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The detection of Scapular Notch with Tomosynthesis after Reverse Shoulder Arthroplasty
—12th CAOS Japan Annual Meeting—

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At the 12th CAOS Japan Annual Meeting held in Osaka on March 22 to 23, 2018, Yoshihiro Hirakawa, M.D.,Ph.D. from the Department of Orthopaedic Surgery at Osaka City University Graduate School of Medicine (currently at Osaka Social Medical Center) gave an academic presentation about tomosynthesis using a Shimadzu SONIALVISION G4 fluoroscopy system, entitled "The detection of Scapular Notch with Tomosynthesis after Reverse Shoulder Arthroplasty" This article provides an overview of that presentation.

1. Purpose

One of the complications that can occur from reverse shoulder arthroplasty (RSA) is scapular notch. Scapular notch is a complication that the liner inserted in the humerus and the scapula are worn out due to their repeated collision during shoulder joint movement. Commonly reported scapular notch is caused by collision between the liner and the lower part of the scapula due to the adduction of the humerus. The bone defect below the scapula can be detected with the frontal XP image of the shoulder joint. In contrast, anterior and posterior scapular notch can occur when the liner inserted in the humerus repeatedly collides the scapula during internal and external rotation of the humerus. However, if anterior and posterior scapular notch occurs, the notch cannot be detected with the frontal XP image of the shoulder joint. Furthermore, the scapular notch near the base plate or screws cannot be detected with the CT image due to metal artifacts.

In recent years, tomosynthesis has been reported as an effective method of detecting bone defects.[1)] Because tomosynthesis can be used to obtain tomography images with less metal artifacts, tomosynthesis offers the possibility of detecting anterior and posterior bone defects that is difficult to detect with XP or CT images.

The purpose of this study is to compare the detection sensitivity and specificity of bone defects around the RSA base plate in pig scapula with XP, CT and tomosynthesis images.

2. Method

2.1 Surgery Method

A DePuy Synthes Delta Xtend™ system was used for RSA on four pig scapula. A control model, anterior bone defect model, posterior bone defect model, and inferior bone defect model were prepared **(Fig. 1)**. No bone defect was made to the scapula in the control model. In the anterior, posterior, and inferior bone defect model, a bone defect was made to the depth where the screw was exposed. A standard 27 mm-diameter base plate was inserted in each model and fixed with four screws. Then a 38 mm-diameter standard glenosphere was installed in each model and fixed with screws. To simulate the state of osteolysis, the bone defects were filled with 1 % agarose gel simulating granulation tissue.

2.2 Evaluation Method

Images of each model were acquired with XP, CT (with metal artifact reduction), and tomosynthesis. Shimadzu's dual linear drive method was used to acquire tomosynthesis images and the T-smart method for reconstructing images was

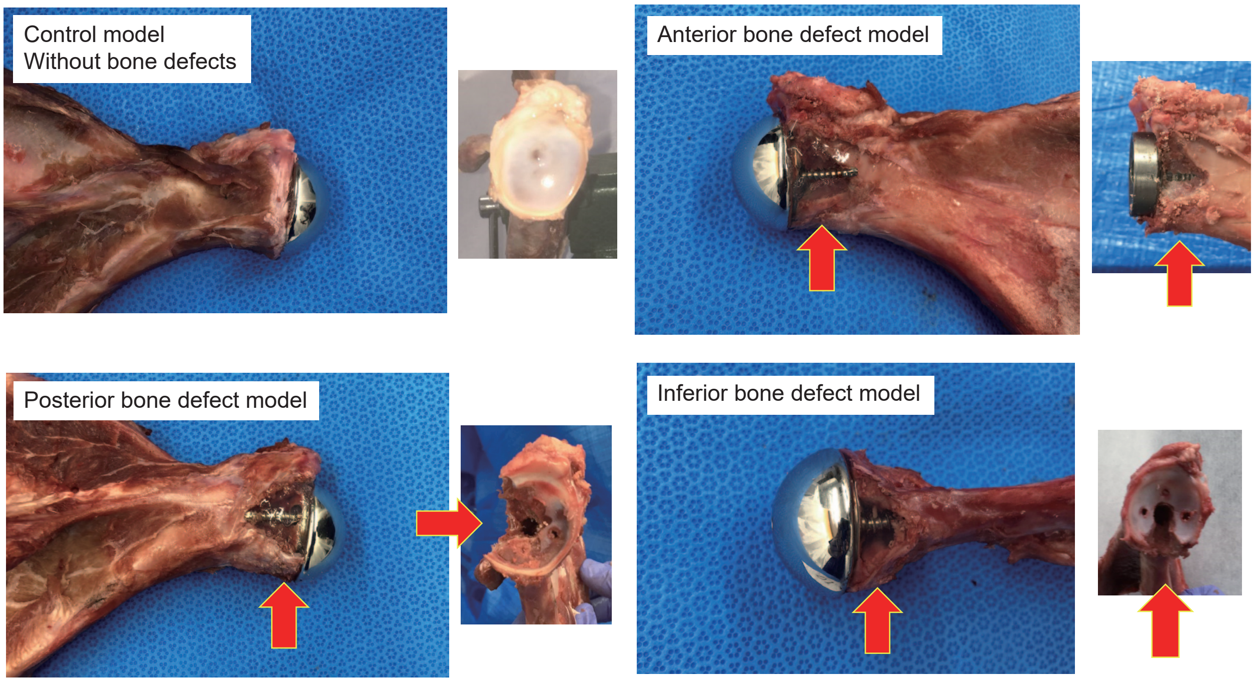


Fig.1 Bone defect Models Made from Pig Scapula

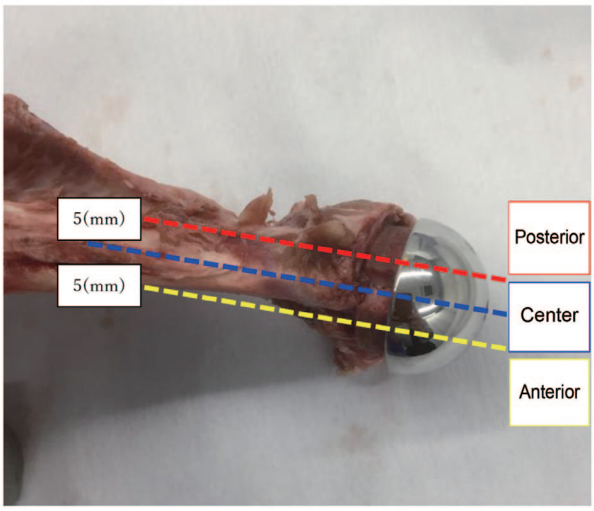
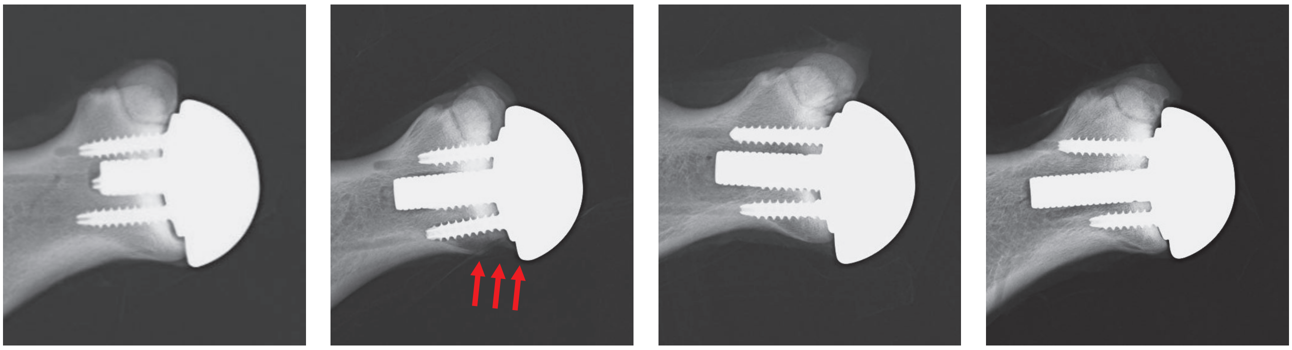


Fig.2 Slice Positions in Tomosynthesis Images

used to reduce metal artifacts. A total of three tomosynthesis slices were evaluated **(Fig. 2)**, with a slice at the 5 mm anterior side from the center peg, a slice at the center peg position, and a slice at the 5 mm posterior side from the center peg. The frontal image was used with XP. CT image slices were acquired at 1 mm pitches, so that all bone defects around the base plate would be shown, and the coronal image was used for evaluation. The evaluation of bone defects was performed by explaining each model to 12 orthopedic surgeons in advance and then having each surgeon look at images with the corresponding model name hidden and deciding whether or not the images matched the respective models. The detection sensitivity and specificity were calculated assuming the image-based evaluation is similar to an examination and the presence of bone defects in each model shows actual bone defects in patients.

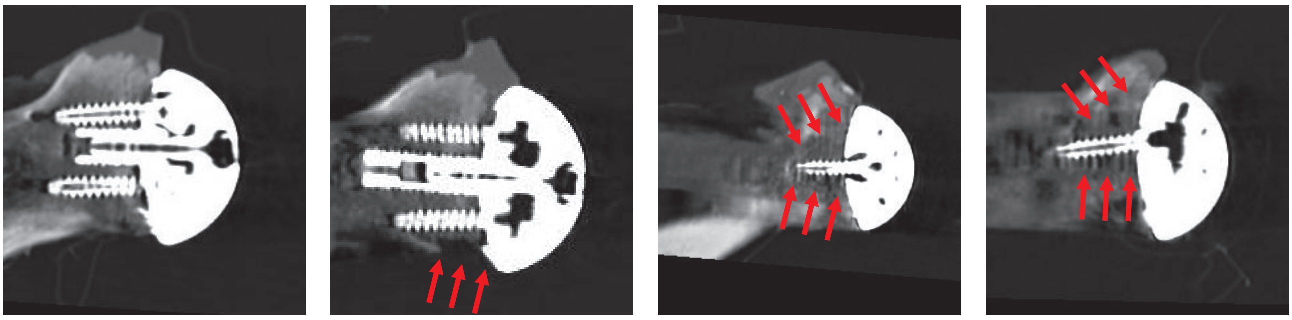
3. Results

With determination based on XP, both sensitivity and specificity were 100 % for the inferior bone defect model, but detection sensitivity was a low 25 % and 9 % for anterior and posterior bone defect models, respectively. That result suggests that XP can only be used to detect inferior bone defects **(Fig. 3)**. With determination based on CT, bone defect detection was low due to screw and base plate metal artifacts, with bone defect detection sensitivity 58 % for the control model, 25 % for anterior bone defect model, 33 % for posterior bone defect model, and 50 % for inferior bone defect model **(Fig. 4)**. In contrast, tomosynthesis clearly showed the outline of both anterior and posterior bone defects, indicated by red arrows in **Fig. 5**, with bone defect detection sensitivity a high 83 % for both anterior and posterior bone defects. Sensitivity and specificity for all models are indicated in **Table 1**.



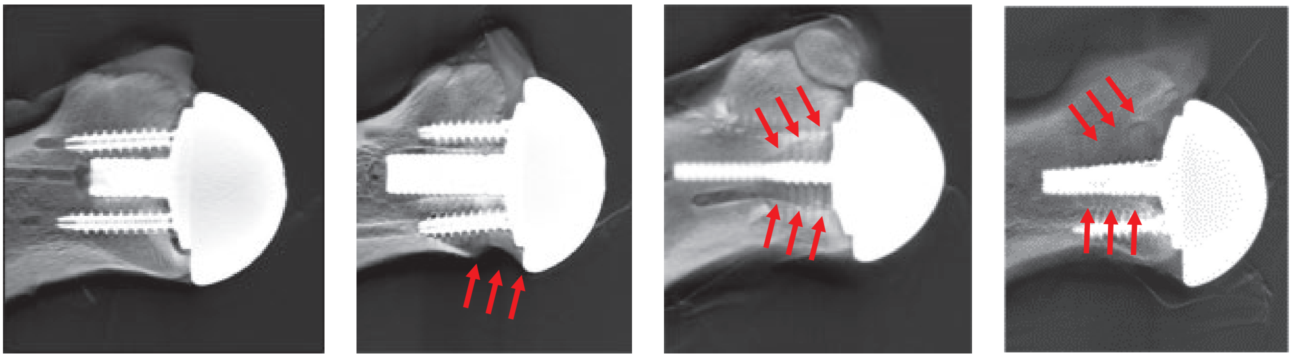
Control model | Inferior bone defect model | Anterior bone defect model | Posterior bone defect model

Fig.3 XP Images



Control model | Inferior bone defect model | Anterior bone defect model | Posterior bone defect model

Fig.4 CT Images



Control model | Inferior bone defect model | Anterior bone defect model | Posterior bone defect model

Fig.5 Tomosynthesis Images

Table 1 Sensitivity and Specificity for All Bone Defect Models

		Sensitivity	Specificity
XP	Control	42 %	89 %
	Anterior bone defect	25 %	100 %
	Posterior bone defect	9 %	94 %
	Inferior bone defect	100 %	100 %
CT	Control	58 %	83 %
	Anterior bone defect	25 %	83 %
	Posterior bone defect	33 %	81 %
	Inferior bone defect	50 %	83 %
Tomosynthesis	Control	75 %	92 %
	Anterior bone defect	83 %	94 %
	Posterior bone defect	83 %	94 %
	Inferior bone defect	100 %	100 %

4. Discussion

Scapular notch has been reported as a complication after RSA surgery. Given that scapular notch has been reported to affect long-term clinical results[1], early detection of scapular notch is important in clinical practice. The results confirm that XP is more than adequate for detecting inferior bone defect, which provides 100 % detection sensitivity. However, anterior and posterior bone defect models could not be distinguished from the control model in XP images, making it difficult to detect bone defects with XP. In CT images, it was difficult to evaluate bone defects because of significant metal artifact effects resulting from the proximity of the bone defects to the base plate and screws. In contrast, tomosynthesis can produce tomographic slices at any location, either anterior, center, or posterior from the peg with less metal artifacts, making it possible to detect anterior and posterior bone defects. Based on the results above, tomosynthesis was found to be very effective for evaluating anterior and posterior bone defects in scapula.

For total knee arthroplasty, tomosynthesis has been reported as an effective method of detecting initial bone defects around implants.[2)] The advantage of tomosynthesis is that it can provide any tomographic images without significantly higher medical care cost and X-ray dose than XP and with far less X-ray dose and less metal artifacts compared to CT.

5. Summary

This study showed that tomosynthesis is extremely useful as an examination method for detecting scapular notch after RSA surgery.

References:

1) Brent Mollon et al.,Impact of scapular notching on clinical outcomes after reverse total shoulder arthroplasty: an analysis of 476 shoulders. Journal of shoulder and elbow surgery.26,1253-1261.2017

2) Yukihide Minoda et al.,Detection of small periprosthetic defects after total knee arthroplasty. The journal of arthroplasty 29. 2280-2284,March.2014