



A Simple Way to Predict the Breast Volume in a Case of Poland Syndrome Using Archimedes' Principle

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Poland syndrome remains a complex malformed entity with various clinical presentations. Perfect symmetry is extremely difficult to obtain in patients with Poland syndrome. Women often require prosthesis implantation for mammary hypoplasia, and while breast volume determination is important. Preoperative breast volume assessment is an important part of breast reconstruction. The ideal measurement has not been routinely applied due to the absence of a standardized, simple, inexpensive, and accurate method. According to previously published literatures, the methods of accurate breast volume assessment included mammography, Grossman-Roudner device, anthropometry, casting, and Archimedes procedure. We designed a simple way to using Archimedes procedure. Only two items needed a transparent plastic container, a 30cc syringe with an 18G needle. The residual volume left in the container not filled by breast tissue can be measuring the amount of water required to fill the entire container. A hole is pierced with the 18G needle on the container and the container filled with water via injection with the syringe. The Archimedes method involves submersion of the measured object into a water-filled container to calculate the amount of displaced water. In summary, this technique is very convenient, it can be done during operation when the patient is lying in supine position. This method allows measurement of the volume differences between asymmetric breasts and also helps the surgeon to estimate the size of the prosthesis needed in augmentation mammoplasty.

Key words: Poland syndrome, Archimedes' principle, breast volume

Case Report

Poland syndrome^{1,2,3} remains a complex malformed entity with various clinical presentations from varying degrees of muscle, bone, skin, and breast atrophy. Comesis and perfect symmetry are extremely difficult to obtain in patients with Poland syndrome.

Women often require prosthesis implantation for mammary hypoplasia, and while breast volume determination is importance in the treatment of Poland syndrome, it has not been fully appreciated by many surgeons. The main reason why such an important measurement has not been routinely applied is due to the absence of a standardized, simple, inexpensive, and accurate method.

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Case presentation

A 22-year-old patient presented with left mammary hypoplasia with right sided breast ptosis. Under the impression of Poland syndrome (Fig. 1), magnetic resonance imaging (MRI) revealed absence of glandular breast tissue, symmetrical muscular groups of bilateral anterior chest wall with relative normal appearance of the pectoralis major and minor muscles. When ptosis is asymmetrical, both breasts required corrections to achieve optimal results. Surgical planning began with a decision for the final ideal goal volume. Under general anesthesia, the patient is placed in the supine position. Only two items are needed for breast volume estimation; a transparent plastic container, a 30cc syringe with an 18G needle. The plastic, transparent container is a sterile irrigation tray from the nursing pack and is 500cc in volume (large enough to embrace the whole breast) (Fig. 2). The container is placed on the right breast with ptosis, and the entire breast tissue is tightly cupped by the container. The residual volume left in the container not filled by breast tissue can be used to measure the amount of water required to fill the entire container. A hole is pierced with the 18G needle on the container and the container is filled with water via injection with the syringe. Using Archimedes' principle, 500cc subtract the volume of water injected should be equal to the volume of the breast tissue cupped by the container (Fig. 3). In our case, 150cc of water was injected, we estimate 350cc is required to augment the right side.

To check the reliability of this method, preoperative volume assessment is useful in breast reconstruction using MRI. Volume measurement was performed on Advantage Workstation version 4.2 (GE Healthcare, Milwaukee, Wisconsin). The margins of the right breast and adjacent subcutaneous tissue was defined by 3D tools manually, slice by slice on a series of axial images, and the volume was calculated by volume tool. The whole process

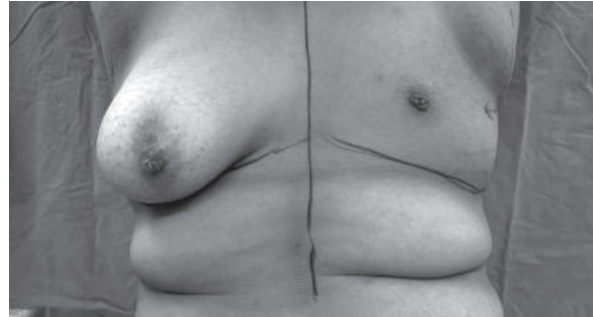


Fig. 1 The patient had left mammary hypoplasia with impression of Poland syndrome, her right breast was ptosis. Severe asymmetrical breast was found.



Fig. 2 A transparent plastic container, a 30cc syringe with an 18G needle. The plastic, transparent container is 500cc in volume to embrace the whole breast. The container is placed on the right breast, and the entire breast tissue is tightly cupped by the container.

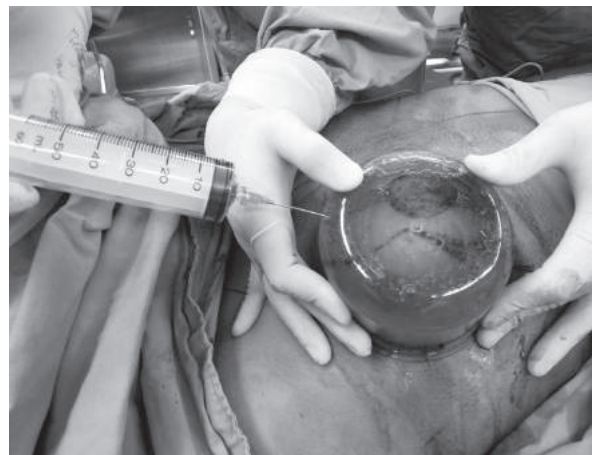


Fig. 3 The residual volume left in the container not filled by breast tissue can be measuring the amount of water required to fill the entire container. Using Archimedes' principle, 500cc subtract the volume of water injected should be equal to the volume of the breast tissue cupped by the container. In our case, 150cc of water was injected, we estimate 350cc is required to augment the lesion side.

was repeated for the left breast subcutaneous tissue (the atrophy side) at the same levels. The final volume difference was then obtained by subtraction of left breast (472 cm^3) from the right breast (827 cm^3). The MRI-estimated volume (Fig. 4) was ($827 - 472 = 355$) around 355 cm^3 .

The pattern for a circumvertical mastopexy⁴ with limited scar was planned for the right breast to correct breast ptosis. Augmentation mammoplasty was then performed through the left axillary approach, a smooth 350cc. MENTOR, breast implant was inserted into the supra-muscular space. Three months post-operative follow up revealed good symmetry, and the patient was very satisfied with the final result (Fig. 5).

Discussion

Preoperative breast volume assessment is an important part of breast reconstruction. In previous literatures, the methods of accurate breast volume assessment included:

- Mammography including MRI
- Grossman-Roudner (GR) device
- Anthropometry
- Casting
- Archimedes procedure

Few were routinely applied as there was no standardized, simple, inexpensive, and accurate method. Mammography volume measurement by Kalbhen⁵ is performed on the craniocaudal mammogram with a ruler. MRI methods are ideal in terms of accuracy. However, these methods are complex, time-consuming, and expensive. And these techniques need experienced radiological staff with sufficient technical infrastructure.⁶⁻⁸ The Grossman-Roudner device⁹ is a graduated disc made of hard transparent polyvinyl chloride material, which can be formed into a cone-shaped device. The GR device is a simple, rapid, and painless measurement method. However special device is needed, and its

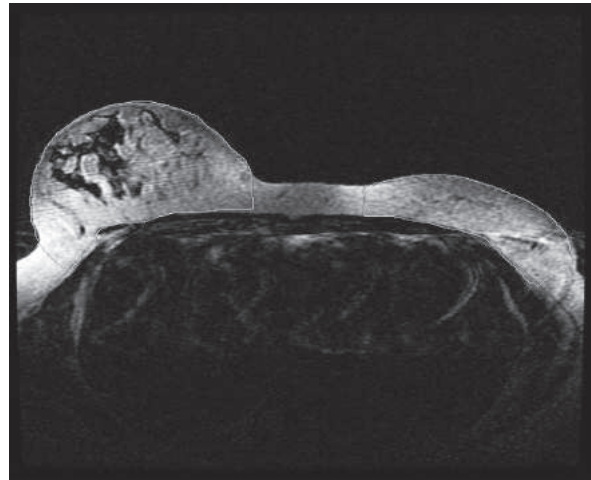


Fig. 4 Volume measurement was performed on Advantage Workstation version 4.2 (GE Healthcare, Milwaukee, Wisconsin). The margin of right breast and adjacent subcutaneous tissue was defined by 3D tools manually slice by slice on a series of axial images, and the volume was calculated by volume tool. The final volume difference was then obtained by subtraction of left breast (472 cm^3) from the right breast (827 cm^3). The MRI-estimated volume was ($827 - 472 = 355$) around 355 cm^3 .

accuracy decreases when measuring larger volumes breasts. In the anthropometry method, breast volume is measured using anatomic dimensions and a geometric volume formula, proposed by Qiao et al.¹⁰ Although anthropometry methods is accurate and reproducible, selection of the appropriate formula is still a problem, and doing calculations is impractical in the clinical setting.

The casting method uses paraffin or thermoplastic material to form a mould. This is the most direct but also the most difficult and uncomfortable method for patients. Many authors¹¹ agree that the casting method has the lowest level of reproducibility and were less accurate for volume.

The Archimedes method involves submersion of the measured object into a water-filled container to calculate the amount of displaced water. In the mastectomy patient, the breast specimens can be directly put into a graduated cylinder and the volumes easily determined.

However, if no surgical specimens could be obtained, a modified version is suggested by Tezel et al.¹² A half-elastic container, an appropriately sized plastic bag, and a plug to seal the bag are used for measurement while the patient is in a seated position. After placing the breast in the container, the difference between the container volume and the water that can be filled into the plastic bag revealing the breast volume.

The technique is tedious and time consuming. Since the water-filled plastic bags do not easily conform to the 3D space in the container, this method does not yield accurate measurements. Our modified Archimedes method is simpler, quicker, does not need special devices and can accurately measure breast volume, confirmed by preoperative MRI.

In summary, this technique is very convenient, and it can be done during operation when the patient is lying in supine position. This method allows measurement of the volume differences between asymmetric breasts and also helps the surgeon to estimate the size of the prosthesis needed in augmentation mammoplasty. Finally, we can check the volumes of breasts immediately after reconstruction on the surgical table.



Fig. 5 Right side breast underwent a circumvertical mastopexy. Then augmentation mammoplasty was performed through the left axillary approach, a smooth 350cc. MENTOR, breast implant was inserted post-operative three months follow up revealed symmetrical appearance of both side breasts.

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