Functionality of Ankle-Foot Orthoses

- Ankle-Foot Orthoses (AFOs) function to correct abnormal gait by controlling ankle motions.
- Disorders such as Cerebral Palsy, Post-Stroke, and Drop-foot often require AFOs.
  - These disorders are characterized by foot-slap during initial contact and toe-drag during swing phase. Typically uncontrollable contractions of the calf muscles are the source of the problem.
- AFOs help by limiting excessive plantar flexion and assisting dorsiflexion.
  - Tend to focus on controlling sagittal plane motion.
  - Coronal and Transverse planes are typically constrained or ignored.
- AFOs have not been completely successfully at reestablishing the power needed for push-off.
  - Need for greater energy storage and release.
  - Need a better understanding of roll-over shape.

Functionality of Transtibial Sockets

- Transtibial sockets have the difficult role of transmitting residual limb loads to the prosthesis.
  - Transtibial residual limbs have boney protrusions from the amputated fibula and tibia.
  - Residual limbs tend to be mutable (volume changes from hour to hour and week to week).
- Patellar tendon bearing sockets rely on geometry to create an interference fit.
  - Secondary attachment mechanisms include silicone suction, locking straps, and buckles.
- Use of CT scans and finite element analyses allows for patient specific socket creation.
- Main problems with current sockets are comfort, sweating, and load transmission.
  - Normal and shear stresses are always focused at four anatomical locations (Patellar tendon, medial tibia, lateral tibia, and popliteal depression).

Ankle-Foot Orthosis Design

- Three main types
  - Non-articulating: Most often used to control knee instability.
  - Articulating with plantar flexion stop: used to control knee extension instability. Also provides for better initial contact and prevents toe-drag (most common).
  - Articulating with dorsiflexion stop: used to control knee flexion instability.
- Full length footplate allows for greater dorsiflexion prior to push off.
- AFOs typically constructed of carbon fiber, polypropylene or nylon.

CCM’s Concept

- Finding the anatomical center of rotation for the tibia with respect to the foot.
  - Will reduce sliding of cuff on the shin.
- Manipulating the carbon fiber layup by adding and removing plies in order to alter the stiffness in various locations.
  - The layup of the foot-plate should be such that it allows for better push-off during the final stage of stance.
- AFO applies restoring forces to counteract eversion and inversion.

Transtibial Socket Design

- Comfort can be manipulated through design (reducing stiffness).
  - Thinning the walls, creating compliant regions, adding a liner.
  - Liner stiffness and coefficient of friction highly correlate to stresses.
- More than 50% of amputees suffer from some type of skin irritation.
  - Typically a result of sweat combined with interface pressures.
- Research should be done on breathable liners and sockets.

Possible Socket Research Areas

- Sweat-free Liner
  - Make a breathable liner that allows sweat to escape.
- Porous Socket
  - Create a breathable socket.
  - Localized porosity regions can also allow for more compliancy.

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