Orthotics Measurement Board for Tibial Torsion and Toe-out[1]

By HANS R. LEHNEIS, C.P.O.[2]

EDITOR'S NOTE: *This article was prepared at the request of the Committee on Advances in Prosthetics and Orthotics of AOPA. The measuring device is obtainable from The Pope Brace Division, 197 South West Avenue, Kankakee, Illinois.*

Coordinated function of the brace-anatomical complex is dependent upon the configuration and fit of the brace with the patient's anatomical structure. Brace alignment should be consistent with individual variations in toe-out and tibio-fibular torsion. The process of accomplishing such proper alignment depends, first upon the anatomical measurement technique and second, upon the orthotic fabrication technique.

Since in conventional orthotics practice individual tibial torsion and toe-out accommodations are rarely made for lack of precise measuring devices and techniques, an orthotics measurement board was devised at New York University. The measurement board was designed to obtain individual measurements of tibial torsion and toe-out as well as to serve as a tracing board. In addition, a technique was developed by which the measurements obtained through the use of the orthotics measurement board can be utilized to make appropriate accommodations for tibial torsion and toe-out in the patient's brace.

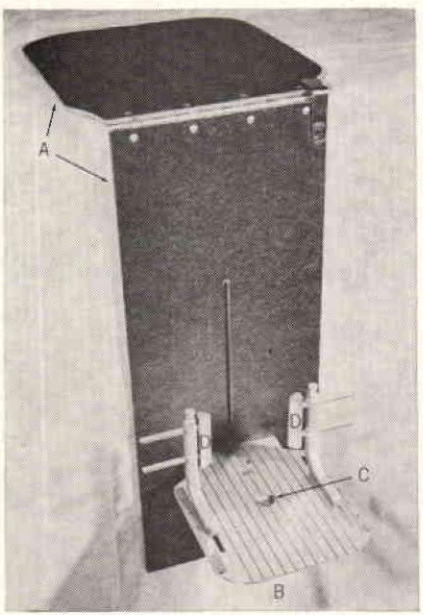

Figure 1

Description of Measurement Board (Fig. 1)

The measurement board consists of two hinged masonite boards (A), an adjustable foot rest plate (B) permitting vertical adjustment as well as rotational adjustment on the goniometer (C), and two malleolar pointers (D) mounted on the foot rest plate (B) which is slotted to allow anterior-posterior adjustability of the pointers. Medio-lateral adjustability is provided by a set screw locking the malleolar pointers in the desired position.

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Measurement Procedure

Prior to the positioning the patient on the measurement board, the medial and lateral malleolus must be marked on the patient's skin to serve as landmarks for the determination of tibio-fibular torsion. Based on the assumption that the ankle joint axis runs through the centers of the malleoli as viewed in the sagittal plane, the width of each malleolus is palpated and its center indicated by a mark approximately one half inch long.

A. *Patient Placement*

Placement of the patient on the measurement board is one of the most critical parts of the procedure. The patient must be seated on a hard surfaced table with both knees flexed approximately ninety degrees over the edge of the table with the measurement board placed under the involved extremity (Fig. 2). Make sure that the popliteal areas are pressed firmly against the hinge of the measurement board on the affected extremity and against the edge of the table on the sound leg. This insures that the knee axis runs parallel to the hinge of the board. The space between the knees in this position should not be excessive, for this would influence the accuracy of the measurements. At this point, the foot plate should not touch the patient's foot so that the weight of the shank will orient the knee axis horizontally in the frontal plane.

B. *Tibial Torsion*

The procedure described does not involve any angular measurement of tibial torsion. Rather, the relative anterior-posterior distance between the medial and lateral malleoli in the transverse plane is a simpler measure for orthotics application.

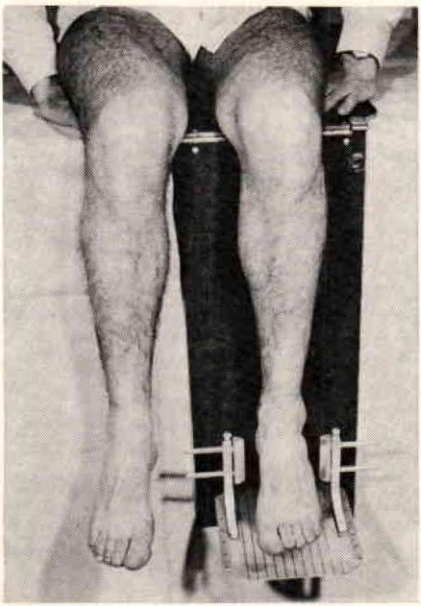


Fig. 2. Positioning patient on Orthotics Measurement Board.

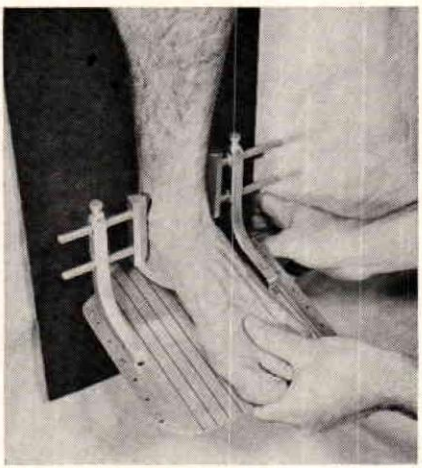
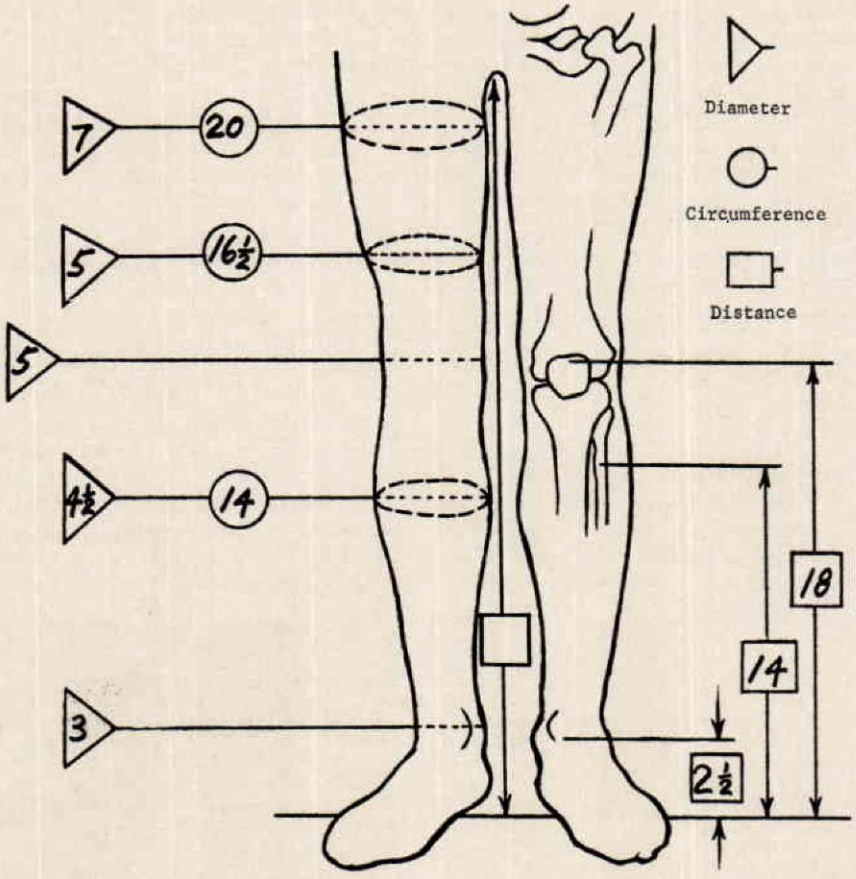


Fig. 3. Measuring tibial torsion.

Following the proper placement of the patient on the measurement board, the foot plate is brought against the patient's foot. Care must be taken that the foot is not distorted in any way as the foot plate approaches the foot, i.e., the foot should not be everted or inverted. To measure the amount of tibial torsion, the goniometer setting must be at the zero mark. This places the adjustment slots in the foot plate at right angles to the surface of the masonite board. With the back of the patient's heel pressed against the board the malleolar pointers are individually adjusted to coincide with the landmarks previously indicated on the patient's skin (Fig. 3). The scale on

LOWER EXTREMITY ORTHOTIC MEASUREMENTS



Degree of Toe-Out 12° Shoe Size 9 D

Tibial Torsion

Distance to Medial Malleolus 3" Distance to Lateral Malleolus 2"

Figure 4

either side of the foot plate measures the distance of the medial and lateral malleolus from the back of the heel. These two measurements are then recorded on the Orthotics Measurement Form (Fig. 4).

Although the angular degree of tibal torsion is not measured, it may be obtained trigonometrically, if so desired (Fig. 5).

C. *Toe-Out*

Toe-out is measured by carefully lifting the patient's foot slightly away from the foot plate so as to free the plate to rotate about the goniometer. The plate is adjusted until one of the longitudinally inscribed marks coincides with the medial border of the foot (Fig. 6). Note, the orthotics measurement board does not measure the degree of toe-out as related to the long axis of the foot; rather it measures the angular relationship between the medial border of the foot and the knee axis. This measure is also recorded on the Orthotics Measurement Form.

Fabrication Procedure

A. *Tibial Torsion*

From the measurements obtained, it is a relatively simple procedure to introduce tibial torsion into the brace. The difference between the medial and lateral malleolar measurements simply indicates the amount of offset needed between the medial and lateral brace ankle joints. If, for example, the medial malleolar measurement is three inches and the lateral measurement is two inches, the difference is one inch. Therefore, the medial ankle joint is offset anteriorly with respect to the lateral ankle joint by one inch plus one eighth of an inch for a total of one and one eighth inches (Fig. 7). The purpose of adding the additional one eighth of an inch is to allow for the usual clearance needed between the malleoli and the brace ankle joints, i.e., if a total of seven sixteenths of an inch is added for ankle clearance, the value of r in figure five increases by this amount, resulting in an increase of y of approximately one eighth of an inch for the average degree of tibial torsion.

Generally, the offset is made on the medial bar if the difference between the malleolar measurements is one inch or less because, normally, the medial malleolus is anterior to the midline of the leg as viewed in the sagittal plane. Should the difference of the malleolar measurements exceed

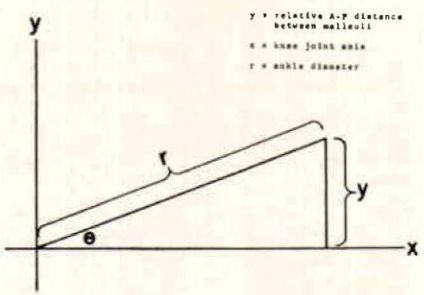


Figure 5

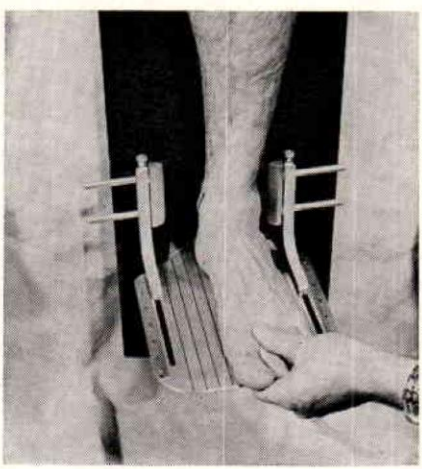


Fig. 6. Measuring toe-out.

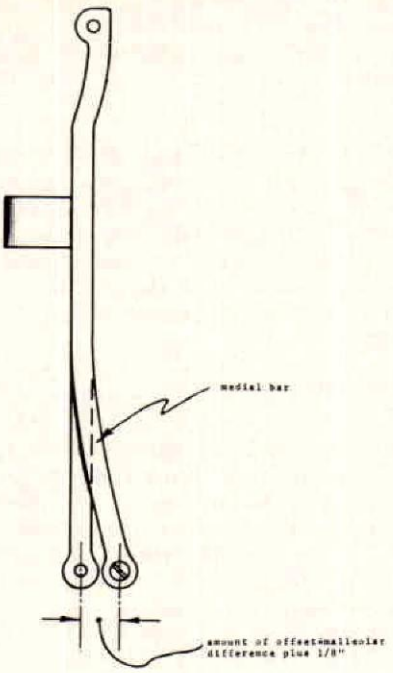


Figure 7

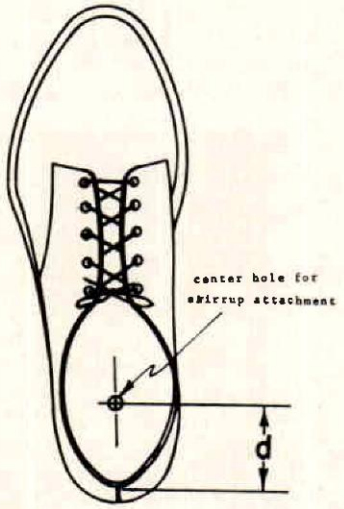


Fig. 9. d = ½ sum of malleolar measurements.

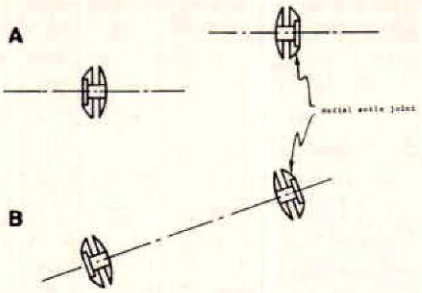


Fig. 8. Ankle joint offset before (A) and after parallel realignment of joint surfaces (B).

one inch, the excess is accommodated by posterior deflection of the lateral ankle joint. After offsetting the ankle joint, both joint surfaces must be re-aligned parallel to each other (Fig. 8).

B. *Toe-Out*

Toe-out accommodation is the final step in brace fabrication. This requires assembly of the stirrup to the leg brace frame. To determine the proper antero-posterior position of the stirrup on the shoe, a hole is drilled through the shoe sole at a point in front of the counter, equal to one half the sum of both malleolar measurements. (Fig. 9). The stirrup is then

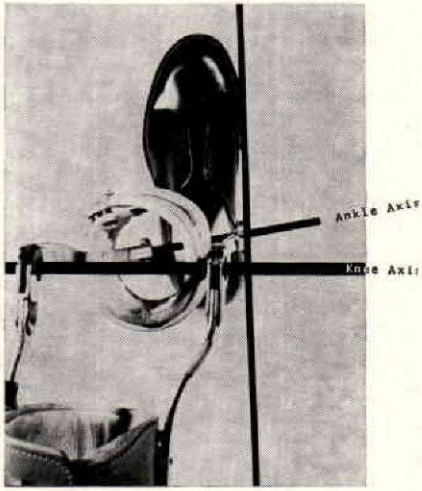


Fig. 10. Relating toe-out to knee axis.

attached to the shoe with one rivet through the center of the stirrup to permit rotation of the shoe on the stirrup to match the degree of toe-out recorded on the Orthotics Measurement Form. As described above, toe-out is measured as the angular relationship between the knee axis and the medial border of the foot. Consequently, in brace fabrication the medial border of the shoe must be related to the brace knee axis (Fig. 10). Two or more additional rivets may then be used to fix the shoe on the stirrup in the desired position.

Summary

The measurement board described is designed to measure the relative distance of the medial and lateral malleoli from the back of the heel in the transverse plane. It is also used to obtain an angular measurement between the medial border of the foot and the knee axis.

Following the procedure described above, the orthotist may produce a brace which more nearly corresponds to the patient's individual anatomical structure. Although the accommodation of tibial torsion is of diminished consequence when limited motion ankle joints are used, its routine introduction in the brace is relatively simple and, of course, of utmost importance with free motion ankle joints. Conversely, toe-out accommodation is not dependent on the type of ankle joint but is an individual measure with equal importance in all cases.

Acknowledgement

The research project described was conducted under the general supervision of Dr. Sidney Fishman and Mr. Norman Berger. I also wish to thank both Dr. Fishman and Mr. Warren Springer for their review of the manuscript.

Gait Analysis Film Loops Available

Three years ago, the Prosthetic-Orthotic Education Program at the Northwestern University Medical School, at the request of the Committee on Prosthetic-Orthotic Education, National Academy of Sciences-National Research Council, prepared a teaching film entitled "Gait Analysis" that demonstrates the more common gait deviation seen in above-knee amputees, together with their causes and means of correction. This proved to be such a valuable instructional film that some 40 copies were printed for loan purposes. At the request of a number of directors of schools of physical therapy, the Committee had prepared sets of loop films taken from the parent production, each of which depicts one single gait deviation. Each set consists of 16 loops that are 7 feet in length and can be rerun for an indefinite period while the instructor discusses the deviation. They can be shown on standard projectors, such as Bell and Howell, Eastman, etc. These sets are being made available at cost and can be purchased for $25.00. Make check payable to the distributor when ordering:

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