Clinical Evidence for the use of Carbon Fiber Prostheses for Running

Overview

- The introduction of the carbon fiber flexible foot allows for the storage and release of mechanical energy, which previously was incapable with the use of a "SACH" type foot.[1]
- The evolution and use of the carbon fiber prosthesis has dramatically changed the capabilities of runners/sprinters, enabling amputees to achieve similar levels of athletic performance to the able-bodied athlete.[1]

Clinical Evidence

Power Output and Energy Return

- While carbon fiber prostheses exhibit improved energy efficiency compared to other prostheses, they do not come near the capabilities of the intact human foot.[1,2]
- Sprint feet while demonstrating improvement upon other carbon fiber flex type prostheses, they cannot produce the same power or work as a human foot.[2,3]

Energetics

- Energy cost increases with increasing amputation level and can be affected by prosthesis type during running.[4]
- Amputees running on carbon fiber running prostheses exhibit lower heart rates and lower VO_2 levels than running on a prosthetic foot not intended for running.[1]

The Effect of Sprint Foot Shape and Stiffness

- Stiffness of the carbon fiber running prosthesis is associated with faster running speeds and increased running symmetry.[1]
- Wider C-shaped curves for sprinting prostheses have been found to improve speed and symmetry.[1]
- Varying degrees of stiffness and shape of the prosthetic foot can affect the speed and functionality of the runner.[1]

The Effect of Alignment, Mass, Position of the Center of Mass, and Inertia

- Shifting the load line of the limb posteriorly increases plantar flexion and puts a greater load on the toe, improving symmetry.[5]
- The prosthesis is made lighter than the residual limb to try to reduce the high metabolic cost exhibited by amputees during activity, as a decrease in prosthetic mass decreases the demand on the muscles to move the leg during the swing phase.[1]
- A running prosthesis needs to be lighter than the intact limb for an amputee to have similar energy costs as able-bodied persons.[1]
- Adjustments in the center of mass and inertia have been to alter gait kinetics.[6,7]

References

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