

Evaluation of the Alignment of the Tibial Malleolus and Lateral Malleolus of the Fibula

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Abstract. [Purpose] The purpose of this study was to determine the intratester reliability of an instrument developed by us for assessing the alignment of the lateral malleolus of the fibula and medial malleolus of the tibia using digital calipers. [Subjects] Eight healthy men without any leg symptoms (29.9 ± 5.8 years) participated in this study. [Methods] Subjects were measured by placing the instrument on their left and right ankles. The distances determined by three-dimensional measurements (width, length, height) from the center of the heel to the bottom edge of the lateral malleolus and the bottom edge of the medial malleolus were measured to 0.1 millimeters. The intratester reliability was assessed using intraclass correlation coefficients (ICCs) and standard errors of measurement (SEM). [Results] Excellent intratester reliability was confirmed. The ICCs ranged from 0.87 to 0.97 with SEMs between 0.76 and 2.93. [Conclusion] The results confirm that our device has excellent reliability when assessing the alignment of the lateral and medial malleolus. Furthermore, the simple design of the device and its easy method of use render our evaluation method useful for physical therapy clinical settings.

Key words: Device development, Three-dimensional Coordinates, Reproducibility

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INTRODUCTION

A lateral ankle sprain is one of the most common injuries among athletes and other young active adults^{1,2)}. Of particular concern is the high proportion (up to 70%) of patients who suffer from repetitive ankle sprains and chronic symptoms after initial injury³⁾. Several studies have examined the fibular position in subjects with ankle instability⁴⁻⁸⁾. However, there is no definite opinion on the same. Results have suggested the development of anterior and posterior positional faults in individuals with ankle instability. In previous studies, fluoroscopy^{4,6)} and MRI images^{5,7,8)} were used to record the positional fault of the lateral malleolus; however, these methods are not convenient. Furthermore, all the evaluation methods used in previous studies involved only two-dimensional measurements. For a more exact evaluation, it is necessary to evaluate with three-dimensional measurements. We developed an instrument to quantify the alignment of the lateral malleolus of the fibula and medial malleolus of the tibia using digital calipers. It is a mechanical instrument which is very easy to use, and the purpose of this study was to determine the intratester reliability of this instrument.

SUBJECTS AND METHODS

Eight subjects (8 men) volunteered to participate in the study. The mean age of the subjects was 29.9 ± 5.8 years. All subjects provided their written informed consent before data collection. Subjects did not have lower extremity injury at the time of testing. Each subject visited the laboratory on 2 separate days to have measurements taken on both legs.

The measuring instrument consists of a pedestal and 2 devices incorporating a caliper (carbon fiber digital caliper, Shinwa Rules Co. Ltd. Niigata, Japan; minimum reading, 0.1 mm). Props were placed vertically on the 4 corners of the pedestal. Moreover, lines were vertically drawn on the pedestal, and the heel cup was installed on a pedestal at the point of intersection of the lines. The reference point on the pedestal was at the point of intersection of the lines. In one of the devices (device 1), it was consist of calipers and column, it is possible to insert horizontal calipers and slide these calipers along the column. Using device 1 and the pedestal, we measured the exact distance (length, width) between the reference point and the measurement point. In the other device (device 2), calipers could be fitted, and the device could stand vertically. Using device 2, we could measure the exact height. In other words, using the devices, it is possible to calculate the three-dimensional coordinates of the measurement points.

Subjects were seated with their hip, knee, and ankle joints at 90°. A pad for fixation was then placed under the thigh to help maintain a neutral position. After the heel was in contact with the heel cup, the subject adopted a 10°-internal rotation of the foot vertical to the frontal plane (refer to the ankle radiographic methods⁹⁾), and a line was drawn connecting the center of the second toe with the heel. Subjects were observed to ensure that no rotations of the lower extremity occurred during testing. The lowest points of the lateral malleolus and medial malleolus were measured. Measurements were taken after the sites were marking was confirmed by palpation and marked (Fig. 1). After the marking and positioning, measurements were taken to determine the position of the measurement sites. The reference point was defined as the point at which the vertical line intersects the posterior margin of the calcaneus and the ground. The distance between the reference point and the measurement point was recorded (length, X; height, Y; width, Z) (Fig. 1). The same examiner performed the positioning and took measurements for all subjects.

To compare the intratester reliability of the device we developed, intraclass correlation coefficients (ICC1, 1) were calculated for measurements taken on the 2 days. In addition to ICC values, the standard errors of measurement (SEM) were also calculated. Both ICCs and SEMs were calculated for the measurement values of the lateral malleolus and the medial malleolus.

RESULTS

Descriptive statistical values for the lateral malleolus and medial malleolus are presented in Table 1. The intratester reliability of measurement values of the lateral malleolus of the fibula and medial malleolus of the tibia are shown in Table 2. The ICC values ranged from 0.87 to 0.97 with standard errors of measurement between 0.76 and 2.93.

DISCUSSION

The purpose of this study was to determine the intratester reliability of a device we developed for assessing the alignment of the lateral malleolus of the fibula and medial malleolus of the tibia. We consider measurements made with our device of the position of the medial malleolus and lateral malleolus are highly reproducible. According to previous studies, the ICC values obtained in this study (ranging from 0.84 to 0.97) indicating almost perfect reproducibility¹⁰⁾. We consider the results of the present study are comparable to those of previous studies in which fluoroscopy and MRI images were used. The results confirm that the alignment of the lateral and medial malleoli can be assessed with excellent reliability using our device. In addition, previous studies have used a two-dimensional evaluation method⁴⁻⁸⁾, whereas our evaluation method allows three-dimensional measurement. Furthermore, the simple design of the device and its ease of use render our evaluation method useful for physical therapy clinical settings.

There were some limitations to the present study. First,

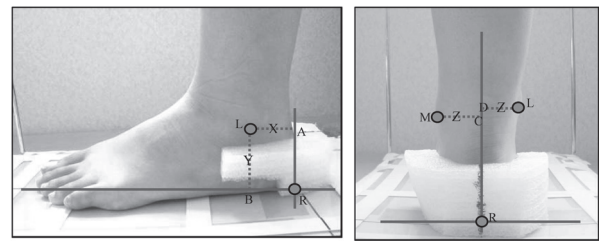


Fig. 1. Measurement of distance and calculation of position.

L: The lowest point of the lateral malleolus

M: The lowest point of the medial malleolus

R: The reference point

·The distance in the sagittal plane between L and A represented by X.

·The distance in the sagittal plane between L and B represented by Y.

·The distance in the frontal plane between L and D, and M and C represented by Z.

*At the side of the medial malleolus, the measurement was performed in the same manner.

Table 1. Mean and standard deviation (SD) values of the lateral malleolus and the medial malleolus.

		Mean	SD
The lateral malleolus	X (mm)	32.3	11.5
	Y (mm)	57.3	3.0
	Z (mm)	39.8	7.8
The medial malleolus	X (mm)	45.2	11.7
	Y (mm)	80.8	3.5
	Z (mm)	24.5	9.6

Table 2. Mean absolute differences, intraclass correlation coefficients (ICCs), and standard error of measurement (SEM) obtained at 2-day intervals.

		Mean difference	ICC	SEM
The lateral malleolus	X	0.2	0.97	2.86
	Y	0.4	0.84	0.76
	Z	0.8	0.87	1.96
The medial malleolus	X	1.2	0.95	2.93
	Y	0.5	0.88	0.86
	Z	1.6	0.88	2.41

we only collected intratester reliability data. Therefore, we still need to determine whether the findings can be generalized between different testers. It is necessary to examine the intertester reliability and demonstrate that our method can be applied in general. Second, it should be noted that our study subjects were free from lower-extremity injury at the time of testing. In cases of pathology, the presence of swelling and deformity may introduce a potential error in both the reliability and validity of the measurements taken using our device. Further work is needed to assess the feasibility of using our method for patients with clinical pathologies of the foot and ankle.

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