Review articles

Evaluation of sucking using ultrasonography in infants: a scoping review protocol

Anna Fernanda Ferreira de Alves Melo[1]
Roberta Lopes de Castro Martinelli[2]
Ana Paula Alves Figueiredo Lima[1]
Aline Natallia Simões de Almeida[1]
Rodrigo Alves de Andrade[1]
Hilton Justino da Silva[1]

[1] Universidade Federal de Pernambuco - UFPE, Recife, Pernambuco, Brasil.

[2] Hospital Santa Therezinha, Brotas, São Paulo, Brasil.

ABSTRACT

Purpose: to identify studies related to ultrasound assessment of suction in infants.

Methods: this research aims to investigate how the literature describes the use of ultrasound to assess suction in infants. It used the "Participants, Concept, and Context" strategy to define inclusion criteria, as follows: population, infants 1 to 180 days old; concept, assessment of suction; and context, ultrasound assessment. The search strategy will be used in the databases of MEDLINE (via PubMed), EMBASE, Web of Science, and Scopus, and studies will be selected based on the inclusion and exclusion criteria established, independently, by two trained professionals. The article analysis protocol will consider the study year and design, the number of infants assessed, their ages, the suction assessment method, the ultrasound suction image acquisition method, and the ultrasound suction analysis method. Data will be presented in charts, narratives, and tables.

Final Considerations: ultrasound has been described in the literature as an assessment instrument that enables the analysis of tongue movements during suction. This scoping review will describe ultrasound acquisition methods to assess suction.

Keywords: Ultrasonography; Infant; Sucking, Breast Feeding, Tongue

INTRODUCTION

Suction is an innate function of the stomatognathic system. Vital to humans, it develops from the 13th to 29th week of intrauterine life, and matures after the 34th gestational week. It is a reflex function up to 3 months after birth, enabling breastfeeding and survival[1,2]. Nutritive sucking is a complex oral sensorimotor activity essential to infants' adequate growth and development, involving the coordination between sucking, swallowing, and breathing, and requiring tongue and mandible movements[3,4].

The tongue plays an essential role in extracting milk during nutritive sucking, in which the negative intraoral pressure is the main driving force to remove milk from the breast. This process is generated by the combination of tongue wave movements and facial muscle contraction around the nipple and areola during breastfeeding, leading the tongue to surround the nipple, and forming a hermetic space during suction[5].

The tactile sensation of the breast tissue in the oral cavity triggers reflex mandibular excursion, forming a seal. Thus, an initial or baseline vacuum is generated, varying between babies. This variation may be related to differences in morphology and elasticity of the nipple and breast and conflicting force vectors exerted by the tongue and mandible on the intraoral mammary tissue[1,6].

Successful breastfeeding requires dynamic synchronicity between the infant's mandible sway, tongue rhythmic motility, and breastmilk ejection reflex[7]. The complexity of tongue development and its functional role in breastfeeding raise controversies regarding criteria for monitoring, assessment, diagnosis, treatment indications, and clinical interventions[8,9].

Some clinical tools are available to observe and diagnose suction patterns in infants, such as the Neonatal Oral-Motor Assessment Scale (NOMAS) and the Digital Swallowing Workstation (DSW, KayPentax, USA) – which distinguishes normal, disorganized, and dysfunctional sucking patterns and quantitatively measures disorganized suction patterns, characterized by difficulties coordinating suction, swallowing, and breathing in breastfeeding[4,10].

Methods have been recently implemented to the previously used ones to extract tongue and palate contours. They employ quantitative and kinematic tongue analyses in various breastfeeding conditions[1,5,11]. However, the knowledge of tongue kinematics during suction is still incomplete, and quantitative methods are not available for clinical use yet.

Ultrasound (US), besides providing lower-cost imaging and not exposing subjects to radiation, has proved to be a valid method to determine muscle dimensions through images[12]. Using US as an auxiliary resource in infants' suction assessment collects more reliable measurement data to apprehend atypical and typical patterns and their possible variations[13].

Despite the advantages of this assessment, there are no standardized methods of US tongue assessment and analysis during suction. Hence, this study aimed to conduct a scoping review to identify study methods related to US assessment of infants' suction in breastfeeding.

METHODS

As this is a scoping review protocol, not involving human participation, it did not require the approval of the originating institution's research ethics committee. It will be conducted according to the norms of the Joanna Briggs Institute (JBI)[14] for review synthesis and writing, according to the PRISMA extension for scoping reviews (PRISMA-ScR)[15]. The protocol was registered in the Open Science Framework, available at: https://osf.io/e936z.

Eligibility Criteria and Review Question

The PCC strategy (participants, concept, and context) was used to define the inclusion criteria, as follows: population assessed: infants 1 to 180 days old; concept: assessment of the function of sucking; context: US assessment. Thus, the research question for this study will be, "How does the literature describe the use of US to assess suction in infants?". The studies considered for the review must inform how the clinical suction assessment was performed and how the US suction assessment was conducted.

Population

This review aims to study infants 1 to 180 days old. This age range was selected because it is the period when babies use suction for exclusive breastfeeding.

The review will exclude animal and in vitro studies because they do not approach the population in question. Studies in premature babies under 34 weeks will also be excluded because their sucking is not mature yet. Premature babies are at risk of breastfeeding difficulties due to their immature neurological

and motor systems, which are enhanced in those with underlying complications[16]. Moreover, ineffective and inefficient breastfeeding performance in premature babies is probably caused by their incapacity to generate proper vacuum force and/or disorganized suction due to poor suction-swallowing-breathing coordination[17].

Concept

The concept of assessment will be infant suction comprehension through US. Quantitative US measures of movements in different parts of the tongue in a sequence of suctions are expected to improve the reliability and reproducibility of this technique. An automated method to quantify tongue movements with US videos may provide more efficient measurements, enabling the formal assessment of US usability in the diagnostic assessment of infants with nutritive sucking problems. Qualitative suction and tongue movement US assessments will also be considered as they contribute to the diagnosis and clinical follow-up of infants.

Studies that used US to assess facial muscles or focused on assessing only swallowing will not be included because they are outside the scope of this review.

In short, the review will consider observational and experimental, descriptive and analytical studies that assessed infants 1 to 180 days old, with the concept of assessing suction, and the context of US assessment. It will exclude expert opinion studies, letters to the editor, errata, proceedings, study review protocols, and studies that cannot be retrieved in full text. Only studies published in English, Portuguese, or Spanish will be considered, and there will be no restriction on their date or country of origin to include the whole scope of existing research.

Context

This review will investigate US assessment. In this context, studies are expected to provide data describing the assessment moment and the details

to be attentive to regarding the infant's position and assessment procedures.

Studies using therapeutic US will not be included in this review because their objective is treatment and do not include the record of images with tongue movements.

Source types

The search strategy will be applied to the databases of MEDLINE (via PubMed), EMBASE, Web of Science, and Scopus, and the studies will be selected based on the inclusion and exclusion criteria established independently by two trained professionals.

Sources of unpublished studies and grey literature will be surveyed in Google Scholar, ProQuest, the Brazilian Digital Library of Theses and Dissertations, and Clinical Trials. This survey will aim to identify potentially relevant grey literature. The main topic terms will be researched, and relevant evidence and material will be collected until the reviewer examines 20 results without identifying a potentially relevant study. The references listed in all studies included in the scoping review will be selected and analyzed to identify potentially useful studies and sources that might be included. If necessary, the study authors will be contacted for further information.

Search strategy

The search strategy was developed to locate published and unpublished studies with the Medical Subject Headings (MeSH): ultrasonic AND sucking behavior. An initial limited search in MEDLINE (via PubMed) was conducted to identify relevant articles on the topic. The words in the relevant articles' titles and abstracts and the indexing terms that describe the articles were used to develop a thorough search strategy for MEDLINE (via PubMed), EMBASE, Web of Science, and Scopus. The search strategy, including all keywords and indexing terms identified, will be adapted to each database included in the search. The search strategy developed for MEDLINE is shown in Chart 1.

Chart 1. Base search strategy for MEDLINE

Terms	Synonyms	Crossing
Ultrasound	('ultrasound'/exp OR 'radiation, ultrasonic' OR 'ultra sound' OR 'ultrasonic' OR 'ultrasonic energy' OR 'ultrasonic irradiation' OR 'ultrasonic measurement' OR 'ultrasonic wave' OR 'ultrasonic waves' OR 'ultrasonics' OR 'ultrasound' OR 'ultrasound radiation')	('ultrasound'/exp OR 'radiation, ultrasonic' OR 'ultra sound' OR 'ultrasonic' OR 'ultrasonic energy' OR 'ultrasonic irradiation' OR 'ultrasonic measurement' OR 'ultrasonic wave' OR 'ultrasonic waves' OR 'ultrasonics' OR 'ultrasound' OR 'ultrasound radiation') AND('sucking'/exp OR 'sucking' OR 'sucking behavior' OR 'sucking behaviour' OR 'sucking movement' OR 'finger sucking'/exp OR 'breastfeeding'/exp)
Sucking	('sucking'/exp OR 'sucking' OR 'sucking behavior' OR 'sucking behaviour' OR 'sucking movement' OR 'finger sucking'/exp OR 'breastfeeding'/exp)	

Data Selection

All identified citations will be grouped in EndNote v.X9 (Clarivate Analytics, PA, USA), and duplicates will be removed. Then, two trained professionals (APA and ANSA) will independently verify the studies' titles and abstracts with the search strategy, based on the inclusion and exclusion criteria. The web application Rayyan (Qatar Computing Research Institute, Doha, Qatar) will be used to explore and filter the results independently, identifying records in a blind and standardized fashion. Relevant studies whose full texts are available in English, Portuguese, or Spanish will be imported to the JBI System for the Unified Management, Assessment, and Review of Information (JBI SUMARI; JBI, Adelaide, Australia). The reasons to exclude full-text studies that do not meet the inclusion criteria will be recorded and reported in the scoping review. Then, the reviewers will verify all information found and, in case of divergences on eligibility, a consensus will be reached through discussion or with a third reviewer.

Research results will be fully reported in the final text and presented in a flowchart according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses – Extension for Scoping Reviews (PRISMA-ScR)[15].

Outcomes

This study aimed to investigate how the literature describes the use of US to assess infants' suction. Thus, investigated outcomes will include data on the characterization of infants, US acquisition and analysis methods, and suction assessment methods.

Data extraction and synthesis

Two independent reviewers will extract data from the articles included in this scoping review with a data extraction tool developed by the reviewers. Extracted data will include specific details on the population, concept, context, study methods, and important recommendations, relevant to the objective of the review.

The article analysis protocol will consider the study year and design, the number of infants assessed, their ages, the suction assessment method, the US suction image acquisition method, and the US suction analysis method.

This is a draft of the data extraction tool, which may be changed and revised as needed during the data extraction process regarding each study included in the review. The changes will be detailed in the full scoping review report. Any divergences between reviewers will be solved through discussion or with a third reviewer. The authors of the articles will be contacted for missing or additional data, when necessary.

Data analysis and presentation

To approach primary research data, results will be presented and organized according to the measured outcome variables and, within these categories, according to the study design or type. Data will be presented in charts, narratives, and tables. A narrative summary will accompany the tabulated results and describe their relationship with this review's objectives and question.

DISCUSSION

Suction is a complex neurophysiological process that involves a sequence of muscle contractions in the upper aerodigestive tract. The tongue-palate pressure and hyoid movement are separate phenomena in the suction and swallowing sequence, and US provides both data to complement clinical assessment[17].

Recent US studies demonstrate that breastmilk is transferred due to the intraoral vacuum generated by

the descending mandible reflex and tongue excursion, along with the positive milk ejection pressure. US study findings are interpreted as essential US markers to reach ideal intraoral vacuums, mammal tissue volumes, and sucking-swallowing-breathing coordination in neurotypical infants[18].

US is a technique that can be used at the bedside and in outpatient and clinical settings. It does not expose patients to radiation and enables nutritive suction assessment[12]. These points make US a promising tool to assess suction in infants and help provide individual guidance and personalized treatment.

Moreover, this imaging technique uses acoustic (non-ionizing) radiation, widely known and used in clinical practice. However, it must be ensured that basic parameters to acquire and analyze US suction images meet acceptable limits to reach more precise and reliable clinical diagnoses. Hence, parameters associated with the professionals' training must be controlled[19,20].

This scoping review aims to describe how the literature conducts US to assess suction in infants. This will enable this instrument to help understand the physiological mechanisms involved in sucking, making it useful to complement the clinical assessment and follow-up on infants.

This scoping review protocol followed all method-ological precepts to develop this type of study and is ready to be carried out. The review will present and summarize the current state-of-the-knowledge on the topic, identifying gaps in scientific evidence and encouraging further research on the topic to help understand the physiological mechanisms involved in sucking and complement the clinical assessment and follow-up on infants.

FINAL CONSIDERATIONS

US has been described in the literature as an assessment instrument that enables the analysis of tongue movements during suction. This scoping review will describe the US acquisition methods in suction assessment.

REFERENCES

1. Elad D, Kozlovsky P, Blum O, Laine AF, Jack Po M, Botzer E et al. Biomechanics of milk extraction during breast-feeding. Proc Natl Acad Sci U S A. 2014;111(14):5230-5. https://doi.org/10.1073/pnas.1319798111. PMID: 24706845. PMCID: PMC3986202.

2. Genna CW, Saperstein Y, Siegel SA, Laine AF, Elad D. Quantitative imaging of tongue kinematics during infant feeding and adult swallowing reveals highly conserved patterns. Physiol Rep. 2021;9(3):14685. https://doi.org/10.14814/phy2.14685. PMID: 33547883. PMCID: PMC7866619.

3. Azarnoosh J, Hassanipour F. Fluid-structure interaction modeling of lactating breast. J Biomech. 2020;103:109640. https://doi.org/10.1016 /j.jbiomech.2020.109640. PMID: 32106935.

4. Lagarde MLJ, van Doorn JLM, Weijers G, Erasmus CE, van Alfen N, van den Engel-Hoek L. Tongue movements and teat compression during bottle feeding: a pilot study of a quantitative ultrasound approach. Early Hum Dev. 2021;159:105399. https://doi.org/10.1016/j.earlhumdev.2021.105399. PMID: 34126586.

5. Zhang F, Bai T, Wu F. Effects of newborn intraoral pressure on colostrum intake. Rev Nutr. 2021;34(e)200195-9. https://doi.org/org/10.1590/1678-9865202134e200195.

6. Alatalo D, Jiang L, Geddes D, Hassanipour F. Nipple deformation and peripheral pressure on the areola during breastfeeding. J Biomech Eng. 2020;142(1):011004. https://doi.org/10.1115/1.4043665. PMID: 31053846.

7. Geddes DT, Kent JC, Mitoulas LR, Hartmann PE. Tongue movement and intra-oral vacuum in breastfeeding infants. Early Hum Dev. 2008;84(7):471-7. https://doi.org/10.1016/j.earlhumdev.2007.12.008. PMID: 18262736.

8. Walsh J, Tunkel D. Diagnosis and treatment of ankyloglossia in newborns and infants: a review. JAMA Otolaryngol - Head Neck Surg. 2017;143(10):1032-9. https://doi.org/10.1001/2017.0948. PMID: 28715533.

9. Geddes DT, Sakalidis VS, Hepworth AR, McClellan HL, Kent JC, Lai CT et al. Tongue movement and intra-oral vacuum of term infants during breastfeeding and feeding from an experimental teat that released milk under vacuum only. Early Hum Dev. 2012;88(6):443-9. https://doi.org/10.1016/j.earlhumdev.2011.10.012. PMID: 22119233.

10. O'Shea JE, Foster JP, O'Donnell CPF, Breathnach D, Jacobs SE, Todd DADP. Frenotomy for tongue-tie in newborn infants. Banco Dados Cochrane Revisões Sist. 2017;91(3):1-35. https://doi.org/10.1002/14651858.CD011065.pub2. PMID: 28284020. PMCID: PMC6464654.

11. Lagarde MLJ, Van Alfen N, Groot SAF, Geurts ACH, Van Den Engel-Hoek L. Adaptive capacity of 2- to 5-month-old infants to the flow, shape, and flexibility of different teats during bottle feeding: a cross-sectional study. BMC Pediatr. 2019;19(477):1-7. https://doi.org/10.1186/s12887-019-1901-0.

12. Zhang F, Cheng J, Yan S, Wu H, Bai T. Early feeding behaviors and breastfeeding outcomes after cesarean section. Breastfeed Med. 2019;14(5):325-33. https://doi.org/10.1089/bfm.2018.0150. PMID: 30864825.

13. Esformes JI, Narici MV, Maganaris CN. Measurement of human muscle volume using ultrasonography. Eur J Appl Physiol. 2002;87(1):90-2. https://doi.org/10.1007/s00421-002-0592-6.

14. Gonçalves JA, Moreira EAM, Trindade EBSM, Fiates GMR. Transtornos alimentares na infância e na adolescência. Rev Paul Pediatr. 2013;31(1):96-103. https://doi.org/10.1590/S0103-05822013000100016.

15. Cordeiro L, Baldini Soares C. Revisão de escopo: potencialidades para a síntese de metodologias utilizadas em pesquisa primária qualitativa. BIS Bol do Inst Saúde. 2020;20(2):37-43. ID: biblio-1021863.

16. Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D et al. PRISMA extension for scoping reviews (PRISMA-ScR): Checklist and explanation. Ann Intern Med. 2018;169(7):467-73. https://doi.org/10.7326/M18-0850.

17. Bagnall A. Feeding problems. In: Jones E, King C, editors. Feeding and nutrition in the preterm infant. Elsevier Heal Sci. 2005. p.165-83. https://doi.org/10.1016/j.pcl.2017.08.021. PMID 29173720. PMCID 10.1016/j.pcl.2017.08.021.

18. Hepper PG, Shahidullah S, White R. Handedness in the human fetus. Neuropsychologia. 1991;29(11):1107-11. https://doi.org/10.1016/0028-3932(91)90080-r. PMID: 1775228.

19. Steele C, Sasse C, Bressmann T. Tongue-pressure and hyoid movement timing in healthy liquid swallowing. Int J Lang Commun Disord. 2012;47(1):77-83. https://doi.org/10.1111/j.1460-6984.2011.00082.x. PMID: 22268903. PMCID: PMC4319712.

20. Douglas P, Geddes D. Practice-based interpretation of ultrasound studies leads the way to more effective clinical support and less pharmaceutical and surgical intervention for breastfeeding infants. Midwifery. 2018;58:145-55. https://doi.org/10.1016/j.midw.2017.12.007.