Relationship between Physical Characteristics and Morphological Features of the Radius Articular Surface

Reo Asai[1], Yuichi Yoshii[1], Yusuke Eda[2], Tomoo Ishii[1]
[1]Tokyo Medical University Ibaraki Medical Center, Ami, Japan. [2]Tsukuba Medical Center Hospital, Tsukuba, Japan
asai.reo.sg@alumni.tsukuba.ac.jp

Disclosures: Reo Asai, Yuichi Yoshii, Yusuke Eda, Tomoo Ishii. No benefits in any form have been received from any commercial party related directly or indirectly to the subject of this study.

INTRODUCTION: Volar locking plates are commonly used for the osteosynthesis of distal radius fractures. Preoperative planning involves X-rays or computed tomography (CT) scans of the unaffected wrist. However, due to the individual characteristics of the bone shape, it is sometimes difficult to estimate the appropriate plate size prior to surgery. For the appropriate preoperative planning, it may be helpful to determine the relationship between bone shape and physical characteristics. In this study, we hypothesized that the morphological characteristics of the distal radius can be estimated from the patient's physical characteristics. To evaluate whether it is possible to predict the plate size from the patient's physical characteristics, we investigated the relationship between the morphological characteristics of the distal radius joint surface in healthy wrist joints and body characteristics.

METHODS: This was a retrospective case-control study (level of evidence III). The radiographic database was accessed to identify patients who underwent CT scans of the unaffected wrist for comparison of the affected side. CT images of the unaffected wrist were evaluated. The absence of previous history and complaints in the unaffected wrist was confirmed through interviews and medical records. Patients with a history of traumatic arm injuries or patients younger than 18 years old were excluded. A total of 79 wrist CT images, 37 men and 42 women (20–95 years old, mean: 58.4 years old for men, 26–91 years old, mean: 62.5 years old for women), were evaluated. CT images were taken at the forearm in a neutral position with a tube setting of 120 kV and 100 mAs, a section thickness of 1–1.5 mm, and a pixel size of 0.3X0.3 mm (Sensation Cardiac, Siemens). The CT images were taken from the metacarpal bone level to approximately 13 cm proximal to the radius joint surface. Physical characteristics such as height, weight, and BMI were recorded for each patient at the initial hospital visit, and these data were retrieved from medical records.

Three-dimensional Bone Morphology and Analysis
A computer analysis software (BoneSimulater, Orthree, Osaka, Japan) was used to analyze the three-dimensional (3D) bone model of the distal radius. The software constructs 3D surface models of the distal radius using a surface construction algorithm. The coordinate system was defined based on the 3D data, and the long axis of the radius was calculated using the 3D surface model. The software finds the proximal-to-distal center curve of the radius shaft by analyzing its cross sections at various locations. Thereafter, the software calculated the central point at each level from the surface data of the radial diaphysis, and the approximate straight line based on the central points was defined as the long axis, which was also defined as the y-axis. The z-axis was parallel to the orthogonal projection of the line initiated at the base of the sigmoid notch of the distal radius and continued to the radial styloid process on the plane perpendicular to the y-axis. The x-axis was defined as perpendicular to the yz-plane. The yz, xy, and xz-planes were defined as the coronal, sagittal, and axial planes, respectively. Three reference points, (1) radial styloid process, (2) sigmoid notch volar edge, and (3) sigmoid notch dorsal edge, were marked on the 3D image (Figure 1-a). The vertical distance between reference points (1) and (2) on the coronal plane was defined as the radius transverse diameter (Figure 1-b), and the vertical distance between reference points (2) and (3) on the sagittal plane was defined as the radius anteroposterior diameter (Figure 1-c). Pearson's correlation coefficient was used to evaluate the correlations between the transverse/anteroposterior diameter of the radius and height, weight, and BMI, respectively.

RESULTS: The transverse/anteroposterior diameters were 27.8±2.3 mm/14.5±1.3 mm for men and 24.2±1.7 mm/12.9±1.0 mm for women, respectively. The height, weight, and BMI were 167.4±7.5 cm/155.7±5.7 cm, 65.9±15.8 kg/53.7±9.5 kg, and 23.3±4.4/22.2±4.2 for men and women, respectively. Overall correlation coefficients of transverse/anteroposterior diameter and height, weight, and BMI were 0.66/0.45, 0.41/0.35, and 0.11/0.15, respectively. There were moderate correlations between transverse diameter and height/weight and between anteroposterior diameter and height. In the analysis by sex, correlation coefficients between transverse/anteroposterior diameter and height, weight, and BMI in men were 0.33/0.23, 0.12/0.24, and 0.00/0.20, respectively. Correlation coefficients between transverse/anteroposterior diameter and height, weight, and BMI in women were 0.47/-0.04, 0.27/-0.06, and 0.08/-0.05, respectively. There was a moderate correlation only between transverse diameter and height in women (Figure 2).

DISCUSSION: We investigated the relationship between the transverse and anteroposterior diameters of the distal radius joint surface and physical characteristics. The overall correlations may be due to the differences in physical characteristics between the sexes. On the other hand, there was a moderate correlation between height and transverse diameter in women. This suggests that women's height may be helpful for selecting the size of the volar locking plate for distal radius fractures.

SIGNIFICANCE/CLINICAL RELEVANCE: Women's height may be one of the factors that determine the width of the distal radius. This information will be helpful in choosing the appropriate plate size for distal radius fractures.

ACKNOWLEDGEMENTS: This study is supported by Japan Society for the Promotion of Science (KAKENHI 23K08618) and the General Insurance Association of Japan.

FIGURES:

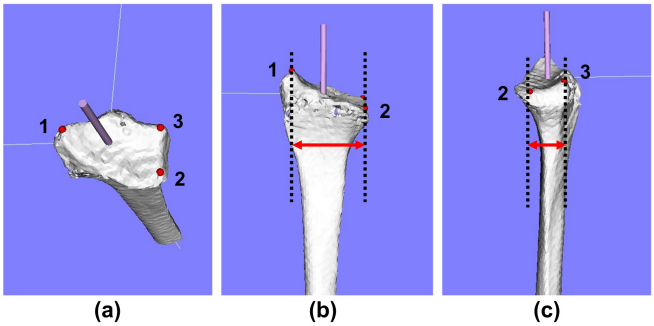

Figure 1

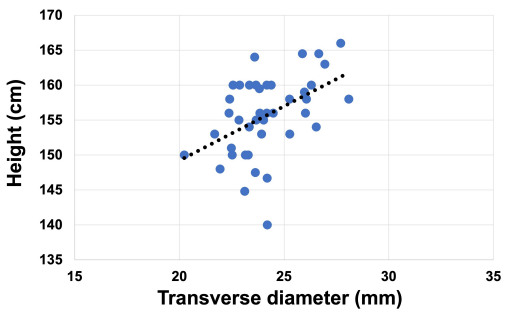

Figure 2