Prosthetics and Orthotics International, 1990, 14, 143–144

Technical Note
An angular alignment measurement device for prosthetic fitting

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Abstract
A device to measure socket/shank angular alignment in a prosthesis equipped with a Berkeley Adjustable Leg® is described. Angular alignment in the sagittal plane can be measured over the entire 20-degree range with a repeatability of 1 degree. This device can be a useful prosthetics fitting, teaching, and research tool.

Introduction

During prosthetics fitting the position of the socket relative to the shank is set by a prosthetist so that a stable gait, an appropriate load distribution on the residual limb, and comfort to the amputee are achieved. Usually this is carried out using an adjustable leg such as the Berkeley Adustable Leg®. This device allows translational and angular adjustment between the socket and shank.

The Berkeley leg is not equipped with a means of quantifying angular adjustment. A record of alignment modification over the course of a clinical session could help to clarify prosthetic fitting. In teaching, quantification of alignment changes can help the student more clearly to identify relationships between degree of alignment modification and change in amputee gait. Alignment change must be accurately measured in clinical research where this is a parameter of interest.

The authors have developed a simple instrument to quantify sagittal plane angular alignment. It is easy to use during prosthetic fitting sessions and does not significantly alter the manner in which the Berkeley leg is normally used. In clinical research studies in which normal and shear interface stresses were measured as well as forces and moments in the prosthetic shank (Sanders *et. al.*, 1990), this device was used to quantify sagittal plane angular alignment changes made in different trials.

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Mechanical design

The device is made up of three components: a frame, a pointer, and a pointer post. The latter is permanently attached to the Berkeley Adjustable Leg. The former two are put on during measurement, then removed.

The frame is milled from a 1.5mm-thick aluminium plate to the dimensions shown in Figure 1, then bent at a right-angle 54mm from the end. A section of a 50mm-radius protractor is affixed with double-stick tape as shown. This design ensures the centre of rotation of the protractor scale is concentric with the centre of rotation of the sagittal or coronal plane adjustment on the Berkeley Adjustable Leg.

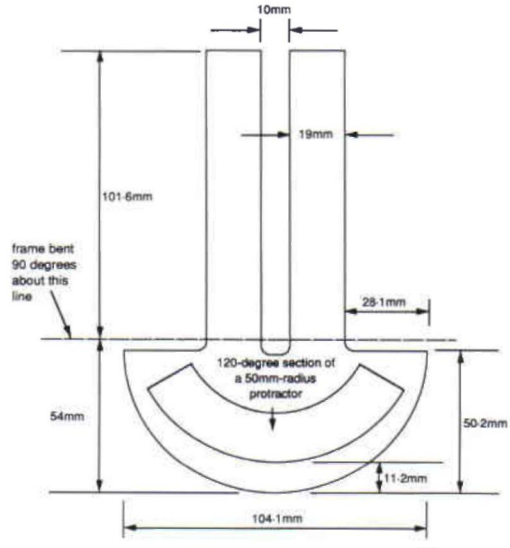

Fig. 1. FRAME: The frame is cut from a 1.5mm-thick aluminium plate to the dimensions shown then bent at a right-angle along the dashed line.

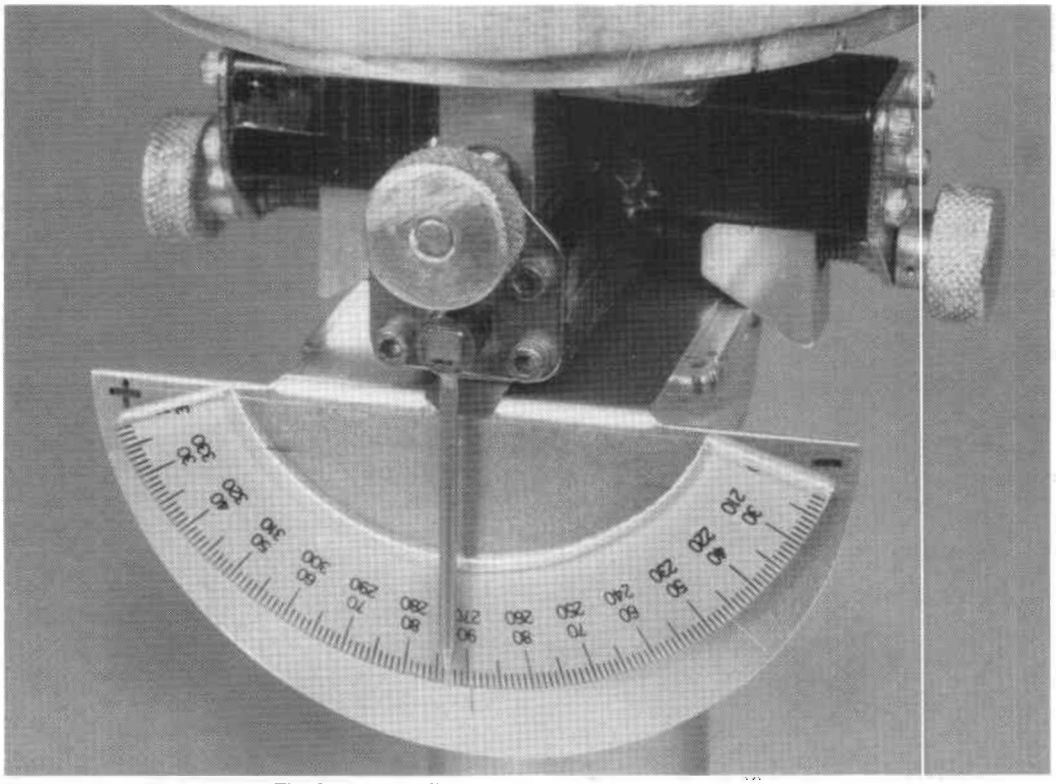

Fig. 2. Angular alignment measurement device in use.

To construct the pointer a 60mm-long 2.5mm-diameter needle is epoxied into a cylinder that has a 5mm-square hole broached through the centre. The needle protrudes 0.5mm into the square hole.

The pointer post, which has dimensions 5mm × 5mm × 9mm, is epoxied to the lower end-plate on the Berkeley Adjustable Leg. The pointer post has a channel on the lower face so that when the pointer is in position the channel is a snug fit with the needle protruding into the square hole on the pointer.

Use of the Device

To use the device to measure sagittal plane (coronal plane) angular alignment, the Berkeley Adjustable Leg must be affixed to the wood block supporting the socket so that the upper slide is in the sagittal plane (coronal plane) (Fig. 2).

An alignment reading is performed by sliding the forks of the frame between the lower pair of wedges on the leg. The pointer is pushed onto the pointer post. Gentle pressure can be applied by the fingers on the surface of the forks to assure uniform contact. Then a reading is taken of the pointer position on the scale (Fig. 2). Because the forks are long, the frame can be pulled forward so that the protractor is close to the pointer. This simplifies reading of the scale.

In evaluation studies repeatability was found to be within 1 degree.

Acknowledgements

This device is used in research supported by the Whitaker Foundation, Prosthetics Research Study (Department of Veterans' Affairs), the Department of Rehabilitation Medicine, the Center for Bioengineering, and the Graduate School at the University of Washington.

REFERENCE

Sanders, J. E., Daly, C. H. (1990). Normal and shear interface stresses in lower-limb prosthetics. In: Images of the twenty-first century — *Proceedings of the annual international conference of the IEEE Engineering in Medicine and Biology Society*, Seattle, Wn, USA, 9–12 Nov., 1989 — New York, NY, *IEEE*, 1443–1444.