Objectives

- Understand the significance of weakness in the calf following stroke
- Appreciate the relevant literature on orthotic prescription after stroke
- Understand the rationale for application of double adjustable AFO in acute stroke
- Review findings of pilot study of AFO application in acute stroke

Weakness

- There was a time when spasticity or hypertonia was treated as a primary obstacle to motor function after stroke.
- Current evidence, however, suggests that weakness may be directly responsible for impaired motor function.
  
  Pak & Patten, 2008

Distribution of weakness

- Weakness tends to be more pronounced distally than proximally.
  - 68% of hip flexion
  - 64% of hip extension
  - 53% of knee flexion
  - 51% of knee extension
  - 45% of ankle dorsiflexion
  - 37% of ankle plantar flexor strength
  
  Pak & Patten, 2008

So what?

- The calf plays a critical role in typical gait.
- Weakness in this muscle group is the likely culprit in knee hyperextension (eccentric PF contraction in mid-stance).
- Strengthening is only likely to occur if the muscle is firing DURING WALKING!
  
  Perry et al. 2010, Cooper et al. 2011
The solution

AFO Evidence

- Strong evidence that dynamic AFOs can improve various elements of gait such as:
  - Speed
  - Step length
  - Stride length
  - Base of support width

  Wang et al. 2007

AFO Evidence

- Systematic review of the impact of AFOs on gait and leg muscle activity in adults with hemiplegia concluded that they might improve
  - Velocity, stride length, gait pattern, walking efficiency
- No conclusions could be drawn regarding muscle activity.
- Many studies are done in the chronic phase of recovery and the participants wear the devices for short periods, i.e. for testing only.

Leung & Moseley 2003, Tyson et al. 2013

AFO Evidence

- The use of AFOs during walking results in the firing of key muscles (i.e. they don’t turn off!).
  - Quadriceps, anterior tibialis, gastrocnemius
- It has also been suggested that an AFO can impact motor learning by providing key peripheral sensory input during training.


H. Double adjustable AFO

- This device provides the best opportunity to most closely replicate typical gait mechanics.
- It has 2 channels with the option of placing pins or springs into the channels to get the desired configuration.
More on the double adjustable

- It is often a good choice for the patient who has both anterior and posterior lower leg weakness. It is less cosmetically appealing to some patients and does require some minimal maintenance to work properly. It also weighs more than a simple plastic AFO but this can be addressed by use of titanium joints.

Why a double adjustable?

- The hypothesis behind the joint selection is that if the patient advances the tibia during walking (facilitated by the anterior pin) then the calf muscles will fire. Repeated firing at the correct time in the gait cycle will theoretically strengthen the calf functionally during gait. The goal is to strengthen the posterior compartment adequately to eventually have no need for the device for gait.
- Secondarily, the springs serve to provide dorsi-assist during swing, while allowing for PF at loading facilitating strengthening of the anterior compartment (eccentrically).

AFO CASE SERIES

AFO Case Study

- In 2010, we initiated a pilot study to examine the contribution of the double adjustable AFO design used in ESTT training.
- Data was collected on 3 participants who were no longer wearing the AFO at 6 months post stroke. Outcomes included lower extremity strength, range of motion, STREAM test, 6MWT, GAITRite computerized gait analysis at self-selected and fast walking speeds, and EMG activity of target muscles including gastrocnemius, tibialis anterior and quadriceps.
  - McCain et al. 2010

Muscle activity: Figures 1, 2, and 3 represent EMG profiles of each participant at the time of testing without the AFO or STC. The graphs depict a consistent picture of general temporal symmetry across testing conditions. Timing of muscle activity across the gait cycle was consistent with expected patterns, i.e. activation of the AT at initial contact, VL activation early in the gait cycle, and peak activation of GAS late in stance. In addition, amplitude increases are seen appropriately in relationship to increases in velocity. Likewise, similar peak muscle activation is seen in the non-paretic limb across muscle groups.
Symmetry: Step length symmetry ratios obtained at the time of final testing ranged from 1.0 to 1.08 across conditions. Swing symmetry ranged from 1.0 to 1.05 and stance symmetry from 1.0 to 1.03. These values are surprisingly close to the values of healthy persons as reported by Patterson et al.

Patterson et al. 2010

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