Evaluation of Breast Engorgement and Intra-mammary Hemodynamicsusing Portable Echo

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Abstract

While the use of a breast band has declined with the widespread adoption of nursing bras, mothers who complain of significant mastalgia can use breast elevation. This method of maintaining the breast in a conical shapeaimed at alleviating the symptoms of breast engorgement. However, its effectiveness in promoting blood flow in the breast has not been ascertained using objective indices. In this study, we aimed to examine the bra-wearing effect on blood flow in the axillary arteries and veins of women with breast engorgement symptoms, along with the bra use effect during lactation and relief from engorgement. After 12 women experienced breast engorgement on postpartum day 3, they wore a bra for 3 hours. Axillary arteriovenous blood flow was measured pre- and post-breastfeeding, as well as pre- and post-wearing a bra using portable echo. The pul-satility (PI) and resistance (RI) indices were calculated. Blood flow in the axillary artery was quantified for four women with non-wired bras. Blood flow in the axillary vein was quantified for one and four women wearing wired and non-wired bras, respectively. The changes after breast-feeding before and after wearing a bra were assessed. The axillary artery’s RI decreased after wearing non-wired bras, indicating increased blood flow into the breast and reduced vascular re-sistance. For the axillary veins, the PI and RI decreased after wearing wired bras, indicating re-duced vascular resistance and blood flow outside the breast. The PI and RI increased after wearing non-wired bras, indicating restricted blood return. Bras that raise the entire breast uniformly may facilitate adequate blood circulation, thus, influencing bra selection.

Keywords: breast care; breast engorgement; intramammary hemodynamics; bra effect; pulsatility; resistance.

1. Introduction

With the establishment of pregnancy, the mammary glands develop because of sex hormones secreted by the placenta. The top bust of a pregnant woman increases by an average of 6.5 cm by the time of delivery. The underbust increases by an average of 10 cm by approximately 36 weeks of gestation and decreases by 2.5 cm just before delivery [1]. The placenta is expelled from the uterus at the end of delivery, triggering a rapid decrease in the blood concentrations of sex hormones; prolactin secreted by the pitui-tary gland becomes dominant, and milk secretion begins. During the early postpartum period, the influx of blood and lymphatic fluid into the breast of the mother results in physiological engorgement. Approximately 30% of the blood supplied to the breast originates from the lateral thoracic artery, a branch of the axillary artery, while the remaining 60% is supplied by the internal thoracic artery, a branch of the subclavian artery [2]. The blood flows back through the leaflet artery to the leaflet, internal tho-racic, and lateral thoracic veins. When the return flow is insufficient, the pressure on the breast interstitium causes symptoms, such as milk fever, redness, and swelling, and problems, such as breast engorgement. Breast congestion causes edema throughout the breast, which leads to the narrowing of milk ducts and ductal opening. These result in a vicious cycle of milk production failureand increased breast pain. For women in the early postpartum period who wish to breastfeed, these symptoms of breast engorgement can cause severe distress and result in the discontinuation of breastfeeding, necessitating early midwifery intervention. One method of midwifery care for breast engorgement has been used since the Meiji era (1868–1912) to improve blood flow in the breast. While the use of a breast band has declined with the widespread adoption of nursing bras, mothers who complain of significant mastalgia can use breast elevation. This method of maintaining the breast in a conical shape [3] aimed atalleviating the symptoms of breast engorgement. However, its effectiveness in promoting blood flow in the breast has not been ascertained using objective indices.

In this study, we used intramammary blood flow as an objective index to verify the effect of breast elevation on relieving breast engorgement. We aimed to measure changes in blood flow in the axillary arteriovenous vein in women with symptoms of breast engorgement and ascertain the effectiveness of breast elevation using a bra in relieving breast engorgement.

2. Materials and Methods

2.1 Research Design

This was a quasi-experimental observational study.

2.2 Study Participants

The study involved 12 women (six first-time mothers and six postpartum mothers) with breast engorgement on the 3rd postpartum day.

2.3 Methods

A poster inviting participation in the study was displayed at the obstetrics and gynecology hospitals in Prefecture A from January to March 2022. Mothers willing to participate in the study were included after confirming that they were ineligible for exclusion. The exclusion criteria were as follows: (1) bra sizes other than Medium or Large; (2) age <17 or >50 years; (3) body mass index (BMI) ≤17 kg/m2; (4) no breast engorgement symptoms (Engorgement Scale level

III or less); (5) history of breast or mammary gland disease; (6) presence of skin diseases, such as atopic dermatitis; (7) presence of skin diseases, such as atopic dermatitis; and (7) knowledge of bra function and incision. After providing consent to participate in the study, participants wore one of four bras (one wired bra and three non-wired bras) for 3 hours. Bra types were selected randomly. Axillary arteriove-nous blood flow was measured at four time points (before and after breastfeeding and before and after wearing the bra) using a portable echo system to determine the pul-satility (PI) and resistance (RI) indices.

2.4 Operational Definition of Terms

Breast Engorgement refers to the circulatory failure of the breast that occurs mainly around the 3rd or 4th day postpartum. Humenick et alcategorized patients with breast engorgement to have an Engorgement Scale score of IV or higher [4].

2.5 Survey Items

2.5.1 Basic Attributes

The basic demographic data of the participants were collected from the Maternal and Child Health Handbook and examined by the researcher. These included age, number of births, body size (height, weight, BMI), breast measurements (top and under bust), and Engorgement Scale score.

2.5.2 Measurement Index

At each time point, the right axillary arteriovenous blood flow was measured us-ing an ultrasound imaging device (portable echo), and the PI and RI were quantified from the obtained measurements as indicators of vascular resistance. The magnitudes of change after breastfeeding and after wearing a bra were calculated and evaluated. Each participant was placed in a supine position with the upper limbs elevated. The axillary arteriovenous pulse was visualized using color Doppler, and pulsed Doppler was used for the measurements.

2.6 Analysis Methods

Basic statistical analyses were performed to analyze the characteristics of the par-ticipants. The magnitudes of change after breastfeeding and after wearing a bra were calculated from the measured values at each time point and compared. SPSS Statistics (version 25; IBM Corp., Armonk, NY, USA) was used to conduct all analyses.

2.7 Ethical Considerations

This study was approved by the Ethical Review Committee of the Shiga University of Medical Science (Approval No.: R2021-027). It was conducted under a contract re-search agreement with the Research and Development Department of Gunze Limited, Japan.

3. Results

3.1 Background Characteristics of the Participants

Three (25.0%) and nine (75.0%) participants were in their 20s and 30s, respectively. Six (50.0%) were first-time mothers, five (41.7%) were second-time mothers, and one (8.3%) was a thirdtime mother. Their average height, weight, and BMI were 159.0 ± 5.0 (mean ± standard deviation) cm, 57.4 ± 7.5 kg, and 22.7 ± 3.1 kg/m2, respectively. The breast measurements were 92.4±5.6 cm for the top bust and 78.9±5.7 cm for the under bust. The Engorgement Scale scores were IV for nine (75.0%), V for two (16.7%), and VI for one (8.3%) participant(s).

3.2 Axillary Arteriovenous Blood Flow

The axillary arteriovenous blood flow data are presented in Table 1.

Of the 12 participants, blood flow data were obtained for the axillary artery in four participants wearing non-wired bras (participants A, B, C, and D) and the axillary vein in one participant wearing a wired bra (participant E) and four participants wearing non-wired bras (participants A, B, C, and F). From these measurements, the changes after breastfeeding and after wearing a bra were assessed.

For the axillary artery, the PI values were -1.05, -0.33, +3.63, and -0.89 for the four participants wearing non-wire bras (participants A, B, C, and D), respectively. The RI values were -0.32, -0.06, -0.25, and -0.26, respectively.

For the axillary vein, the PI was -4.27 and the RI was -0.89 for the participant wearing the wire bra. The PI values for the four participants wearing non-wire bras (participants A, B, C, and F) were +0.74, +0.49, -3.47, and +0.04, respectively. The RI values were +0.39, +0.20, -0.61, and +0.04, respectively.

Table 1. Axillary arteriovenous blood flow and changes in each participant.

	Participants	After breastfeeding before wearing the bra	After breastfeeding after wearing the bra	Amount of variation
Axillary Artery PI	1	n/a	n/a	n/a
	2	n/a	n/a	n/a
	3 (C)	5.77	9.40	3.63
	4	n/a	n/a	n/a
	5	n/a	n/a	n/a
	6 (B)	1.68	1.35	-0.33
	7	n/a	n/a	n/a
	8 (A)	2.33	1.28	-1.05
	9	n/a	1.20	n/a
	10	n/a	2.19	n/a
	11	3.35	n/a	n/a
	12 (D)	1.63	0.74	-0.89
Axillary Artery RI	1	n/a	n/a	n/a
	2	n/a	n/a	n/a
	3 (C)	1.15	0.90	-0.25
	4	n/a	n/a	n/a

	5	n/a	n/a	n/a
	6 (B)	0.73	0.67	-0.06
	7	n/a	n/a	n/a
	8 (A)	1.00	0.68	-0.32
	9	n/a	0.60	n/a
	10	n/a	0.82	n/a
	11	0.90	n/a	n/a
	12 (D)	0.72	0.46	-0.26
Axillary Vein PI	1	n/a	0.34	n/a
	2	n/a	n/a	n/a
	3 (C)	3.88	0.41	-3.47
	4	1.23	n/a	n/a
	5	0.46	n/a	n/a
	6 (B)	0.50	0.99	0.49
	7	n/a	1.39	n/a
	8 (A)	0.26	1.00	0.74
	9 (F)	0.73	0.77	0.04
	10	n/a	0.72	n/a
	11 (E)	5.07	0.80	-4.27
	12 (D)	n/a	2.53	n/a
Axillary Vein RI	1	n/a	0.24	n/a
	2	n/a	n/a	n/a
	3 (C)	0.93	0.32	-0.61
	4	0.71	n/a	n/a
	5	0.36	n/a	n/a
	6 (B)	0.41	0.61	0.20
	7	n/a	0.60	n/a
	8 (A)	0.15	0.54	0.39
	9 (F)	0.43	0.47	0.04
	10	n/a	0.52	n/a
	11 (E)	1.36	0.47	-0.89
	12 (D)	n/a	0.77	n/a

4. Discussion

In this study, the RI of the axillary artery decreased in all four participants who wore non-wired bras. The RI is an index for evaluating peripheral vascular resistance. It increases when the blood flow into the periphery from the vessel is hindered and decreases when blood flows into the periphery easily [5]. The decrease in RI values for the axillary arteries in this study may have been caused by the breast elevation facili-tated by the design of the non-wired bras. Non-wired bras are specifically engineered to provide gentle support to the entire breast without exerting pressure on the axillary region [6]. The edematous condition of the entire breast makes it difficult for arterial blood to flow into the breast owing to congestion. However, wearing this bra for 3 hours reduces breast weight, facilitates venous return, reduces breast engorgement, and raises the breast to the extent that the axillary artery, which distributes blood to the breast, is relieved of its vascular resistance.

Vessels supplying tissues with low peripheral vascular resistance have low pulsa-tility and PI, whereas those supplying tissues with high peripheral vascular resistance have high pulsatility and PI. In this study, the pulsatility coefficient, PI, decreased in participants A, B, and D. This was attributed to a decrease in the vascular resistance of the axillary artery due to the wearing of non-wired bras and inferred to be an en-hancement of blood flow into the breast from the lateral thoracic artery; the lateral thoracic artery branches off the axillary artery. However, participant C showed an in-crease in PI. This was attributed to the reduction of the vascular resistance of the axil-lary artery, which promoted blood inflow. However, the vascular resistance of the lateral thoracic artery, which supplies blood to the axillary artery, and the leaflet artery in the breast, which supplies blood to the external thoracic artery, remained unchanged. This increased the pulsatility of the axillary artery.

We also speculate that the increased pulsatility of the axillary artery may have been caused by the increased pulsatility of the axillary artery because of the reduction of the vascular resistance of the axillary artery and the increased blood flow velocity.

In the axillary veins, decreased RI and PI values were observed in participant C, who wore a non-wired bra, and participant E, who wore a wired bra. These results indicated that the vascular resistance of the axillary vein was reduced, and annular flow of blood outside the breast was facilitated. However, participants A, B, and F ex-hibited increased RI and PI values in the axillary veins after wearing the non-wired bras, suggesting that the increased vascular resistance of the axillary veins did not promote annular flow of blood out of the breast. The reduction of the vascular re-sistance of the axillary veins in participants C and E may have resulted from the design of the bras; the entire breast was raised uniformly. The results of this study indicated that wearing a bra that raised the breast uniformly without over-tightening the axillary and nipple areas promoted blood flow in and out of the breast. It also improved the circulatory insufficiency of blood in the breast. We believe that this has implications for the selection of bras as breast care products.

To our knowledge, this was the first attempt to measure blood flow in the breast of women with symptoms of breast engorgement during the early postpartum period; blood flow measurement was extremely difficult owing to the degree of engorgement symptoms. However, no previous reports have shown that blood flow can be measured, suggesting its usefulness as an objective index for evaluating breast congestion symp-toms in the future.

One limitation of this study was the small sample of participants for whom blood flow data could be quantified. It is technically difficult to assess blood flow. It is a bi-ological index with large individual differences, and the participants whose data could be quantified were few owing to the

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difficulty of this study. We will continue our ul-trasonography training and conduct further research on blood flow data and the ef-fects of wearing bra.

5. Conclusions

This study used intramammary blood flow dynamics to verify the mitigating ef-fect of breast elevation on breast engorgement. The results showed that non-wired bra, which are shaped to elevate the entire breast uniformly may improve intramammary blood cir-culation insufficiency.

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