

## Effects of therapeutic ultrasound in mammary engorgement: pilot study

### Efeitos do ultrassom terapêutico no ingurgitamento mamário: estudo piloto

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**RESUMO | INTRODUÇÃO:** A amamentação constitui uma importante etapa no processo reprodutivo, oferecendo benefícios tanto para mãe como para a criança. O Ingurgitamento mamário é uma complicação que ocorre do terceiro ao quinto dia de pós-parto. O Ultrassom Terapêutico (UST) é amplamente utilizado, e consiste em um aparelho capaz de produzir energia acústica de alta frequência. **OBJETIVO:** verificar o efeito agudo do ultrassom no processo terapêutico do ingurgitamento mamário. **METODOLOGIA:** Estudo transversal, que avaliou a mama e classificou o ingurgitamento, além de realizar avaliação da dor e da percepção subjetiva das mamas. Foi administrado o protocolo com ultrassom terapêutico na frequência de 1Mh, modo pulsado, intensidade/dose de 0,5w/cm<sup>2</sup>, ciclo ativo de 20% com tempo de aplicação de 02 minutos por área de radiação efetiva (ERA). Após aplicação, a lactente foi submetida à amamentação e realizada nova avaliação das mamas. **RESULTADOS:** A amostra foi composta por 4 mulheres entre 20 e 30 anos com quadro de ingurgitamento mamário. O valor inicial do ingurgitamento mamário foi de 2 a mediana e a final foi de 1 a mediana. Em relação à dor mamária, inicialmente foi de 5 mediana e a final 2 a mediana. Em todos os casos analisados houve melhora na dor, na disponibilidade do leite e no aspecto de ingurgitamento da mama. **CONCLUSÃO:** O ultrassom terapêutico se mostrou eficaz na redução da dor, no aumento da disponibilidade do leite e na melhora do enrijecimento característico do ingurgitamento mamário.

**PALAVRAS-CHAVE:** Ingurgitamento mamário. Ultrassom terapêutico. Mamas. Aleitamento.

**ABSTRACT | INTRODUCTION:** Breastfeeding is an important step in the reproductive process, providing benefits for both mother and child. Breast engorgement is a complication that occurs from the third to the fifth postpartum day. Therapeutic Ultrasound (UST) is widely used, and consists of an apparatus capable of producing high frequency acoustic energy. **OBJECTIVE:** to verify the acute effect of ultrasound in the therapeutic process of breast engorgement. **METHODOLOGY:** Cross-sectional study, which evaluated the breast and classified the engorgement, besides evaluating the pain and the subjective perception of the breasts. The protocol with therapeutic ultrasound was administered at a frequency of 1Mh, pulsed mode, intensity / dose of 0.5w / cm<sup>2</sup>, active cycle of 20% with application time of 02 minutes per effective Radiation Area (ERA). After application, the infant was submitted to breastfeeding and a new breast evaluation was performed. **RESULTS:** The sample consisted of 4 women between 20 and 30 years of age with breast engorgement. The initial value of breast engorgement was 2 the median and the final value was 1 to median. Regarding breast pain, it was initially 5 median and the final 2 median. In all the analyzed cases there was improvement in pain, milk availability and breast engorgement aspect. **CONCLUSION:** Therapeutic ultrasound has been shown to be effective in reducing pain, increasing milk availability and improving the stiffness characteristic of breast engorgement.

**KEYWORDS:** Breast engorgement. Therapeutic ultrasound. Breasts. Breastfeeding.

## Introduction

Breastfeeding is an important physiological process for mothers and newborns, which starts with the newborn leaving the placenta, when the levels of estrogen and progesterone hormones fall and prolactin levels increase, responsible for stimulating milk production by the mammary glands<sup>1</sup>. It is also the moment of increase in the production of the hormone oxytocin, which has its production and release stimulated by suction to the maternal breast, favouring the ejection of milk<sup>2,3</sup>.

Breastfeeding supplies the newborn's nutritional necessities, is an important factor of protection against diseases, contributes to psychological and emotional development and keeps growth within normality<sup>4,5</sup>. Breastfeeding also contributes to women's health, as it contributes to a faster uterine involution<sup>1</sup>, reduces the risks of diabetes development, breast and ovarian cancer, reduces weight more quickly and is a natural contraceptive method<sup>6,7</sup>. Meantime, incorrect breastfeeding techniques, infrequent breastfeeding, pre-established feeding schedules, suction time control, bottle feeding, incomplete emptying of milk and premature newborn are important factors that predispose to the development of lactation complications such as breast engorgement<sup>8</sup>.

Breast engorgement is a very common complication, and occurs more frequently from the third to fifth postpartum day<sup>9</sup>. It is developed as a result of the increase in the vascularization of the breast and accumulation of milk, caused by lymphatic and vascular congestion<sup>10</sup>. The sequence of events leading to the occurrence of engorgement are milk retention in the alveoli, alveolar distension, compression of the ducts, obstruction of the milk flow, worsening of alveolar distension and increased obstruction. The increase in pressure inside the ducts causes changes at the intermolecular level of the accumulated milk, which becomes more viscous<sup>8</sup>.

Engorgement can be classified as physiological or pathological, with physiological engorgement being a normal process of lactogenesis<sup>11</sup>. Pathological engorgement, is characterized by the appearance of symptoms such as pain, enlarged breasts, shiny skin, local hyperemia, breast edema and flattened nipples,

there may be discomfort, fever and malaise, and may progress to mastitis that is acute infection of the mammary gland<sup>12</sup>. As the localization, engorgement may be restricted to areola and nipple (areolar), to the body of the breast (peripheral) or to undertake both<sup>13</sup>. Because it involves the processes of lactogenesis, engorgement has implications for the long-term success of lactation and breastfeeding<sup>14</sup>.

The management of engorgement varies in the clinical setting with a wide variety of procedures. Traditionally, the maintenance of breastfeeding and manual milking to balance the production and consumption of milk by the child has been adopted as therapy. Associated with these procedures, other isolated or associated procedures are common in the usual practice of health professionals, with the use of varied, controversial protocols and without scientific evidence of the effectiveness of the procedures<sup>15</sup>. Among the instruments used in clinical practice it is the therapeutic ultrasound (TUS).

The TUS is a device widely used by physiotherapists, having proven its effectiveness in the treatment of pathologies<sup>16</sup>. Introduced in the 1950s, UST is characterized by the emission of high frequency acoustic energy (1 to 3MHz) and intensity (0.1 to 3 W/cm<sup>2</sup>) which is transmitted to the soft tissues by a coupling agent. Its use is based on the thermal and mechanical effects in the soft tissues, mainly in tissues with high protein content<sup>17</sup>.

The thermal effect is generated when the acoustic energy is absorbed by the tissues, promoting a vibration between the molecules, the greater the intensity of the ultrasonic beam, the more continuous the emission, the greater the vibration intensity and more heat is produced in the tissues<sup>16,18</sup>. The mechanical or non thermal effects are generated from the relation between stable cavitation and microcurrent<sup>16</sup>. The parameters for UST application are head frequency, emission mode, ERA (Effective Radiation Area) of the transducer, intensity, duration of application and treatment frequency, such parameters being adapted according to the proposed use<sup>19</sup>.

Since conventional UST, being an easy-to-access and relatively inexpensive treatment, has considerable mechanical effects on cells, altering the permeability

of membranes, it is believed that these effects may be effective in the treatment of breast engorgement, which is a problem that afflicts thousands of women, presenting itself as one of the most recurrent pathologies during the breastfeeding period. Thus, the objective of this study is to verify the acute effect of therapeutic ultrasound in reversing the pathological complications of breast engorgement in primiparous women.

## Methods

This is a cross-sectional study, with a quantitative and qualitative approach. Eighteen women were selected by convenience for inclusion on the study. The criteria were: primiparous women, of immediate puerperium who performed normal non-premature child-birth. Women who did not sign the informed consent form (EHIC) and women who could not sustain the minimum time (2 minutes) required for the ultrasound procedure were excluded.

The research project was submitted to the research ethics committee of the Brazilian Educational Association - SOEBRAS obeying resolution 466 of the year 2012, obtaining a favorable endorsement (Opinion with the number of the Opinion: 2,869,737).

The selected women were informed about all procedures and all the material collects occurred in the bed (apartment) at rest. At the first moment, the nursing team of the hospital informed which women had the occurrence of breast engorgement, then the research team approached to the patient through a visit, later, after selecting the patients, according to the inclusion criteria, was performed the evaluation and classification of engorgement according to the levels proposed by the adapted Robson scale<sup>21</sup>, pain evaluation through VAS and subjective assessment of breast perception.

A standardized questionnaire was used to collect the variables of breast engorgement, breast pain and perception. The instrument was organized by the authors themselves for evaluation and analysis of the data, and was composed by 5 items. Item I is an adaptation of Robson's breast engorgement scale<sup>21</sup>,

item II visual analogue scale (VAS), item III subjective perception of breast status before application of the protocol, item IV perception about milk availability, and item V perception of the breast after lactation.

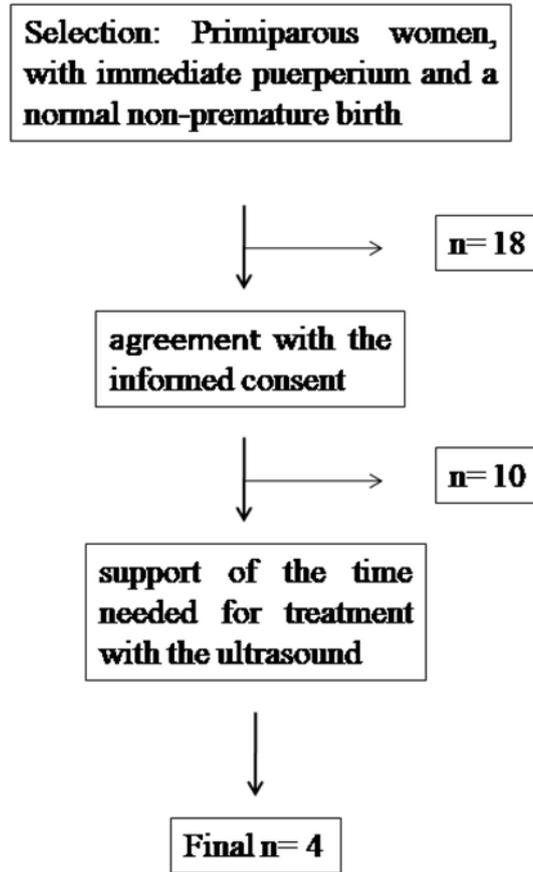
The USR Sonopulse treatment protocol of the IBRAMED brand was administered with 7 cm<sup>2</sup> of ERA at a frequency of 1Mh, pulsed emission mode, intensity / dose of 0.5w/cm<sup>2</sup>, active cycle of 20% with application time of 02 minutes by ERA, in circular, slow and rhythmic movements of the head over the engorged breast. These parameters were determined in order to generate mechanical and non-thermal effects. Ultrasonic water-soluble gel was used as the coupling medium. The apparatus was previously calibrated, and the treatment consisted of a single application. After the UST application, the infant was submitted to breastfeeding and at the end of breastfeeding, a new evaluation of the breasts was performed using the previously mentioned scales and the women responded to items IV and V of the questionnaire organized by the researchers.

All collected data were digitalized and later analyzed statistically in the statistical program SPSS®, version 20.0, for Windows. Initially, the methods of descriptive statistics (median, maximum and minimum) were used. For the qualitative analysis, all the answers related to each woman who participated of the study were presented in a table.

## Results

The study sample consisted of 4 women between 20 and 30 years old, primiparous in immediate puerperium, who were treated at the Hospital Mário Ribeiro and presented breast engorgement (Figure 1). The mean age of women was 24.00 ± 3.74 years. The participant women were low-income, living in the city of Montes Claros-MG Brazil, with high school completed and married.

Figure 1. Flow diagram of sample selection process



The initial value of breast engorgement was 2 the median and the final value was 1. Respecting to breast pain, it was initially 5 median and the final 2. These results are summarized in Table 1.

Table 1. Inferential analysis of breast engorgement and breast pain of women in immediate postpartum.

Variables	Women (n=4)					
	Before procedure			After procedure		
	Median	Maximum	Minimum	Median	Maximum	Minimum
Breastengorgement	2	3	1	1	2	1
Breastpain	5	6	4	2	3	1

The chart 1 shows the patients reports about the perception of the breasts before and after the application of the protocol, on the availability of milk during breastfeeding and breast status. In two cases the baby was breastfed and in the other two, one baby did not wake up to breastfeed and the other one was very agitated, not accepting breastfeeding at the time of care.

**Chart 1.** Report of the perception of women with breast engorgement about the proposed ultrasound procedures

Patient	Report
n1 (age 22)	<ul style="list-style-type: none"> <li>• Perception of the breasts before lactation and TUS application was hardened, painful and with ejection of a small amount milk.</li> <li>• After ultrasound application the patient's perception was of satisfaction, greater availability of milk and partial emptying of the breast.</li> <li>• Breasts with little hardening, reduced pain and little milk ejection.</li> <li>• The milk was ejected because the newborn breastfed.</li> </ul>
n2 (age 24)	<ul style="list-style-type: none"> <li>• Perception of the breasts before lactation and application of ultrasound was hard breasts, painful and with little ejection of milk.</li> <li>• After ultrasound application the patient's perception was of satisfaction, greater availability of milk and partial emptying of the breast.</li> <li>• Perception of the breasts after lactation: lighter sensation, painless breast with complete emptying.</li> <li>• The milk was ejected because the newborn breastfed.</li> </ul>
n3 (age 30)	<ul style="list-style-type: none"> <li>• Perception of the breasts before lactation and application of ultrasound was breasts hard, painful and with no ejection of milk.</li> <li>• After ultrasound application the patient's perception was of satisfaction and greater availability of milk.</li> <li>• Perception of the breasts after ultrasound: there was no lactation, but there was decrease of the level of pain.</li> <li>• The newborn did not wake up for breastfeeding, but during the ultrasound application there was milk flow in both breasts.</li> </ul>
n4 (age 20)	<ul style="list-style-type: none"> <li>• Perception of the breasts before lactation and application of ultrasound was hard breasts, painful and with little ejection of milk.</li> <li>• After ultrasound application the patient's perception was of satisfaction and greater availability of milk.</li> <li>• Breasts with lighter sensation and no pain.</li> <li>• The milk was not ejected because the newborn was agitated and did not breastfeed.</li> </ul>

Among the patients in whom the infants breastfed, the initial report on breast perception was hardened, painful and with little milk ejection. After application of the protocol, all mothers reported were satisfied, with greater availability of milk for the newborn.

The participant n1 exhibited partial emptying and in n2 there was complete emptying of the breast. Regarding to the perception of the breast after ultrasound application, n1 noticed improvement in hardness, from hardened to slightly hardened and decrease of pain, n2 reported that her breasts were lighter and painless. In both cases there was increased milk availability, reduced pain and improved breast tightening.

Among the women who did not breastfeed the initial perception was hardened and painful breasts, n3 did not show milk ejection and n4 had little ejection. In both cases they reported being satisfied, as there was an increase in milk availability and pain reduction. In all cases analyzed there was improvement of pain, milk availability and breast engorgement aspect, regardless of breastfeeding.

## Discussion

This study aimed to evaluate the immediate effect of TUS in breast engorgement and showed that the improvement of pain after the application of ultrasound is related to its analgesic effects and to the effect of cavitation that promotes micro massages in the cells<sup>16</sup> resulting in fluidization of the milk, increasing its ejection and availability, promoting a lighter sensation to the breasts. The results found in this study demonstrate positive effects of the ultrasound in the therapeutic process of breast engorgement.

We found only the study developed by Mclachlan et al.<sup>21</sup>, which had the aim of analyze the effects of ultrasound on breast engorgement, and the results, according to the authors, could not be attributed to therapeutic ultrasound. It was a randomized, double-blind study with 117 women, divided into two groups. The study in question presented a methodology similar to ours and, unlike our findings, the improvement of breast engorgement could not be attributed to the use of TUS. The absence of studies that used a methodology similar or comparable to ours, in addition to limiting our discussion, demonstrates the need for further studies involving TUS and breast engorgement, taking into consideration the positive results found in this pilot study.

In the study performed by Mclachlan et al.<sup>21</sup>, the population consisted of 111 women and 117 breasts, aged between 16 and 42 years old and mean of 30.4 years, the sample consisted of multiparous and primiparous, less than half primiparous. In our study the sample consisted only of primiparous women because they were more predisposed to engorgement. In the study made by Mclachlan et al.<sup>21</sup>, ultrasound was used in a continuous mode, in which thermal effects were important, and, in our study, we used the pulsed mode, making it difficult for some comparisons regarding the refutation of the results found.

The present literature recommends using the pulsed mode for acute processes. According to Martins<sup>3</sup>, pulsed ultrasound, especially at low intensities, has many beneficial effects; due to the decrease in its thermal effect, it is used in situations such as acute inflammation, subacute inflammation, neuropathic pain and edema; since the continuous mode has its thermal effect generated by the intermolecular friction in the tissues that occur by the movement of the electrolytic medium of the interstitial liquids, both of the water and the solutes, making the continuous ultrasound wave contraindicated in the acute inflammatory processes. Based on such information we opted for the use of the pulsed mode, instead of the continuous mode, paying special attention to the acute characteristic presented by breast engorgement, noting that the literature does not present any studies comparing continuous or pulsatile differentiation.

In the study presented by Mclachlan et al.<sup>21</sup>, the treatment time ranged from 8 to 15 minutes, whereas in our study, the time was equivalent to 2 minutes per ERA (effective radiation area) of the ultrasonic head, with a total application time between 12 and 16 minutes, being a similar and comparable period of time, and the treatment consisted in a single application in order to evaluate the acute effects of ultrasound in the short term.

The study by Mclachlan et al.<sup>21</sup>, obtained positive results even using the continuous modality, however in the interpretation of the results, both the placebo and experimental groups were equally effective and the interpretation of the final result was impaired. A methodological detail of this study called attention, as for the placebo machine, the crystal was removed

and replaced by a resistor producing only superficial heat. This information allows to infer that in both groups heat was used, this explains the similarity of results obtained in the control and placebo groups. One point that may have limited the results of our study was the n used when compared to the studies discussed. New studies involving a larger sample size should be performed in order to make the data presented here more effective and reproducible.

Leite et al.<sup>20</sup>, affirms that the continuous form produces a greater amount of heat due to the vibration of cellular particles, which with the friction between them, produces the thermal effect. A physiological thermal effect can be achieved by promoting pain relief, decreased joint stiffness and increased local blood flow.

For Olsson et al.<sup>22</sup>, the difference between the modes of continuous and pulsed application is in the interrupted propagation of waves, in the continuous, the voltage across the ultrasound transducer must be applied continuously and its frequency cycles are above 100%, throughout the treatment period. In pulsed mode the voltage is applied in bursts, with frequency cycles less than 100%, so the thermal effect is less uttered and the mechanical effect is higher, allowing the opening of treatment fields where, the predominantly thermal effect is not desirable as treatment for pain.

According to Bertolini<sup>23</sup>, the therapeutic effects of non-thermal ultrasound come from stable cavitation and acoustic micro flow, which can alter the structure, permeability and function of the cell membrane, stimulating a fast improvement of the inflammatory process, repair and tissue regeneration, producing analgesic effects and decreasing edema. Belanger<sup>16</sup> also states that acoustic energy is better absorbed by tissues with high density and high protein content. However, Laurindo et al.<sup>24</sup>, affirm that human milk has many peculiarities in its composition, having high concentrations of proteins, so, the use of ultrasound in the therapeutic process of breast engorgement is justified.

Our study, like Mclachlan's et al.<sup>21</sup>, obtained positive results in the therapeutic process of breast engorgement. However, one study used the continuous mode and ours the pulsed mode, making it doubtful which one should be the best protocol.

Further studies are suggested, with two experimental groups to evaluate the efficacy between the two modalities in the treatment of breast engorgement.

As no adverse effects were observed, TUS proved to be safe for use in a randomized controlled trial. As a limitation of the study, the reduced sample, the dependence of the infant to obtain the results of milk availability and unique application of the protocol is emphasized.

## Conclusion

The therapeutic ultrasound has shown to be effective in the immediate effect of reducing pain, increasing milk availability and improving the stiffness characteristic of breast engorgement, making it a safe and effective alternative in the therapeutic process of this disease.

## Author contributions

Santos FO participated of data collection, construction of theoretical reference and construction of work; Fernandes JM participated of data collection, construction of theoretical reference and construction of the work; Dos Santos JLR participated of the work correction, adaptation to the scientific model and formatting of the work to the norms of the magazine; Alves MR participated of the organization of data and statistical analyzes; Vieira MM participated in the collection of data, orientation processes and initial formatting of the work; Rodrigues VD participated in the data collection, processes of orientation, correction and formatting of the the initial work.

## Competing interests

No financial, legal or political competing interests with third parties (government, commercial, private foundation, etc.) were disclosed for any aspect of the submitted work (including but not limited to grants, data monitoring board, study design, manuscript preparation, statistical analysis, etc.).

## References

1. Martins M, Maia Filho ALM, Costa CLS, Coelho NPMF, Costa MS, Carvalho RA. Ação anti-inflamatória da fração lipídica do Ovis aries associado ao ultrassom terapêutico em modelo experimental de tendinite em ratos (*Rattus norvegicus*). Rev Bras Fisioter. 2011;15(4):297-302. doi: [10.1590/S1413-35552011000400007](https://doi.org/10.1590/S1413-35552011000400007)

2. Nelas P, Coutinho E, Chaves C, Amaral O, Cruz C. Dificuldades na amamentação no primeiro mês de vida: impacto dos contextos de vida. Revista INFAD de Psicologia. 2017;3(1):183-92. doi: [10.17060/ijodaep.2017.n1.v3.987](https://doi.org/10.17060/ijodaep.2017.n1.v3.987)

3. Martins MZO, Santana LS. Benefícios da amamentação para saúde materna. Interfaces Científicas-Saúde e Ambiente. 2013;1(3):87-97.

4. França GVA, Brunken GS, Silva SM, Escuder MM, Venancio SI. Determinantes da amamentação no primeiro ano de vida em Cuiabá, Mato Grosso. Rev Saúde Públ. 2007;41(5):711-18. doi: [10.1590/S0034-89102007000500004](https://doi.org/10.1590/S0034-89102007000500004)

5. Souza Filho MD, Gonçalves Neto PNT, Martins MCC. Avaliação dos problemas relacionados ao aleitamento materno a partir do olhar da enfermagem. Cogitare Enferm. 2011;16(1):70-5. doi: [10.5380/ce.v16i1.21114](https://doi.org/10.5380/ce.v16i1.21114)

6. Castro KF, Souto CMRM, Rigão TVC, Garcia TR, Bustorff LACV, Braga VAB. Intercorrências mamárias relacionadas à lactação: estudo envolvendo puérperas de uma maternidade pública de João Pessoa, PB. Mundo saúde. 2009;33(4):433-9.

7. Alencar AP, Nascimento G, Lira P, Fonseca F, Fonseca R, Alves B et al. Principais causas do desmame precoce em uma estratégia de saúde da família. Saúde Meio Ambient. 2017;6(2):65-76.

8. Sousa L, Haddad ML, Nakano AMS, Gomes FA. Terapêutica não-farmacológica para alívio do ingurgitamento mamário durante a lactação: revisão integrativa da literatura. Rev Esc Enferm USP. 2012;46(2):472-9. doi: [10.1590/S0080-62342012000200028](https://doi.org/10.1590/S0080-62342012000200028)

9. Giugliani ERJ. Problemas comuns na lactação e seu manejo. J Pediatr. 2004;80(supl 5): 147-154.

10. Heberle ABS, Moura MAM, Souza MA, Nohama P. Avaliação das técnicas de massagem e ordenha no tratamento do ingurgitamento mamário por termografia. Rev Latino-Am Enfermagem. 2014;22(2):277-85. doi: [10.1590/0104-1169.3238.2413](https://doi.org/10.1590/0104-1169.3238.2413)

11. Ngo LTH, Chou HF, Gau ML, Liu CY. Breastfeeding self-efficacy and related factors in postpartum Vietnamese women. Midwifery. 2019;70:84-91. doi: [10.1016/j.midw.2018.12.014](https://doi.org/10.1016/j.midw.2018.12.014)

12. Karaçam Z, Sağlık M. Breastfeeding problems and interventions performed on problems: systematic review based on studies made in Turkey. Türk Pediatri Arş. 2018;53(3):134-148. doi: [10.5152/TurkPediatriArs.2018.6350](https://doi.org/10.5152/TurkPediatriArs.2018.6350)

13. Mangesi L, Dowswell T. Treatments for breast engorgement during lactation. Cochrane Database Syst Rev. 2010(9):CD006946. doi: [10.1002/14651858.CD006946.pub2](https://doi.org/10.1002/14651858.CD006946.pub2)

14. Robson BA. Breast engorgement in breastfeeding mothers. Cleveland, OH: Case Western Reserve University; 1990.

13. Mangesi L, Dowswell T. Treatments for breast engorgement during lactation. Cochrane Database Syst Rev. 2010(9):CD006946. doi: [10.1002/14651858.CD006946.pub2](https://doi.org/10.1002/14651858.CD006946.pub2)

16. Bélanger AY. Recursos fisioterapêuticos: evidências que fundamentam a prática clínica. São Paulo: Manole; 2012.
17. Devrimsel G, Metin Y, Beyazal MS. Short-term effects of neuromuscular electrical stimulation and ultrasound therapies on muscle architecture and functional capacity in knee osteoarthritis: a randomized study. *Clin Rehabil.* 2018;33(3):418-427. doi: [10.1177/0269215518817807](https://doi.org/10.1177/0269215518817807)
18. Dolibog P, Dolibog PT, Franek A, Brzezińska-Wcisło L, Wróbel B, Arasiewicz H et al. Comparison of ultrasound therapy and radial shock wave therapy in the treatment of venous leg ulcers—clinical, pilot study. *Postępy Dermatol Alergol.* 2018;35(5):454-461. doi: [10.5114/ada.2018.79191](https://doi.org/10.5114/ada.2018.79191)
19. Nasution SS, Erniyati E, Aizar E. The effectiveness of DC Motor Vibratory Stimulus (DMV) among Postpartum Women on Giving Breast Milk. *Open Access Maced J Med Sci.* 2018;6(12):2306-2309. doi: [10.3889/oamjms.2018.436](https://doi.org/10.3889/oamjms.2018.436)
20. Leite APB, Pontin JCB, Martimbianco ALC, Lahoz GL, Chamlian TR. Efetividade e segurança do ultrassom terapêutico nas afecções musculoesqueléticas: overview de revisões sistemáticas Cochrane. *Acta Fisiátr.* 2013;20(3):157-60. doi: [10.5935/0104-7795.20130026](https://doi.org/10.5935/0104-7795.20130026)
21. McLachlan Z, Milne EJ, Lumley J, Walker BL. Ultrasound treatment for breast engorgement: A randomised double blind trial. *Aust J Physiother.* 1991;37(1):23-8. doi: [10.1016/S0004-9514\(14\)60531-6](https://doi.org/10.1016/S0004-9514(14)60531-6)
22. Olsson DC, Martins VMV, Pippi NL, Mazzanti A, Tognoli GK. Ultra-som terapêutico na cicatrização tecidual. *Cienc Rural.* 2008;38(4):1199-1207. doi: [10.1590/S0103-84782008000400051](https://doi.org/10.1590/S0103-84782008000400051)
23. Bertolini GRF, Silva TS, Ciena AP, Artifon EL. Comparação do ultrassom pulsado e contínuo no reparo tendíneo de ratos. *Fisioter Pesqui.* 2012;19(3):242-7. doi: [10.1590/S1809-29502012000300009](https://doi.org/10.1590/S1809-29502012000300009)
24. Calil VMLT, Leone CR, Ramos JLA. Composição nutricional de colostro de mães de recém-nascidos de termo adequados e pequenos para a idade gestacional. II Composição nutricional do leite humano nos diversos estágios da lactação: Vantagens em relação ao leite de vaca. *Rev Paul Pediatr.* 1992;14:14-23.