees improvement in wrist flex/ext TAM (5-100 degrees)
      • Flex= 18 (3-46 degrees)
      • Ext= 17 (1-50 degrees)
    • Maintained at 12 month follow up
    • 8.2 points out of 10 in patient satisfaction
    • No complications reported
    • Conclusions: “static progressive stretch is a useful treatment for patients who have posttraumatic or postsurgical wrist stiffness and whose progress has plateaued after a course of conventional physical therapy.”
• Lucado, 2008
  - 25 patients (out of 249 pts referred to therapy over 3 years retrospectively studied) with stiffness in wrist flex/ext or pron/supination after DRF
  - Treated with SPS orthosis (wrist flex/ext or forearm pron/sup) for avg of 11 weeks
  - Avg time from injury to orthosis= 14 weeks (range 7-27)
  - 30- minutes; 1 to 3 times per day
    - Wrist flexion and extension arc increased 30 degrees
      - Flex= 11 (SD=11)
      - Ext= 19 ( SD=14)
    - Forearm rotation arc increased 34.5 degrees
      - Pron= 20 (SD= 24)
      - Sup= 14.5 (SD=16)
    - Grip strength increased 24.5 pounds (SD=18)
  - Median DASH score improved from 43 to 19
  - Wrist ROM correlates with better functional outcome (DASH scores)
  - No long-term follow up
  - Conclusions: ROM increased with SPS and “as wrist extension, forearm pronation, and supination increased, subjects reported better functional outcome as reflected by the DASH scores.”

• McGrath, et al. 2009
  - 38 patients with forearm rotational contractures after UE injury
  - Treated with bidirectional SPS orthosis for avg of 12 weeks (3-57)
  - Average time from injury to orthosis = 21 weeks (7-75)
    - Pts treated within 16 weeks of injury had higher gains in ROM than patients who were treated 16 weeks or more after injury
  - Improved 42 degrees forearm rotation (0-122 degrees)
    - Pron= 12 (-10 to 70 degrees)
    - Sup= 31 (0-85 degrees)
  - 8.1 points out of 10 in patient satisfaction (2 reporting poor satisfaction)
    - 2 patients reported loss of pronation
  - Conclusions: “static progressive splinting was successful in restoring forearm rotation in patients who failed other physical therapy techniques”

• Lucado, 2009
  - Prospective case series
    - 8 patients (over 2 years prospectively followed) with stiffness in wrist flex/ext after DRF
      - Loss of TPM of wrist prompted most recommendations for SPS
    - Treated with SPS orthosis (wrist flex/ext) for avg of 13 weeks (3-26 weeks)
    - Avg time from injury to orthosis= 11 weeks (range 8-21)
    - 30- minutes; 1 to 3 times per day
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- Wrist flexion and extension arc increased by 41 degrees at 12 weeks (60
degrees at 1 year)
- Median DASH score improved from 42 to 21 at 12 weeks; to 14 points at 1
year follow up
- Maintained gains over 1 year
  - Majority made most gains within 1st 6 weeks of using the splints
  - Compliance with splint wear instructions was a problem
- Conclusions: ROM increased with SPS and “the subjects of this study
demonstrated a meaningful improvement in function as reflected in
improved DASH scores.”

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