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Original article

Three-dimensional assessment of the normal Japanese glenoid and comparison with the normal French glenoid

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ABSTRACT

Introduction: In 2014, reverse total shoulder arthroplasty was approved in Japan. We were concerned that the base plate might be incompatible with Japanese who were generally smaller than Westerners. Therefore, we investigated the dimensions and morphology of the normal Japanese glenoid and compared with the normal French glenoid.

Materials and methods: One hundred Japanese shoulders without glenoid lesions (50 men and 50 women) were investigated and compared with 100 French shoulders (50 men and 50 women). Computed tomography was performed with 3-dimensional image reconstruction and images were analyzed using Genosys software. Glenoid parameters (width, height, retroversion and inclination) were compared between Japanese and French subjects.

Results: In Japanese subjects, the mean glenoid width was 25.5 mm, height was 33.3 mm, retroversion was 2.3° and inclination was 11.6° superiorly. In French subjects, the mean glenoid width was 26.7 mm, height was 35.4 mm, retroversion was 6.0° and inclination was 10.4° superiorly. Glenoid width and height were significantly smaller in Japanese subjects than French subjects ($P = 0.001$ and $P < 0.001$), while retroversion was significantly greater in French subjects ($P < 0.001$). There was no significant difference of inclination.

Conclusions: These findings will help surgeons to identify suitable patients for RSA and perform the procedure with appropriate preoperative planning.

Level of evidence: IV: retrospective or historical series.

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1. Introduction

Reverse total shoulder arthroplasty (RSA) was first proposed by Grammont in 1985 [1]. Although the RSA has long been a standard procedure in Western countries, it became available in Japan from April 2014. Since the minimum size of base plate was 25 mm, we were concerned that it might be incompatible with Japanese patients who were generally smaller in physique than Westerners. However, there were no data comparing the glenoid size in Japanese and Westerners.

Scapular notching is a radiographic observation specific to RSA and represents an osseous defect in the scapular neck [2]. If the notch becomes large, glenoid component loosening might occur, so prevention is desirable. It has been recommended that the base plate should be implanted as low as possible, flush with

inferior glenoid margin with inferior inclination [2–5]. Excessive retroversion of the glenoid and a biconcave glenoid can also lead to poor results, so asymmetric reaming or bone grafting may sometimes be required to reduce retroversion [6,7]. Therefore, we considered that evaluation of glenoid inclination and version were necessary to determine the correct position and angle of the base plate. However, evaluation of glenoid morphology in Japanese subjects using three-dimensional computed tomography (3DCT) has never been performed, and there has never been a comparison of glenoid morphology between Western and Asian subjects. The purpose of this study was therefore to investigate the dimensions and morphology of the normal glenoid in Japanese subjects by 3DCT, as well as to compare the findings with the normal French glenoid since RSA was developed in France.

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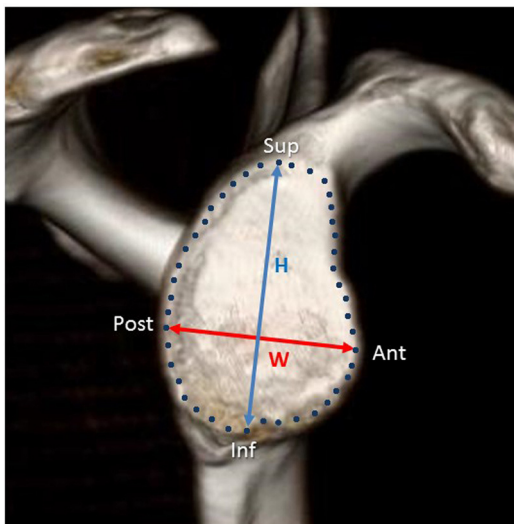


Fig. 1. Measurement of glenoid size. 3DCT scan showing the glenoid articular surface contour mapped by hand in the sagittal view (circling points). The superior-inferior height (H) is the 3D distance between the points Sup and Inf; the anteroposterior width (W) is the 3D distance between the points Ant and Post.

2. Materials and methods

2.1. Subjects

CT scans of patients who had fractures of the proximal humerus or clavicle were retrieved at three surgical centers, including two in Japan (Osaka and Nagoya) and one in France (Lyon). Scans were excluded if the patient had glenoid disease, trauma, or not whole scapula, or if there were significant imaging artifacts. We also excluded patients who had a history of shoulder dislocation or subluxation and those with previous shoulder surgery. One hundred

shoulders without glenoid lesions were assessed in 100 Japanese subjects, including 50 men and 50 women. The mean age was 51.7 ± 18.1 (15–90) years and the mean height was 161.9 ± 10.1 cm (men: 170.5 ± 5.6 (153–184) cm, women: 155 ± 7.2 (140–172) cm). In addition, 100 shoulders without glenoid lesions were assessed in 100 French subjects, including 50 men and 50 women with a mean age of 51.9 ± 20.1 (17–88) years.

2.2. 3D reconstruction of the scapula

Three-dimensional (3D) reconstruction of CT scans was performed using Digital Imaging and Communications in Medicine (DICOM) images to investigate the surface of the scapula. Dedicated software (Glensys®; Imascap, Brest, France) that was recently validated [8] was used to interactively extract the articular glenoid surface and compute 3D measurements.

2.3. Measurement of glenoid size

As indexes of glenoid size, we measured the maximum anteroposterior glenoid width (glenoid width) and the maximum superior-inferior glenoid height (glenoid height). The surface contour was adjusted manually in the sagittal plane until it included the entire articular surface of the glenoid. Then the most superior and inferior points of the contour of the articular surface of the glenoid were selected in the sagittal view, and the glenoid height was measured as the distance between these two points. Next, anterior and posterior points were set so that both points were on the surface contour of the glenoid and were in the same plane normal to the superior-inferior axis while maximizing the 3D anterior–posterior distance, and the glenoid width was measured as the distance between these points (Fig. 1). The reproducibility of these 3D measurements have previously been evaluated [9]. Three orthopaedic surgeons independently examined the images twice and both intra- and inter-observer reliability were calculated using intra-class correlation coefficients (ICC). The intra-observer reliability for width

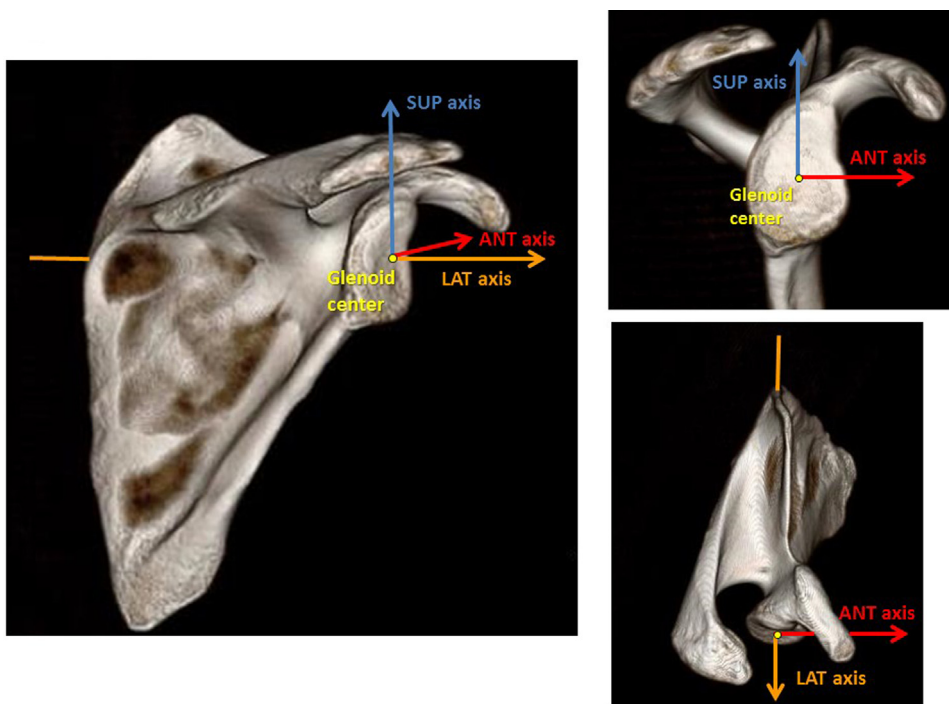


Fig. 2. Glenoid reference coordinate system. Medial-lateral (LAT-axis): this axis is fitted on the supraspinatus fossa as a line between the spine and body of the scapula projected on the scapular plane. Posterior-anterior axis (ANT-axis): this axis is perpendicular to the scapular plane. Inferior-superior axis (SUP-axis): this axis is perpendicular to both the ANT-axis and the LAT-axis.

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