

## **Design of Hinged Ankle-Foot Orthosis based on natural joint kinematics**

In Hinged Ankle-Foot Orthoses (HAFO), a mechanical hinge determines rotation between an upper part tied to the shank and a lower part supporting the foot. The hinge location is still critical, since usually decided without complete knowledge of patient's ankle joint kinematics, often leading to unnatural motion. Several studies on ankle kinematics demonstrated that its rotation axis changes position during flexion, thus evidencing a major criticality when the hinge axis of the orthosis must be fixed in a single position.

This work is aimed at defining a subject-based method for a more physiological design of HAFOs, by looking at in-vivo patient specific joint kinematics. This should lead to precise positioning of hinge axis, respecting more the subject's anatomical and functional characteristic, particularly in gait conditions.

Kinematic data were collected in-vivo on a normal subject through stereo-photogrammetry, and processed according to the Instantaneous Helical Axis (IHA) method. A special HAFO was designed and realized with hinge axis placed in correspondence of the Mean Helical Axis (MHA) or in the intermalleolar direction. Motion analysis was then repeated with subject wearing the new HAFO.

The algorithm calculated the IHAs axode during motion, the MHA and its dispersion parameters. These results were used firstly to design the new HAFO and then to verify its effectiveness.

The method is an effective tool for more physiological design of HAFOs. The results highlighted major criticalities in the in-vivo determination of the ankle joint kinematics, providing basic information for further improvements, especially for marker placement and data processing.