

# The physiological effects of massage before breast pumping on blood flow, temperature, and tension – A pilot study

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## Short report

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# Abstract

**Aim:** To test the feasibility of our ultrasound protocol in evaluating the physiological changes during breast milk expression, and the impact of breast massage on temperature, blood flow and tension.

**Method:** Breast massage was used for the right breast, and the left breast had no massage. Temperature was measured at baseline, post massage (for right breast), and post pump. The ultrasound scans were performed using a Toshiba Aplio 500 system (Toshiba Medical Systems, Otawara, Japan). B-mode, doppler ultrasound and shear wave elastography (SWE) were used. Blood flow of the IMA and LTA were measured at baseline, post massage (for right breast), 10 minutes into pump (relaxation and tension phase), and post pump. SWE was used to measure breast tension during the tension and relaxation phase of breast pump, after the breast milk was completely drained.

**Results:** There was a slight decrease in breast temperature post massage, and further decreased post pump. With breast massage, the SWE values were higher at relaxation phase compared to no massage (left breast). However, with massage, the tension phase also showed less increase of SWE values compared to no massage, and appeared to be lower than no massage. Blood flow of IMA did not appear to follow a particular trend, with and without massage.

**Conclusion:** Breast massage prior to pumping breast milk helped to reduce the temperature of the breast, showing that it has an effect in relieving breast engorgement. Massage also reduced the tension of the breast during the pump tension (suction) phase. There was no observable trend of massage on blood flow in both the IMQ and LTA.

## Background

Exclusive breastfeeding is strongly encouraged by the World Health Organization (WHO) up to at least six months after birth,<sup>1</sup> as babies who receive human milk are less likely to suffer health problems as newborns and later in life compared with babies who receive formula milk.<sup>2</sup> Inadequate milk supply has been cited as one of the top reasons for early discontinuation of breastfeeding.<sup>3,4</sup>

Massage has been found to be an effective and low-risk treatment choice which can help to increase milk secretion.<sup>5</sup> It can also help to relief pain associated with engorgement and mastitis.<sup>6</sup> These factors may facilitate continuous breastfeeding for a longer period of time. However, the physiological changes in which massage is associated with has not been studied.

Ultrasound studies on the internal mammary artery (IMA) and lateral thoracic artery (LTA) have been used to evaluate the blood flow characteristics of the human lactating breast.<sup>7</sup> In addition, shear wave

elastoplasty (SWE), a recent technology, allows visualisation and measurement of tissue elasticity which may provide a useful quantification of breast tissue stiffness.<sup>8</sup> Newer breast pumps have additional functions such as massage, the effects of the massage function on the physiological changes of the breast can be measured using SWE. This study aimed to test the feasibility of our ultrasound protocol in evaluating the physiological changes during breast milk expression, and to compare the physiological impact of breast massage on blood flow, tension, and temperature.

## Methods

This was a pilot experimental study. The participants were recruited from antenatal classes conducted by “Wong Boh Boi Pte Ltd”. The ultrasound procedure was conducted at the Singapore General Hospital, by a single certified Senior Ultrasonographer. The participants were given SGD\$50 (~USD\$38) for participating in the study. The study was approved by two ethics board in Singapore – the Singapore Institute of Technology Institutional Review Board (SIT-IRB) and Singhealth Centralised Institutional Review Board (CIRB).

The Hegen PCTO double electric pump was used in this study. The machine has adjustable suction levels are ranging from 1 to 12 as well as 3 expression rhythms - slow, medium or fast for the mothers to choose their optimum and most preferred expression mode. The device also has an automatic massage mode. For this study, we used a level 5 suction at slow mode to ensure standardisation. The massage was performed by placing the device at four meridian points (GB-21, GB-22, ST-18, CV-17) for 25 seconds at each side, and five cycles of the massage was used. Massage was applied only to the right breast; left breast received no massage.

### Ultrasound scanning

A standardised ultrasound protocol was written and adhered to for all participants (table 1). The ultrasound scans were performed using a Toshiba Aplio 500 system (Toshiba Medical Systems, Otawara, Japan). B-mode, doppler ultrasound and SWE. A high-resolution transducer frequency of between 5-12 MHz with single focal zone was used whilst maintaining highest image resolution of area of interest.

B-mode real-time survey of the breasts were used to find the location/landmarks of the lateral and medial arteries before using Doppler mode on these vessels. Post pump, B-mode was used to assess if the milk ducts were appropriately drained out so that the elastography could yield accurate results. Breast screening for pathologies was not performed.

## Data collection

The temperature of the breast was measured in degrees Celsius at baseline, post massage (for right breast), and post pump. It was taken by using an infrared thermometer, placed lateral to the sternum, at mid upper portion of the breast.

Blood flow of the IMA and LTA were measured using resistive index (RI). The RI is calculated by the ultrasound machine, derived from the maximum, minimum, and mean Doppler frequency shifts during a defined cardiac cycle. In short, the  $RI = (PSV - EDV) / PSV$ , where PSV is peak systolic velocity, and EDV is [end-diastolic velocity](#).

Blood flow was measured at baseline, post massage (for right breast), 10 minutes into pump (relaxation and tension phase), and post pump. The IMA is located alongside the sternum from second to the sixth intercostal space, deep to pectoral muscle, passing towards the mammary gland. Doppler velocity readings were obtained near the origin of the IMA branch, distal to the pectoral muscle. The LTA is located laterally and superiorly to the breast near the axilla. Doppler velocity readings were obtained near the origin of the LTA branch (Geddes 2009).

Shear wave elastoplasty using kPa was used to measure breast tension during the tension and relaxation phase of breast pump. This was performed after the breast milk was completely drained. The depth of the region of elasticity map was limited to 5 cm. A total of five 2D shear-wave elasticity values of the mammary tissue were taken during tension and relaxation of the pump, and the median of the readings was obtained.

## Results

Two healthy Chinese females who had been breast feeding for at least one month were recruited into the study. Both had given birth to their first child and had a University degree. The age of participants 1 and 2 were 31 and 27 respectively. Each ultrasound scan took approximately two hours.

### Temperature

Breast temperature dropped from baseline to post pump (figure 1). There was a slight decrease in breast temperature post massage, and further decreased post pump. The breast temperature was lower at post pump with massage for both participants.

## Blood flow

There was a sharp increase in RI at the IMA post massage for participant 2, but no change for participant 1 (figures 2a and 2b). At post pump, the RI returns to slightly lower than baseline values. Blood flow of IMA did not appear to follow a particular trend, with and without massage. The ultrasound images of the IMA with and without massage are in figures 3 and 4.

Blood flow of LTA showed a slightly increasing trend post massage. However, post pump, the RI returned to near baseline levels.

## Tension

With breast massage (right breast), the SWE values were higher at relaxation phase compared to no massage (left breast) (figure 5). However, with massage, the tension phase showed less increase in SWE values, and the tension phase values appeared to be lower, when compared to no massage. The ultrasound images of the breast tension with and without massage is in figure 6.

## Discussion

This was a preliminary study to evaluate the feasibility of our ultrasound protocol in evaluating the physiological changes during breast milk expression, and the effects of massage on temperature, blood flow, and tension. We have shown our ultrasound protocol to be feasible, which could be used in future studies which endeavours to do an in-depth exploration on the physiological changes during breast milk expression. Overall, our study found that massage prior pumping breast milk helped to reduce the temperature of the breast after massage, and post pump. It also reduced the tension of the breast during the pump tension (suction) phase. There was no observable trend of massage on blood flow.

The decrease in temperature after massage could be associated with the relief pain and engorgement. During engorgement, the mothers describe the breast as feeling tense and hot.<sup>6</sup> Breast massage has been found to be an effective way to help relief engorgement,<sup>6</sup> and the reduction in breast temperature has proven its physiological effects. Pain and engorgement are frequently experienced by breastfeeding mothers, which is one of the common reasons for cessation of breastfeeding. Massage could help relief these symptoms, encouraging the mothers to breastfeed for a longer duration.

During pump suction phase breast, it was found that the breast tension was higher. However, with massage, it was found that the tension from the suction motion was reduced. This reduction in tension could potentially help reduce the mothers' discomfort during breastfeeding. SWE is a more recent technology. Hence, no previous study has quantitatively evaluated the tension of the breast with and without massage. This is a novel aspect of our study.

Our study found that there was no change in blood flow with massage. This could concur with a previous study by Geddes and colleagues,<sup>7</sup> which found that there was no association of blood flow in the IMA and LTA with milk production. A limitation of our study was the inability to compare the volume of milk produced with and without massage, as study participants came for a single ultrasound session. We were unable to compare the volume of milk from the left and right breast as they could yield different volumes at baseline. A challenge of this study was to measure the SWE during the peak of tension phase as it only lasted a second. The ultrasonographer had to pick up the tension phase by listening to the rhythm of the pump.

A systematic review found that various massage techniques, such as the Oketani breast massage, oxytocin massage back massage, aromatherapy massage, Tuina massage and acupoint massage were effective in helping to increase milk production.<sup>5</sup> Our study found that massage helped to reduce breast temperature and tension. This could potentially be the mechanism in which massage helps to increase milk production. However, as our sample size is small, we could not make a definitive conclusion.

## Conclusion

The present study observed factors potentially associated with favourable breastfeeding outcomes using a breast pump with massage function. Breast massage prior to pumping breast milk helped to reduce the temperature of the breast. Massage also reduced the tension of the breast during the pump tension (suction) phase. There was no observable trend of massage on blood flow in both the IMQ and LTA.

## Declarations

Ethics approval and consent to participate

This study has been approved by the Singapore Institute of Technology Institutional Review Board (SIT-IRB) and Singhealth Centralised Institutional Review Board (CIRB), reference number 2020/2868. Written consent was obtained from all participants.

Consent for publication

Not applicable

#### Availability of data and materials

Data sharing is not applicable to this article as no datasets were generated or analysed during the current study.

#### Competing interests

The first author (Mabel Leow) is paid by Hegen Pte Ptd to write the manuscript. However, she has no associations with the company.

#### Funding

This study is funded by Hegen Pte Ptd, a company that develops and sells breast milk pumps and baby milk bottles.

#### Authors' contributions

All authors conceptualised the manuscript, ABM and LC wrote the ultrasound protocol. ABM performed the ultrasound scan. ABM and ML performed the data analysis. ML wrote the manuscript. All authors approved of the final manuscript.

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#### Funding

This study is funded by Hegen Pte Ltd. The funders are not involved in the study. Wong Boh Boi Pte Ltd which provides antenatal class is paid to help conduct the study. Wong Boh Boi Pte Ltd does not promote the products of any company.

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## Table

Table 1. Ultrasound scan protocol	
Patient will set up their breast pump sitting on the ultrasound table	
Breast pump settings:	
<ul style="list-style-type: none"> <li>• Single expression</li> <li>• Suction level = 5</li> <li>• Expression mode = 1 petal</li> </ul>	
<b>Left Breast</b>	Take temperature
Before Pump	IMA Doppler (RI + PSV)
	LTA Doppler (RI + PSV)
During Pump	IMA Doppler (RI + PSV) Tension (Suction) & Relaxation
	LTA Doppler (RI + PSV) Tension (Suction) & Relaxation
Pump Ends	IMA Doppler (RI + PSV)
	LTA Doppler (RI + PSV)
SWE	Five 2D shear-wave elasticity values
	Tension (Suction) & Relaxation
	Median stiffness (kPa) readings will be determined by the report
	Take temperature
<b>Right breast</b>	Take temperature
	Hegen massage of meridian points
	Take temperature
Before Pump	IMA Doppler (RI + PSV)
	LTA Doppler (RI + PSV)
During Pump	IMA Doppler (RI + PSV) Tension (Suction) & Relaxation
	LTA Doppler (RI + PSV) Tension (Suction) & Relaxation
Pump Ends	IMA Doppler (RI + PSV)
	LTA Doppler (RI + PSV)
SWE	Five 2D shear-wave elasticity values
	Tension (Suction) & Relaxation
	Median stiffness (kPa) readings will be determined by the report
	Take temperature

Footnotes: Doppler ultrasound of the internal mammary artery (IMA) and the lateral thoracic artery (LTA) were taken. The IMA is located alongside the sternum from second to the sixth intercostal space, deep to pectoral muscle, passing towards the mammary gland. Doppler velocity readings will be obtained near the origin of the IMA branch, distal to the pectoral muscle. The LTA is located laterally and superiorly to the breast near the axilla. Doppler velocity readings will be obtained near the origin of the LTA branch.

Legend: SWE, Shearwave elastography; RI, Resistive index; PSV, Peak systolic velocity

## Figures

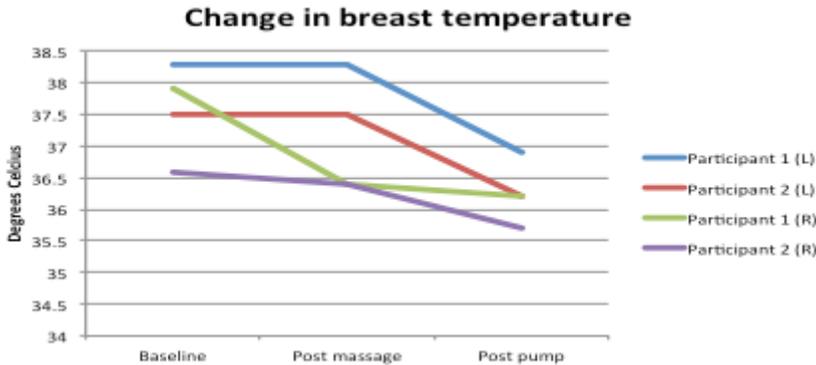


Figure 1

Change in breast temperature

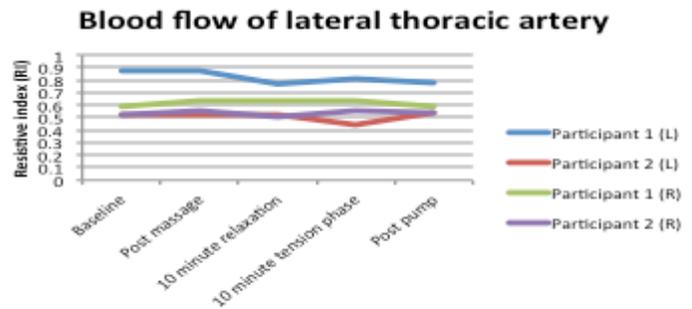
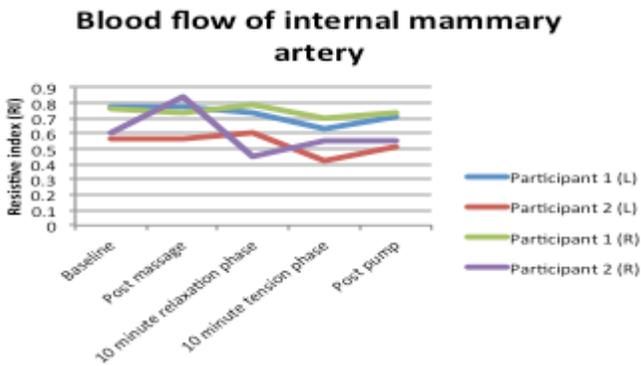
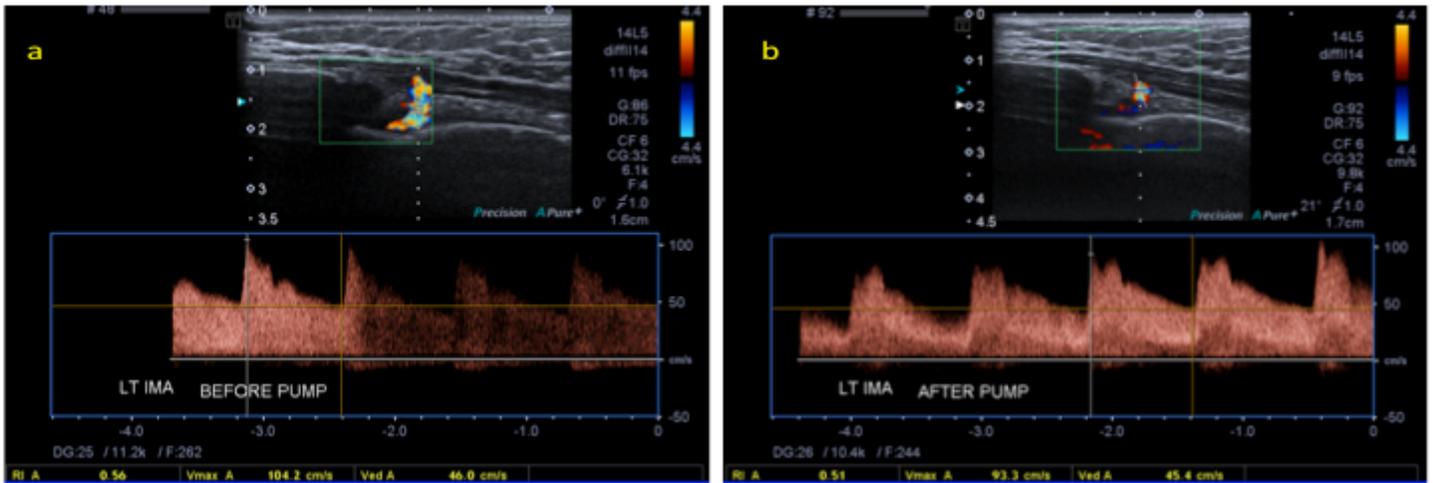


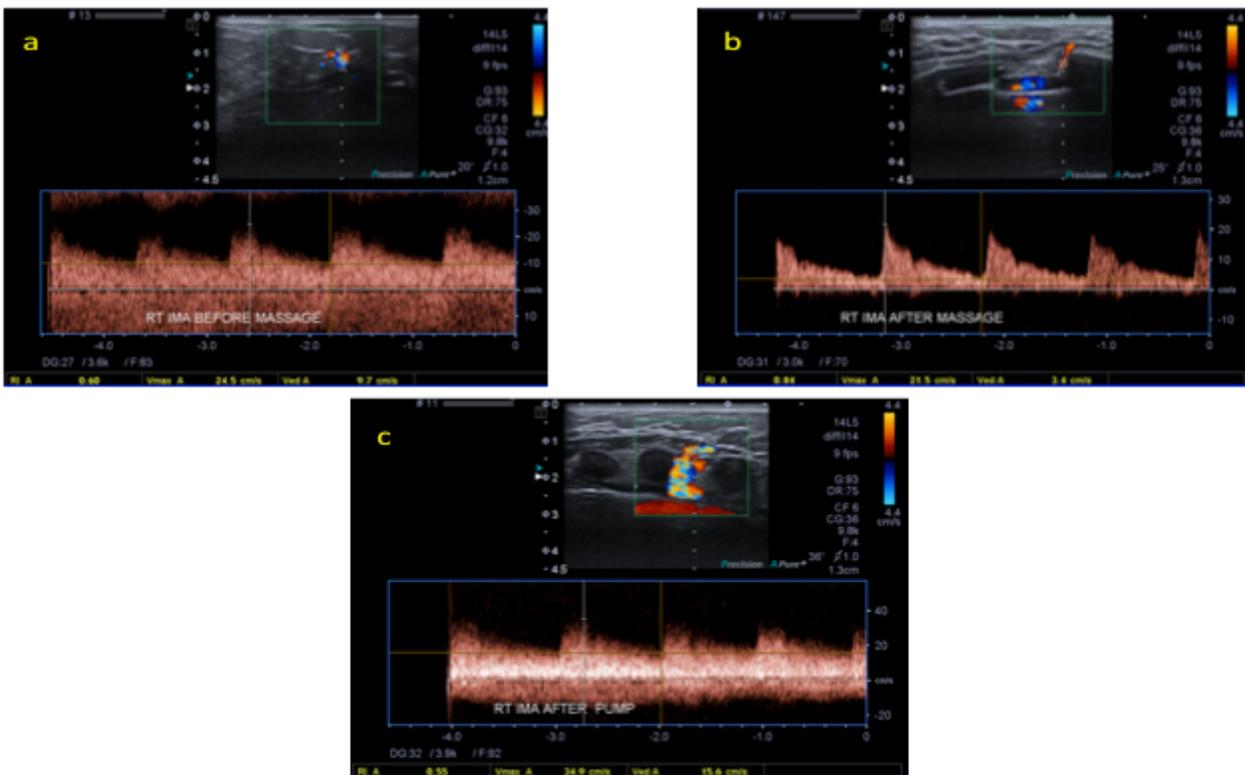
Figure 2

a. Blood flow of internal mammary artery b. Blood flow of lateral thoracic artery



**Figure 3**

Doppler ultrasound of the internal mammary artery without massage 27-year old female, where Doppler ultrasound of the internal mammary artery (IMA) showed (a) before pump, the IMA had resistive index of 0.56 (b) after pump, the IMA resistive index of 0.51.



**Figure 4**

2 Doppler ultrasound of the internal mammary artery with massage 27-year old female, where Doppler ultrasound of the internal mammary artery (IMA) showed (a) before massage, the IMA had resistive index of 0.60 (b) after massage, the IMA had resistive index of 0.84 (c) after pump, the IMA resistive index of 0.55

### Shear wave elastoplasty during relaxation and tension phase of pump

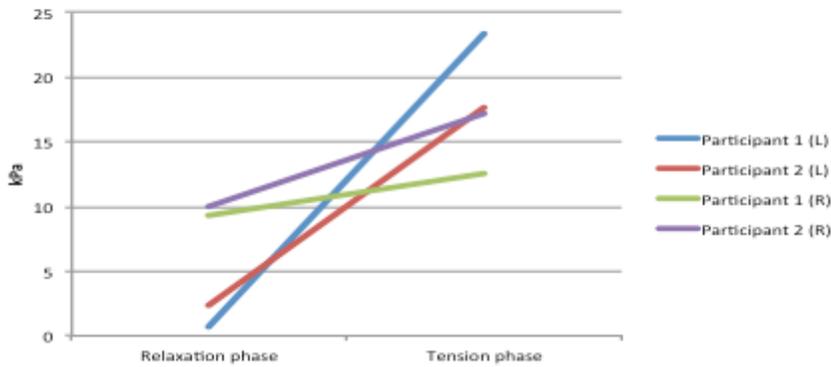


Figure 5

Shear wave elastoplasty during relaxation and tension phase of pump.

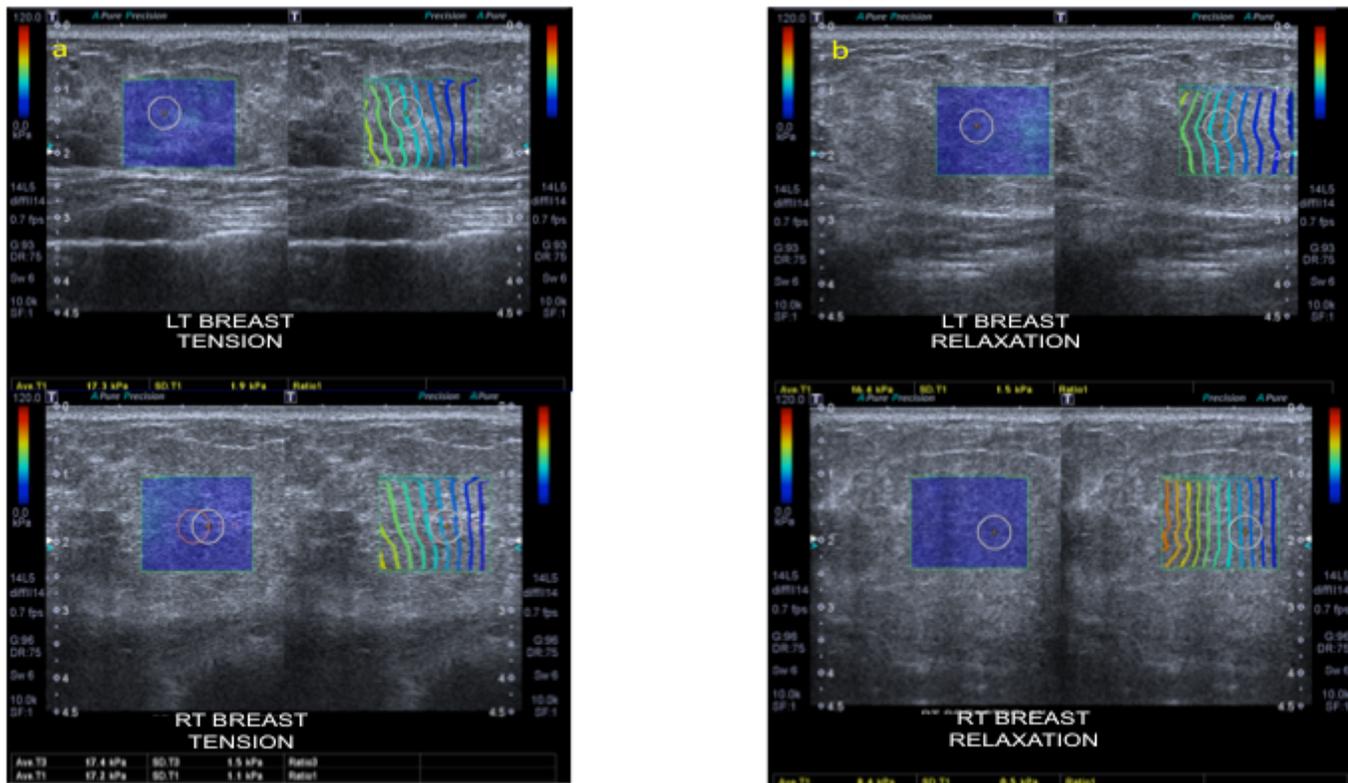


Figure 6

Shear wave elastoplasty of the breast tension and relaxation phase. Shear wave elastography, SWE was performed on the breasts after the milk ducts were drained and 5 measurements were taken at each breast during tension and relaxation. Median measurements were taken respectively (a) Left breast tension SWE where median of 5 values was 17.7 kPa (b) Left breast relaxation SWE where median was 16.2 kPa (c) Right breast tension SWE where median of 5 values was 17.2 kPa (d) Right breast relaxation SWE where median was 10.0 kPa