Al-Mustaqbal University

Collage of Engineering

Prosthetics and Orthotics Engineering

Second Stage

ORTHOTICS I

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AFO MATERIALS AND BIOMECHANICS

AFO MATERIALS

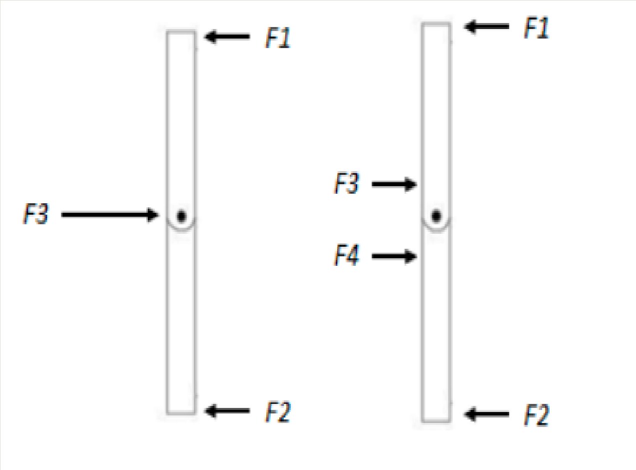
- AFO's are commonly referred to as braces or cotton, leather, plastic foams, and rubber materials, while the functional AFO's may be made from flexible, semi-rigid, or rigid plastic or graphite materials.
- They are relatively thin and easily fit into most types of shoes.
- An ankle - foot orthosis may be made from a carbon fiber reinforced material having low weight carried on the front of the lower leg, extending over the lateral ankle and preventing planar flexion.
- The orthosis may be worn under ordinary clothes and shoes and promotes more natural gait pattern

CONT.

- The frame is preferably constructed from thin flexible fiber glass reinforced with plastic resin material.
- The reinforcement element being made of rigid carbon fiber reinforced with plastic resin material.
- This tough flexible element is preferably made of aramid fiber reinforced with plastic resin.
- The AFOs can be made from thermoplastic materials, by putting the thermoplastic sheets in the oven to warm it to required temperature.
- It can be easily formed in the mold after being taken out from the oven

BIOMECHANICS OF AFOS

- In order to maintain the anatomical joints in their proper positions and to restrain abnormal movement, orthosis design is normally based on two types of forces system: the three point pressure (3PP control) and the ground reaction force GRF control.
- In the first case it is intended to block or restrain the rotation of two body segments about the anatomical joint that unites them.
- An example is given in Figure on how the rotation of an articulation can be prevented by applying three forces: one at the free end of each segment (F1 and F2) and a third force directly at the revolute joint (F3).
- A variation of the 3PP control system, often used in orthotic practice, is the four point pressure system.
- In this system, the force F3 is replaced by two forces (F3 and F4) to decrease the pressure applied directly at the anatomical joint.



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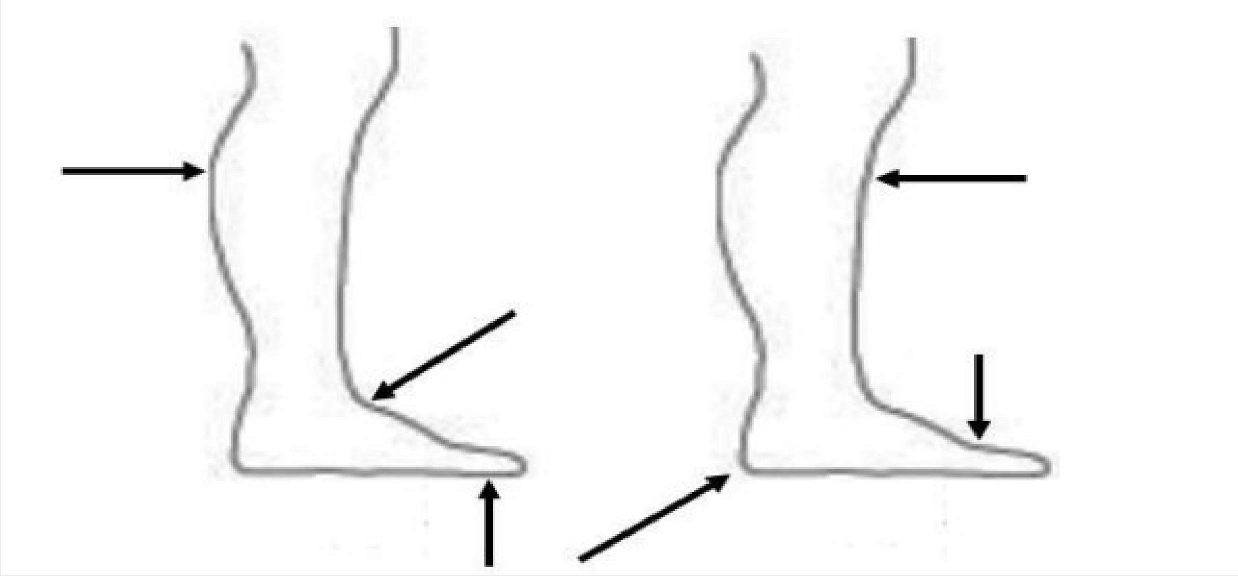
- In the case of AFOs, the 3PP control system is applied to prevent the motion of the anatomical joints of the ankle foot complex.



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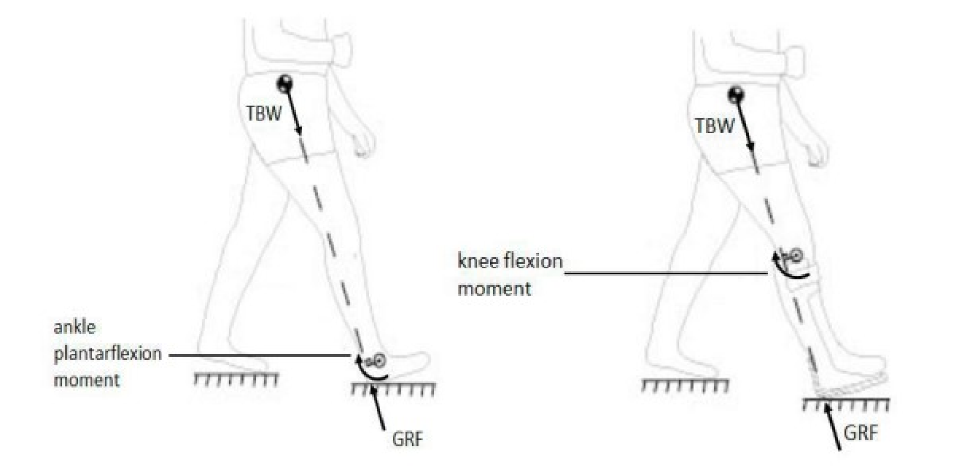
- The GRF control aims to rectify the motion of a body segment and/or a joint using (or not) an orthopedic device during the stance phase, when the foot contacts the floor. At heel strike, the heel hits the floor and a GRF is generated as an equal and opposite force.
- If the total body weight is not aligned with the ankle joint, the GRF will create a plantarflexion moment at the ankle joint. However, as many patients have a foot disability, drop foot, they cannot dorsiflex their foot back to a neutral position.
- For this reason, the AFO is used to restrain the plantarflexion at the initial contact in the gait cycle, and the GRF is transferred to the next free joint in the kinematical chain – the knee joint, creating a flexion moment and preventing knee hyperextension



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- In AFOs design, changing the lever arm length or the surface area can increase the patient's comfort.
- Since the moment M developed at the ankle joint can be calculated through the equation= F.L , increasing the length l will reduce the force F developed between the orthosis and the patient limb.
- The pressure exerted on the patient skin is also a matter of concern and may reach relatively high values. However, it can be easily decreased it by increasing the surface area since the pressure is inversely proportional to the surface area, P=F/A.