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# Measurement of breast volume is a useful supplement to select candidates for surgical breast reduction

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## ABSTRACT

**INTRODUCTION:** The indication for breast reduction in a public welfare or an insurance paid setting depends on the severity of the subjective symptoms and the clinical evaluation. The purpose of this study was to evaluate the use of breast volume as an objective criterion to establish the indication for breast reduction surgery, thus establishing a standard decision basis that can be shared by surgeons and departments to secure patients fair and equal treatment opportunities.

**MATERIAL AND METHODS:** A total of 427 patients who were referred to three Danish public hospitals with breast hypertrophy in the period from January 2007 to March 2011 were included prospectively in the study. The patient's subjective complaints, height, weight and standard breast measurements were registered as well as the decision for or against surgery. Breast volume was measured using transparent plastic cups.

**RESULTS:** Cut-off values for breast volume were calculated based on whether or not the patients were offered reduction surgery. Most patients (93%) with a breast volume below 800 cc were not offered surgery, while most with a volume exceeding 900 cc were offered surgery (94%). In the grey zone between 800 and 900 cc, the indication seemed to be less clear-cut, and additional parameters need to be included.

**CONCLUSION:** Breast volume can be used as an objective criterion in addition to the presently used criteria. Breast volume can easily be measured and has become appreciated by plastic surgeons dealing with patients with breast hypertrophy as a tool which facilitates their decision-making and patients' acceptance of the decisions made.

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and improvement in both physical and psychological symptoms after reduction mammoplasty were demonstrated in numerous studies [3-7], including prospective randomised clinical trials [8-10].

Whether a woman suffering from breast hypertrophy is offered a reduction mammoplasty in the public health-care system depends on a set of criteria including symptoms and objective findings. In Denmark, the departments of plastic surgery have quite unanimous guidelines regarding breast hypertrophy and indications for reduction mammoplasty. For the procedure to be covered by public health care in Denmark, a patient seeking surgery due to breast hypertrophy must express relevant physical symptoms, preferably be 18 years of age, have a body mass index (BMI) below 25 kg/m<sup>2</sup>, and have a breast large enough to allow resection of at least 400-500 g on each side, while still leaving behind a breast of a "normal" size. These criteria correlate well with the criteria for insurance coverage described in studies performed outside Denmark. The background for these criteria is a need to differentiate between cases primarily based on cosmetic complaints and those primarily based on functional complaints.

The criterion concerning the expected resection weight has been widely debated [5, 11-13]. The minimum resection requirement is typically 400-500 g per breast, but the origin of this criterion is uncertain [13, 14]. The focus of this paper, however, is not to discuss this criterion, but instead to propose an alternative and superior way of objectifying this criterion – an alternative which can be applied when deciding if surgery is appropriate (rather than after surgery, when the actual weight of the resected tissue is known). It is reasonable to assume that a larger resection weight is more closely associated with the condition being functional and not merely cosmetic [15]. The sternal notch-to-nipple distance and the degree of ptosis (the distance from the lower pole of the breast to the sub mammary fold) are objective measurements that are often seen in a patient's chart. They first and foremost describe the degree of ptosis of the breast and not the volume. Other physical characteristics such as height, weight and chest

## ORIGINAL ARTICLE

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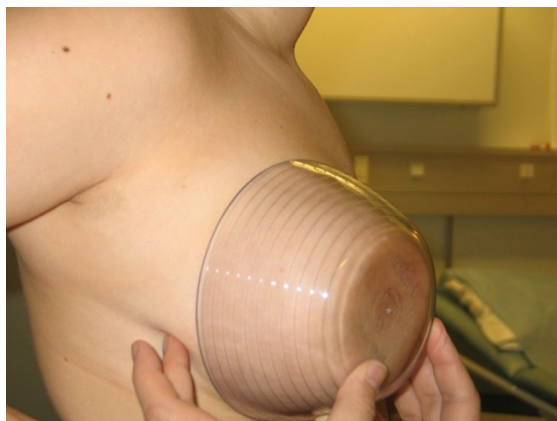
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Every year, approximately 250 women are referred for plastic surgery units in Zealand, Denmark, with a diagnosis of breast hypertrophy, which may be associated with physical as well as psychosocial problems resulting in an impaired quality of life [1, 2].

The insufficient effect of nonsurgical interventions is well-described. Furthermore, improved quality of life


**FIGURE 1**

Breast volume measurement using transparent plastic cup.



circumference are used to some extent. These measurements and the surgeon's subjective estimate of the weight which can or should be resected provide the surgeon with an important overall impression of the patient. The decision to offer surgery or not has always been based on a combination of the above-mentioned measurements.

In Denmark, there has been a desire to introduce preoperatively measured breast volume as an objective criterion. Currently, no gold standard method for breast volume measuring exists and such measuring has not been performed routinely in patients with breast hypertrophy in Denmark. The method presented in this article originates from Sweden, where it has been used for many years [16]. It was first introduced to Danish surgeons during a Nordic meeting. It is a fast and easy way to assess breast volume by use of transparent plastic cups, relying on the same technique as the Grossman-Roudner device [17] and yielding the same advantages. The cups exist in different sizes, ranging from 200 cc to 2,000 cc. Thus, the method does not share the limitation seen in the Grossman-Roudner device where volumes above 500 cc are problematic.

Our aim was to investigate if breast volume measured with plastic cups was a relevant measurement in breast hypertrophy decision-making and, if possible, to identify cut-off values for acceptance/rejection of breast reduction in the public hospital setting.

## MATERIAL AND METHODS

The participants in this multicentre trial were three Danish hospitals (Rigshospitalet, Roskilde Hospital, and Herlev Hospital). Between January 2007 and March 2011, 427 women referred with the diagnosis of breast hypertrophy had their data registered at their first consulta-

tion. Preprinted forms were used and the following parameters were recorded: breast-related symptoms (shoulder/neck pain, bra strap grooving, back pain and headache), objective measurements (weight, height, body mass index, chest circumference, sternal notch-to-nipple distance, the degree of ptosis, and the breast volume). With the use of transparent plastic cups (**Figure 1**), the volume of each breast was measured. Eleven different sizes were used: 200, 275, 350, 500, 650, 850 (two different forms of cup), 950, 1,150, 1,350, 1,600 and 2,000 cc. If the measured volume fell between two cup sizes, a best estimate was made by the surgeon. Below 750 cc, this estimate was made at 25 cc intervals; i.e. 475 cc; above 750 cc the interval used was 50 cc. In women with slightly differently sized breasts, the volume of the largest breast was used in the statistical analysis.

The decision to operate or not was made by the examining surgeon if he/she was a certified specialist. In cases where the surgeon was not yet a specialist, or if there was a need for discussion, the decision was cleared with a senior colleague or in a conference with more colleagues. The decision was made without using the breast volume as a parameter and according to the excising criteria as mentioned in the introduction. However, since the surgeon was not blinded, with time the knowledge of the breast volume probably in some cases added to the indication and thus influenced the decision. Excluded from the study were patients referred with asymmetric breasts, breast ptosis alone and patients not offered surgery due to overweight, as were patients with incomplete data.

## Statistical analysis

The basic statistical data were calculated using Excel, Microsoft Office 2011 for Mac.

The cut-off values were found based on the predefined requirement that each cut-off value should be true in 95% of cases, or as close to this number as possible. Each possible cut-off value was considered, i.e. 600 cc, 650 cc, 700 cc etc., and the volume with the highest per-


**TABLE 1**

Outcome – surgery or no surgery – according to breast volume of the 427 patients. The values are % (n).

	< 800 cc (N = 90 ≈ 21%)	[800-900[ cc (N = 120 ≈ 28%)	≥ 900 cc (N = 217 ≈ 51%)
Surgery	7 (6)	56 (67)	94 (204)
No surgery	93 (84)	44 (53)	6 (13)

a) The volumes used for categorisation were the volumes for which most patients were either not operated or operated and at the same time made the interval between these two (the grey zone) as narrow as possible.

centage of patients operated or not operated was found. When the data were categorised according to this, the 95% criterion could not be met: none of the volumes measured resulted in operation in 95% of the cases; the highest number of “agreement” was 93% for not being operated and 94% for being operated with the respective volumes as described in the results section (Table 1). Lowering or increasing the threshold, respectively, did not yield higher percentages, but only widened the interval (grey zone) between the two cut-off values.

The data followed a normal distribution, but no statistics were calculated.

*Trial registration:* not relevant.

## RESULTS

A total of 427 patients participated in the study. The patients' mean age was 33.1 (range 15-82) years. The mean BMI was 23.7 kg/m<sup>2</sup> (range 17.9-32.2 kg/m<sup>2</sup>). The mean volume of the largest breast was 972 cc (range 275-2,200 cc). Additional clinical data are shown in Table 2.

The most frequent breast-related symptoms were shoulder/neck pain, seen in 86% of the patients, followed by back pain in 54%. Bra-strap grooving was experienced by 40% of the women, and 33% experienced frequent headaches.

A total of 277 patients (65%) were offered surgery and 150 patients (35%) were not. Their breast volume characteristics are shown in Table 1. A strong correlation between breast volume and decision outcome was found (Table 2).

## DISCUSSION

The suggested lower cut-off value of 800 cc as the preoperatively measured breast volume in our study – below which 93% of the patients were denied surgery, Table 1 – correlates well with the requirements in Sweden [18]. Additionally, with a cut-off value of 800 cc and a resection weight of 400 g in accordance with the existing guidelines, the patient would end up with a breast volume close to “normal”. The general opinion held by Swedish plastic surgeons [18] is that a breast volume close to 400 cc in a woman of average height and weight (165 cm, 60 kg, BMI 22 kg/m<sup>2</sup>) is fairly normal.

The upper cut-off value of 900 cc led to surgery in 94% of patients with a breast size larger than this. This leaves us with a zone between 800 and 900 cc where additional factors need to be taken into consideration before selecting patients for surgery. This could be body morphology, age, posture, co-morbidity, symptoms and, of course, the remaining objective measurements such as sternal notch-to-nipple distance, degree of ptosis and chest circumference.



TABLE 2

Preoperative anthropomorphic data. The values are mean  $\pm$  1 standard deviation (range).

	All (N = 427 $\approx$ 100%)	Surgery (n = 277 $\approx$ 65%)	No surgery (n = 150 $\approx$ 35%)
Age, years	33.1 $\pm$ 13.3 (15-82)	35.8 $\pm$ 13.4 (16-82)	28.2 $\pm$ 11.5 (15-71)
Height, m	1.67 $\pm$ 0.07 (1.43-1.84)	1.67 $\pm$ 0.07 (1.48-1.84)	1.67 $\pm$ 0.06 (1.43-1.8)
Weight, kg	66.0 $\pm$ 7.37 (48-89)	67.1 $\pm$ 6.79 (49-89)	63.8 $\pm$ 7.96 (48-88)
BMI, kg/m <sup>2</sup>	23.7 $\pm$ 2.02 (17.9-32.2)	24.1 $\pm$ 1.75 (18.9-32.2)	22.9 $\pm$ 2.25 (17.9-31.2)
Sternal notch to nipple distance: largest side, cm	28.3 $\pm$ 3.46 (20-45)	29.3 $\pm$ 3.26 (21.5-45)	26.3 $\pm$ 2.92 (20-40)
Ptosis: largest side, cm	6.45 $\pm$ 2.64 (0-20)	7.1 $\pm$ 2.66 (2-20)	5.2 $\pm$ 2.11 (0-13)
Volume of the largest breast, cc	972 $\pm$ 290.4 (275-2,200)	1,095 $\pm$ 250.5 (650-2,200)	745 $\pm$ 212.1 (275-1,800)

The two cut-off values predicted the outcome correctly 93% and 94% of the time, respectively, which is very close to our aim of finding a cut-off value that predicts the outcome correctly in 95% of patients. A total of 28% of patients were in the zone between the two cut-off values. Surely, a lower percentage in this grey zone would be preferred, but compared with the present situation with no valid objective criteria, this is a step in the right direction. It may seem obvious that women with breasts above 900 cc (and with concurrent functional problems) would be offered surgery. However, this has only been quantified now, owing to the present study. In the process of becoming familiar with breast volume measurement, it has become evident that the preoperative “guesstimate” of breast volume is quite demanding and often associated with large discrepancies, even among experienced surgeons. In addition, it must be noted that breast density is variable and not always 1 kg/l. This problem is hard to overcome with simple measurements.

Patient selection for breast reduction is – and should always be – based on an overall and individual assessment of each patient. This explains why some patients in this study had a BMI of more than 25 kg/m<sup>2</sup> and why one patient with a breast volume of 1,800 cc did not have surgery performed (Table 2). Cut-off values based on volumetric measurements are meant to be a supplemental tool for the surgeon rather than an absolute criterion when selecting patients. Nevertheless, the method has the potential to make patient-selection more standardised, satisfy the demand from health authorities and insurance companies for an objective criterion, level out differences between departments and surgeons and establish more precise national guidelines.

However, the current study has some limitations, primarily the fact that the surgeons were not blinded regarding the breast volume when making their decision. We must therefore caution against over-interpretation

of our results. In the optimal set-up, one surgeon would assess the breast volume and another surgeon would make the decision based on the existing criteria, ignorant of the volume. This would have provided us with more reliable cut-off values. However, this was not practically feasible. The surgeons were instructed to make their decision based on existing criteria and not the measured volume. Nevertheless, the surgeons learned of the possibility of using breast volume as a supplementary tool in their decision-making, a fact that merely emphasises the need for objective criteria.

A total of 427 women were included in this study. With an annual rate of referral of approximately 250 women a year, this number should be expected to be higher. However, an unknown number of referrals were returned due to a too high BMI. In addition, not all potential participants were included due to lack of collaboration/forgetfulness among the surgeons. Nonetheless, we believe the included patients to be representative for patients suffering from breast hypertrophy in Denmark.

The surgeons were individually instructed in performing volume measurements before their data were used in this study. A test with six women (12 breasts and two different observers) showed a low degree of inter-observer variation. Differences were only found among women with large breast volumes of more than 1,100 cc, probably due to larger intervals between large cup sizes.

However, our experience is that with all the limitations mentioned, measuring the breast volume offers a significant help in selecting the breast hypertrophy patients who are eligible for surgery. Measurement facilitates the communication between the plastic surgeons dealing with breast hypertrophy patients. Furthermore, the demand for objective criteria in the specialty of plastic surgery is steadily increasing and measurement of the breast volume is one relevant way of meeting this demand. Since its introduction, the breast volume has often been used when discussing patients during conferences and it is found to be a useful tool in difficult cases. The plastic cups are very helpful in explaining the decision process to the patients. Furthermore, the plastic cups are inexpensive, easy to clean, and can be used for years.

## CONCLUSION

We have presented an objective criterion suggesting that – as a rule of thumb – patients with breast volumes below 800 cc should generally be denied surgery in a public welfare setting. A breast volumes exceeding 900 cc and a BMI below 25 kg/m<sup>2</sup> generally strengthens the indication and such patients would be offered surgery if suffering relevant physical problems. In patients with

volumes between 800 and 900 cc, further measurements such as body morphology, sternal notch-to-nipple, degree of ptosis, chest circumference and patient characteristics should be taken in to consideration. We find it important to emphasize that the proposed cut-off values are guidelines and not strict criteria when selecting patients for surgery. A blinded study could possibly provide more precise cut-off values.

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