

Photographs for anthropometric measurements of the breast region. Are there limitations?

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ABSTRACT

PURPOSE: To determine the limitations of the photographs used to obtain the anthropometric measurements of the breast region.

METHODS: Five women, between the ages of 18 to 60 years, were evaluated. Photographs of the frontal and left and right profile views of their breasts were taken. Based on the current literature, the most commonly used anthropometric and anatomic landmarks for breast measurement were marked in their different positions. The different points were used to evaluate if the direct anthropometry was possible in a standardized way and determine how the points and the positions can to be used in any breast measurements.

RESULTS: There were some limitations to the use of defining points of the breast fold, as well as of its lower portion and lateral extension positions in both profiles.

CONCLUSION: The defining points of the breast fold and the profile photographs have some limitations and we suggested how the points and positions can be used for breasts measurements.

Key words: Anthropometry. Breast. Body Weight and Measures. Mammoplasty. Thorax.

Introduction

The study of the structure of the female breast is important in clinical practice to define the best surgery technique to be used¹. At the same time, the patient feels the need to be informed in advance about the asymmetries to minimize some unrealistic expectations of the surgery outcomes². The standard photographic documentation has been used as a tool, becoming a source of scientific information for any evaluation³.

Direct and indirect anthropometry are two different measurement methods used for breast evaluation. Direct anthropometric measurements can be taken from the patient in a clinical setting, using linear measures and anthropometric points. Indirect anthropometry is a technique used for measuring photographs or images. The analysis of these images can be performed using software tools that have their own calibration made either by linear markers or pixels and provides real-time data without the physical presence of a patient⁴.

The use of photographs not only provides a pre-operative registry data but also has greater advantages over direct anthropometry as it reduces the patient's discomfort, allows measurements (and re-measurements) at any time and enables centesimal precision provided by the graphics software tools⁴.

For female breast evaluation, significant aspects are considered, such as differences in volume, surface area, and contour, which are difficult to be measured accurately using a pre-set protocol⁵. Several authors have determined some reference parameters for esthetically perfect breasts⁶⁻¹⁰. Moreover, these authors have established values for breast positioning, volume and shape using linear and reproducible measures that are applied to the general population. These studies have also identified the factors that influenced the changes of these measurements such as weight, age, pregnancy, lactation and biotype.

Computerized photogrammetry could be more efficient and less intrusive for the patient and contribute to a more objective analysis of the postoperative results, especially after mastoplasty.

Quieregatto *et al.*¹¹ found differences between the tape and compass measurements of volunteers evaluated by direct anthropometry. In this study, the authors marked the patient's anatomic points in frontal view only.

Sivagnanavel *et al.*¹² and Assunção *et al.*¹³ have proposed software validation studies to achieve comparable measurements. Although the authors used the same computer-aided tools and theoretical basis, the results could have been different.

The present study aimed to describe the difficulties found in determining the points using indirect anthropometric measurements of the breast.

Methods

The research was approved by the Institutional Research Ethics Committee (approval number CEP 1054/10). Written informed consent was obtained from all participants prior to their inclusion in the study and anonymity was ensured.

Five volunteers with different types of breast and different ages were selected for the study. We attempted to identify the extremes related to the degrees of ptosis and hypomasty for a more comprehensive assessment. A total of 18 points were marked on the volunteers' skin surface, then photographs were taken of the frontal, right and left profiles of the patient placed in a standing position.

Description of the search strategies for selection of the points

An electronic search was performed in the MEDLINE database via PubMed, from 1966 until December 2013. The search strategy used was based on the descriptors presented above (Table 1). It was used in combination with the following terms:

In the articles selected from the literature review, 16 authors have described both anatomic and anthropometric measurement points of the breast region (Table 2)^{6-11,14-24}.

TABLE 1 - Search strategy in the database.

“Breast”[Mesh] AND “Body Surface Area”[Mesh] = 13
“Breast”[Mesh] AND “Anthropometry”[Majr] = 109
(“Breast”[Mesh] AND “Anthropometry”[Majr]) NOT “Breast Neoplasm”[Mesh] = 109
“Breast”[Mesh] AND (“Body Weights and Measures”[Mesh] OR “Body Weights and Measures/methods”[Mesh]) = 782
((“Photogrammetry”[Mesh] OR “Photography”[Mesh]) AND “Breast”[Mesh]) = 1013
(“Photogrammetry”[Majr] AND “Breast”[Majr]) OR (“Anthropometry”[Mesh] AND “Anthropometry/methods”[Mesh]) AND “Body Weights and Measures”[Majr] = 1280
(((((“Photogrammetry”[Mesh] OR “Anthropometry”[Mesh]) OR “Anthropometry/methods”[Mesh]) AND “Breast”[Mesh])) AND “Body Weights and Measures”[Mesh]) = 687
“Breast”[Mesh] AND “Photogrammetry”[Mesh] = 15
((“Photogrammetry”[Mesh Major Topic]) AND “breast”[Mesh]) = 10
(“Photogrammetry”[Mesh] OR “Photogrammetry”[All Fields]) AND (“Breast”[Mesh] OR “Breast”[All Fields]) AND (“Body Weights and Measures”[Mesh] OR “Body Weights and Measures”[All Fields]) OR (“Anthropometry”[Mesh] OR “Anthropometry”[All Fields]) = 355243

TABLE 2 - Anthropometric and anatomical points and line segments found in the literature.

Authors (n = 16)	Publ. Year	# Citat	# Meas	IJ-Xi	IJ-Pa	IJ- Pu	IJ- Umb	IJ- SMMe	Cl- Pa	Ac- Pa	Ax- Pa	Pa- LM	Pa- SMLa	Pa- SMMe	Pa- Pa	PAP- Dia	Ac- EpL	Ac- Um	An- gle
Smith <i>et al.</i> ¹⁴	1986	38	6								x	x	x	x	x				x
Westreich ⁸	1997	35	16	x	x	x	x	x	5 cm	x					x	x			olec
Penn ⁶	1955	1st	4	x					x					x	x				
		ref.																	
Loughry <i>et al.</i> ¹⁵	1989	21																	
Brown <i>et al.</i> ⁹	1999			x			x								x				
Malata <i>et al.</i> ¹⁶	1994	18	4	x															x
Smith <i>et al.</i> ⁷	1986	13	6	x						x									
Quiao <i>et al.</i> ¹⁷	1997	13	8	x					x										
Sigurdson & Kirkland ¹⁸	2006		5	x						x									
Denoe <i>et al.</i> ¹⁹	2009		2	x															
Pozzobon <i>et al.</i> ²⁰	2009	-	5	x						x									x
Odo <i>et al.</i> ¹⁰	2009	-	6	x						prof									x
Vandeput & Nelissen ²¹	2002		3	x															
Kim <i>et al.</i> ²²	2007																		
Agbernoku <i>et al.</i> ²³	2011		4	x															
Liu & Thompson ²⁴	2011		8	x															
TOTAL			5	14	1	1	2	5	1	1	6	11	6	13	5	6	2	1	3

Publ. Year: Year of publication; # Citat: Number of citations; # Meas: Number of measurements; Ac: Acromion; Ax: Axillary Line; Cl: Clavicle; EpL: Lateral Epicondyle; IJ: Jugular Notch; LM: Anterior Midline; Pa: Nipple; Pu: Pubis; SMMe: Infra Mammary Fold; SMLa: Lateral Mammary Fold; Um: Humerus; Umb: Umbilicus; Xi: Xiphoid; 1/2Um: Half distance between acromion and olecranon; prof: Profile; obl: Oblique; olec: Olecranon.

Eighteen points were selected: mid-portion of the breast fold (MPBF), lateral portion of breast fold (LPBF), Umbilicus (U) and pubis (Pu), the central portion of the sternal notch (SN), basis of the xifoid process (Xi), the central portion of the breast papilla (CBP) right and left sides, acromion (AC) right and left sides, the anterior projection of the lateral epicondyle (LEP) right and left sides, half distance between the center of the sternal notch and the acromion, named as “x” point of the clavicle (xCl) right and left sides, the proximal point of anterior axilla line (Ax) right and left sides, and the half distance between the acromion and the lateral epicondyle, named as the mid-point of the humerus (1/2 Hum) right and left sides (Figure 1).

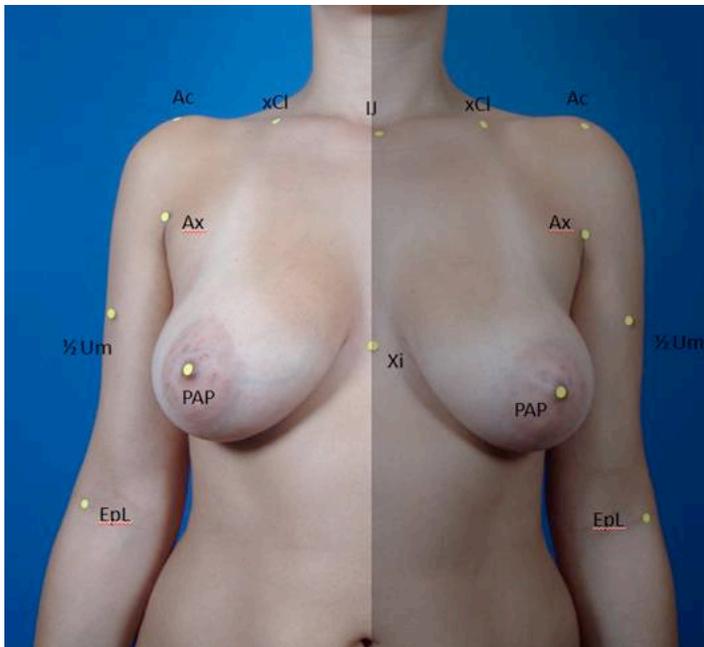


FIGURE 1 - Labeling of anatomic and anthropometric hemibody points, front view. Counterclockwise: SN = Central portion of the sternal notch; xCl = half distance between SN and the acromion; Ac = lateral prominence of the acromion; Ax = proximal point of anterior axillary line; 1/2Um = Half distance between acromion and olecranon; EpL = previous projection of the lateral epicondyle; PAP = Central portion of the breast papilla; Xi = basis of the xifoid process. Photographic image.

The transverse line of gnathion and the lower margin of the umbilicus were marked on the photographic image of the breast region (Figure 2).

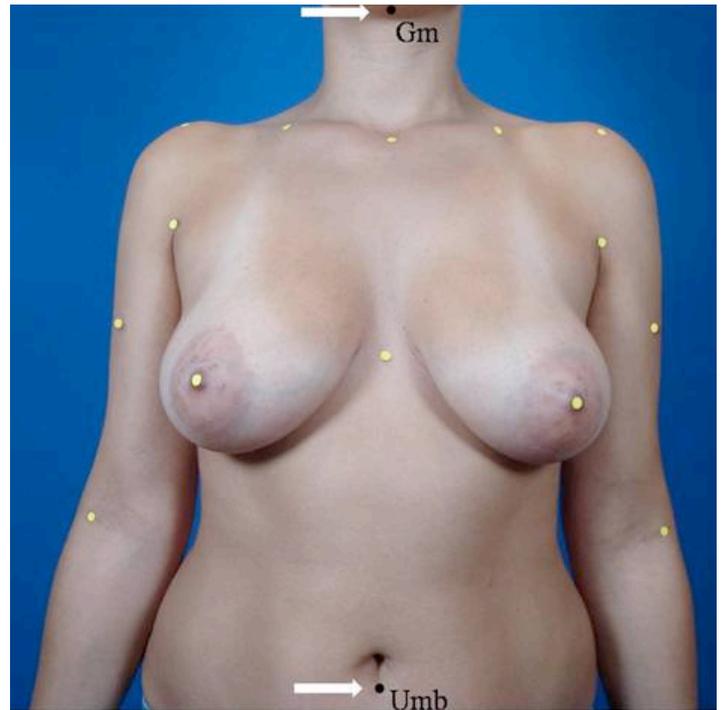


FIGURE 2 - Photo framing of the breast region. Gn = gnathion; Umb = lower margin of the umbilicus.

Results

It was observed that the sagging breasts (ptosis) overlapped the lower and mid- points of the breast fold, blocking the view both in the anterior position (AP) and the profile view (Figure 3).



FIGURE 3 - Blocked view of the lower mid-point of the breast fold. Profile photo image shows the blocked view of the breast fold. The arrow shows the blocked view of the mid-point of the breast fold.

The precise point of the lateral extremity of the breast fold could not be determined in breasts with ptosis and in small breasts (Figure 4) (hypomastia) (Figure 5).



FIGURE 4 - Extension of the lateral point of the breast fold. The arrows show an extension beyond the anterior axillary line.

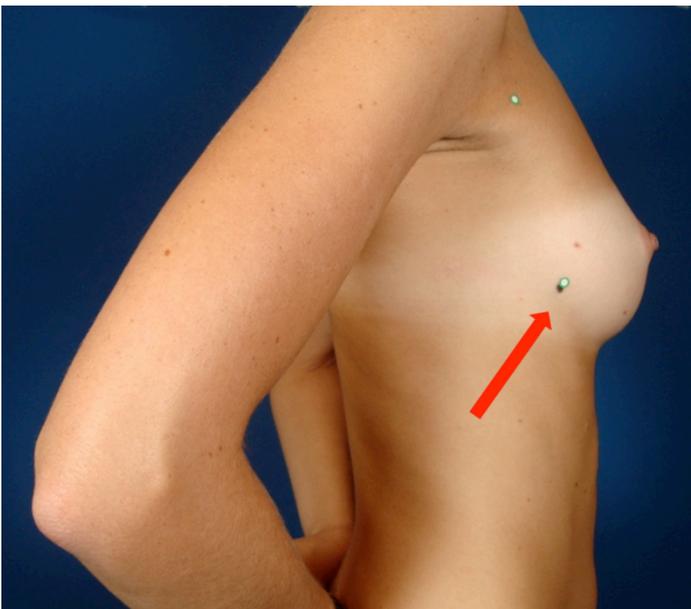


FIGURE 5 - Difficulty in determining the breast fold. Photo image shows the difficulty in visualizing the lateral extremity of the breast fold in a patient with hypomastia. The arrow shows the lateral portion of the breast fold.

The reference points of the umbilicus (Umb) and the pubis (Pu) were also excluded, because these points did not show the correct position of the midline. The column and pelvis deviations changed the centralization of the midline. The best choice was to use the basis of the xiphoid process to mark the midline.

The use of self-adhesive labels to mark the anatomic points was considered a better choice compared to the use of a demographic pencil or a felt-tip pen (Figure 6). The analysis of photographs showed that some points marked with pen were of difficult visualization and caused discomfort to the patient, contrary to the use of self-adhesive labels.



FIGURE 6 - Points marked with a pen. The image shows the difficulty in visualizing the marks made with a pen on the acromion and mammary papilla.

The following points were excluded: (a) the midline of the breast fold due to the difficulty in visualizing the fold in a breast with ptosis, and (b) the lateral extremity of the breast fold due to the difficulty in visualizing the fold in sagging and hypertrophic breasts.

Discussion

The systematization and standardization of photographic positions and angles and the use of markers on the anthropometric and/or anatomic landmarks can assure the reliability and reproducibility of a scientific study and are prerequisites for scientific publications^{3,25-28}.

An objective evaluation of the breasts, which represent femininity, sensuality and motherhood, allows a

better understanding of a woman's physical and mental health²⁰. Penn⁶ was the precursor of the breast evaluation using direct anthropometry. He examined measurements in 20 female subjects who he described as having aesthetically perfect breasts. His objective was to find normal patterns of the breasts. Since then several authors have published articles in order to develop protocols for measuring the breasts using direct anthropometry^{4,7-9,16}.

Liu and Thomson²⁴ examined 109 volunteer women. Their main purpose was to determine the anthropometric measurements of the breasts, which could be aesthetically acceptable in cosmetic and reconstructive surgeries. The authors used photographic images in 5 different positions (front view, right and left oblique views and right and left sides). The images were then examined by a group of plastic surgeons, members of the American Society of Plastic Surgeons (ASPS), and patients of the Department of Plastic and Reconstructive Surgery at Yale School of Medicine. Neither the methods that were used for the measurement of the photographs nor the most appropriate positions for their analysis were mentioned in the article.

The use of graphics software in photograph measurements, which are static and do not require the physical presence of the individual in data collection, enables centesimal precision, reduces the possibility of errors and allows the evaluator to measure these photographs at different times, and is less intrusive and embarrassing for the patient^{4,8}. These were the reasons that encouraged us to develop a study on breast measurement and whose results could be reproducible for future studies.

Odo *et al.*¹⁰ have analyzed preoperative and postoperative results of mammary asymmetry using direct anthropometry. In comparative studies on surgeries to correct breast asymmetry, Pozzobon *et al.*²⁰ have used nuclear magnetic resonance (NMR) and linear measurements in breasts.

As there is no consensus on the points that can be used for breast measurements, neither the ideal instrument for this evaluation, we decided to do some research on a reproducible and accurate tool for this procedure.

The volunteers with previous history of any type of surgery on the breasts and/or thoracic deformities were excluded to minimize any possible interference in the study, as these deformities could cause distortions during the measurements made with the use of direct anthropometry. Also not included were the women whose breast sizes exceeded the line below the umbilicus, and therefore, would exceed the photographic framing used in this study.

To determine the anatomic and anthropometric points to be used for the breast measurements in the present study, we

analyzed the literature of the last 56 years. Seventeen articles that associated the use of direct anthropometry for the measurements of the breasts with the anthropometric and anatomic points were selected.

According to Westreich⁸, the segment of the axilla to the center of the mammary papilla and the lateral point of the breast fold make accurate measurements of this organ very difficult, because the landmarks made on the soft tissue structures do not remain constant over time. These measurements may vary quite a bit from woman to woman and be even altered by any movement made by the patient, therefore, the results could be inaccurate. The author has excluded any landmarks made on soft tissue structures from his study.

Smith *et al.*¹⁴ found 15 to 20% of differences in measurements, where the measurement started in the reference point of the anterior axillary line to any other point of reference on the chest. The authors concluded that any minimal changes of the patient's position would change these measurements assessed by direct anthropometry. In this specific case, the measurements were made using a photographic image, and therefore, they were not affected by the patient's positions or breathing movements of the chest.

Considering all the points and measurements selected from the articles, the present study evaluated five volunteers to determine the feasibility of using photogrammetry as an alternative assessment tool. These points were marked on the skin surface, and after, the volunteers were photographed in a standing position. Some breasts overlapped the point marked in the lower and mid-portion of the breast fold, obstructing the visualization of the self-adhesive labels in AP and profile views.

It was not possible, for example, to precisely locate the point on the lateral extremity of the breast fold in breasts with large lateral extension in AP and profile views. In small breasts (hypomasty), this point was also difficult to be precisely determined because the breast fold did not have a well defined contour. Thus, only the points and measurements described earlier in this study were used, except the profile view. For the study on the use of photographs, some authors used photographic images in 5 different positions (front view, right and left oblique views and right and left sides)^{3,8,28}. In our study, we suggest the use of AP position because the points in oblique and profile views are not visible within the precise limits of the photographic documentation of the breast. The upper line of the photographic framing was delimited by the gnathion and the lower line by the bottom margin of the umbilicus, according to Hochman *et al.*³.

Several authors have attempted to standardize photographs for clinical evaluation, however, the variability remains a challenge^{3,28-31}.

No measurements of the profile were obtained, therefore, the choice made for the anatomic position was that less subject to bias, since it is well known in anthropometric studies.

The standardization of the photographic framing, the distance and the height of camera and spotlights, the patient positioning are required for subsequent evaluations, such as the comparisons between pre and post-operative procedures to allow valid comparisons between techniques and results, preserving the scientific rigor²⁷. Obtaining linear measurements from photographs rather than directly from the individual has proved to be another effective way to evaluate the breasts³². According to Nechala *et al.*⁴, photogrammetry has advantages over direct anthropometry. The use of graphics software in photograph measurements, which are static and do not require the physical presence of the individual in data collection, enables centesimal precision, reduces the possibility of errors and allows the evaluator to measure these photographs at different times, and is less intrusive and embarrassing for the patient. A photograph is quicker and more efficient and can be examined immediately after they were taken. It does not require specific technical training and is cheaper compared to 3Ds scanners.

Lighting is an extremely important resource to preserve the technical accuracy of clinical photographs. Excessive lighting or light overexposure can mask folds, wrinkles or scars. Similarly, poor lighting or underexposure may cause obscuring shadows and enhanced wrinkles or scars³³. In the present study, 2 light diffusers were connected to the Photo-Flood lamps. Each difuser was placed at a 45 degree angle to the photographic background. The adequate lighting provided photographs without shadows and a proper measurement of the breasts.

To standardize the distance between the feet and the background, a mold was made using 1 cm thickness EVA foam, in purple, to maintain the volunteer's positioning 70 cm from the background with a 30cm distance between the feet, as suggested by DiBernardo *et al.*³⁰.

There is a particular similarity between direct anthropometry and photogrammetry related to some body segments (head, face, eyes, nose, mouth and ears)⁴, contrary to the breast region. This can be explained by the fact that no formula has been found yet to identify the actual measurements based on those obtained by indirect anthropometry. Quieregatto *et al.*³⁴ demonstrated that direct and indirect anthropometry with three different software to the breast region, did not present correlation

between them.³⁴ Therefore, the design used in this study suggests that its possible measurements in the breast region and can guarantee the analysis and reproducibility for further publications.

The present study has showed that the use of photographic images of the breasts cannot be used indiscriminately. Some parameters should be established to measure the breasts especially in studies that evaluate these organs in two different time periods (e.g. pre and post operatively) and the same image framing and points should be used in both periods.

Conclusion

The frontal view photographs of the patient's breasts is better when compare with the lateral positions, and can be used for an universal types of breasts with this points described. The following points: mid-portion of the breast fold, lateral portion of the breast fold, umbilicus (Um) and pubis (Pu) points should not be used for photogrammetry of any type of breast size and shapes.

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