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Technical note

A trans-femoral brim adapter for CAD CAM measurements

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Abstract

A computer aided design/computer aided manufacture (CAD CAM) brim measurement adapter was designed for use with a Berkeley casting stand. This measurement adapter accommodates all IPOS/CANFIT-PLUS trans-femoral brim sizes and shapes, allows brim positioning, provides adequate stability, and provides a substantial cost saving by using existing, functional hardware as a base.

Introduction

The successful application of computer aided design/computer aided manufacture (CAD CAM) technology to the production of prosthetic sockets is contingent on the acquisition of reliable input data (Engsberg *et al.*, 1993). In the IPOS/CANFIT-PLUS trans-femoral system the input method involves selecting the appropriate brim for a patient, taking a series of circumference measurements along the stump, and entering the data into a computer. These measurements are used mathematically to produce an image of a quadrilateral or ischial containment socket on a computer screen for modification and/or carving. Since the final socket shape is based on brim dimensions and physical measurements from the patient, accurate measurements from the stump and appropriate brim selection are imperative.

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Reliable and accurate CAD CAM measurements cannot be achieved without suitable, stable brim positioning. A brim support system must support the total body weight of the patient, conform to a variety of brim sizes and shapes, be adjustable to the patient, be stable and secure, be relatively inexpensive, and be simple to use and install. Failure to provide a stable brim support system will lead to erroneous measurements due to proximal/distal limb movement inside the brim and/or excessive brim distortion.

The success of the Berkeley casting frame, as well as the abundance of Berkeley stands in the prosthetic and orthotic community, makes this an ideal platform for a CAD CAM oriented measurement stand. A Berkeley casting frame is adjustable for height, has a high degree of stability, and is easy to set up and operate.

An adapter has been developed to integrate IPOS CAD CAM quadrilateral and ischial containment brims with the Berkeley casting stand. The adapter takes advantage of features present in the Berkeley base while providing the necessary options for successful brim selection, brim positioning, and measurement of the stump. This note will describe the design criteria, fabrication procedure, and operation of such a measurement jig.

Method

Design criteria

The CAD CAM brim measurement adapter was designed based on the following criteria:

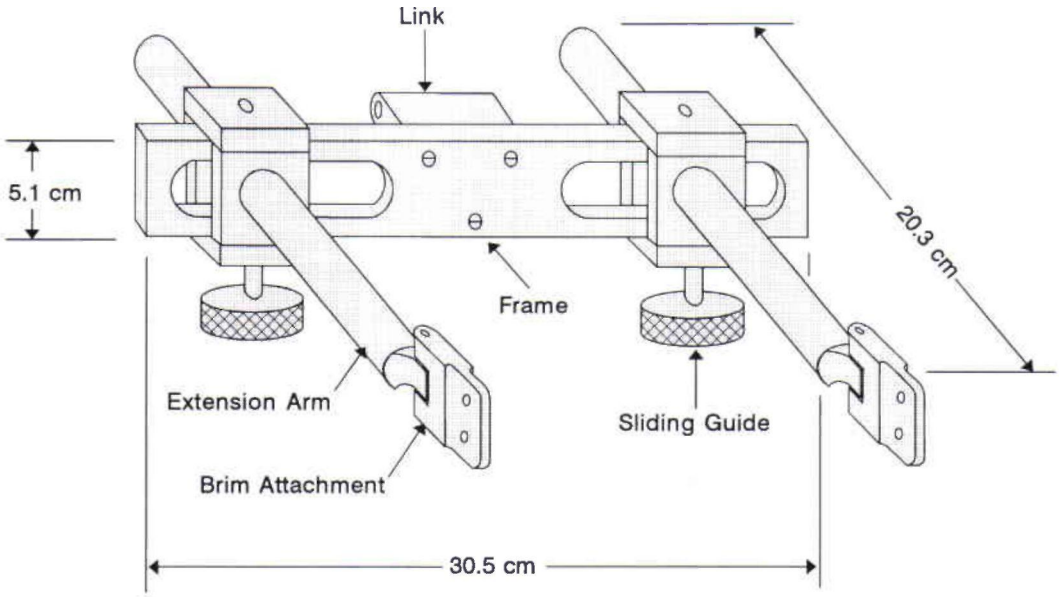

Fig 1. Outline and dimensions of brim adapter.

- accommodate all IPOS brim shapes by providing mediolateral adjustments for circumference and anteroposterior adjustments for quadrilateral and ischial containment styles;
- easy adjustment of brim position in the sagittal and transverse plane;
- no interference with Berkeley base adjustments;
- ability to bear 200 kg of vertical load on the weakest point;
- provide stability and security for the patient;
- simple to install and configure;
- relatively inexpensive.

Components

All jig components were machined out of aluminium stock to provide a light-weight adapter (Fig. 1). A link section was used to connect the brim adapter to a Berkeley casting stand using the standard interface. The hinge attachment mechanism permitted rotation in the transverse plane by adjusting a screw on the Berkeley stand. Since the link segment was secured to the adapter by three bolts, different links could be interchanged for different measurement stands.

A 30.5 cm long central adapter frame was cut out of 1.9 cm by 5.1 cm bar stock. Two 2.5 cm by 10.2 cm tracks were machined out of the bar to allow mediolateral adjustment of the brim attachments. The two extension arms were cut from 20.3 cm by 2.5 cm rod and machined to connect to the brim attachment section. By tapering the ends of the extension arms, 180 degrees of motion was permitted and adequate brim clearance was maintained.

The extension arms were secured to the adapter frame by two sliding guides. These guides functioned as dual u-clamps while allowing extension arm movement along, and at right angles to, the adapter frame. Since a screw could be placed at the top or bottom of the clamp, sufficient clearance was provided between the locking screw and the proximal shelf of the plastic brim.

Operation

Installation

IPOS CAD CAM brims are installed on the adapter using two sets of threaded studs supplied with the plastic brims (medial and lateral). The studs are inserted from inside the brim, through the attachment plate, and secured outside the plate. These studs may have to be trimmed to avoid discomfort to the medial side of the contralateral limb.

Once the brim was securely attached to the adapter, the brim adapter was installed directly into the quadrilateral brim interface unit on the

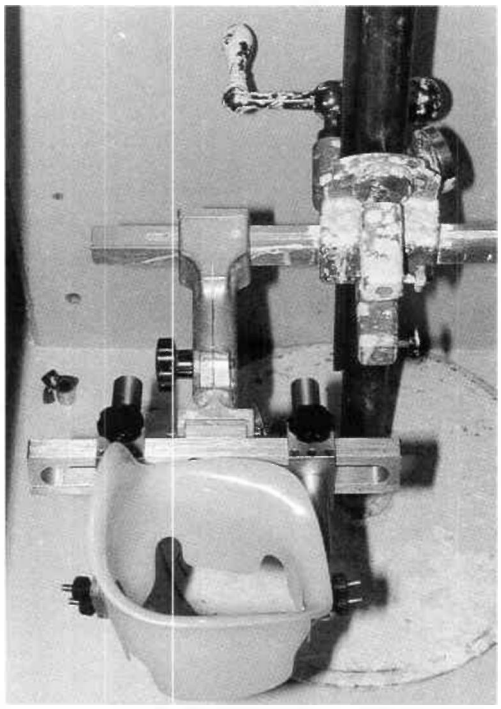

Fig 2. Brim adapter mounted on a Berkeley stand.

Berkeley stand using standard insertion and locking techniques. Since this unit was integrated into the existing attachment interface, the adapter could be used interchangeably with other Berkeley attachments (i.e. quadrilateral brim, casting rings, etc.).

Patient setup

Before using this measurement system, the clinician should pull one ply stockinette across the top of the brim. The patient should be oriented such that he/she faces away from the stand and is securely positioned between the parallel bar supports.

Once the patient is properly positioned, the brim adapter can be raised, using the Berkeley stand, until approximately 90% of the body weight is supported by the brim. Upon loading, brim deformation can be expected in the ischial region. The amount of deformation can be limited by reducing the amount of body-weight that is transferred to the brim.

Using the adapter and the casting stand, the brim can be positioned by adjusting for hip flexion, abduction/adduction, and/or rotation in the transverse plane. Abduction, adduction, and hip flexion can be adjusted using original Berkeley components while transverse rotation can be performed using the jig outriggers. When the brim is in a satisfactory orientation, the clinician can take distal measurements or a cast from the residual limb as required and outlined by the CAD CAM system.

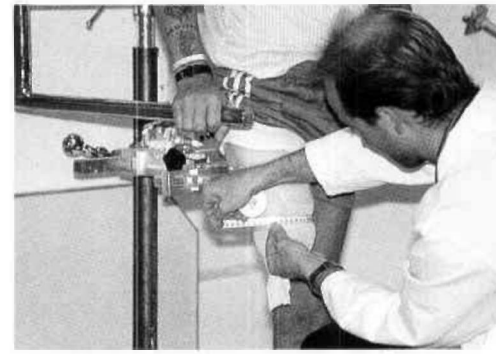

Fig 3. Patient position during CAD CAM measurements.

Maintenance

Maintenance of the brim adapter is minimal. If the adapter is kept clean (i.e. free of plaster build-up that inhibits free movement of the components), no lubrication or other regular maintenance is required.

Conclusion

The IPOS brim adapter defined in this paper provides an easy to use, low maintenance option for using existing casting hardware for CAD CAM oriented measurements. By changing the interface link section this adapter could be used with a variety of measurement stands.

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