Measurement of Breast Volume: Comparison of Techniques

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A system of graduated disks has been previously described as a method to determine breast volume.[1] The accuracy and limitations of this system have not previously been reported. Comparison of these disks with a standardized volumetric method shows this simple system to be accurate. Standard linear correlation analysis was good for the entire group of breasts measured (r = 0.718). Conversion to true volume M is represented by the least-square line $M = 20.33 + 1.37G$.

The correlation is expected to fail at volumes greater than 425 cc (greater than the calibration on the largest Grossman disk). Elimination of volumes greater than 425 cc, however, produced no improvement in correlation coefficient. Firm breasts (i.e., capsular contractures) displace less uniformly into the conical restraint of the disk and cause an overestimation of their volume. Three breasts in this series were evaluated with Baker grade III and IV capsular contractures. Elimination of these values improved the correlation between the two volume analyses (r = 0.853 and $M = 1.56G - 4.48$). We suggest that when confronted with very large or firm breasts that volumes determined by the Grossman disk be interpreted with care. A formula for calculation of the true breast volume from the Grossman measurement has been derived and presented.

Methods and Results

Fifteen patients were evaluated following surgical procedures for breast asymmetry reconstructive procedures, including latissimus dorsi flaps, standard silicone gel augmentation, and reduction mammaplasty.

Volume determination was done with two methods by a single observer. The Grossman device was utilized to measure volume on both breasts. Two measurements of each breast were done and averaged for a mean value. Breast-volume casting was also done on all patients.[2]

Thirty breasts were evaluated by both techniques. Total volume by the mold technique varied from 170 to 610 cc. Utilizing regression analysis, the two methods of breast-volume determination were compared (r = 0.718 corresponding to $p < 0.001$). The plot of volumes for each technique is shown in Figure 1.

Discussion

Hokin[3] has developed a mathematical formula for planning volumes of reconstructed breasts. However, no reliable and easily used method has been evaluated for measurement of the normal breast. In a large series of "normal" volunteers, Campaigne et al.[2] have shown that volumetric determination by the chest-wall-mold/volume-displacement technique is highly accurate and reproducible. This method is the basis for evaluation of the Grossman device.

Breast volume by the mold technique corre-

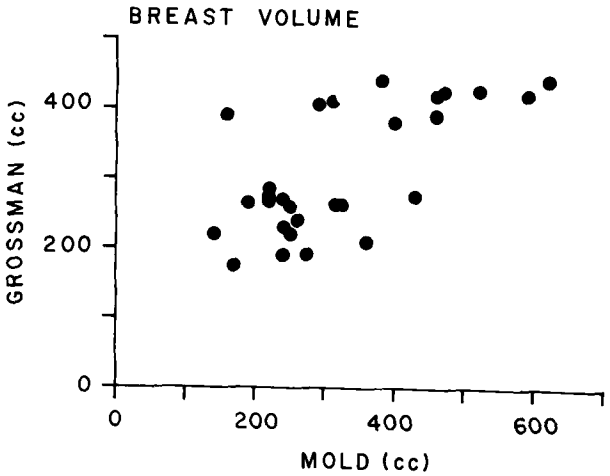

FIG. 1. Breast volume by mold technique versus Grossman device (r = 0.718; $p < 0.001$). Linear approximation of true volume mold by $M = 20.3 + 1.37G$, where M is mold volume and G is volume by the Grossman device.

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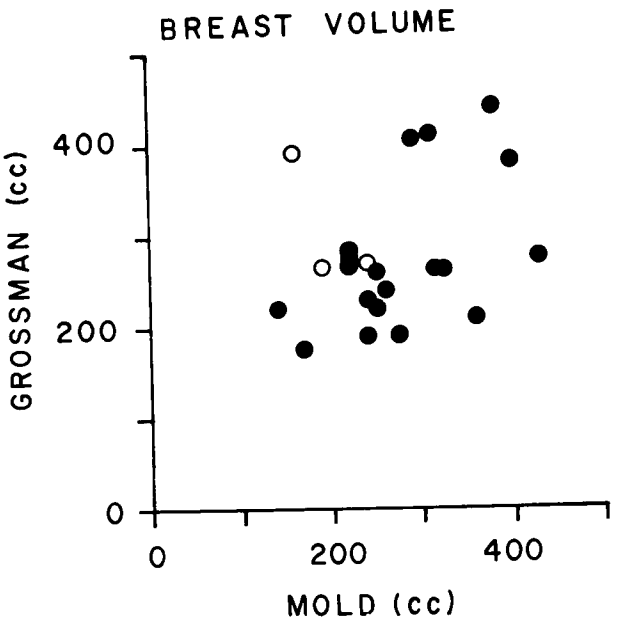

FIG. 2. Breast volume by mold technique versus Grossman device ($r = 0.361$; $p > 0.051$); linear equation $M = 1.50 + 0.9x$; open dots represent patients with capsular contractures eliminating these points ($r = 0.853$; $p < 0.001$); and the equation for conversion of Grossman volume G is $M = 1.56x - 4.48$.

lates with the volume determined by the Grossman device. Standard correlation analysis for bivariate data using the least-squares line $y = a + bx$ was done. The linear correlation coefficient r was calculated by the usual product-moment formula.

Using this approach for all data points (30 breast volume pairs; mold and Grossman), the relationship between mold volume M and the Grossman volume G was $M = 20.33 + 1.37G$. The correlation coefficient, the r value, was found to be 0.718, with a corresponding t value of 5.457 at 28 degrees of freedom ($p < 0.001$).

However, mold volumes greater than 425 cc would be expected to become increasingly less well predicted by the Grossman device because this represents the upper limit of calibrated markings on the device. Correlation coefficients were therefore calculated for mold volumes greater than 400, 425, and 450 cc. However, the expected decrease in correlation above each of these levels could not be proven. Figure 2 shows the scatter plot for mold volumes less than 450 cc.

The correlation coefficient r is decreased compared to the overall group (0.361) and the least-squares line is $M = 150 + 0.906$. However, three patients were identified with mold volumes less than 425 cc and capsular contractures (Baker III and IV) following unilateral augmentation. These three were the only breasts in which the Grossman volume exceeded the mold volume. This supports the observation that firm breasts do not displace adequately into the cone of the Grossman disk. Eliminating these three values (open dots in Figure 2), the correlation is improved ($r = 0.853$, with $p < 0.001$). A new conversion formula is then calculated ($m = 1.56G - 4.48$).

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