Reduction Mammaplasty: What Cup Size Will I Be?

Marion Chan, MBBS, FRACS(Plast)*
Sarah Lonie, MBBS, BMedSci, Dip Surg Anat*
Sean Mackay, MBBS, MD, FRACS†
Kirstie MacGill, MBBS, Dip Anat, FRACS(Plast)*

**Background:** Predicting cup size after reduction mammaplasty is a challenge well recognized by plastic surgeons. This study presents a method whereby the weight of tissue to be excised can be predicted on the basis of the initial and desired cup size.

**Methods:** Breast density was calculated from resection specimens. Cup volumes of a specific range of bra style were then measured by filling the bra cups with modeling clay on a mannequin and the volume measured via water displacement. These data were then correlated to breast tissue volume and weight.

**Results:** The average breast tissue density calculated was 0.98 g/ml (SD = 0.05). Bra cup volume measurements showed a steady progression according to both cup and band sizes. A table was constructed to predict the weight of tissue required for excision to achieve the desired change in cup size.

**Conclusion:** These results can assist plastic surgeons in predicting the amount of breast tissue to excise to achieve a given cup size. A secondary use of these results is a breast volume guide for implant planning.

**Disclosure:** The authors have no financial interest to declare in relation to the content of this article. All bras were provided at no charge from Triumph International (Australia) Pty Ltd, Southbank, VIC, Australia.

**Background**
A challenge for plastic surgeons performing reduction mammaplasty is to predict the volume of tissue to remove to achieve the patient’s desired outcome. Previous methods attempted to reliably estimate breast size and predict resection volumes for breast reduction procedures have included water displacement, casting, and more recently the development of 3-dimensional imaging systems. However, due to factors such as cost and feasibility, none of these methods have become established in the clinical setting.

Regnault and Daniel initially proposed a formula for estimating the resection weight of breast tissue during reduction mammaplasty to achieve a desired cup size. This technique and the data were subsequently validated and improved upon by Turner and Dujon. Descamps et al described another formula to determine resection weights by correlating the following 4 variables: notch to nipple, nipple to inframammary crease distance, body mass index, and age. Unfortunately, these methods relied heavily on metric measurements of the female breast and the traditional brassiere measuring system, the latter which was shown by Turner and Dujon to result in the underestimation of breast reduction weight. Moreover, Pecter noted that in his method of determining cup size, the measured band size on a woman would not match the actual circumference of a manufactured bra. An example described by the author is a woman with an underbust chest circumference of 30 inches, who would wear a bra with a band size of 36. However, measurement of size 36 bras from 3 different manufacturers indicated an average circumference of only 27 inches. It is the elastic property in the band that allows the bra to stretch to the 30 inches necessary to fit comfortably around the woman’s chest.

Developing a better technique to estimate resection volumes would benefit plastic surgery trainees and junior surgeons in performing such a procedure more accurately and also aid in satisfying patient curiosity during the initial consultation with respect to how much tissue might be excised. Moreover, in some parts of the world, estimated resection weights must be obtained by insurance companies before a reduction procedure in order for claims to be processed.

Traditionally, bra sizes as labeled by the manufacturers are determined by using the conventional brassiere sizing system, which takes into account band size and bust circumference. Band size is measured by the circumference of the chest immediately below the breasts, and bust circumference is measured around the fullest part of the breasts. The planned postoperative cup size is determined by patient preference, aesthetic considerations such as the balance among the patient’s height, hips, and bust, and...
surgical considerations such as pedicle size and skin flap thickness. It should be noted that most, if not all, breast reduction techniques affect a patient’s cup size only and do not affect band size.

The aims of the study were to develop a method to predict resection weights for reduction mammoplasty procedures to achieve desired cup sizes and create a useful format to use this information as a guide in chart format. To achieve this, we needed to establish first that breast weight can be attributed to volume and second volume measurements of cup sizes.

**METHODS**

This study was conducted at Box Hill Hospital, Eastern Health, Melbourne, VIC, Australia.

Ensuring Breast Weight Can Be Attributed to Breast Volume

Although the volume (in milliliters) of a reduction specimen is a major factor in determining the final outcome of a reduction procedure, it is much more common for surgeons to obtain measurements in weight (usually in grams). Thus, to present any predicted resection amounts in a similar way (ie, grams), it was necessary to correlate breast weight (grams) to breast volume (in milliliters). As a result, breast density measurements were taken as a pilot study (stage I—see below) before commencement of stage II—measuring bra cup volumes.

Stage I—Measuring Breast Density

Data were collected from breast tissue specimens excised from mastectomies, wide local excisions, and breast reduction surgeries over the course of a 6-month period. Each specimen was weighed intraoperatively with a set of digital scales and volume measured via water displacement with a 1900cc graduated Receptal suction canister (Hospira, Inc. Lake Forest, Ill., USA). Each excised breast tissue specimen was completely submerged in the canister containing water at room temperature upon a level surface. Compression of the specimen was avoided, and the increase in volume was read from the scale on the canister to an accuracy of 25 ml. Small volume tissue specimens were excluded from the study to maintain accuracy. The density of each breast specimen was then calculated by dividing mass (grams) by volume (milliliters).

Canister Calibration

The Receptal suction canister is manufactured for use with a plastic liner on the interior surface, and this liner was not used for measurements in this study. Before commencing measurements in stages I and II, the Receptal suction canister was calibrated without the liner by filling the canister with a volume of water as specified by the scale as marked on the canister and then cross-checking the accuracy of the markings by weighing the volume of water with a set of digital scales. A linear relationship was found from this calibration exercise, and a graph was plotted to show this. A line of best fit was drawn through the plotted values on the graph, and a linear equation was obtained for this line of best fit ($R^2 = 0.99945$) by using Microsoft Office Excel 2007 ($y = 1.0663x$, where $y =$ weight of fluid in canister (grams) and $x =$ volume of fluid in canister (milliliters)). All measurements recorded from the study were subsequently adjusted by using this equation.

Stage II—Measuring Bra Cup Volumes

We standardized our bra cup measurements by limiting measurements to bras provided to us by one style from one single company only. Twenty-two bras (Symphony W style number 10075626) were provided by Triumph International Australia. This style of bra was chosen for a number of reasons. First, it is an enclosed style that leaves less scope for variation in accurately filling the cups (when compared with a lower-cut style, which may allow a variable amount of breast tissue to bulge over the top of each cup); second, availability of a comprehensive range of band and cup sizes (whereas some styles are specifically made for smaller or larger breasted women and do not cover a large size range); and third, the availability of this brand in Europe, Asia, Africa, America, and Australasia to aid with generalizability of this study.

With the assistance of a professional bra fitter from Triumph©, each bra was fitted onto a mannequin with an adjustable chest circumference and each right-sided cup filled with modeling clay (Fig. 1). Parameters for filling the bra were of similar principles to those professional bra fitters
would regularly use as a guide: (1) the underbust wire sup-
port of the bra (inclusive of the anterior midpoint of the 
bra) must remain in contact with the chest wall of the man-
nequin at all times; (2) the filling of clay should not extend 
posteriorly beyond the anterior axillary line of the manne-
quinn or beyond the line of stitching across the top of the bra; 
and (3) the line of stitching across the top of the bra should 
lie reasonably close to the chest wall of the mannequin 
along its entire length. The resultant mass of modeling clay 
ﬁtted to each bra cup size was then weighed, and the volume 
measured by water displacement, using the same technique 
as described earlier for the breast specimens.

Establishing Bra Cup (Volume) Measurements

The volume of reduction required to achieve a desired 
cup size was considered as equivalent to the difference be-
tween the preoperative and postoperative cup sizes. This 
was plotted in the table form of volume differences in cup 
size for a given chest circumference to determine resec-
tion volume.

Data Analysis

Data were analyzed using SPSS Statistics 17.0 (©IBM 
Corporation 2010, Somers, N.Y., USA). Data on various 
band/cup volumes were tabulated manually.

RESULTS

Breast Density

Fifteen breast specimens were obtained in stage I and 
consisted of 9 unilateral mastectomies (4 of these patients 
also underwent axillary clearances), 2 wide local excisions, 
and 8 specimens from 4 cases of bilateral reduction mam-
maplasty. To prevent double measuring, tissue specimens 
from only the right breasts were considered from reduc-
tion mammoplasties. The resultant weight of breast tissue 
excised for each case was divided by its respective volume 
placement measured to calculate density (grams per mil-
liters) (Fig. 2). The average breast tissue density calculated 
was 0.98 g/ml (SD 0.05). The minimum density calculated 
was 0.92 g/ml, with a maximum value of 1.09 g/ml.

Bra Cup Volumes

Bra cup volume measurements were plotted (Fig. 3) 
and show a steady progression according to both cup and 
band sizes.

An interesting observation from this exercise was that 
the volumes of larger cup sizes (such as E and F) increased 
in a rapid manner with small increases in band sizes be-
yond 14 and 16. When an extra cup size (EE) was added 
onto the graph, however (Fig. 4), we found that the vol-
ume curve increased much more steadily. Although an EE 
cup size was not available in this style, some manufacturers 
do provide this extra cup size.

Control

Techniques were also used to control bra ﬁtting and 
clay ﬁlling errors and inconsistencies. After ﬁtting all 22 
bras to the mannequin with modeling clay, the professional 
bra fitter was then asked to refit and reﬁll 5 of the 22 bras 
chosen to encompass the range of volumes encountered. 
The volumes recorded for these 5 bras and the amount 
in which they differ from their initial measurements are 
shown in Table 1. As expected, a greater percentage of er-
ror was noted for the smaller volumes.

Correlation of Stages I and II Data

As stated earlier, breast tissue weight is more easily 
measured in the operating theater in comparison with 
breast tissue volume. From the data obtained in stage I, it 
was shown that breast density is of a value 0.98 g/ml, with 
an SD of 5%. Hence, the bra cup volumes measured from 
stage II of the study can reasonably be correlated to weight 
of breast tissue. Figure 5 was then constructed from these 
data to predict the weight of tissue required for excision to 
achieve the desired change in cup size.
DISCUSSION

We successfully determined cup size and correlation with volumes and tabulated resection volumes in reduction mammoplasty to obtain the correct change in cup size. The volume of the patient’s breasts can be estimated according to the data in Figures 3 and 5. During the preoperative assessment, the suggested or desired cup size could also be fitted to a mannequin to illustrate the expected result postsurgery. The surgeon may then consult the data in Figure 5 as a guide to predict the amount of breast tissue to excise. A secondary use of these results is estimating cup size changes for implant procedures (Fig. 5) or breast volume for a given band and cup size (Fig. 3) to plan for mastectomy and implant-based reconstruction.

Our finding that for a given cup size, volume increases with band size supports the paradigm in which band size is regarded as a variable measurement, which ultimately determines cup size.9 In general, similar cup volumes may be obtained by decreasing the band size as the cup size increases and vice-versa by increasing the band size as the cup size.10 This technique is often used by commercial bra fitters. For example, a woman who would normally wear a size of 14B bra can also be fitted with a size of 12C bra as both bras are of similar volume (provided that the smaller band is not too tight). Obviously, these results are only a

---

**TABLE 1. Volumes of the 5 Bras That Were Refitted and Refilled**

| Bra Size | Volume Remeasured (ml) | Initial Volume Measured (ml) | Error (ml) | Error (%) |
|----------|------------------------|-----------------------------|------------|-----------|
| 14F      | 1,092.65               | 1,129.96                    | −37.31     | 3.30      |
| 20D      | 906.1                  | 932.75                      | −26.65     | 2.86      |
| 14DD     | 746.2                  | 703.56                      | 42.64      | 6.06      |
| 16B      | 453.05                 | 479.7                       | −26.65     | 5.56      |
| 12B      | 373.1                  | 346.45                      | 26.65      | 7.69      |

Column “Error (%)” represents the error as a percentage of the initial volume measurement.
guide and the treating surgeon will also consider aesthetic factors such as the patient's height, overall build, and the proportions of the bust and hips.

A limitation in this study and calculating reduction volumes may be that patients individually cannot be relied upon to wear correctly fitted bras and the same size bra made by different commercial companies may not necessarily be of the same volume. The topic of wearing “wrong sized bras” has attracted much attention, both in the popular media and in the medical literature, especially in relation to aesthetic breast surgery. Women may wear a bra sized incorrectly according to the judgment of a professional bra fitters: supporting wires that compress or cut into the breast; or where the anterior midpoint of the bra is not lying flat against the chest; or where the back horizontal strap is running too high or too low on the back to provide adequate support. It may however be sized differently compared to traditional recommendations for comfort or aesthetic reasons.

Breast morphology also varies in terms of chest wall positions and base diameters. Larger breasts tend to become more ptotic and bulbous, making accurate bust measurements increasingly difficult (Fig. 6). This suggests that the traditional technique in determining bra size can be very inaccurate, and the inherent error is compounded by many different styles of bras manufactured and the lack of standardization between brands. This is why to control for these variables, our study elicited the help of (1) a professional bra fitter, along with (2) bras from a single style and company only. If preoperative and expected postoperative bra sizes are elements to be considered as part of a breast reduction consultation, the accuracy of bra fit should be examined and regardless of the technique, measurements obtained should only act as a guide to determining bra size.

Another potential limitation of this study is the relative subjectivity involved in filling the cups with modeling clay, which may be less compressible than breast tissue. The research group was greatly assisted by the availability of an experienced professional bra fitter. This expertise would not commonly be available in the clinical setting. Hence, it would be beneficial for the surgeon to have sound knowledge about bra fitting techniques or for patients to visit a professional bra fitter before their initial consultation. The authors’ experience in this project suggests that it would not be difficult for surgeons working in this area to either develop the necessary expertise or refer patients to selected commercial bra fitters.

It should be emphasized that this study is only a guide to obtaining desired cup size, and patients must be aware preoperatively that a particular cup size cannot be guaranteed or promised.

Future directions and studies to further guide resection volumes for cup sizes to supplement these data would be to analyze prospective data on how the patient’s actual bra cup sizes change with predicted compared with actual data. Additionally, a further arm would be to compare to 3-dimensional imaging volume assessments to our weight assessments for reduction mammaplasty. Three-dimensional imaging has been shown to be most reproducible for actual breast volume assessments and prediction in breast augmentation surgery.

**CONCLUSION**

A table was derived from this study showing the weight of breast tissue to excise in reduction mammaplasty to achieve the desired cup size. This can be used as a reference guide for resection volume in breast reduction procedures or as a secondary use, volume estimates for...
implant sizing. This guide should be used in conjunction with adequate consultation and thorough understanding between the surgeon and patient in regard to the definition of the preoperative breast size and the expectation of the postoperative breast size.

Sarah Lonie
Maroondah Hospital, Eastern Health
15 Davey Drive, Ringwood East, VIC 3135, Australia
E-mail: sjlonie88@gmail.com

ACKNOWLEDGMENTS
The authors would like to thank Eastern Health Surgical Research Group, Department of Surgery, Monash University, Eastern Health, Melbourne, VIC, Australia; Michael Lo and Adel Morsi, Plastic Surgery Unit, Eastern Health, Melbourne, VIC, Australia; Richard Masters, General Surgery (Breast) Unit, Box Hill Hospital, Eastern Health, Melbourne, VIC, Australia; Sue MacDonald, Triumph International (Australia) Pty Ltd, Southbank, VIC, Australia. This study was approved by the Eastern Health Research and Ethics Committee.

REFERENCES
1. Turner AJ, Dujon DG. Predicting cup size after reduction mammoplasty. Br J Plast Surg. 2005;58:290–298.
2. Baldwin CJ, Kelly EJ, Batchelor AG. The variation in breast density and its relationship to delayed wound healing: a prospective study of 40 reduction mammoplasties. J Plast Reconstr Aesthet Surg. 2010;63:663–665.
3. Choi M, Unger J, Small K, et al. Defining the kinetics of breast pseudoptosis after reduction mammoplasty. Ann Plast Surg. 2009;62:518–522.
4. Tepper O. 3D imaging for planning and analysis in aesthetic breast surgery. Plast Reconstr Surg. 2009;124:108–109.
5. Tepper OM, Unger JG, Small KH, et al. Mammmometrics: the standardization of aesthetic and reconstructive breast surgery. Plast Reconstr Surg. 2010;125:393–400.
6. Regnault P, Daniel R-K. Breast reduction. In: Regnault P, Daniel K, eds. Aesthetic Plastic Surgery. Principles and Techniques. Boston, Mass.: Little Brown; 1984.
7. Descamps MJ, Landau AG, Lazarus D, et al. A formula determining resection weights for reduction mammoplasty. Plast Reconstr Surg. 2008;121:397–400.
8. Pecter E. A new method for determining bra size and predicting post-augmentation breast size. Plast Reconstr Surg. 1998;102:1259–1265.
9. Kanhai R, Hage J, Joris M-D. Bra cup size depends on band size. Plast Reconstr Surg. 1999;104:300.
10. Macdonald S, Queensland, Australia: Sales Department, Triumph International (Australia) Pty Ltd.; 2010.
11. Greenbaum AR, Heslop T, Morris J, et al. An investigation of the suitability of bra fit in women referred for reduction mammoplasty. Br J Plast Surg. 2005;58:290–298.
12. Pecter E. Embrace the bra. Plast Reconstr Surg. 2008;122:1595–1597.
13. King NM, Lovric V, Parr WCH, et al. What is the standard volume to increase a cup size for breast augmentation surgery? A novel three-dimensional computed tomographic approach. Plast Reconstr Surg. 2017;139:1084–1089.
14. Crittenden T, Veitch D, Henneberg M, et al. Measuring breast volume in hypertrophy: laser scanning or water displacement? Aust J Plast Surg. 2018;1:33–40.

Fig. 6. Three different ways of measuring overbust (ie, bust circumference) measurements, resulting in 3 entirely different measurements.