NVEO
Natural Volatiles & Essential Oils

# A study of the Assist Device for Accurate Position in Ankle Joint

**Dong-Hee Hong[2515], Hyeong-Gyun Kim[2]***

*[1]Dept. of Radiology Science, Shinhan University, 95, Hoam-ro, Uijeongbu-si, Gyeonggi-do, 11644, Republic of Korea*
*[2]Dept. of Radiology Science, Far East University, 6-32, Daehak-gil, Gamgok-myeon, Eumseong-gun, 27601, Chungcheongbuk-do, Republic of Korea*
*hansound2@hanmail.net[1], Jung7818@hanmail.net[2*]*

**Abstract**

**Background/Objectives**: In this study, the posture was maintained at a certain angle when taking a mortise view to develop an assistive device for accurate diagnosis and to confirm its usefulness.

**Methods/Statistical analysis**: After designing in consideration of the average foot size of men and women, modeling was obtained, and then an auxiliary device was fabricated with a 3D printer using the FDM method. For the evaluation of the usefulness of the manufactured assistive devices, the Mortise view was performed for adult men and women, and the change of the Mortise line for each angle was confirmed by video.

**Findings**: In conclusion, the practicality of the assistive device was confirmed by minimizing the discomfort that occurs in maintaining the posture when the assistive device is worn, and by minimizing unnecessary physical contact that occurs during the photographing process.

**Improvements/Applications**: The experiment was conducted with a small number of ordinary people, and there is a limitation in that the problem of not being fixed well may occur when the size of the foot is too large or too small.

***Keywords***: General projection, 3D Printer, Assist device, Mortise view, Ankle joint

## 1. Introduction

X-ray imaging is used in the field of radiology, and it is possible to see internal structures of the human body by transmitting X-rays through the human body. General photographing using x-rays is to photograph the human body without using a contrast medium or apparatus, and photographs before and after, or if necessary, photographing a side or a diagonal line. In addition, it is of diagnostic value due to its high sharpness and resolution, and accurate posture maintenance is required to reduce the exposure dose to the patient. In particular, Mortise View, which is performed to observe the presence or absence of a lesion suspected of a specific trauma, sprain, or dislocation of the ankle joint during ankle photographing, is an image obtained by clearly obtaining the degree of separation of the neck-end calf joint, distal tibia joint, and neck tibia joint. To increase the diagnostic value of the foot, give the foot an inward angle of 15-20°. Since the difference or distortion of the image may occur due to the change of the angle of the foot, the accuracy of the examination may be degraded. Therefore, we intend to manufacture an ankle aid through an experimental study using a 3D scanner and a 3D printer.

3D printing is a method of stacking each material by curing or melting it, and the most popular method is lamination (Fused Deposition Modeling; FDM). FDM is a method of laminating and molding by melting filaments by heat and extruding them through a nozzle at a certain pressure. to be. The supplied material is in the shape of a filament or wire, and is continuously supplied by being wound on a roll such as a protective cartridge or a thread. These solid materials are softened and extruded into a material close to the liquid phase while passing through a temperature controlled temperature controlled head, and a three-dimensional model is created through a fusion lamination process one by one. Using 3D technology, it is possible to increase cost efficiency, minimize the error range of images, and is highly versatile in the fast-changing manufacturing industry, and it is possible to manufacture the final product without the

assembly process by stacking raw materials layer by layer. In the US, 3D printing technology can be applied to all fields that require power, such as portable and transportation, and is commercially available in earnest.

Therefore, in this paper, an assistive device was developed to make the patient more comfortable and improve the accuracy of the image by fixing the photographing posture of the patient with discomfort and the elderly patient. We want to check whether the mortise line is widened by making a difference by ° to see if it is a condition to be considered in clinical treatment.

## 2. Materials and Methods

### 2.1. Design and manufacture of assist device

#### 2.1.1 Assistive Device Design Initiative

This study was produced for the purpose of fixing it accurately, taking into consideration the difficulty of maintaining the posture when taking Mortise View. Mortise View photographing posture has limitations in posture maintenance, and in consideration of this, the usefulness of assistive devices that can accurately fix and maintain the ankle by rotating the ankle by angle was evaluated.

After designing the design, the size was quantified by drawing a blueprint (Figure 1), and a model was made to test the usefulness of auxiliary devices. Through this, limitations and defects were identified, and supplements and corrections were repeated.

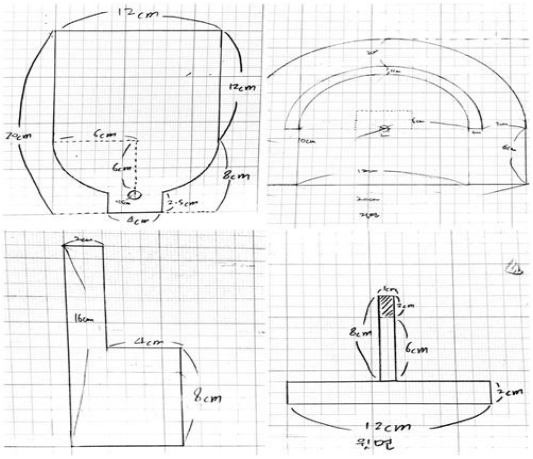


**Figure 1. Assist device design**

#### 2.1.2 3D Modeling

Focusing on the presence or absence of scattered rays, foot fixation ability, angle display, 180° rotation, and inspection convenience, 3D Modeling was designed with an engineering CATIA program and converted into STL files (Figure. 2). The overall size is 200 × 60 × 160 mm, and the footrest size is 120 × 10 × 200 mm.

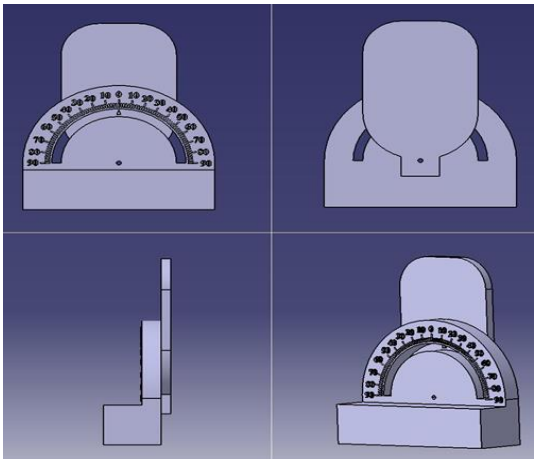

**Figure 2. 3D Modeling and STL file**

**2.1.2 3D printer manufacture**

Modeling was completed based on the design designed by the CATIA program for engineering, and the product was produced with a 3D printer. Stratasys Objet350 Connex model was used as the 3D printer equipment used in manufacturing. The size of the print bed is 340 × 340 × 200 mm, the nozzle diameter is 0.1 mm, and the stacking thickness is up to 28 μm (at least 16 μm). As a raw material, FDM technology was applied to create a three-dimensional structure in which light is irradiated to a photo sensitive liquid polymer, which is a liquid state, and laminated one by one.

In this study, before the finished product was manufactured, it was confirmed using a CAD file before making it with Woodlock material, and the rotation center axis between the protractor and the scaffold was different, so when the marking line of the scaffold was rotated, it did not coincide with the ruler of the protractor. When the intersection of the protractor's central axis and the scaffold rotation axis is located at the bottom, it can be confirmed that the side of the scaffold touches the floor at a certain angle and becomes the limit of rotation (Figure 3). In this way, the limitations and defects were repeatedly corrected and supplemented, and the clinical application of the finished auxiliary device was evaluated for general functionality in adult men and women.

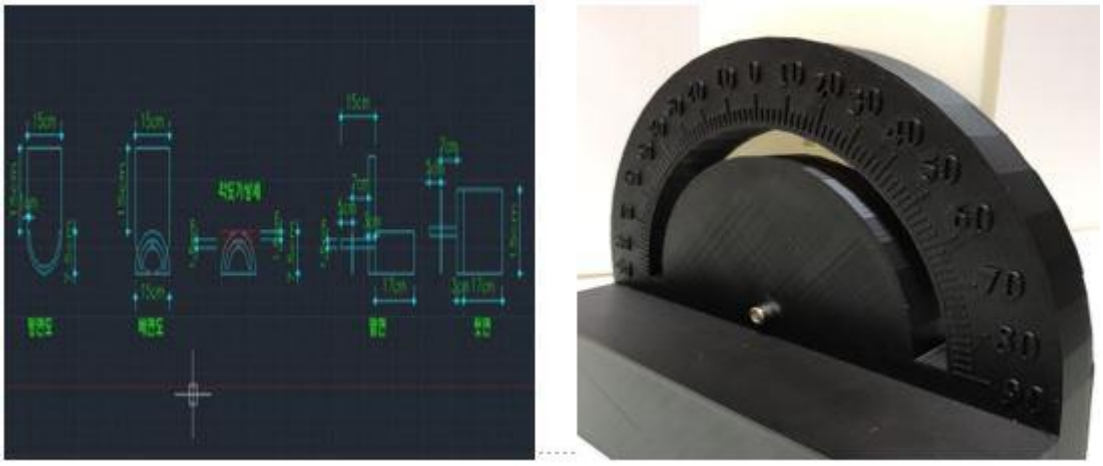

**Figure 3. assist device CAD file image and 3D printer making**

**2.2. Assessing the usefulness of assistive devices**

Through this experiment, by wearing an auxiliary device made by a 3D printer, the usefulness of an auxiliary device that can be maintained by rotating the ankle by angle to check whether there is

unnecessary physical contact, whether the shooting posture is accurately fixed, and the accuracy of the image. Was studied.

The experimental method was taken with 10 adult males and females wearing assistive devices, and the conditions for image acquisition were the same as SID 100cm, 63 kV, 20mAs, and FOV 10 × 10 cm², and took 5˚ increments from 0 to 35˚. I did(Figure 4).

**Figure 4. After wearing the assistive device, the experiment was conducted.**

## 3. Results

### 3.1. Assist device manufacture

Based on the designed design, the assistive devices and 3D modeling files made of wood rock are shown, and the usefulness of maintaining an accurate angle during ankle fixation and internal rotation in mortise view shooting was evaluated.

Based on the design and photographs, the auxiliary devices were printed using the FDM method in which a filament-type thermoplastic material was melted in a nozzle and printed in a thin film form(Figure 5).

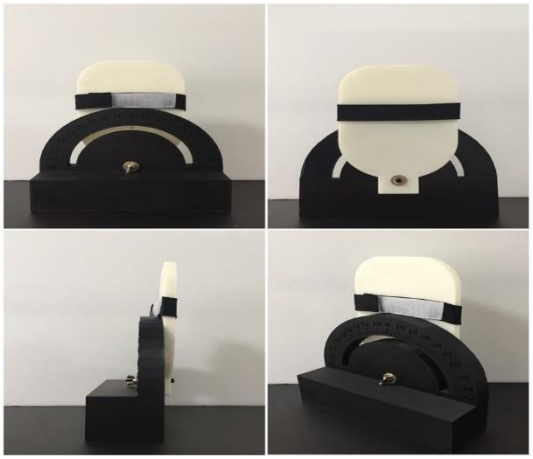

**Figure 5. Assist devices printed by 3D printer**

The output auxiliary device is composed of a body part, a footrest part, and a connection part.

The body part is marked with a scale of 0°~180° in order to accurately see the desired angle, and a groove is made so that the arrow of the footrest part can be seen.The floor is designed in a flat square

shape to fix the movement of the device, so it is stable when shooting Was to be maintained and printed with a thickness of 6 cm.

The footrest part has a band part attached to the foot so that the foot can be fixed, and an arrow to see the angle through the groove in the body part was made.

The connection part was manufactured to maintain the overall stability so that the body part and the footrest part were not separated from each other, and the rotation of the footrest part was fixed at a desired angle.

### 3.2. Assessing the usefulness of assistive devices

Mortise view examination images include the Talotibial Joint, which is the junction of the talus and Tibia, and the Talofibular Joint, which is the junction of the Talus and Fibula, Mortise line, which is the junction of these two joints, should appear well.

The test method using the new auxiliary device developed as a result of the experiment is geometrically the same as the existing test method, and the neck-end calf joint, the distal tibia joint, and the neck-end tibia joint should appear without overlap, and between the neck heels and the bones of union In terms of satisfying the condition that poetry and the like appear more clearly, it can be seen that it meets the condition of obtaining a better image than the conventional inspection method without wearing an auxiliary device.

When taking Mortise view after wearing assistive devices for 10 adult men and women,

It was confirmed that the mortise line overlapped the talotibial joint at 0° and 5°, and it was confirmed that it was slightly open at 10° and 15°. It was confirmed to be visible. After that, the functionality of the assistive device was confirmed by confirming that the Talofibular joint narrowed at 30° and 35°.

In the process of photographing using assistive devices, physical contact is minimized when maintaining the photographing posture except when the assistive devices are worn, thereby reducing the possibility of causing discomfort. In addition, it was confirmed that the motion of the foot was fixed by the image, so that the motion blur did not appear, and the artifacts caused by the assistive devices did not appear.

## 4. Discussion

It was confirmed that a very stable state and accurate posture are possible when the test posture of the Mortise View is maintained with the assistive device completed by this study. In the process of shooting, physical contact was minimized to minimize discomfort for contact. In addition, since the foot was fixed by the auxiliary device, it was confirmed that there was no motion blurring due to movement, and the artifact caused by the auxiliary device did not appear.

However, the manufactured aids are based on the average foot size of about 6,400 adult males and females in Korea, so if the foot size is too large or too small, it may cause a problem of not being fixed well. In addition, there are limitations in applying to patients with traumatic diseases, and since the evaluation was not conducted on actual patients, but 10 adult men and women were targeted, it is inconvenient for elderly patients, patients with pain, or patients with disabilities to use assistive devices. It is believed that additional clinical usefulness evaluation is necessary for patients as they may suffer from discomfort.

## 5. Conclusion

In this study, in consideration of the difficulty in maintaining the posture of the patient during general photographing, we attempted to manufacture an assistive device according to the photographing

method. Assistive devices for photographing with the feet inwardly angled were manufactured, and among them, the usefulness of the assistive devices was evaluated by photographing them in a Mortise view.

Based on the average foot size of about 6,400 adult males and females in Korea, the design was drawn by setting the footboard as 12cm wide and 20cm long and 6cm below the protractor. Based on the completed design, an auxiliary device was manufactured using woodlock, and then elaborately manufactured with a 3D printer.

As a result of photographing by increasing the Mortise view by 5° each from 0 to 35° by wearing an auxiliary device, it was confirmed that the Mortise line was most clearly visible at 20° and 25°. In addition, by visually confirming the change of the mortise line for each angle, the practicality of the auxiliary device was confirmed.

This minimizes discomfort in maintaining the posture and minimizes unnecessary physical contact during the photographing process. In addition, the use of auxiliary devices is easy, so accessibility is good.

**6. References**

1. Jeon GE, Jin GH. A Survey of the Management of Patient Dose at Medical Center, Journal of the Kor ean Society of Radiology, 2009; 3(1):23-8
2. Hong D.H. (2015). Evaluation of Usefulness of Image by Using New Compression Paddle for Mamm oplasty Patient During Mammography. Journal of radiological science and technology, 38(3), 231-3
3. Seoung YH. 3-Dimensional Printing for Mesh Types of Short Arm Cast by Using Computed Tomogra phy. the Journal of Korean Contents, 2015;15(1):308-15.
4. Kim K. W., Jung J. H., Yoo K. Y., Kim J. M., Jung H. W.& Lee J. A et al. Comparison Study on CNR and SNR of Thoracic Spine Lateral Radiography. Journal of radiological science and technology,2013;36( 4):273-80
5. Choi EJ, Kim SA, Bae JY, Kwon YJ, Lee KH. A Study on the State-of-the-Art of 3D Printers, The Korea Society of Computer and Information. 2013; 21(2): 385-8.
6. Seoung YH. 3-Dimensional Printing for Mesh Types of Short Arm Cast by Using Computed Tomogra phy. The Journal of the Korea Contents Association, 2015; 15(1): 309 - 15
7. Park SH, Park JH, Lee HJ, Lee NK. Current Status of Biomedical Applications using 3D Printing Techn ology, Journal of the Korean Society for Precision Engineering. 2014; 31(12):1067-76.
8. Ahn DG, Application of 3D printing technology to mold industry, The Korean society of mechanical engineers, 2014; 54(4):.46-51.
9. Choi W. J., Ye S. Y.& Kim D. H. Making Aids of Magnetic Resonance Image using 3D Printing Techno logy Journal of the Korean Society of Radiology, 2016;10(6): 403-9
10. Wohler T. Wohlers Report 2013. Wohlers Associates Inc..2013;23-52.