The Standardization of Bra Cup Measurements
Redefining Bra Sizing Language

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KEYWORDS

• Breast augmentation • Bra cup sizing • Breast hemicircumference • Highly cohesive gel implant • 3-D imaging • Sister sizes • Breast measurements • Tissue-based planning • Biodimensional planning

KEY POINTS

- Patients and plastic surgeons communicate with "bra-cup sizing language."
- There is no standard bra cup or sizing system, so no one is speaking the same language.
- Studying ~6000 patients, bra cup sizing may be standardized with one hemicircumference measurement only.
- We can all speak the same language and have a comparison among bra manufacturers.
- This bra cup sizing system will help set patient expectations preoperatively and postoperatively.

OVERVIEW

During the process of breast augmentation after discussing the safety of implants and cost, the discussion comes down to outcome and expectations. Every patient and her plastic surgeon may know there is no uniform bra cup sizing standard but we continue to speak using "bra cup" language. The standardization of bra cup sizing, although seemingly a simple and straightforward goal, has been elusive since the bra was designed and brought into a more modern style and design in the late 1800s.[1] There are many challenges in developing a standardized bra cup system. The first and most significant is that bra cup sizes are a continuum. Bra cups are categorized as if there is a specific or ideal bra cup size, when in reality women's breasts occur as a fluid range of shapes, sizes, and volumes. A huge conundrum, however, is created because patients and plastic surgeons use and emphasize "bra cup size" language without any specific reference point.

In addition, within the process of breast augmentation, patient education, tissue-based planning, and implant selection are the most critical aspects of the process and outcome.[2] In any initial breast consultation the most frequently asked questions include: "Okay, so what size will I be after surgery?" or "What size will this implant make me?" Occasionally even more uneducated misconceptions arise: "My friend had 350's and I want her cup size and to look like her." Most patients have specific expectations regarding bra cup size, and failure to achieve real or unrealistic expectations remains the leading cause of patient dissatisfaction. In addition, implant size change remains one of the primary causes for breast revision in most studies, often exceeding actual surgical complications. Optimizing soft tissue coverage, while still achieving a patient's postoperative goal, is perhaps the most significant factor in breast implant surgery if one is to produce stable

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long-term results.[3] Hence the challenge: implant selection, which determines the eventual bra cup size, is critical in patient education and the management of patient expectations[4]; however, this is never truly achievable until all are speaking the same bra cup language. Patient and surgeon perceptions may never be exact, although there should be some overlap of a patient's goals and what range is best to maintain soft tissue support. This in no way, however, should minimize the importance or even dissuade from establishing some guidelines and standards that are useful in bridging this gap.

METHODS

The prospective data from more than 5993 patients enrolled and measured in the Allergan Medical silicone breast implant study (Allergan Style 410 Silicone Cohesive Breast Implant Study) undergoing primary breast augmentation were analyzed and also compared with a single-surgeon primary augmentation cohort of 450 patients. Data collected in this study included the breast hemicircumference (HC). This HC is measured as the medial breast inflection point, the most medial point of the breast, across the nipple areola level to the lateral breast inflection point. This HC is measured over the maximum apex of the breast. Data at 6 months and 1 year were recorded, with the reported measurements at 1 year used for this study. There were approximately 50 investigator surgeons in the overall study contributing these measurements. Measurements would be expected to vary a few millimeters from surgeon to surgeon, but should be consistent with their own measurements. In total, breast HC was recorded in 5993 patients and 11,986 breasts having primary breast augmentation. The breast HC data obtained preoperatively were then compared with the postoperative data collected at the 1-year follow-up visit. These data were collected from the national cohort and from the largest primary augmentation, single-surgeon cohort in the United States. Reported bra cup size from patients enrolled in the study was also detailed by size and bra manufacturer, preoperatively and postoperatively at 1 year. In addition, data were collected with regard to specific patient implant volume used in augmentation.

For the purpose of this study, most measurements were performed manually. However, more recently with the advent of three-dimensional (3-D) imaging systems, some measurements were performed and recorded by computer analysis with registered landmarks. Furthermore, we have confirmed and validated our 3-D data comparing the manual HC measurements with the Vectra 3-D computer-generated data (Canfield Scientific, Fairfield, NJ, USA). Manual HC measurements correlate to 0 to 1 mm from Vectra 3-D imaging HC measurements. Data among specific bra manufacturers were then compared to determine if there were any significant differences in bra cup sizing among manufacturers.

RESULTS

The patient's reported bra cup size and manufacturer were compared with the breast HC measured at 1 year in a large prospective study of primary breast augmentation patients. In addition, the data from the largest single-surgeon primary augmentation cohort in the United States were also evaluated separately in 450 patients to determine if there was any variability from a single surgeon verses multi-surgeon measurement methods. The data from both groups are shown (**Table 1**). For the national cohort, an average HC of 20.0 cm correlated to a reported bra cup size of a "B cup," 21.5 cm HC on average was a "C cup," 23.4 cm HC correlated to a "D cup," and 25.0 cm correlated to a "DD cup." In the single-surgeon cohort the data were similar with patients reporting "B cup" having a 19.3 cm HC, "C cup" 21.3 cm, "D cup" 23.5, and "DD cup" 25.3. The greatest degree of variability between the overall and single-surgeon cohorts was in the "B Cup" group, which varied by 7 mm. There was a 0- to 3-mm variance for the other cup sizes. There were a very limited number of "A Cup" patients within the large cohort, the average being 17.8 and the single-surgeon cohort 16.5 cm. The average postoperative bra cup measurements

Table 1
Postoperative hemicircumference measured across the maximum projection of the breast from the medial inflection point to the lateral inflection point where the breast creates a crease in the skin when the breast is displaced or pushed medially or laterally

	Post Hemicircumference	
Post Cup Size	Overall Data (cm)	Bengtson Cohort (cm)
B	20.0	19.3
C	21.5	21.3
D	23.4	23.5
DD	25.0	25.3

Overall data are collected, in addition to separate data from one surgeon site of the largest single-surgeon cohort.

between the single cohort and group cohort rounded to the nearest 0.5 cm are "B cup" 19.5 cm, "C cup" 21.5 cm, "D cup" 23.5 cm, and "DD cup" 25.0 cm (**Fig. 1**).

Within the main cohort, data from individual bra manufacturers were analyzed. The leading bra manufacturers reported by the patients in this study included Bali, Warners, Calvin Klein, Maidenform, and Victoria's Secret (**Table 2**). Victoria's Secret comprised the most, with 5328 of 6231 or 86% of the total of bras worn, thus the average HC is skewed toward the Victoria's Secret brand. However, some important information may be gleaned. Of the 187 patients wearing Bali, it took more volume and a greater HC to fill a reported cup on average: 4 mm more for size B, 3 mm size C, and 15 mm for size D. Calvin Klein, however, demonstrated a significantly smaller HC for each cup size. Of the 241 patients, the average cup size was 15 mm smaller for size A, 9 mm smaller for size B, 15 mm smaller for size C, and 18 mm smaller for D. The 424 patients who wore a Maidenform bra revealed a difference of 7 mm larger for size B but all other sizes essentially the same average. Warner bras required more breast to fill their bra cup: 6 mm for a "B," 5 mm for a "C," and 6 mm for "D" cup patients. Again, because Victoria's Secret was the dominant bra reported in close to 6000 patients, their sizes are essentially the same as the average recorded 1 to 2 mm different than the mean. Many patients rely on the information given to them at a retail store, so we further corroborated our findings by enlisting the services of an expert sizer from Victoria's Secret to confirm our measurements of a primary augmentation patient at a "C Cup," which we measured with a 21.5-cm HC in the middle of our C range. It is also very important to note that these measurement data and bra cup manufacturer data were collected during the years 2001 to 2008. Measurement systems, particularly Victoria's Secret, have changed as they have moved to more of a lingerie line, and in 2015 the system used for measurement will undersize patients one to two bra cup sizes, whereas other manufacturers have remained relatively in line with their measurements. Finally, the average volume in milliliters to bring a patient up one cup size from a B to a C or C to a D using our measurement techniques with shaped highly cohesive gel implants, and based on our data, was 205 mL.

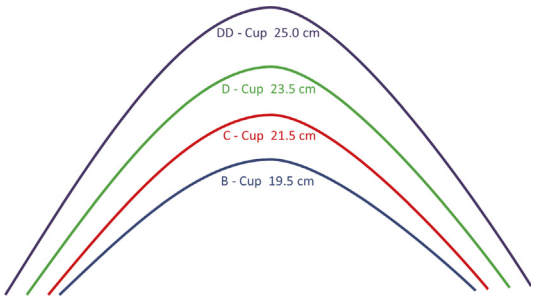

Fig. 1. Standardization of the bra cup can be based on one measurement, the breast hemicircumference. It is based on measuring the medial to lateral breast inflection points, which represent the take-offs points where the breast attaches to the chest wall. The average bra cup size measurement between the largest single-surgeon cohort and total group cohort is shown here.

DISCUSSION

Life is all about expectations. Patient and plastic surgeon understand there is no standard bra cup size; however, preoperative and postoperative bra cup size remains the primary terminology and language used to determine expected breast size postoperatively. Most breast patients have specific expectations with regards to bra cup size, and achieving real or unrealistic expectations with regard to cup size postoperatively is a leading cause of patient dissatisfaction and occasionally litigation. In addition breast implant size change remains a primary driver for breast revision.[5] Every plastic surgeon has heard: "I would just like to be a full "C," or "My plastic surgeon said I was going to be a "C" cup, and I'm only a "B." Bra sizes clearly vary among manufacturers and additional factors, such as demi and full cup coverage, specific fabrics, padding, and elastics, can all affect the fit of a bra. In addition, most bra cups are measured with a bra on, which can also affect the measurements.

There are multiple ways to try and skirt this cup size challenge, but all fall short and are mainly unhelpful. Surgeons have tried placing implants in bras, but breasts appear smaller when the implant is placed inside the body, so placing implants inside a bra or on the chest under a tight spandex shirt does not give a truly accurate visual of the postoperative result. The patient's individual breast tissue and shape also contribute significantly to their individual outcome. Patient education often relies on the use of before and after images, but searching for prior augmentation patients with a similar breast shape and preoperative volume is time consuming, often frustrating, and again does not answer the question of an actual postoperative bra cup size range. A patient's preoperative shape, soft tissue coverage, skin envelope, and existing volume remain a determinant of the outcome. The advent of 3-D imaging and

Table 2
Breast hemicircumference measurements from the medial and lateral breast inflection points across the maximum projection of the breast for the most commonly reported bra manufacturers in our study

	Post Hemicircumference				
Post Cup Size	Victoria's Secret (cm)	Calvin Klein (cm)	Maidenform (cm)	Bali (cm)	Warners (cm)
B	20.0	19.1	20.7	20.4	20.6
C	21.5	20.0	21.4	21.8	22.1
D	23.4	21.7	23.4	24.5	24.0
DD	25.0	23.0	25.0	26.0	25.5

As an example, Calvin Klein bras require less breast tissue to fill a designated bra cup size.

simulation continues to transform practices in many ways. In 2008, 3-D imaging was initiated and used for the HC measurements as a new method to confirm manual measurements recorded by the plastic surgeon (**Fig. 2**). Simulations can vastly improve the patient's preoperative educational experience, allowing patients to visualize and understand their breasts in ways previously unmatched.[6] Validated measurements are easily integrated visually into the new bra cup measurement system (**Fig. 1**). In addition, we continue to use our bra cup sizing system, which has been confirmed in more than 2000 additional breast patients measured. It is a significant benefit for the surgeon and particularly the patient to visualize their range of outcomes before surgery. An even greater benefit will be to claim the bra cup size range for what the patient is viewing.

Because this system is based on the HC alone, bra bandwidth must also be measured to obtain a properly fitted bra. Many women seek out the expertise of bra shop fitters, who in turn each have their own techniques for sizing and fitting their customers for their specific brands. For many patients, confusion exists when patients either underestimate or overestimate their thoracic circumference or band size. Also, few understand the concept of sister sizes, for example a patient wearing a 34C may also fit into a 36B bra. In the United States, the US Standard Clothing Size sets modest guidelines, but no formal standard inch-based brassiere sizing system currently exists.[7] Complicating the sizing process even further, a woman's breast size may vary on a monthly basis because of her menstrual cycle and weight gain and loss. Thus, establishment of an accurate band size is important, as is recognition that cup sizes are a range and ever changing.

From the purely medical standpoint, there are few published reports that describe a method for

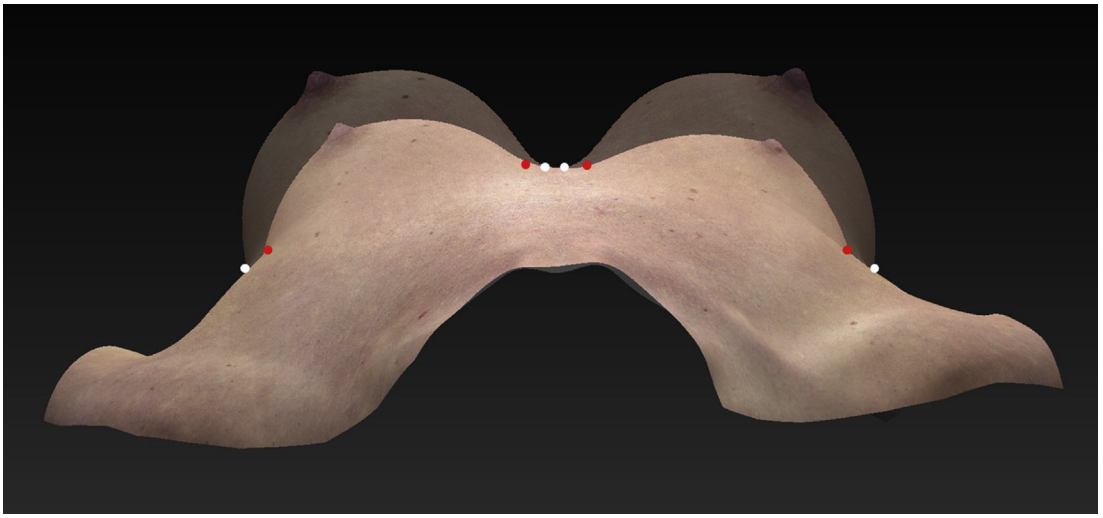

Fig. 2. The breast hemicircumference is shown here measured from the medial and lateral breast inflection points where the breast attaches to the chest. Shown here is a Canfield Vectra simulation of a breast augmentation identifying the measurement markings.

accurately predicting postoperative bra cup size after primary breast augmentation. The first published effort to develop standardized breast measurements in aesthetic breast surgery is credited to Maliniac in 1937.[8] He has also been credited for describing the vast differences that exist in women's breast size and shape. Smith and colleagues[9] published a connection between bra cup size and anthropomorphic measurements of the breast in 1986. They provided average values of 55 consecutive female volunteers without aesthetic evaluation. In 1998, Pechter[10] published an excellent review citing the origins of the modern bralike devices and was the first to develop a system that used the circumference of the breast as a predictor of bra cup size. In the direct breast measurement system Pechter proposed, he derived the following scale: A = 7 inches, B = 8 inches, C = 9 inches, D = 10 inches, with each 1-inch increment determining bra cup size up or down. His direct measurement system measured the HC of "small breasted" women while standing, and "full breasted" women while lying down. He determined that his new method corresponded to the stated cup size in 84% of the women evaluated. In a retrospective telephone survey Young and colleagues[11] followed 112 women who underwent a breast augmentation between 1980 and 1992. Based on the patient's recollection of preoperative and postoperative bra size, they concluded that the average breast augmentation caused a two-cup bra cup size increase. The authors also reported complication rates of 21%, including high capsular contracture rates, and concluded that capsular contracture distorts the breast into a more spherical shape and altered the volume to surface area relationship.

In a follow-up article to his previous work on breast augmentation and bra cup sizing, Pechter[12] studied the relationship between breast widths and underbust circumference and their correlation to bra cup size in 1000 women over 5 years. These combined measurements were then used to select an implant that would achieve the patient's desired postoperative bra cup size.[12] Pechter's article did not describe a specific volume required to increase or decrease a breast by one cup size. He defines the correlation between the breast width and underbust circumference to bra size. His system correlates every increase in 1 inch of breast width equals an increase in one cup size. He also never correlated these measurements to specific manufacturers. In addition, Pechter's measurements slightly overestimate our reported cup sizes by about 1 to 1.5 cm or about one-half of one bra cup; however, he has done the most recent formal study advancing this topic forward.

In their 1997 study, Qiao and coworkers[13] used the difference between the circumference at the level of the axilla and across the nipples to determine breast volume. These measurements in particular are most often used by bra manufacturers when determining the correct bra size for women. Since Maliniac's classic book was published in 1950,[14] there have been relatively few published studies that have gone on to further develop a standardized system to measure women's breasts.[15–17] The incorporation of tissue-based planning and anthropomorphic measurements into the preoperative evaluation of breast augmentation patients has been shown to improve patient understanding and accountability, and improve surgical outcomes.[4] They have not, however, helped significantly in fully setting patient expectations with respect to bra cup sizing.

In reviewing specific implant volumes required to achieve specific bra cup size changes, for instance from a reported A > C or B > C, our data show that approximately 205 mL increases a bra cup size by one cup with shaped breast implants. Prior literature has suggested that 100 mL would increase cup size by one cup, and thus, 225 mL would increase breast size by two cup sizes, with a range in the literature from 100 to 275 mL.[18,19]

Valid concerns have been raised concerning the data from this study, such as the implants studied were all shaped cohesive devices with most in the submuscular orretropectoral position. Although it is true shaped devices may revolumize the breast slightly differently than round or elliptical devices and affect the overall fill of the upper pole of the breast, the measurements of the breast HC are performed across the maximum projection of the breast, with the breast supported if any laxity or stretch is present. The device augments and elevates the breast volume on top of the implant and the final overall volume includes both implant and breast. The final HC should be very close regardless of the device shape, certainly not enough to vary a cup size significantly. However, it is important to confirm these data with round devices in the future. Again retrospectively the HC measurement correlates to reported bra cup sizes well regardless of implant shape.

There have been no studies to date that correlate standardized breast measurements with reported bra sizes specific to a manufacturer, preoperatively and postoperatively in primary breast augmentation from a large prospective clinical trial, or those that specifically correlate size change to a specific augmented volume. Our results parallel and confirm Pechter's work in a larger scale in correlating a breast HC

measurement only used in determining a patient's bra cup size. By implementing our data showing an HC of 19.3 cm correlates to a reported bra cup size of a "B Cup," 21.5 cm HC on average was a "C Cup," 23.4 cm HC correlated to a "D Cup," and 25.0 cm a "DD Cup." This is the next step toward the standardization of bra cup sizing based on one measurement only (HC). We have also used this bra cup measurement data to retrospectively ask patients following surgery what is the most common bra cup they wear. With the exclusion now of Victoria's Secret, which currently tends to oversize cup sizes by one to two bra cup sizes, more than 80% of the last 2000 breast augmentations fall within half of a bra cup size based on our reported single HC measurement. The single-surgeon cohort data along with Pechter's bra cup measurement data are further supportive.

SUMMARY

Plastic surgeons and their patients continue to primarily use bra cup language in discussing augmentation, revision, and reconstruction outcomes; however, without a standardized system, no one is speaking the same language. Using the data collected in this large study, bra cup sizes may now be standardized along with a starting point for comparing all bra manufacturers with this standard with a simple conversion applied. This is a major advancement in that patients and plastic surgeons may now be speaking the same language. From a patient standpoint, this new method will help streamline bra cup sizing postoperatively, pointing them in the right bra cup direction depending on manufacturer, providing a more accurate and at least a common starting point for the patient and the surgeon.

By applying actual cup size language to specific visual outcomes, we hope to improve patient education and the management of expectations. The incorporation of visual tools including 3-D imaging provides patients the opportunity to visualize their range of outcomes and assign a specific cup size measurement; adding a specific bra manufacturer matched to their result will help further to meet expectations and improve surgeon-patient communication (**Fig. 1**). Sister size confusion may be eliminated because the HC measurement is independent of the band width that requires a separate independent measurement. To further improve the informed consent process, patients can sign off on their range of expected outcomes. This new standard should decrease the incidence of revisions for size change, which currently represents one of the leading reasons for revision. The future should be interesting and show new advancements in 3-D imaging and simulation. Will the addition of 3-D printing allow patients to visually evaluate their simulated size, or will we be able to holographically project the simulation onto the patient's body? Bra cups are indeed a conundrum and a continuum; however, our new objective bra cup sizing system based on one quick measurement is the beginning of a new era in developing an innovative bra cup sizing system and language that will yield significant benefits to the patient and the plastic surgeon.

Editorial Comments by Bradley P. Bengtson, MD

The universal language of breast size uses "bra-cup" language. We speak to our patients and other plastic surgeons using "bra cup language," when in fact without a standard, no one actually knows what the other person is talking about. Studying over 6000 patients and now also confirming a patient's bra cup measurement postoperatively in over an additional 3000 patients, this system is fast, easy and reproducible. It is independent of the band width which is measured separately. This system helps to set patient expectations, helps to limit unmet or unrealistic expectations, decreases potential litigation and assists getting plastic surgeons and their patients on the same page both preoperatively and postoperatively. A good simple starting point is a "C-cup" measured at 21.5 cm, increasing or decreasing 2–2.5 cm per cup. This technology may also be applied to 3-D imaging and simulation as well.

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REFERENCES

1. Available at: http://en.wikipedia.org/wiki/Brassiere. Accessed April 1, 2015.
2. Adams WP. The process of breast augmentation: four sequential steps for optimizing outcomes for patients. Plast Reconstr Surg 2008;122:1892–900.
3. Tebbetts JB. Augmentation mammaplasty; tissue assessment and planning. In: Spear S, editor. Surgery of the breast, principles and art. 2nd edition. Philadelphia: Lippincott Williams & Wilkins; 2005. p. 1261.
4. Tebbetts JB. An approach that integrates patient education and informed consent in breast augmentation. Plast Reconstr Surg 2002;110(3):971–8.

5. Maxwell GP, Van Natta BW, Murphy DK, et al. Natrelle style 410 form-stable silicone breast implants: core study results at 6 years. Aesthet Surg J 2012; 32(6):709–17.
6. Glicksman C. Patient education in breast augmentation. In: Spear SL, editor. Surgery of the breast. 3rd edition. Baltimore (MD): Lippincott Williams & Wilkins; 2011. p. 1261.
7. US standard clothing sizes-definition for the clothing industry. Available at: http://www.apparelsearch.com/Definitions/Miscellaneous/US_standard_clothing_sizes.htm. Accessed April 1, 2015.
8. Maliniac JW. Sculpture in the living. New York: Lancet Press; 1934. p. 112.
9. Smith DJ, Palin WE, Katch VL, et al. Breast volume and anthropomorphic measurements: normal values. Plast Reconstr Surg 1986;78:331.
10. Pechter EA. A new method for determining bra size and predicting post- augmentation breast size. Plast Reconstr Surg 1998;102(4):1259–65.
11. Young L, Nemecek JR, Nemecek DA. The efficacy of breast augmentation: breast size increase, patient satisfaction, and psychological effects. Plast Reconstr Surg 1994;94:958.
12. Pechter E. Determining bra size for breast augmentation an improved technique for determining bra size with applicability to breast surgery. Plast Reconstr Surg 2008;121(5):348e–50e.
13. Qiao Q, Zhou G, Ling Y. Breast volume measurement in young Chinese women and clinical applications. Aesthetic Plast Surg 1997;21(5):362–8.
14. Maliniac JW. Breast deformities and their repair. 1st edition. New York: Grune & Stratton; 1950.
15. Penn J. Breast reduction. Br J Plast Surg 1955;7: 357.
16. Westreich M. Anthropomorphic breast measurement: protocol and results in 50 women with aesthetically perfect breasts and clinical application. Plast Reconstr Surg 1997;100(2):468–79.
17. Brown TP, Ringrose C, Hyland RE, et al. A method of assessing female breast morphometry and its clinical application. Br J Plast Surg 1999;52(5):355–9.
18. Karabulut AB, Ozden BC, Arcini AA. A nomogram for predicting the degree of breast augmentation according to implant size. Aesthetic Plast Surg 2008; 32:298–300.
19. Regnault P, Baker TJ, Gleason MC, et al. Clinical trial and evaluation of a proposed new inflatable mammary prosthesis. Plast Reconstr Surg 1972;50:220.