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Implant volume estimation in direct-to-implant breast reconstruction after nipple-sparing mastectomy

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Wei-Chung Shia, PhD,[a,1] Hui-Ju Yang, MD,[b,1] Hwa-Koon Wu, MD,[c] Shih-Lung Lin, MD,[d] Hung-Wen Lai, MD, PhD,[e,f,g] Yu-Len Huang, PhD,[h] and Dar-Ren Chen, MD[a,g,*]

[a] Cancer Research Center, Changhua Christian Hospital, Changhua, Taiwan
[b] Department of Dermatology, Changhua Christian Hospital, Changhua, Taiwan
[c] Department of Medical Imaging, Changhua Christian Hospital, Changhua, Taiwan
[d] Department of Reconstructive, Plastic & Hand Surgery, Changhua Christian Hospital, Changhua, Taiwan
[e] Endoscopic and Oncoplastic Breast Surgery Center, Changhua Christian Hospital, Changhua, Taiwan
[f] School of Medicine, National Yang Ming University, Taipei, Taiwan
[g] Comprehensive Breast Cancer Center, Changhua Christian Hospital, Changhua, Taiwan
[h] Department of Computer Science, Tunghai University, Taichung, Taiwan

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ABSTRACT

Background: Nipple-sparing mastectomy (NSM) is an increasingly popular alternative to more traditional mastectomy approaches. However, estimating the implant volume during direct-to-implant (DTI) reconstruction following NSM is difficult for surgeons with little-to-moderate experience. We aimed to provide a fast, easy to use, and accurate method to aid in the estimation of implant size for DTI reconstruction using the specimen weight and breast volume.
Methods: A retrospective analysis was performed using data from 145 NSM patients with specific implant types. Standard two-dimensional digital mammograms were obtained in 118 of the patients. Breast morphological factors (specimen weight, mammographic breast density and volume, and implant size and type) were recorded. Curve-fitting and linear regression models were used to develop formulas predicting the implant volume, and the prediction performance of the obtained formulas was evaluated using the prospective data set.
Results: Two formulas to estimate the implant size were obtained, one using the specimen weight and one using the breast volume. The coefficients of correlation (R^2) in these formulas were over 0.98 and the root mean squared errors were approximately 13.
Conclusions: These implant volume estimate formulas benefit surgeons by providing a preoperative implant volume assessment in DTI reconstruction using the breast volume and an intraoperative assessment using the specimen weight. The implant size estimation formulas obtained in the present study may be applied in a majority of patients.

* *Corresponding author.* Comprehensive Breast Cancer Center, Changhua Christian Hospital, No. 135, NanXiao Street, Changhua 500, Taiwan. Tel.: +886 4 7238595x4882; fax: +88647228289.
E-mail address: darren_chen@cch.org.tw (D.-R. Chen).
[1] These authors contributed equally to this work.

Background

Nipple-sparing mastectomy (NSM)[1] has gained increased recognition as an alternative to more traditional mastectomy approaches. The acceptance of NSM as a prophylactic procedure, in addition to its therapeutic uses, is increasing.[2] In addition, the cosmetic advantages of NSM are significant. Breast volume assessment is one of the most important steps during the preoperative setting in every breast surgery procedure. Appropriately estimating the implant size in NSM is highly dependent on the experience of the surgeons and directly impacts the appearance of the breast after reconstruction. In addition to a common procedure using a temporary sizer during surgery, several replacement solutions, such as using 3D surface imaging and premastectomy breast volume as assessed via mammography or magnetic resonance imaging, have been reported to aid in decision-making.[3,4] Predicting the breast volume may be useful as an indication for mammoplasty and for calculating the resection weight preoperatively.

Although breast cancer patients are finding NSM and immediate breast reconstruction surgery to be a highly acceptable option, choosing the appropriate implant volume in direct-to-implant (DTI) reconstruction following NSM is challenging for physicians. In the present study, we aimed to generate an accurate estimate of the implant size after NSM using breast morphological factors (specimen weight, mammographic breast density and volume, and implant size and type). The overall goal of the present study was to provide a fast and accurate method to aid physicians in the estimation of the implant size for NSM patients.

Methods

Study population

This retrospective study was approved by the Institutional Review Board of Changhua Christian Hospital, Taiwan (No. 160110) and was exempt from informed consent. A total of 414 breast cancer patients, aged 30-69 y, who underwent NSM were initially recruited. Patients with bilateral breast reduction or augmentation surgery and patients with incomplete records were excluded. Finally, a total of 182 patients enrolled between January 2009 and December 2015 were included.

Single-stage DTI and tissue expander/implant reconstructions are the most common implant-based reconstructions after NSM. In consideration of the obtained sample sizes for DTI and tissue expander/implant currently, the present study focused on patients who underwent DTI following NSM. Thus, formula development was performed using data from 145 patients with specific implant types. The patient selection process is shown in Figure 1. Age, weight, height, body mass index (BMI), and associated comorbidities (diabetes mellitus, hypertension, and dyslipidemia) were recorded as patient factors. Specimen weight, mammographic breast density and volume, and implant size and type were recorded as breast morphological factors.

Volumetric and density assessment of the breast

Standard two-dimensional digital mammograms were obtained in 118 of the 145 selected patients using a full-field digital mammography (FFDM) system, including a Senographe Essential/Senographe DS (GE Medical Systems), Mammomat Inspiration (SIEMENS), and Selenia Dimensions (HOLOGIC, Inc). These data covered 62.8% of the study patients and constitute a sufficiently representative data set. All mammograms were obtained from the Department of Medical Imaging at Changhua Christian Hospital in Taiwan.

Estimating the breast volume from the abnormal side may result in an incorrect implant size. Considering the esthetic value of symmetrical features in breast reconstruction with a consistent standard, the volumetric estimate of the breast was taken from the cranial caudal view of the contralateral side of the lesion (the normal side). For patients with more than one image record, only the record before or on the date of surgery was preserved. Volpara (Volpara version 1.4.2, Matakina Technology, NZ)[5,6] was used to assess the volume and density of the breast and fibroglandular volume on a per-image basis. By analyzing the X-ray dose absorption in the fibroglandular tissue on the raw FFDM data using a specific algorithm, the breast volume was calculated based on the tissue volume.

Reconstruction after nipple-sparing mastectomy

This study was conducted in the Comprehensive Breast Cancer Center of Changhua Christian Hospital, Changhua, Taiwan. NSM was followed by immediate implant breast reconstruction. An incision was made on the lateral portion of the upper outer quadrant, 1 cm away from the nipple-areolar complex. At the time of the surgery, a sentinel lymph node biopsy was also performed through this incision. Subcutaneous undermining was then performed along the entire surface of the breast, followed by retro glandular undermining, allowing a complete "subcutaneous mastectomy." Subnipple tissue was frozen to ensure a cancer-free status. Finally, the mammary gland was replaced by a breast implant under the pectoralis muscle, allowing immediate breast reconstruction. In this way, the breast envelope and the nipple-areolar complex were entirely preserved.

In all cases, the NSM incision line was located in the upper outer quadrant. The implant was placed under the pectoralis muscle, with or without the serratus muscle elevated inferiorly, depending on the surgeon's preference. Hence, the pectoralis may partially remain subcutaneously along the inferior breast. Currently, acellular dermal matrices are not allowed in Taiwan. The surgeons use a sizer for the implant choice and make decisions based on the visual aspect before the implant placement. The implant volume was recorded for all NSM patients.

Statistical analysis

Pearson correlation coefficients between implant size and morphological factors were first examined to determine the most suitable references for implant size choice. Subsequently, curve-fitting and linear regression models were used to develop formulas predicting the implant volume. Least