

Anthropometric Measurements and
Volumetric Measurement of the Human Female Breast

유방용적 측정과 인체계측에 관한 연구

-중년여성을 대상으로-

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◀ 목 차 ▶

I. Introduction

II. Methods

III. Results

IV. Discussions

References

<국문요약>

본 연구는 유방절제수술을 받은 여성들이 착용하는 브래지어와 보정물의 중량을 결정하는데 필요한 예비자료를 수집하기 위하여 중년여성 12명을 대상으로 31항목에 대한 인체계측 및 석고법에 의한 유방용적측정을 실시하고 얻어진 유방관련 항목자료와 각 치수별 무게자료를 비교·분석하였다. 그 결과는 다음과 같다.

1. 유방용적 측정결과 모든 피험자에 있어 오른쪽과 왼쪽 유방용적에 차이가 있는 것으로 나타났다.
2. 브래지어 컵 치수는 가슴둘레와 밑가슴둘레간의 차이로 결정되는 것이므로 유방용적과 브래지어 치수의 크기가 일치하지 않는 것으로 나타났다.
3. 절반 이상의 피험자가 자신의 브래지어 치수를 잘못 선택하고 있는 것으로 나타났다.

I. INTRODUCTION

Breast cancer is one of the most frequently occurring cancers in woman(Hirxhaut 1996). According to American cancer Society, 182,000 women would be diagnosed with breast cancer and 46,000 women died form it in 1995(Schachter 1996). In Korea, breast cancer is the second of occurring frequency in women(ministry of health and social affair 1999).

Only a small minority of the breast cancer survivors have breast conservation surgery because of fear of the recurrence of breast cancer(Jiyeon Kim 1994) and most of them wear mastectomy brassieres with prostheses, an artificial breast form. The variety of prosthesis shapes and sizes enables the patients to come fairly close to matching the shape, the touch and weight of the other side of their own breast.

In Korea, however, there is no company which manufactures prostheses and brassieres for the mastectomy patients. Only a few vendors provides the imported products. Especially for developing our own prostheses, it is necessary to get physical data about the human female breast, but no studies have been reported in the field of clothing and textiles.

Studies of the determination of breast volume have been shown for a breast augmentation and reconstruction or a reduction mammoplasty, which need breast symmetry. Bouman(1970) determined breast volumes by measuring the volume of water displacement, using a rigid cylindrical device and a plunger. Grossman and Roudner(1980) developed measuring device which has the graduated scale on its surface. Ward and Harrison(1986) developed device worn around the chest and its principle is the displacement of air by a piston.

The aim of wearing prosthesis also concerns contour and volumetric symmetry, so that the measurement data of human female breast volume is very useful for determination of prosthesis volume. For this study, twelve middle aged female volunteers' breast volumes were evaluated and anthropometric measurements around chest area were made to compare the volume and the size of the breast. This study should be the first step to develop our own prostheses for breast cancer survivors in Korea.

II. METHODS

To select the subjects, we only picked brassiere size A for this study, ranging from 70 to 95 of the chest circumference sizes because all the imported prostheses are for A cup size. Especially for the size 95, more subjects were chosen. According to our survey, the problem of the prostheses weight was found to the patients, so that the more data of large sizes would be helpful to determine the proper prostheses weight for the patients who wear the large size prostheses.

Twelve volunteers, whose ages from 40 to 55, were recruited and their brassiere sizes were reported. Some fixed points such as inner/lateral breast crease and nipple on the chest wall, side neck point and shoulder point were determined for the size measurement. The subjects were requested to wear a sheer brassiere with no wire or artificial pad because their breasts tend to droop due to their ages and prosthesis should be worn with mastectomy brassiere. Twenty-nine body measurements were taken in left and right breasts by measuring tape and Martin's anthropometric measurement tool, as shown fig 1. and tab.1.

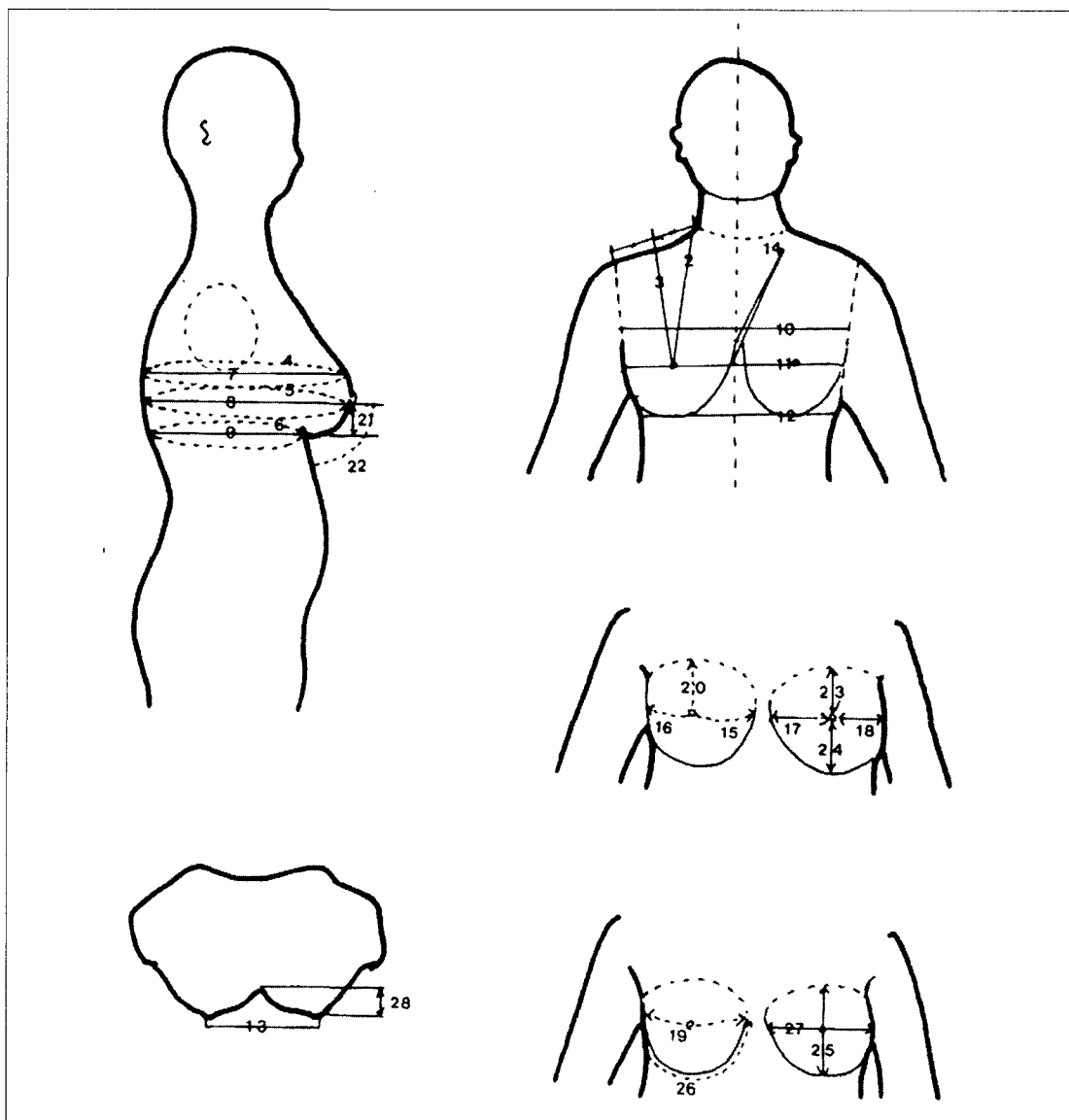


Fig.1 Body parts measured

Volume determination of the breast was done by a standard chest-wall casting technique(Campaigne, 1979) with rapidly hardening plaster of paris. The resultant breast mold got to cure and the volumes were determined by the displacement of water.

III. RESULTS

Each of the measurements, breast volume and brassiere size are shown in Table 2. They were not analyzed by statistical method because the number

<Table 1> body measurement reference

| | Reference | Representation |
|---------------|--|--|
| height | 1. stature | linear distance from the floor to vertex |
| length | 2. bust point length I | distance from side neck point to nipple |
| | 3. bust point length II | distance from mid shoulder to nipple |
| circumference | 4. upper chest circumference | horizontal distance around both axilla point and back |
| | 5. chest circumference | horizontal distance around nipples and back |
| | 6. under bust circumference | horizontal distance around breast drooping line and back |
| depth | 7. upper chest depth | anterior-to-posterior linear distance on upper chest circumference line |
| | 8. chest depth | anterior-to-posterior linear distance on chest circumference line |
| | 9. under bust depth | anterior-to-posterior linear distance on under bust circumference line |
| breadth | 10. upper chest breadth | linear distance on the upper chest circumference line |
| | 11. chest breadth | linear distance on the chest circumference line |
| | 12. under bust breadth | linear distance on the under bust circumference line |
| | 13. bust point breadth | linear distance between nipples |
| breast | 14. inner breast crease length I | distance from midline to inner breast crease |
| | 15. inner breast crease length II | distance from inner breast crease to nipple |
| | 16. breast lateral length I | distance from nipple to lateral breast crease |
| | 17. breast inner length | linear distance from inner breast crease to nipple |
| | 18. breast lateral length II | linear distance from nipple to lateral breast crease |
| | 19. inner-to-lateral breast length I | distance from inner breast crease to lateral breast crease passing nipple |
| | 20. upper breast length I | distance from nipple to upper chest |
| | 21. inframammary crease I | maximum droop distance along a line from the inframammary crease to nipple |
| | 22. inframammary crease II | distance from the lowest point of the breast to nipple |
| | 23. upper breast length II | linear distance from nipple to upper chest circumference line |
| | 24. lower breast length | linear distance from nipple to inframammary crease II |
| | 25. superior-to-inferior breast length | linear distance from upper chest circumference line to inframammary crease II |
| | 26. drooping line length | distance between inner breast crease and lateral breast crease through the drooping line |
| | 27. inner-to-lateral breast length II | linear measurement between lateral breast crease and inner breast crease |
| | 28. breast height | vertical distance from nipple to midline on the transverse plane |
| weight | 29. weight | body weight |

of volunteers was too small. As shown from Table 2, the range of each of the values is very large due to the diversity within the group of volunteers.

All data presented in Table 2 indicate left-to-right

difference between left and right breasts. Moreover, increase of brassiere sizes are not consistent with the increase of breast volume. Comparing subject no.4(80A) with subject no.5(85A), in the chest

circumference sizes subject no.5 are larger, but in most breast measurements subject no.4 are larger than subject no.5. In the group of the volunteers who wears brassiere size 95A, each of the values is also quite different. Their breast volume measurements are also highly different and various.

Determination of the brassiere size is according to the chest circumference and difference between the chest circumference and the under bust circumference(cup size). However, the differences of the two parts doesn't include the information of breast volume, so that one has to wear the bigger

<Table 2> Measurements and Breast Volumes

unit : cm

| Reference | Subject No. | | | | | | | | | | | |
|--|-------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | |
| 1. stature | 155.0 | | 162.0 | | 150.0 | | 154.5 | | 159.0 | | 160.0 | |
| 2. bust point length I | 22.9 | | 26.7 | | 28.3 | | 27.5 | | 27.3 | | 30.8 | |
| 3. bust point length II | 19.0 | | 25.0 | | 25.0 | | 25.0 | | 24.4 | | 28.2 | |
| 4. upper chest circumference | 77.2 | | 85.6 | | 83.0 | | 86.0 | | 95.4 | | 95.0 | |
| 5. chest circumference | 79.0 | | 86.5 | | 83.0 | | 90.0 | | 97.3 | | 100.0 | |
| 6. under bust circumference | 71.5 | | 76.0 | | 77.0 | | 82.0 | | 85.5 | | 87.0 | |
| 7. upper chest depth | 17.5 | | 16.6 | | 18.7 | | 17.5 | | 20.3 | | 19.8 | |
| 8. chest depth | 17.8 | | 21.1 | | 20.5 | | 22.2 | | 21.9 | | 25.6 | |
| 9. under bust depth | 17.5 | | 17.0 | | 17.5 | | 20.0 | | 21.5 | | 22.5 | |
| 10. upper chest breadth | 25.2 | | 28.5 | | 27.8 | | 27.5 | | 32.5 | | 32.8 | |
| 11. chest breadth | 25.0 | | 26.7 | | 25.5 | | 27.0 | | 31.4 | | 32.9 | |
| 12. under bust breadth | 24.8 | | 26.4 | | 25.5 | | 25.5 | | 29.5 | | 29.0 | |
| 13. bust point breadth | 16.8 | | 17.6 | | 18.6 | | 18.2 | | 19.3 | | 20.5 | |
| sides of breast | R | L | R | L | R | L | R | L | R | L | R | L |
| 14. inner breast crease length I | 0.5 | 0.5 | 1.0 | 0.7 | 0.5 | 0.5 | 0.3 | 0.3 | 0.3 | 0.4 | 0.3 | 0.3 |
| 15. inner breast crease length II | 8.3 | 8.8 | 10.5 | 11.3 | 11.0 | 12.2 | 13.0 | 12.5 | 9.4 | 9.5 | 15.0 | 14.3 |
| 16. breast lateral length I | 8.3 | 8.1 | 12.4 | 11.1 | 14.5 | 12.5 | 13.5 | 15.0 | 10.3 | 8.7 | 15.3 | 16.5 |
| 17. breast inner length | 9.0 | 7.5 | 8.4 | 8.2 | 8.3 | 7.3 | 12.5 | 11.9 | 8.8 | 8.1 | 14.5 | 13.8 |
| 18. breast lateral length II | 4.3 | 4.4 | 6.9 | 9.1 | 7.1 | 6.0 | 13.0 | 13.9 | 5.0 | 5.6 | 13.8 | 16.0 |
| 19. inner-to-lateral breast length I | 16.7 | 16.5 | 21.2 | 19.3 | 20.5 | 19.0 | 20.0 | 21.3 | 20.2 | 17.8 | 25.0 | 13.3 |
| 20. upper breast length I | 7.9 | 8.6 | 10.0 | 9.3 | 11.3 | 11.0 | 11.5 | 11.3 | 10.7 | 11.6 | 13.0 | 12.8 |
| 21. inframammary crease I | 5.5 | 5.5 | 5.2 | 5.4 | 5.0 | 4.5 | 6.0 | 6.0 | 6.8 | 7.3 | 6.3 | 5.0 |
| 22. inframammary crease II | 5.5 | 5.5 | 5.8 | 5.8 | 6.0 | 5.0 | 6.8 | 7.0 | 7.5 | 7.9 | 7.0 | 5.5 |
| 23. upper breast length II | 6.5 | 8.5 | 9.6 | 8.7 | 9.6 | 10.2 | 11.3 | 11.5 | 9.4 | 9.7 | 11.2 | 11.5 |
| 24. lower breast length | 3.8 | 4.0 | 3.9 | 4.8 | 3.8 | 3.7 | 4.0 | 4.1 | 4.4 | 3.6 | 4.6 | 4.2 |
| 25. superior-to-inferior breast length | 10.4 | 11.4 | 12.4 | 13.1 | 13.4 | 13.9 | 15.3 | 15.6 | 13.6 | 14.1 | 15.8 | 15.7 |
| 26. drooping line length | 20.8 | 18.2 | 31.0 | 30.5 | 28.5 | 28.0 | 34.5 | 33.8 | 27.2 | 26.1 | 39.5 | 33.7 |
| 27. inner-to-lateral breast length II | 13.3 | 12.5 | 15.0 | 13.4 | 15.5 | 15.5 | 15.1 | 15.8 | 15.2 | 13.9 | 17.5 | 17.3 |
| 28. breast height | 1.3 | 1.7 | 3.5 | 3.1 | 2.5 | 2.6 | 3.2 | 3.8 | 4.0 | 5.5 | 3.0 | 3.2 |
| 29. breast volume(cc) | 122.1 | 183.1 | 233.4 | 259.5 | 198.4 | 176.1 | 416.1 | 452.9 | 275.1 | 332.2 | 497.4 | 371.0 |
| 30. weight(kg) | 45.0 | | 54.0 | | 53.0 | | 50.0 | | 56.0 | | 68.0 | |
| 31. brassiere size | 70A | | 75A | | 75A | | 80A | | 85A | | 90A | |

<Table 2> continued

unit : cm

| Reference | Subject No. | | | | | | | | | | | |
|--|-------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| | 7 | | 8 | | 9 | | 10 | | 11 | | 12 | |
| 1. stature | 148.0 | | 151.0 | | 150.0 | | 153.0 | | 161.5 | | 161.0 | |
| 2. bust point length I | 30.0 | | 30.9 | | 26.8 | | 28.3 | | 30.5 | | 29.3 | |
| 3. bust point length II | 28.0 | | 29.0 | | 25.5 | | 27.0 | | 26.5 | | 27.4 | |
| 4. upper chest circumference | 88.0 | | 88.8 | | 89.7 | | 85.5 | | 97.7 | | 95.0 | |
| 5. chest circumference | 94.0 | | 98.8 | | 93.0 | | 92.4 | | 103.5 | | 97.7 | |
| 6. under bust circumference | 79.0 | | 84.9 | | 85.7 | | 84.0 | | 94.5 | | 86.0 | |
| 7. upper chest depth | 19.0 | | 20.7 | | 23.0 | | 19.5 | | 23.4 | | 18.8 | |
| 8. chest depth | 23.2 | | 22.5 | | 23.7 | | 23.6 | | 25.4 | | 23.2 | |
| 9. under bust depth | 19.5 | | 20.4 | | 22.6 | | 20.6 | | 25.5 | | 19.3 | |
| 10. upper chest breadth | 29.0 | | 29.8 | | 32.0 | | 28.8 | | 30.6 | | 32.0 | |
| 11. chest breadth | 28.3 | | 30.9 | | 28.0 | | 28.5 | | 32.2 | | 29.8 | |
| 12. under bust breadth | 26.0 | | 28.3 | | 27.6 | | 27.8 | | 30.5 | | 29.8 | |
| 13. bust point breadth | 19.6 | | 19.9 | | 18.7 | | 19.2 | | 22.0 | | 19.2 | |
| sides of breast | R | L | R | L | R | L | R | L | R | L | R | L |
| 14. inner breast crease length I | 0.4 | 0.3 | 0 | 0 | 0.7 | 0.6 | 0.3 | 0.3 | 0.5 | 0.6 | 0.7 | 0.5 |
| 15. inner breast crease length II | 13.0 | 13.3 | 10.6 | 11.1 | 12.3 | 12.0 | 13.5 | 11.0 | 10.0 | 9.4 | 11.1 | 11.0 |
| 16. breast lateral length I | 15.7 | 16.0 | 11.8 | 11.1 | 12.8 | 12.6 | 15.2 | 13.8 | 11.6 | 9.5 | 15.8 | 15.5 |
| 17. breast inner length | 12.3 | 13.2 | 9.8 | 8.6 | 11.6 | 10.8 | 11.6 | 11.2 | 10.4 | 7.5 | 11.1 | 9.8 |
| 18. breast lateral length II | 14.7 | 15.4 | 5.5 | 7.5 | 12.0 | 12.2 | 14.7 | 13.3 | 4.6 | 4.9 | 15.5 | 14.2 |
| 19. inner-to-lateral breast length I | 25.0 | 24.0 | 22.7 | 22.6 | 21.0 | 20.0 | 24.5 | 23.0 | 21.6 | 18.9 | 23.0 | 22.5 |
| 20. upper breast length I | 12.5 | 13.5 | 11.7 | 11.2 | 7.2 | 11.8 | 13.0 | 11.0 | 9.6 | 9.3 | 13.5 | 12.0 |
| 21. inframammary crease I | 7.0 | 5.5 | 6.9 | 7.4 | 4.2 | 4.2 | 6.5 | 6.7 | 6.6 | 5.4 | 5.5 | 7.0 |
| 22. inframammary crease II | 8.0 | 6.2 | 10.1 | 10.3 | 5.0 | 5.0 | 7.3 | 7.2 | 7.6 | 6.6 | 6.8 | 7.5 |
| 23. upper breast length II | 12.2 | 13.0 | 11.4 | 9.7 | 10.8 | 9.0 | 11.5 | 11.2 | 11.1 | 7.6 | 12.4 | 11.0 |
| 24. lower breast length | 5.3 | 3.7 | 4.5 | 4.5 | 3.0 | 3.8 | 4.2 | 5.0 | 3.5 | 3.3 | 5.2 | 5.8 |
| 25. superior-to-inferior breast length | 17.5 | 16.7 | 14.8 | 13.6 | 13.8 | 12.8 | 15.7 | 16.2 | 13.1 | 11.4 | 17.6 | 16.8 |
| 26. drooping line length | 36.0 | 35.8 | 32.6 | 30.1 | 31.0 | 29.8 | 34.5 | 34.0 | 27.4 | 24.8 | 34.0 | 33.0 |
| 27. inner-to-lateral breast length II | 17.1 | 19.0 | 17.9 | 16.1 | 15.6 | 14.9 | 16.5 | 16.0 | 14.4 | 13.8 | 16.5 | 16.0 |
| 28. breast height | 3.5 | 3.8 | 5.0 | 4.9 | 2.8 | 3.0 | 2.8 | 2.9 | 1.2 | 1.1 | 3.7 | 3.6 |
| 29. breast volume(cc) | 382.2 | 435.2 | 685.7 | 672.8 | 231.1 | 218.7 | 444.2 | 416.2 | 449.0 | 450.9 | 519.3 | 408.1 |
| 30. weight(kg) | 59.0 | | 56.0 | | 60.0 | | 57.0 | | 74.0 | | 64.0 | |
| 31. brassiere size | 95A | | 95A | | 95A | | 95A | | 95A | | 95A | |

cup size even if the difference comes from one's obesity, not from the large breast volume.

Additionally, according to the Korean Standards, one should take cup size B when the difference is under 12.5cm and whose difference is under

15.0cm, cup size C should be chosen. Every volunteers answered they choose cup size A, but reviewing the difference between two parts, most of them wear the wrong size. From subject no.5 to no.12, difference over 12cm was found.

IV. DISCUSSIONS

We haven't chosen subjects that much for this study. However, the comparison of the data between left and right breasts reveals that a difference exists, as we presumed that there would be a certain difference for the left-to-right breast. The data shows the larger chest circumference doesn't mean the larger breast volumes and it may represent the current size specification cause some problems for fitting.

The goal in reconstruction of the postmastectomy defect involves creation of the appearance of symmetry (David et. al 1986) and to achieve volumetric symmetry, various methods of estimating breast volume are used in the field of plastic surgery. Likewise, the determination of breast volume would be very useful in making better-fitted brassieres for "normal" people and also in making better-fitted prostheses for mastectomy patients. However, there are no previous studies for these aims.

The various breast measurements also should be the guidelines for establishing the brassiere sizes and developing our own prostheses. Especially for the middle aged women who get to be obese, the difference between the chest circumference and the under bust circumference (cup size) would not match the real breast volume. From our survey to the patients who wear prostheses, we found the problem about the prostheses' weight. It's because we don't have a variety of prosthesis size and just rely on the imported products.

We should develop our own specifications for the various prosthesis size and shape. In America, most of those who used a breast prosthesis were satisfied with it (Ganz 1996). As a result of these findings, we have begun an initial study to develop our own mastectomy brassiere and prosthesis. In further

study, techniques of breast volume measuring should be refined and data of more volunteers may be obtained, which are statistically significant, so that we hope to help the breast cancer survivors' rehabilitations and the attitudinal changes to their life.

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