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Efficacy of Thickened Liquids for Eliminating Aspiration in Head and Neck Cancer: A Systematic Review

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Abstract

Objective—To appraise the current videofluoroscopic evidence on the reduction of aspiration using thickened liquids in the head and neck cancer population.

Data Sources—Search terms relating to *deglutition or dysphagia or swallow and neoplasms and oncology or head and neck cancer and viscosity or texture and apira or residu** were combined with honey or nectar, xerostomia, respiratory aspiration using Boolean operators.

Review Methods—A multi-engine literature search identified 337 non-duplicate articles of which 6 were judged to be relevant. These underwent detailed review for study quality and qualitative synthesis.

Results—The articles reviewed in detail predominantly described heterogeneous study samples with small sample sizes, making for difficult interpretation and generalization of results. Rates of aspiration were typically not reported by bolus consistency, despite the fact that a variety of stimulus consistencies was used during VFSS. Studies confirmed that aspiration is a major concern in the head and neck cancer population and reported a trend towards more frequent aspiration post-(chemo)radiotherapy.

Conclusion—Overall, the literature on thickened liquids as an intervention to eliminate aspiration in the head and neck cancer population is limited. Because aspiration is known to be prevalent in the head and neck cancer population and thickened liquids are known to eliminate aspiration in other populations, it is important to determine the effectiveness of thickened liquids for reducing aspiration in the head and neck cancer population.

Keywords

head and neck cancer; dysphagia; aspiration; thickened liquid; pneumonia; deglutition; deglutition disorders

Dysphagia (swallowing impairment) is a common and debilitating consequence for patients who undergo radiation therapy for the treatment of head and neck cancer (HNC). Often, individuals who undergo radiation therapy (RT) suffer from both acute and long-term swallowing complications⁽¹⁾. The long-term side effects that negatively impact swallowing not only affect the survivor physically, but may contribute to decreased quality of life and decreased participation in everyday life⁽²⁾. A variety of reviews have been conducted regarding swallowing outcomes in those treated with radiation and/or chemotherapy⁽³⁻⁶⁾. Although multiple reviews have been conducted, the literature still lacks specific information regarding the prevalence, severity and management of aspiration (i.e., entry of foreign material into the airway) following radiation therapy.

Aspiration is a primary concern when HNC patients present with dysphagia, as it involves material passing through the vocal folds and entering the trachea. Penetration is a related event, in which material enters the supraglottic space during videofluoroscopic assessment (VFSS), but is not observed to travel all the way below the vocal folds. Aspiration risk will be defined for the purposes of this review as a score of 3 or above on the Penetration-Aspiration Scale⁽⁷⁾. This is a widely-used scale, which classifies the severity of penetration-aspiration based on the depth of airway invasion and whether or not material is successfully ejected. Scores of 1 and 2 are seen in healthy people and reflect either complete absence of material entering the laryngeal vestibule, or transient penetration of material into this area with subsequent ejection. Scores of 3 and higher are considered to reflect abnormal airway protection, and indicate the presence of material in the supraglottic space or below, without spontaneous clearing. Aspiration remains under-identified and under-reported in the head and neck cancer population, including those who have undergone RT^(8, 9). One reason why aspiration may not be apparent to patients and clinicians during non-instrumental assessment is the fact that RT may lead to sensory impairments in the tracheal area⁽⁸⁾. Aspiration that is not sensed by the patient, thereby leading to a lack of any overt physical response to the aspiration event (such as coughing or throat clearing) is known as “silent aspiration”. Aspiration is dangerous to individuals who have undergone physically rigorous treatments for cancer, and may lead to pneumonia and fatality⁽¹⁰⁾. Although some may view aspiration as an acute toxicity of dysphagia, research has also shown that chronic aspiration remains common up to one-year post-RT in head and neck patients⁽¹¹⁾.

Many different interventions may be used to decrease the risk of aspiration while aiming to make swallowing easier and safer. These strategies include the implementation of postural changes, modification of cancer treatment techniques, therapeutic exercises, tailored radiation to spare important structures involved in swallowing, and texture modification of liquids and foods⁽⁸⁾. Thickened liquids are used to slow bolus flow in the hopes of preventing aspiration and are widely thought to be effective for neurogenic dysphagia⁽¹²⁾. One randomized clinical trial has shown reduced aspiration with thickened liquids in individuals with dementia and/or Parkinson’s disease who are known to aspirate thin liquids⁽¹³⁾. However, gaps remain in our understanding of the efficacy of thickened liquids for reducing aspiration in the head and neck cancer population. The purpose of this systematic review is to appraise and synthesize the current evidence regarding the reduction of aspiration using thickened liquids, as tested using videofluoroscopy in the HNC population.

Methods

Search strategy

The intent of this review is to examine the use and effectiveness of thickened liquids for reducing aspiration in the HNC population with dysphagia. We conducted a comprehensive multi-engine literature search, according to the standards outlined in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement [PRISMA]⁽¹⁴⁾. Our search strategy is illustrated in Figure 1. The initial yield of 351 candidate records for review was obtained through two searches, which were later combined. In the first search, electronic databases Ovid Medline, Ovid Medline in Process, Embase, AMED and PsycInfo were searched for the MeSH terms 'deglutition or deglutition disorders or dysphagia or swallow', 'neoplasms and oncology' or 'cancer and head and neck', and 'viscosity or texture or thick or liqui*' and 'aspira* or residu* or xerostomia'. The use of asterisks in search term specification allows for words sharing a common stem but different endings (e.g., "aspirate", "aspiration", "aspirating") to be found based on the single search term. Dates of inclusion were specified as 1985 forward to current. In the second search, electronic databases Medline and Embase were searched for the MeSH terms 'deglutition', 'deglutition disorders', and 'swallow* or deglutition or dysphagi*', 'head and neck neoplasms or neoplasms or head or neck', 'viscosity', 'honey', 'thin* or thick* or gum*', 'visc*', 'honey or nectar', 'respiratory aspiration', 'pneumonia aspiration', 'inhalation', 'aspirat*', 'xerostomia'. This search had no date limitation.

Duplicate articles were removed from the initial search yield of 351 articles, leaving 337 articles, for which the titles and abstracts were screened for relevance by the first author (CB). A total of 262 articles were excluded based on lack of relevance to the study questions, meaning that they did not describe swallowing function for different consistencies of food and liquid in the head and neck cancer population. The remaining 70 articles underwent a second level of screening via full-text review to confirm relevance; this led to the exclusion of an additional 44 articles. The remaining 26 articles underwent detailed full-text review and appraisal of study quality using the questions listed in Table 1. Five full-text articles (i.e. 19%) were reviewed in duplicate by an independent blinded rater (CMS), with 100% agreement between both raters regarding quality and inclusion decisions. In the event that discrepancies had occurred at this stage, a meeting would have been convened to establish consensus. The quality review led to a final set of 6 articles to be included in the qualitative synthesis. A risk of bias assessment was conducted for each of these 6 articles, according to the criteria set out by the Cochrane Bias Methods Group⁽¹⁵⁾. Based on the small number of articles that qualified for final review, and heterogeneity in participant demographics across studies, it was decided that data pooling and meta-analysis could not be performed.

Inclusion criteria

Studies were required to be in English and published in a peer-reviewed journal. Studies included were those that involved subjects with HNC treated with radiation with or without chemotherapy or surgery. It was required that articles assess swallowing function using VFSS, and that aspiration status be reported. It was our original intent to limit inclusion to

articles in which swallowing function had been studied using more than one thickened liquid; however, this strategy led to a severely limited set of articles for consideration. Consequently, the requirement was relaxed to allow the inclusion of studies describing swallowing with thin liquid barium in addition to at least one other texture

Exclusion criteria

Abstracts and conference posters were excluded from the search. Studies describing cancers other than primary cancer in the oral cavity, nasopharynx, hypopharynx or larynx were excluded, as were studies in which participants were reported to have etiologies of dysphagia involving disorders other than, or in addition to head and neck cancer. Studies involving cases that were not newly diagnosed were also examined⁽¹⁶⁾. Studies involving patients who were unable to take food/liquid orally were excluded, as the review focused on efficacy of thickened liquids for reducing aspiration. A handful of studies examined a mixture of radiation with or without chemotherapy and was most frequent for treatment approaches, while surgery (with or without radiation therapy) was least occurring⁽¹⁷⁻²⁶⁾. Articles selected for detailed review were excluded on the basis that they either did not meet the criterion of evaluating the swallow via VFSS, studying swallowing with both a thin and at least one other consistency, or failed to report rates of aspiration in their study^(17, 22, 27-31).

Instrumental swallowing assessments were used in each of the 26 papers considered for review. Videofluoroscopy was the primary means of assessment, while a few of the articles used endoscopy (FEES) to assess swallow function^(24, 32, 33). Although FEES and VFSS are both used frequently for the assessment of swallow function, endoscopy involves a period of visual white-out during pharyngeal constriction, which hampers the ability to directly visualize aspiration and laryngeal closure. Since the aim of this review is to examine the occurrence of aspiration with thickened liquids, studies using FEES were excluded.

Results

The subset of articles selected for qualitative synthesis included largely heterogeneous samples of patients with varying tumor sites, stage, and treatment type. Detailed descriptions of participants were, however, provided in all 6 articles and are summarized in Supplementary Table 2 in the online materials for this manuscript << NOTE TO EDITOR: please include a link to the online table here >>. Cancer sites included but were not limited to the oral cavity, nasopharynx, larynx, and hypopharynx. Tumor stages spanned I-IV and specific TNM staging was reported in three studies⁽³⁴⁻³⁶⁾. Of the six articles reviewed, three articles disclosed the absence of related disorders and/or previous history of dysphagia^(34, 37, 38). The remaining articles did not provide details regarding any known history of dysphagia or potential additional causes of dysphagia.

Patient participants in the identified studies had undergone a variety of different primary cancer treatments. Among these, radiation with or without chemotherapy was identified to be the most frequent primary cancer treatment approach, while surgery (with or without radiation therapy) was reported with the least frequency⁽¹⁷⁻²⁴⁾. While one article included patients who had undergone surgery or neck dissection⁽³⁵⁾, all participants had also

undergone various forms of radiation with or without chemotherapy (see Supplementary Table 2). Summaries of each included study follow below.

Articles accepted for qualitative synthesis

Agarwal and colleagues⁽³⁴⁾ conducted a study to assess factors affecting swallow function following curative intent definitive (chemo) radiotherapy for HNC patients. Swallow function was assessed in 47 patients who were all treated with CRT. VFSS was conducted at baseline as well as at 2, 6, and 12 months post-treatment. Agarwal and colleagues used the Penetration-Aspiration Scale⁽⁷⁾ as an objective measure of aspiration severity. They found the prevalence of PAS scores of 3 and higher, indicating penetration, increased from 27% at baseline to 37% at the 6 month follow up. Similarly, aspiration (i.e., scores of 6-8) was observed in 19% of patients at baseline and increased to 29% at the 6 month post-CRT VFSS. Specific information regarding aspiration prevalence by bolus consistency was not reported.

Lazarus and colleagues⁽³⁸⁾ examined swallowing in nine patients undergoing CRT (external beam radiation and chemotherapy) compared with age-matched healthy controls. Analyses included observation of abnormal oropharyngeal motility, residue and aspiration, temporal analyses, and biomechanical analyses. It was found that oral and pharyngeal motility may become compromised when external-beam radiation is provided to laryngeal or tongue areas. Overall, three patients were reported to be able to handle liquids, three were able to handle liquids and paste/pudding consistency, and the remaining three were able to tolerate all bolus consistencies. A total of 8/9 patients aspirated on liquid during the VFSS. Maneuvers or postures were attempted in order to eliminate aspiration in five of these patients, and aspiration was successfully eliminated for at least one bolus volume in all five. Details regarding the reduction of aspiration with thicker consistencies in those who aspirated liquids were not reported.

Eisbruch and colleagues⁽³⁷⁾ examined swallow function via VFSS after intensive chemoradiation for HNC patients. Aspiration was observed in 14% of participants at baseline VFSS, but increased to 65% prevalence at 1-3 month follow up, and 62% at 6-12 month follow up. Eisbruch and colleagues concluded that changes in the swallow occur post-treatment that promote aspiration in head and neck cancer patients treated with CRT. Details regarding the relationship between bolus consistency and aspiration prevalence were not reported.

Graner and colleagues⁽³⁵⁾ aimed to assess swallow function before and after CRT with neck dissection. Upon review of VFSS, it was noted that 55% of patients had penetration on thin and thick liquid. Aspiration was seen in 64% of the patients involved in the study. Six patients aspirated thin liquid while six aspirated thick liquid. Overall, three subjects aspirated with puree consistency. The specific relationship between bolus consistency and aspiration within individuals was not reported.

Pauloski and colleagues⁽³⁹⁾ compared objective swallow function with patient complaints of dysphagia in subjects with HNC treated with radiotherapy with or without chemotherapy. Participants were evaluated via VFSS, from which objective timing measures were derived.

In addition, participants were asked whether they felt they had a swallowing problem and to subjectively estimate the amounts of food/liquid taken orally, and to document the consistencies they were consuming. The data show that patients with complaints of dysphagia showed a higher frequency of swallows with aspiration on all bolus consistencies than the individuals without complaint. Within-participant comparisons of swallowing pre-versus post-treatment were not provided. Aspiration was reported to occur between 16-22% of the time for liquid swallows (at 1, 3, 5, and 10 ml), yet only 8% of the time with a paste consistency (3 cc). When aspiration was compared by tumor site and complaint versus no complaint of dysphagia, it was found that subjects with oral cavity tumors experience less aspiration overall. However, patients with tumors based in the pharynx or larynx who complained of dysphagia had a higher frequency of aspiration on most bolus types than those who did not complain of dysphagia.

Newman and colleagues⁽³⁶⁾ aimed to compare RADPLAT (concurrent selective supra-dose intraarterial Cisplatin and external-beam radiation) to systemic chemoradiation treatment and to document the effects they each have on swallowing and speech. Aspiration at one month post-treatment occurred at various volumes with both liquid and paste consistencies. Aspiration occurred more frequently with 5 mL liquid boluses in the RADPLAT group (27%), while aspiration occurred frequently with 1 mL (31%), 3 mL (40%) and 10 mL (22%) liquid boluses in the CRT group. Both groups aspirated on the 3 cc paste bolus with similar frequency (13% collectively). Overall, subjects who underwent RADPLAT experienced less aspiration on small volume liquid boluses.

Timing of VFSS post-treatment

The time-point at which VFSS was conducted for the six articles chosen for qualitative synthesis was inconsistent. Two of the studies evaluated swallow function approximately one year post-treatment, which allows the patient time to recover from acute symptoms^(34, 37). Many of the studies also evaluated the swallow at earlier time points (e.g., at 3 months and 6 months), which provides a more complete picture of progression over time post-treatment⁽³⁴⁻³⁹⁾. A quality limitation of one study was the lack of baseline measures of swallow function⁽³⁸⁾. It should be noted that baseline measures in the studies analyzed for this review reflect swallowing status in individuals with confirmed head and neck cancer, prior to the initiation of chemo- and/or radiotherapy for their cancer. As such, these baseline measures capture any abnormalities that may have been present in swallowing function as a result of the cancer itself and allow a better appreciation of the impact (either positive or negative) of intervention. In the absence of baseline measures, such comparisons are not possible.

Aspiration Status and Operational Definition

All 6 studies included for qualitative synthesis reported aspiration status based on videofluoroscopic evaluation. However, operational definitions of aspiration were only provided in 3 of the studies^(34, 35, 37). A validated rating tool to measure aspiration (i.e., the Penetration-Aspiration Scale⁽⁷⁾) was used in only one study⁽³⁴⁾.

Stimuli used in Videofluoroscopy

The food and liquid stimuli used in the studies selected for qualitative synthesis are detailed in Supplementary Table 3. Liquid barium was used in all VFSS procedures, however, only 1 of the 6 studies specified the liquid brand⁽³⁴⁾. Thick liquids were used in two studies^(34, 35). One of these studies described swallowing for a thin liquid compared with a medium thick liquid and an even thicker liquid⁽³⁴⁾. Although three thickness levels of liquids were utilized, additional details were not provided characterizing the viscosity or flow properties of the stimuli. Other consistencies used in the studies reviewed include puree (with or without barium paste), pudding, paste (with or without pudding), soft solids, and solids (cookie coated with barium paste). It is evident that there are inconsistencies across protocols with regards to the stimuli given to patients (see Supplementary Table 3). Furthermore, detailed information on how different stimuli were mixed with barium was lacking from all articles, such that reproduction of the stimuli would not be possible. In an ideal situation, both rheological values of viscosity and information regarding barium concentration are required in order to adequately describe the stimuli used in a given study. In addition, other information such as temperature and bolus volume is important, and if reported, would represent desirable methodological rigor and quality.

Other interventions

In addition to exploring swallowing with different liquid consistencies, 3 of the 6 articles explored postural changes or compensatory maneuvers as interventions to eliminate aspiration for some patients^(34, 35, 38) (see Supplementary Table 3). Postural change has been found to reduce the risk of aspiration in individuals with HNC post-surgery while airway protection maneuvers are reported to help those HNC patients with radiation history^(40, 41). In the studies reviewed, Agarwal and colleagues⁽³⁴⁾ found postural change to be more effective with thick barium. Newman reported that the use of maneuvers aided in reduction of laryngeal penetration in two patients⁽³⁶⁾.

Risk of Bias

Evaluation of the risk of bias was performed for all 6 articles selected for qualitative synthesis, according to the guidelines set out by the Cochrane Bias Methods Group⁽¹⁵⁾. As shown in Supplementary Table 4, one of the most common risks of bias lay in videofluoroscopy protocols that were terminated early, resulting in incomplete data. This is not an unexpected finding given the typical clinical rules for terminating VFSS exams when repeated aspiration events are witnessed despite attempts to resolve the problem; nevertheless, this reality contributes to uneven numbers of observations across participants within a study. An additional common bias was the failure to report blinding of raters when assessing the VFSS evaluations. Many studies failed to disclose whether the raters were blinded to the time of assessment (pre-vs. post-treatment) or to the type of bolus consistency being evaluated. In addition, 50% of the articles did not clearly define the term “aspiration”, leading to potential differences in interpretation across studies.

Rates of Aspiration

Articles were assessed for the percentage of participants in the sample displaying aspiration post-treatment. Overall, three studies could be compared given a baseline aspiration status and post-evaluation at approximately 6 months. A fourth study provided aspiration in “number of swallows” rather than per participant. Within the three studies providing comparable data, 19% of participants aspirated pre-treatment, while 30% of subjects aspirated approximately 6 months post-treatment^(34, 35, 37). The percentages of aspiration occurrence represent aspiration over the entire VFSS examination; sufficient detail to allow comparisons of rates of aspiration on particular consistencies could not be obtained from these articles. It would be extremely desirable to determine whether specific consistencies would have aided in the elimination of aspiration in these participants.

Four studies specifically reported aspiration status for each consistency provided^(35, 36, 38, 39). Graner and colleagues⁽³⁵⁾ found that 6 individuals (n=11) aspirated on both thin and thick liquid post-treatment. A list of the stimuli utilized in this study can be found in Supplementary Table 3. There was no difference in aspiration rates between the two consistencies in this study, but the overall subject number is quite small. Newman and colleagues⁽³⁶⁾ report aspiration of various liquid volumes and a paste consistency. Chemoradiation patients’ aspiration prevalence with liquid was reported as 31%, 40%, and 22% for 1 ml, 3 ml, and 10 ml volumes, respectively, while RADPLAT aspiration prevalence with thin liquid was reported as 27% for 5 ml volumes. Aspiration rates for the thicker, puree consistency for RADPLAT and chemoradiation patients combined were reported to be substantially lower at 13%⁽³⁶⁾. Pauloski and colleagues⁽³⁹⁾ accounted for aspiration in each swallow for 1, 3, 5, and 10 mL liquid volumes plus one paste bolus. Swallows with aspiration were also separated by tumor site and by the subject’s view of their swallowing impairment. Aspiration frequency ranged from 0% on thin liquids in individuals with oral cancer who did not complain of dysphagia to 30% of swallows on thin liquids in individuals with laryngeal tumors who complained of dysphagia. A trend towards less aspiration on pureed consistencies for patients with laryngeal and pharyngeal tumor sites was reported.

Conclusion

Based on the studies identified for detailed review and qualitative synthesis, it is clear that aspiration is a burden for HNC patients both before and after radiation treatment. It is also evident that there is a significant gap in the literature with regards to describing the effectiveness of thickened liquids for reducing aspiration in the head and neck cancer population as a whole. Although the 6 studies identified for synthesis report aggregate information regarding rates of aspiration, only 4 report any detail regarding aspiration by consistency^(35, 36, 38, 39). Only one study reported data in a way that would permit comparison of aspiration status on a thin liquid to aspiration status on thicker liquids. The lack of detailed descriptions of the stimuli used represents a serious limitation with respect to understanding the impact of bolus consistency on aspiration in the HNC population.

Despite these limitations, the literature does contain some evidence to suggest that thicker consistencies may prevent aspiration in the HNC population. For example, aspiration

occurred on 17% of 1 mL liquid boluses in individuals treated with (C)RT in one study, while aspiration occurred only 8% of the time on 3 cc of paste⁽³⁹⁾. Although these data are insufficient to support the conclusion that aspiration was effectively eliminated by 50% by use of a paste consistency, the data provide an important preliminary indication suggesting reduced aspiration risk with thicker consistencies.

One observation arising from the literature reviewed is the fact that most studies had a primary goal of detailing the impact of cancer treatment on swallowing function, and explored interventions other than texture modification to address aspiration and dysphagia in patients with HNC. Temporal and biomechanical analyses were sometimes used but these measures were not applied to understanding the impact of bolus consistency on swallowing function⁽³⁵⁻³⁹⁾. As such, we conclude that a complete understanding of the impact of thickened liquids as a compensatory technique for addressing swallowing dysfunction in the HNC population is currently lacking. Although compensatory maneuvers have been shown to eliminate some aspiration in this population, thickened liquids have yet to be employed as an evidence-based intervention for HNC patients. There is clearly a need for rigorous and controlled research to address this gap in our understanding.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1. PRISMA diagram used for article selection inclusion

Table 1

Questions used in the quality rating

Quality Rating Questions	
1	Is the article in a peer reviewed journal?
2	Does the study involve individuals with new HNC treated with radiotherapy with or without chemotherapy?
3	Is the article in English?
4	Does the study use VFSS to examine the swallow?
5	Are at least two textures reported (one thin)
6	Are consistencies repeatable to make?
7	Is aspiration status reported?
8	Is sufficient data reported for at least one thickened consistency?
9	Have individuals had previous surgery or radiation?
10	Does the study include subjects with additional disorders that would cause dysphagia or have a history of dysphagia?