

Case Report

Three-Dimensional Simulation for Breast Augmentation of Female Asymmetric Pectus Excavatum: A Case Report

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Aesthetic Surgery Journal
Open Forum

2019, 1–6

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DOI: 10.1093/asjof/ojz010

www.asjopenforum.com

OXFORD
UNIVERSITY PRESS

Abstract

Breast augmentation for women with asymmetric pectus excavatum (PE) has a characteristic problem in that surgeons need to select implants while considering the left-right difference in breast volume, contour, and position. We herein report a 33-year-old woman with severe asymmetric PE who presented with residual breast asymmetry after chest wall correction using the Nuss procedure. Her right breast appeared hypoplastic and the right anterior chest wall remained depressed. Augmentation of the right breast with a silicone implant was performed, selecting the inserted implant preoperatively with the assistance of three-dimensional (3D) simulation. The breast asymmetry and anterior chest wall depression were improved to a natural appearance. Three-dimensional simulation represents an advantageous way to preoperatively select optimal implants for breast augmentation in asymmetric PE women with breast asymmetry.

Level of Evidence: 5

Editorial Decision date: April 3, 2019; online publish-ahead-of-print April 9, 2019.



Breast augmentation with silicone breast implants is a useful treatment option for female patients with asymmetric pectus excavatum (PE) who have residual breast asymmetry after chest wall correction.¹ However, it is sometimes difficult to select optimal implants in consideration of the left-right difference in breast volume, contour, and position. Although the utility of three-dimensional (3D) simulation for breast augmentation in healthy women has been described,^{2,3} there are no reports on whether 3D simulation can also be employed for women with PE and breast asymmetry. We herein present the clinical outcome of a female patient with asymmetric PE who successfully received a breast implant with the assistance

of 3D simulation. This case report demonstrates the merits of 3D simulation for breast augmentation in women with asymmetric PE.

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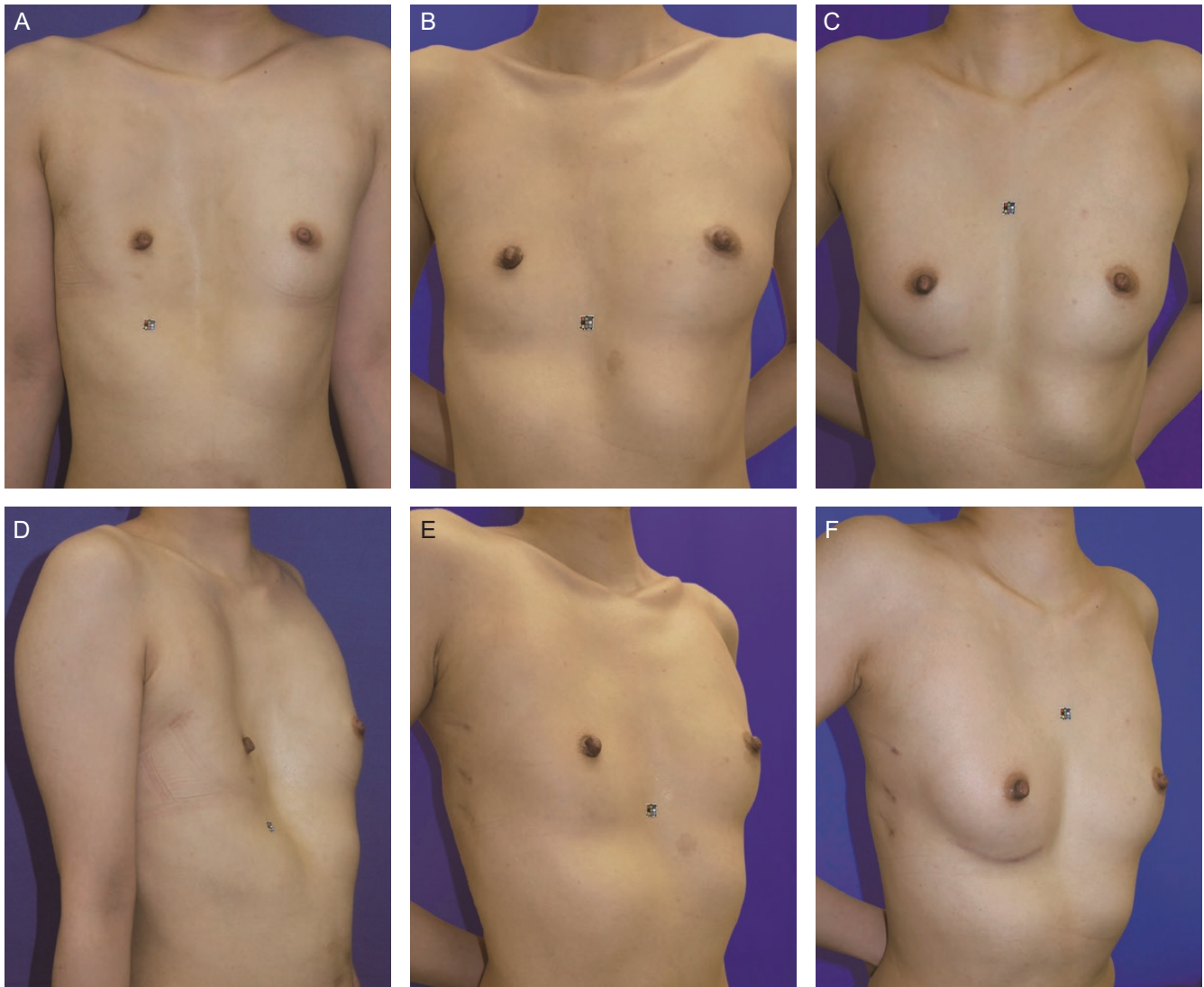


Figure 1. A 33-year-old woman with severe asymmetric pectus excavatum. (A-C) Frontal view and (D-F) right oblique view. The colored grid on the patient is a color and size matching sticker (CasMatch; Bear Medic Corporation, Tokyo, Japan) with which photo color tones and sizes can be accurately adjusted on Adobe Photoshop (Adobe Inc., San Jose, CA, USA). (A, D) Before chest wall correction with the Nuss procedure. (B, E) Four years after the Nuss procedure, the right breast appeared hypoplastic and the right anterior chest wall depression remained. (C, F) Nine months after right breast augmentation, the breast asymmetry and anterior chest wall depression had improved to a natural appearance.

CASE REPORT

A 33-year-old woman with asymmetric PE visited our Plastic and Reconstructive Surgery Department in May 2017 for the treatment of residual breast asymmetry after chest wall correction using the Nuss procedure⁴ 4 years before by one of the coauthors (M.N.), a pediatric plastic surgery specialist (Figure 1A,D). Sternal torsion before the Nuss procedure was 34.3° counterclockwise and classified as severe asymmetry according to Yoshida's classification⁵ (Figure 2A). Upon presentation, the patient's right breast appeared hypoplastic and the right anterior chest wall depression remained (Figure 1B,E). Chest computed tomography showed

that sternal torsion was 27.2° counterclockwise (Figure 2B). Moreover, the thickness of the right mammary gland at the level of the nipple was thinner than that of the left. Augmentation of the right breast only with a silicone breast implant was planned as the patient declined simultaneous breast augmentation of the contralateral side. Prior written informed consent was obtained from the patient regarding the publication of clinical data and findings.

3D Simulation and Breast Augmentation

To select the implant to be inserted, a 3D image of the patient's breasts was taken with the Vectra H1 (Canfield

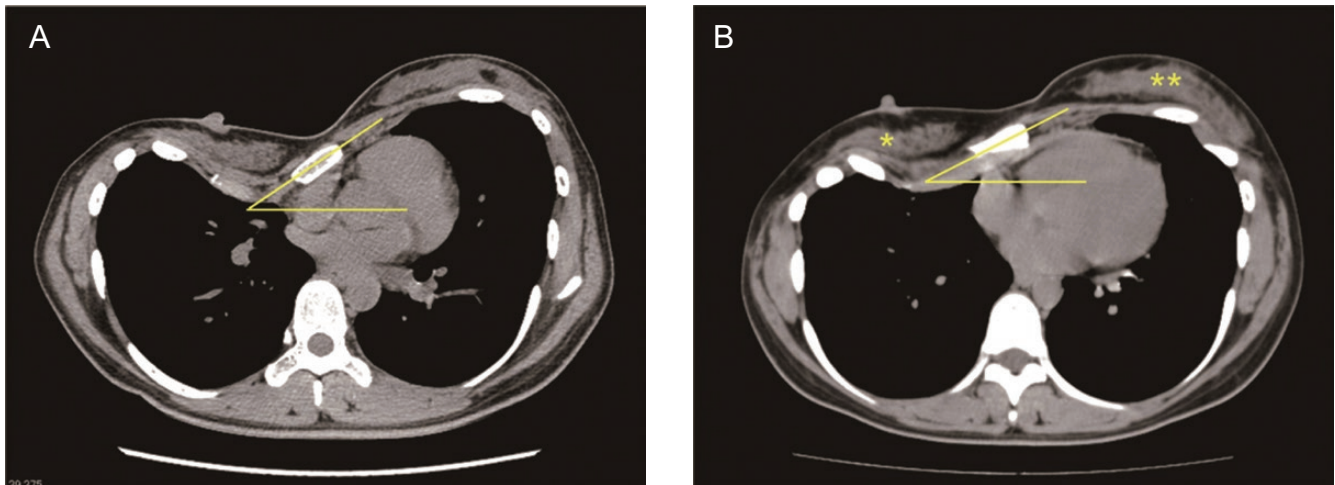


Figure 2. Chest computed tomography. (A) Before chest wall correction with the Nuss procedure, the sternal rotation angle (angle between the 2 yellow lines) was 34.3° counterclockwise. (B) After the Nuss procedure, sternal torsion was 27.2° counterclockwise. The thickness of the (*) right mammary gland was thinner than that of the (***) left.

Scientific, Inc., Parsippany, NJ, USA) handheld 3D imaging system. The implant outcome was simulated using the Vectra Breast Sculptor (Figure 3), a 3D simulation software bundled with the Vectra H1, for the selection of a 140-mL full-height, low-projection, anatomically shaped, cohesive silicone gel implant (JTF3-FL100-140; Allergan plc, Dublin, Ireland) (Figure 4). A large vertical height was necessary to fill the depression of the anterior chest wall. Since the right breast contour was slightly distorted in the region of chest wall depression in simulated images and the simulation results were not completely trustworthy (Figure 4B,E), the implant was selected based on the height of the nipple in the patient's eye view and not on breast contour. In the simulation, the implant was positioned on the symmetric line of the contralateral inframammary fold. In March 2018, the implant was inserted into the patient subpectorally through an inframammary fold incision and positioned at the same position as in the simulation under general anesthesia by the first author (Y.Y.), a breast reconstruction specialist.

Postoperative Course

No significant morbidities were detected in the perioperative period. At 9 months after surgery, the breast asymmetry and anterior chest wall depression had improved to a natural appearance, although the rib bows remained asymmetric and a visible scar remained (Figure 1C,F). The postoperative breast contour was more symmetrical than indicated in the simulated results (Figure 4C,F). Cosmetic evaluations were done by the patient and by 6 board-certified plastic surgeons uninvolved in the operation using the Likert scale,⁶ with ratings from 1 (result worse than before treatment) to 5 (excellent result). The patient verbally rated her result as

5 to the operating surgeon, while the mean score rated by board-certified plastic surgeons was 4.67 (range, 4-5).

DISCUSSION

We describe the case of a 33-year-old female patient with asymmetric PE after the Nuss procedure that successfully underwent augmentation of the right breast with the assistance of 3D simulation. Fonkalsrud was the one who first directed attention toward the characteristic symptoms and surgical management of female patients with PE when compared with those in males.⁷ The clinical manifestations of female asymmetric PE are generally counterclockwise torsion of the sternum and chest wall depression on the right side accompanied by right breast hypoplasia.^{1,5,7,8} Although aesthetic correction of asymmetric PE should focus on breast asymmetry in addition to chest wall deformity,^{1,9} reports focusing on the correction of breast asymmetry in female asymmetric PE patients are scarce.^{1,9-13}

We consider there are two reasons for remaining breast asymmetry after chest wall correction using the Nuss procedure, which has become the most widely used technique for PE treatment.¹¹ First, the Nuss procedure does not always correct the chest wall deformity of asymmetric PE completely, especially in severely asymmetric cases defined in Yoshida's classification⁵ as a sternal rotation angle of over 25° , as seen in our patient. Indeed, the procedure has difficulty resolving asymmetric PE when compared with its results with symmetric PE.^{14,15} Such residual breast asymmetry has been coined by Park as "pseudohypoplasia" of the breast on the depressed side.⁹ Second, although some authors reported that the volume of both breasts in women with PE was almost the same,^{7,16} others pointed out that breast volume was also

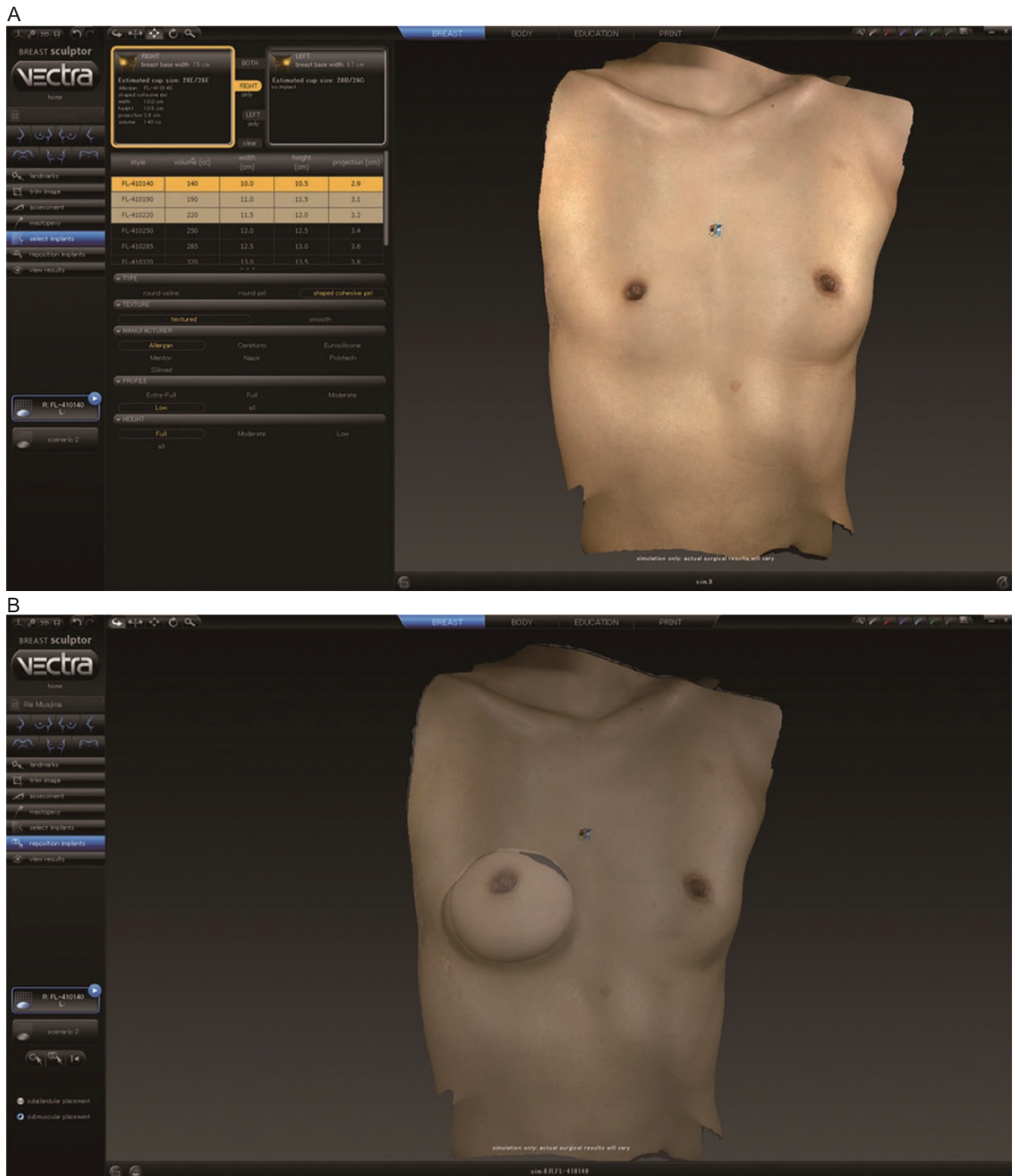


Figure 3. Screen capture of the Vectra Breast Sculptor 3D simulation software. (A) Selecting an implant from product catalogs. (B) Adjusting the position of the selected implant.

unbalanced in asymmetric PE cases.^{1,9,17} Many asymmetric PE patients exhibit chest wall depression on the right,⁵ with the right breast smaller than the left in most instances.^{1,9,17} In

such patients, breast asymmetry can remain even if the chest wall deformity is completely corrected. We propose that this type of residual breast asymmetry is termed “true hypoplasia”

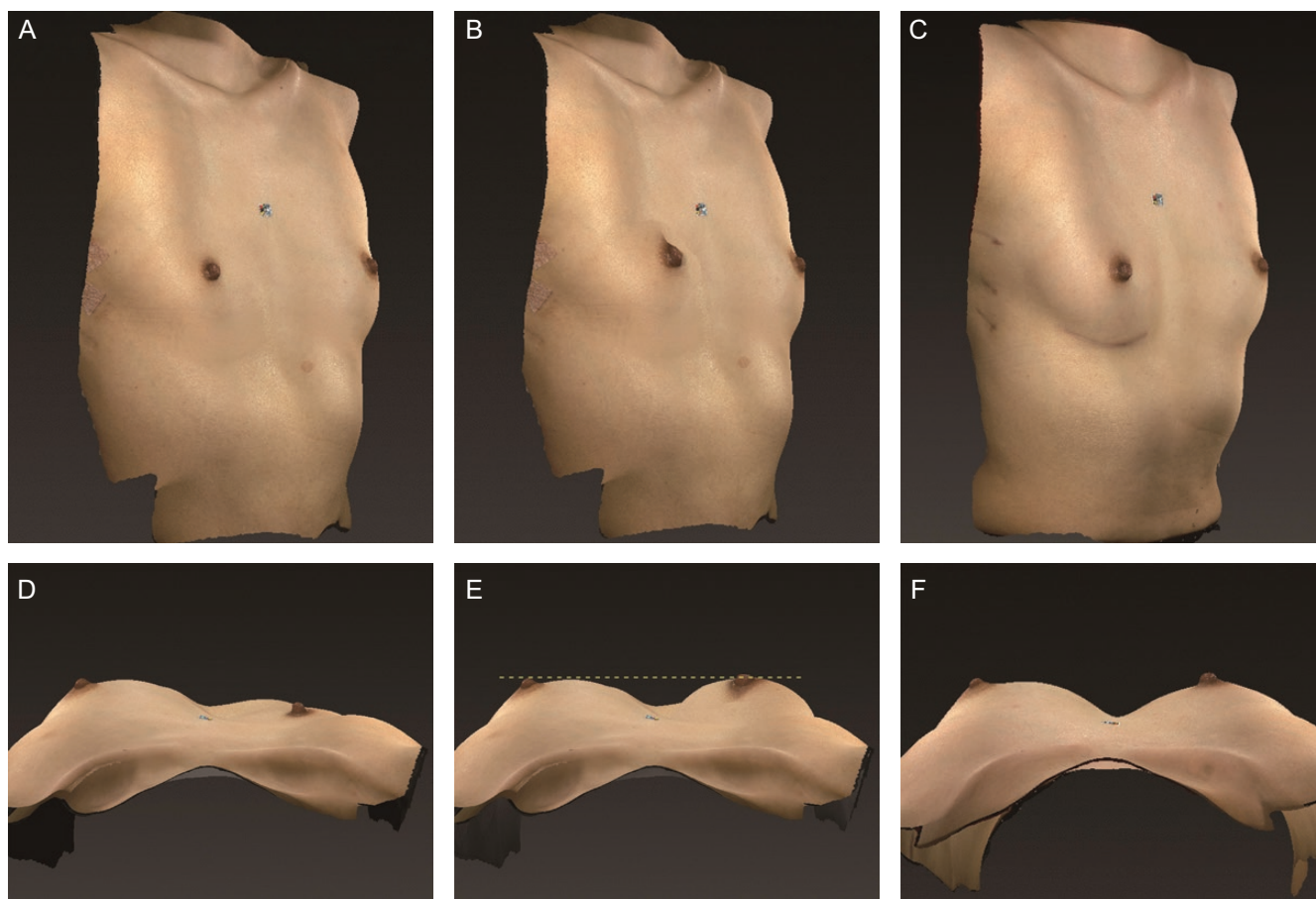


Figure 4. Three-dimensional images of a 33-year-old woman. (A-C) Right oblique view and (D-F) patient's eye view. (A, D) Actual images before breast augmentation. (B, E) Simulated images with a 140-mL anatomically shaped implant in the right breast. The implant was selected primarily based on the height of the nipple in the patient's eye view (dotted line). (C, F) Actual images after breast augmentation.

of the breast on the depressed side. Thus, some patients possibly have both pseudohypoplasia and true hypoplasia, as in the case of our own.

Whichever the cause of hypoplasia, residual breast asymmetry after chest wall correction may require breast augmentation on the hypoplastic side. Because the breasts of women with PE are generally smaller than those of healthy women,¹⁶ some patients opt for breast augmentation bilaterally. Breast augmentation for women with asymmetric PE poses a characteristic problem that is unique from that for healthy women in that the surgeon needs to select implants to match the left-right difference in breast volume, contour, and position. Some operators choose the implant for the smaller breast intraoperatively using sizers after augmentation of the larger breast.^{9,12} However, in the absence of numerous implant options in the operating room, the breast implant to be inserted must be selected and ordered during preoperative planning. Three-dimensional simulation appears well suited for such situations.

The 3D simulation system used in the current case provides easy-to-use simulations of breast augmentation as

well as of mastopexy, chin augmentation, rhinoplasty, and other procedures. In the simulation step, surgeons can select breast implants from all of the product catalogs they normally use for a simulated outcome calculated based on gravity and the shape and placement of the selected implant. This kind of simulator is particularly advantageous for breasts with left-right difference, such as in women with asymmetric PE who have pseudo and/or true breast hypoplasia on the depressed side.

Three-dimensional simulation of breast augmentation is helpful for procedures in healthy women, with 90.8% accuracy in predicting volume and 98.4% accuracy in predicting surface contour.² As for healthy women with breast asymmetry, 3D scanning of breasts plays an important role in implant selection for asymmetry correction.¹⁸ On the other hand, there have been no studies on the merits of 3D simulation for asymmetric PE women with breast asymmetry. This report is the first to demonstrate the advantage of 3D simulation on breast augmentation in such cases.

There are limits to 3D simulation for breast augmentation in asymmetric PE women. The simulation system

we adopted was originally designed for healthy women and could not clearly simulate the area of the depressed chest wall. The system needs to isolate each breast on the chest wall to simulate breast augmentation,³ but it appears slightly problematic to distinguish the breast from a depressed chest wall. We suspect this to be the reason for the obvious chest wall depression appearing in the simulated results of our patient (Figure 4B,E). To compensate for this drawback, we chose the implant based on the height of the nipple in the patient's eye view and not on the overall breast contour (Figure 4E). This does not necessarily mean that only the height of the nipple matters in breast augmentation for asymmetric PE. However, we consider that a full-height implant can fill the anterior chest wall depression, and when it is positioned on the symmetric line of the contralateral inframammary fold, nipple position remains as a main selection determinant. As a result of selecting the implant based on the nipple height in the patient's eye view, the actual postoperative breast contour became more symmetrical than that in the simulated results and was highly rated by the patient.

CONCLUSION

Three-dimensional simulation represents an advantageous way to preoperatively select optimal breast implants for breast augmentation in asymmetric PE women with breast asymmetry.

Disclosures

The authors declared no potential conflicts of interest with respect to the research, authorship, and publication of this article.

Funding

The authors received no financial support for the research, authorship, and publication of this article.

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