Are Breast Implant Manufacturers’ Volume Labels Scientifically Obsolete?

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Abstract

The manufacture of breast implants is surrounded by secrecy and proprietary technologies, with resultant differences among various brands. Upon choosing implants for a breast augmentation patient, we encountered the unexpected “fact” that two round implants produced by different manufacturers, with seemingly same advertised diameter and projection, had different claimed volumes.

We set to make sense of this finding and compared the catalogues from two manufacturers to the theoretical calculations based on the presumed shape of the implants, whether a segment of a sphere or an oblate spheroid.

While both manufacturers had labels “close” to the calculated volume, one of them was consistently more in-range. Yet, the differences that clearly exist from labeled volumes prove beyond doubt, that the breast implants manufacturers volume labels are scientifically obsolete, and should not be the primary factor in the preoperative decision-making.

Keywords: Breast implants; Preoperative assessment; Breast augmentation

Introduction

When choosing implants for a breast augmentation patient, surgeons may be faced with the unexpected “fact” that two round implants produced by different manufacturers, with seemingly same advertised diameter and projection, have different claimed volumes.

Upon a closer examination of the catalogues, multiple discrepancies could be identified.

- A 160 cc (Moderate) Eurosilicone implant matched the dimensions of a 175 cc (Moderate Plus) Mentor implant with a diameter of 10 cm and a projection of 3.1 cm.
- A 240 cc (Moderate) Eurosilicone implant matched the dimensions of a 275 cc (Moderate Plus) Mentor implant with a diameter of 11.7 cm and a projection of 3.5 cm.
- A 650 cc (Moderate) Eurosilicone implant matched the dimensions of a 700 cc (Moderate Plus) Mentor implant with a diameter of 15.8 cm and a projection of 4.9 cm.

The implications of this situation can be significant in terms of implant-selection, in particular for the patient, when what only matters for her is the implant’s volume. In order to make sense of this finding, we set to compare the catalogues of two breast implant manufacturers and verify the correlation of breast implant measurements.

Methods

Comparing implants by different manufacturers is not an easy task when they offer different ranges of shapes, diameters, projections, texture, and feel.

To that end, and for simplicity, we chose to compare smooth, round implants of two well known manufacturers in Europe and North America.

Round implants are shaped as segments of a sphere, with a flat posterior surface, and a convex anterior surface.

The concept of a round implant implies that they are designed as segments of a perfect sphere. Subsequently, the volume of a segment of a sphere can be obtained using the formula:
Where a spherical segment is a three-dimensional geometrical object that is obtained with a pair of two parallel planes intersecting a sphere with radius $R$. This creates two circles with radii $b$ and $a$, respectively. The height of the segment $h$ is the distance between the bases.

This creates two circles with radii $b$ and $a$, respectively. The height of the segment $h$ is the distance between the bases (Figure 1). For breast implants, the value could be the radius of the implant, $b$ is considered zero, and $h$ is the projection.

However, a close inspection of round breast implants may suggest that they are not fashioned from perfect spheres, but rather from an ellipse. If the ellipse is rotated about its semi-major axis, the result is a prolate (elongated) spheroid, similar in shape to an American football. If the ellipse is rotated about its semi-minor axis, the result is an oblate (flattened) spheroid [1,2] (Figure 2).

A sphere may result when the generating ellipse is a circle.

As such, the implant would be fashioned as half of an oblate spheroid, and its volume is calculated using the formula:

$$V = \frac{4}{3}\pi b^2 h \frac{c}{2}$$

where $b$ is the semi-major axis, while $c$ is the semi-minor axis.

These two formulas allow us to calculate the theoretical volume of an implant. Furthermore, the ratio of the calculated volume to the labelled volume indicates the fill percentage of the implant.

We compared round smooth breast implants in the catalogues from Mentor and Eurosilicone.

**Results**

Looking back at the comparisons made earlier while

- A 160 cc (Moderate) Eurosilicone implant with a diameter of 10 cm and a projection of 3.1 cm matched the dimensions of a 175 cc (Moderate Plus) Mentor implant, yet the matching calculated volume of a segment of a sphere would be 137.3 cc, and that of an oblate spheroid 162.3 cc.

- A 240 cc (Moderate) Eurosilicone implant with a diameter of 11.7 cm and a projection of 3.5 cm matched the dimensions of a 275 cc (Moderate Plus) Mentor implant, yet the matching calculated volume of a segment of a sphere would be 210.6 cc, and that of an oblate spheroid 250.9 cc.

- A 650 cc (Moderate) Eurosilicone implant with a diameter of 15.8 cm and a projection of 4.9 cm matched the dimensions of a 700 cc (Moderate Plus) Mentor implant, yet the matching calculated volume of a segment of a sphere would be 542 cc, and that of an oblate spheroid 640.5 cc.

<table>
<thead>
<tr>
<th>Diameter (cm)</th>
<th>Projection (cm)</th>
<th>Labeled Volume (mL)</th>
<th>SS Volume (mL)</th>
<th>Fill</th>
<th>OS Volume (mL)</th>
<th>Fill</th>
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<td>10</td>
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<td>569.4</td>
<td>71%</td>
<td>711.1</td>
<td>89%</td>
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</table>

| Fill          | Moderate Profile | average | 72% | 90% |

Table 1: Comparison of labeled and calculated volumes for mentor moderate profile implants (SS: Segment of Sphere calculated theoretical volume; OS: Oblate Spheroid calculated theoretical volume).
Diameter (cm)  Projection (cm)  Labeled Volume (mL)  SS Volume (mL)  Fill  OS volume (mL)  Fill
8.9  2.8  125  98.6  79%  116.1  93%
9.5  2.9  150  115.5  77%  137  91%
10  3.1  175  137.3  78%  162.3  93%
10.5  3.2  200  155.7  78%  184.7  92%
10.9  3.3  225  172.8  77%  205.3  91%
11.3  3.4  250  191.1  76%  227.3  91%
11.7  3.5  275  210.6  77%  250.9  91%
12  3.6  300  228  76%  271.4  90%
12.3  3.8  325  254.5  78%  301  93%
12.5  3.9  350  270.4  79%  319.1  92%
12.8  4  375  290.9  79%  343.1  92%
13.1  4  400  303.1  77%  359.4  91%
13.6  4.2  450  343.9  76%  406.7  90%
14.1  4.3  500  377.3  75%  447.6  90%
14.6  4.5  550  424.4  77%  502.2  91%
15  4.6  600  457.4  76%  541.9  90%
15.8  4.9  700  542  77%  640.5  91%
16.5  5.1  800  614.7  77%  727  91%

Table 1b: Comparison of labeled and calculated volumes for mentor moderate plus profile implants (SS: Segment of Sphere calculated theoretical volume; OS: Oblate Spheroid calculated theoretical volume).

From these 3 observations we can note that the labeled Eurosilicone implants volumes are closer to the calculated volumes.

Looking at the Table 1 and 2, we notice that the labeled implants volumes approximate more those calculated from the formula for oblate spheroids.

The fill percentage for Mentor ranged from 68% to 99% when
calculating segments of spheres, but is 79.4% to 101% when considered as oblate spheroids. Eurosilicone’s fill percentage on the other hand ranged from 77% to 101% when calculating segments of spheres, but 92.7% to 106.4% when considered as oblate spheroids.

**Discussion**

Comparing labeled breast implants volumes among several manufacturers is not an intuitive idea, and as plastic surgeons we often need to use implants from various manufacturers.

The tables clearly show that there is no consistent difference between the labeled volume and the calculated volume in both manufacturers we chose to compare.

Due to lack of standardization in terms of breast implant projection labeling, it is understandable that different manufacturers may have different dimensions for various projections. Still, a thorough search of the literature on PubMed and Medline fails to reveal any insight as to such differences between breast implant manufacturers, or what it could signify.

However, the Eurosilicone catalogue does include a reference to fill percentage (without further explanation) of 85% for the Low Profile and High Profile, but goes up to 100% for the Medium and Extra High Profile implants.

Mentor catalogue on the other hand has no mention of fill percentage, and as such no further clarifications can be obtained.
Ideally however, catalogues from more manufacturers should be analyzed, and water submersion of the implants could be done to compare the labelled volumes and determine their accuracy. Nevertheless, judging from the differences between the calculated and the labeled volumes, these differences are rather small, and likely not clinically significant.

To that end, taking into account the facts that we revealed, the volume labeling can be misleading to both the surgeon and the patient when choosing implants from different manufacturers.

Moreover, of the many algorithms available for selecting breast implants such as the TEPID [3] or the high-five method of Tebbets [4], and the Atiyeh method [5], all rely on breast measurements and on soft tissue envelope to determine the optimal breast implant size for a patient. Yet, patients seeking augmentation mammoplasty often present to our clinics requesting a certain implant size that their friends have had, and that they were satisfied with.

It should be noted though that final breast size and shape following augmentation mammoplasty is influenced by many factors and not only by the size and shape of a given implant. Position of the implant on the chest wall and its relationship to the nipple-areola complex is of prime importance. The position of the infra-mammary fold should not be overlooked either. Moreover, late capsular contracture has a definite impact on final breast shape, volume and projection. It is logical to assume that the less the fill volume percentage, the more will be the change in shape and projection. Any liquid filled deformable container will take a spherical shape when subjected to compressive forces. As a corollary, it is thus logical to assume also that it may be advisable to select implants with the highest fill volume percentage and with the least deformable fill material.

As already stated in a recent publication, “There is no one implant that is appropriate for every patient. This makes breast augmentation both an art and a science” [5]. As such, there is no single implant volume that fits a single patient, but rather a range. Therefore, if a patient requests a specific volume, this may not necessarily affect the final result, provided the patient’s anatomic measurements are respected. Clearly, the differences that exist from labeled volumes prove beyond doubt, that the breast implant manufacturer’s volume labels are scientifically obsolete, and should not factor in the preoperative decision-making.

References
1. Geometric calculators.
2. Oblate Spheroid - Volume.