Review articles

Ultrasound assessment of swallowing: a scoping review protocol

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ABSTRACT

Purpose: to conduct a scoping review to identify procedures to obtain and analyze ultrasound images related to swallowing in adults and older adults.

Methods: the strategy (participants, concept, and context) was employed to determine inclusion criteria – population (adults and older adults), concept (ultrasound assessment), and context (assessment of swallowing). The review will analyze observational, experimental and/or quasi-experimental, descriptive, analytical, and qualitative studies, and opinion texts and articles. It will exclude studies unavailable in full text, in animals, or in vitro, letters to the editor, errata, study protocols, and studies using ultrasound with purposes other than swallowing. There will be no restriction on the language. Two independent professionals will select the studies in the databases (MEDLINE, EMBASE, LILACS, Web of Science, and Scopus). The review will analyze the year of publication, study design, sample, age, and procedures to assess swallowing with ultrasound. Data will be presented in diagrams, tables, and narrative.

Final Considerations: the literature has described ultrasound as an assessment instrument to analyze biomechanical swallowing movements. This scoping review will describe methods to acquire ultrasound images to assess swallowing.

Keywords: Ultrasonography; Deglutition; Deglutition Disorders

INTRODUCTION

Biomechanical swallowing parameters have been assessed with imaging examinations using various technological resources, such as videofluoroscopy, videofluoroscopy swallowing study, and ultrasound (US)[1]. In the latter, static and dynamic images of superficial and internal structures of the human body are obtained from the reflection or scattering of high-frequency (typically 1 to 15 MHz) pulsed sound beams, sent through a movable transducer [2].

US assessment of swallowing has the advantage of being a noninvasive, easy-to-apply, low-cost technique that takes real-time dynamic images focused on visualizing soft tissues and hyoid movement[3]. In comparison with traditional dysphagia diagnosis methods, this technique does not use contrast agents or ionizing radiation[4,5].

US has been used to assess the oropharyngeal phase of swallowing to visualize anatomical structures and temporally associate movements in the oral and pharyngeal phases of swallowing[1]. US operates in five basic modes: A, B, M, Doppler, and elastography[2,6], of which modes B and M are most frequently used in studies to assess movements of the tongue, hyoid bone, and larynx[1]. B-mode provides bidimensional direct images of the tongue in both the coronal and sagittal planes with adequate resolution, while M-mode enables qualitative and quantitative analyses of the cyclical tongue movements in relation to time[6,7]. The Doppler mode, in its turn, makes it possible to analyze the amplitude, duration, and energy of the swallowing peak[8].

The literature describes studies that used US to assess the swallowing of healthy and dysphagic individuals to complementarily diagnose dysphagia and analyze biomechanical movements of swallowing, addressing the number of swallows, amplitude of tongue movements, and speed and amplitude of hyoid bone displacement in swallowing[3,5,9].

Studies have used robust methods to assess the reliability of measuring the amplitude of hyoid bone displacement with US, obtaining significant results with 0.858 interrater reliability (95% CI: 0.744 – 0.924) and 0.968 intrarater reliability (95% CI: 0.903 – 0.990)[10].

Hence, US has countless advantages and clinical applicability to assess swallowing in normal and dysphagic individuals. However, the various methodological applications hinder the comparison and analysis of results. This study aimed to conduct a scoping review, mapping the literature to describe procedures used in ultrasound assessment of swallowing in adults and older adults.

METHODS

This is a scoping review protocol, which does not involve human participation. Hence, it was exempted from evaluation by the originating institution's research ethics committee. It will be conducted according to the norms of the Joanna Briggs Institute (JBI)[11] for review syntheses and written according to the Preferred Reporting Items for Systematic Reviews and Meta-analyses – Extension for Scoping Reviews (PRISMA-ScR)[12]. The protocol was registered in the Open Science Framework and is available from: https://osf.io/xm3sz.

The study will be divided into phases: Phase 1 – Developing the research question and defining eligibility criteria; Phase 2 – Developing the search strategy and defining databases; Phase 3 – Selecting titles and abstracts of possibly eligible studies; Phase 4 – Selecting articles based on full-text reading; Phase 5 – Extracting data.

Review question

The review question was based on the mnemonic elements P (Population), C (Concept), and C (Context), suggested in the JBI scoping review guide. The population will comprise adults and older adults with swallowing disorders or normal swallowing, the concept will be the description of US image acquisition and analysis methods related to swallowing, and the context will be the assessment of the swallowing function. Hence, this scoping review protocol aims to answer the following research question: "How does the scientific literature describe US image acquisition and analysis procedures related to swallowing in adults/older adults with or without swallowing disorders?".

Inclusion criteria
Participants

This scoping review will consider primary studies that used US to assess swallowing measures in adults (18 years or older) of both sexes, either diagnosed with or free from swallowing disorders (dysphagia). Secondary studies conducted with such populations were also considered for inclusion.

This review will consider studies that used complementary examinations (videofluoroscopy,

videoendoscopy swallowing study, electromyography) to diagnose swallowing disorders, as well as speech-language-hearing clinical assessment. Studies that analyzed US swallowing measures only in children and/or newborns or that used US to assess aspects unrelated to swallowing phases will be excluded.

Concept

The concept of interest in this scoping review is the description of procedures used to acquire and analyze US images related to swallowing in adults and older adults: precautions taken before the examination, the patient's position, food consistency assessed, transducer position, transducer type, image operating mode, image improvement parameters, kinematic and morphological parameters analyzed with the device, anatomical planes of the tongue being studied, and software used to construct quantitative and qualitative swallowing analyses. The authors of this review will present the possibilities of using US to assess the swallowing function.

Context

This scoping review will consider evidence in the literature, published in scientific journals or other means of scientific dissemination (e.g., dissertations and theses) assessing adults' and/or older adults' swallowing with US. This will identify procedures used to assess swallowing with US and the evidence available on the topic. This scoping review will include studies that used US as a tool to acquire and analyze images related to swallowing in healthy or dysphagic adults and/or older adults.

Source types

The review will consider experimental and quasi-experimental study projects (including randomized controlled trials, nonrandomized controlled trials, before-and-after studies, and interrupted temporal series), analytical observational studies (including prospective and retrospective cohort, case-control, and analytical cross-sectional studies), descriptive observational studies (including case series, individual case reports, and descriptive cross-sectional studies), qualitative studies, and opinion texts and articles.

Studies unavailable in full text, studies in animals, studies in vitro, letters to the editor, errata, study protocols, studies using US to assess speech, suction, or phonation, studies using US to assess the esophageal phase of swallowing, and studies using US with therapeutic purposes will be excluded.

Search strategy

The search strategy was developed with the help of a librarian in health sciences with expertise in review studies to find published and unpublished studies. The terms were selected based on conceptual block macrostructure, in which each one represented a field to be investigated in relation to another one. The research terms were validated with the Medical Subject Headings (MeSH) for MEDLINE, LILACS, Scopus, and Web of Science, and EMTREE terms, for EMBASE. After validated, the descriptors were used as search pillars, determining synonyms and their relationships. Thus, the search strategy was formed (Ultrasound AND Deglutition OR Dysphagia), based on which the advanced manual search strategy was developed, as shown in Table 1.

Table 1. Search strategy individualized per database

Database	Search strategy
EMBASE	'ultrasonography'/exp OR ultrasonography) AND ('swallowing'/exp OR swallowing) AND ('dysphagia'/exp OR dysphagia
Scopus	ultrasonography AND swallowing AND dysphagia
MEDLINE via PubMed	("Ultrasound Diagnosis" OR "tongue Ultrasound" OR "Ultrasonography"[mh] OR D014463[id] OR ultras*) AND (Deglutition[mh] OR Deglutition OR D003679*[id] OR "Deglutition Disorders" OR "Dysphagia" OR D003680[id] OR dyspha* OR deglu*)
LILACS	ultrasonography AND swallowing AND dysphagia
Web of Science	(ALL=(ultrasonography)) AND ALL=(swallowing)) AND ALL=(dysphagia)

The review will include studies published in any language, with no restriction on time.

Study selection/sources of evidence

Following the search, all records identified will be collected and loaded to Rayyan web software (Qatar Computing Research Institute, Doha, Qatar), and duplicates will be removed. After a pilot test, two independent reviewers will analyze and assess the titles and abstracts according to the inclusion criteria for the review. Potentially relevant sources will be retrieved in full text, and their citation details will be imported to the JBI System for the Unified Management of the Assessment and Review of Information (JBI SUMARI) (JBI, Adelaide, Australia)[13].

Two independent reviewers will assess in detail the full text of selected records regarding the inclusion criteria. The scoping review will record and report the reasons for excluding sources of evidence in full text that did not meet the inclusion criteria. Any divergences between reviewers in each stage of the selection process will be solved by discussion or with the help of one or more other reviewers. The results of the search and the study inclusion process will be fully informed in the final scoping review and presented according to PRISMA-ScR[12].

Data extraction

Data will be extracted from records included in the scoping review by two or more independent reviewers, using a data extraction tool developed by the reviewers. These data will encompass specific details on the participants, concept, context, study methods, and key findings relevant to the review question. A draft of the data that will be extracted is provided in Chart 1. The data extraction tool will be modified and revised as needed during the process of extracting data from each source of evidence. Such modifications will be reported in detail in the scoping review. Any divergences between reviewers will be solved by discussion or with the help of one or more other reviewers. If necessary, the study authors will be contacted to request data absent in the text or additional ones.

The review will also identify the degree of recommendation to use US in swallowing assessment, the level of evidence of research, the authors' professional area, whether publications were uniprofessional or multiprofessional, the most investigated topics, and the frequency of publications.

Data analysis/presentation

The results will be presented in tables, narrative, and diagrams, organized according to the procedures used to acquire and analyze US images and the study types or designs. Data extracted from the studies will encompass the year of article publication, the country of origin, the type of study, and participants. The review will also extract information on procedures prior to the US assessment (e.g., patient's position, instructions given by the evaluator, whether a head stabilizer was used), acquisition procedures (e.g., frames, echogenicity), and swallowing image analysis protocols. The narrative will discuss the results presented in tables according to the scoping review objectives and question.

Chart 1. Data to be extracted from selected studies to map procedures used in ultrasound assessment of swallowing

Authors
Article Title
Year of Publication
Place
Objective
Sample number
Mean age
Profile of the sample (adults or older adults either healthy or with dysphagia [underlying disease])

Ultrasound equipment
Type of transducer
Software used to take images
Model of head stabilizer
Software used to analyze images
Ultrasound mode

Patient's position
Head position
Transducer position
Food consistency used to assess swallowing
Volume used to assess swallowing
Instructions to patients for the swallowing assessment
Number of task repetitions
Settings (outpatient center, ward, research environment)
Biomarkers used to assess swallowing
Psychometric measures analyzed
Software configuration to take images (frames, speed, echogenicity...)
Reference points used to measure distance and amplitude

Measuring units used
Software configuration to analyze images

DISCUSSION

US is a swallowing assessment tool that enables the analysis of ecstatic and dynamic images of superficial and internal structures of the stomatognathic system. However, the various methodological applications hinder the standardization of results and protocols, despite their robust assessment methods and significant results. The main US findings refer mostly to the oral and pharyngeal phases, of which the most evident ones are tongue movement and hyoid bone displacement during swallowing biomechanics[4].

This scoping review was developed to address this variability in the process of acquiring and analyzing US images related to swallowing in adults/older adults. It will map the literature to identify evidence on the topic and existing gaps and, based on the results, summarize information to develop a protocol for speech-language-hearing therapists to assess swallowing in adults/older adults using US.

The publication of this scoping review protocol follows the JBI methodological recommendations, ensuring greater transparency in the review and reproduction process. This protocol presents the scoping review plan, which is important to minimize report biases. If this protocol needs to be modified in the review process, such changes will be explained in the scoping review.

The studies included in the review will be descriptively approached if a qualitative analysis is not possible. The search strategy may also be modified, if necessary, to meet the review objectives. The results will provide an overall view of the procedures to acquire and analyze US images related to swallowing in adults/older adults.

This protocol followed all recommended methodological precepts to develop scoping reviews and has been concluded, being ready to be carried out. Extracted data will be presented in tables, diagrams, and a narrative text. The review will summarize the current knowledge on procedures to acquire and analyze US images of swallowing in adults/older adults, possibly identifying existing gaps in scientific evidence. Hence, it may encourage further research on the topic.

FINAL CONSIDERATIONS

The literature has been describing US as an assessment instrument to analyze biomechanical swallowing movements. This scoping review will describe methods to acquire US swallowing assessment images.

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Authors' contributions:

RAA: conceptualization, methodology, formal analysis, original draft writing;

ANSA: methodology, formal analysis, original draft writing;

MECPM, ENFS: original draft writing;

LAP, LCB: supervision and original draft review and editing;

HJS: conceptualization, methodology, project administration, and original draft review.