Carbon fibre prostheses and running in amputees: A review

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Kilde:

- *Foot and Ankle Surgery* er publiseret af Elsevier for European Foot and Ankle Societies
- 10 publikationer, hvoraf 7 er med proteser
Introduktion

• Sport and development – the introduction for carbon fiber
• Reduce disadvantage -> mechanical advantage
Mål for artiklen

• This review will present what is currently known about carbon prostheses and their effect on the running technique of transtibial amputees.
• Headliners:
  – Power output and energy return
  – Shape and stiffness
  – Centre of mass and inertia
  – Kinematic and kinetic patterns of running
Fig. 2. The different sprint foot designs: (A) Cheetah (Össur), (B) flex-sprint (Össur), (C) flex-run (Össur), (D) sprinter (Otto Bock), and (E) C-sprint (Otto Bock).
Indhold

• Power output and energy return

  – A study measuring dynamic hysteresis has been conducted. This showed a Cheetah foot (Össur, Reykjavik, Iceland) to have 63% energy efficiency [4].

  – The human has an foot energy efficiency of 241% during running at 2.8 m s⁻¹ [6] - In contrast, the SACH foot has been reported to have an energy efficiency of 31% and the flex foot 84% during running at 2.8 m s⁻¹ [6]

  – Peak angle power values were found to be considerably higher, as was mechanical work done, for the intact foot (1853–2741 W) compared to the flex-sprint (870–1012 W) and Cheetah (307–637 W) [7].
Indhold

• Shape and stiffness

  – Different cheetah (standard shape, harder stiffness – wider shape, normal stiffness – wider shape, harder stiffness) were used to optimize maximal running speed (30 m). A stiffer foot, wider c-curve gave the fastest sprint speed of all, plus a greater amount of both plantar and dorsiflexion than the Cheetah [21].

  – carbon fiber prostheses allow amputees to attain the same energy cost levels as able-bodied persons during running. It is not known whether this also holds for or is exceeded in sprinting.[18]
Indhold

• Center of mass and inertia
  – Alignment and position of centre of mass (CM) differs between sprint foot models and individual set-ups
  – CM and inertia changes had little effect on gait kinematics, but did alter gait kinetics [26,27].
    • Such studies have not been found on how these changes affect running so it is not yet known how much of an increase in swing phase speed can be gained.

• Kinematic and Kinetic patterns of running
  – Asymmetry at the start of the approach run, i.e. at a slower running speed, tended to increase running speed by increasing intact limb step length[29].
  – Asymmetric limb patterns have also been seen. At foot contact the residual limb knee [11] and hip [11,12] are more flexed than the intact limb.
  – Reduced prosthetic limb vertical ground reaction forces [12], knee extensor moment [6,12] and horizontal braking and propulsive forces [12]
Konklusion

• Current running prostheses do not match the human foot in terms of energy efficiency,
• The stiffness and shape of the prostheses could be optimized.
• Carbon prostheses, although considerably lighter than a human limb, allow amputees to reach the same energy cost when running as able-bodied persons