



# Chest CT findings in patients with dysphagia and aspiration: a systematic review

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## ABSTRACT

The objective of this systematic review was to characterize chest CT findings in patients with dysphagia and pulmonary aspiration, identifying the characteristics and the methods used. The studies were selected from among those indexed in the Brazilian Virtual Library of Health, LILACS, *Índice Bibliográfico Español de Ciencias de la Salud*, Medline, Cochrane Library, SciELO, and PubMed databases. The search was carried out between June and July of 2016. Five articles were included and reviewed, all of them carried out in the last five years, published in English, and coming from different countries. The sample size in the selected studies ranged from 43 to 56 patients, with a predominance of adult and elderly subjects. The tomographic findings in patients with dysphagia-related aspiration were varied, including bronchiectasis, bronchial wall thickening, pulmonary nodules, consolidations, pleural effusion, ground-glass attenuation, atelectasis, septal thickening, fibrosis, and air trapping. Evidence suggests that chest CT findings in patients with aspiration are diverse. In this review, it was not possible to establish a consensus that could characterize a pattern of pulmonary aspiration in patients with dysphagia, further studies of the topic being needed.

**Keywords:** Respiratory aspiration; Tomography, X-ray computed; Lung.

## INTRODUCTION

The epidemiology of aspiration syndromes is not well described in the literature because of the lack of specificity and sensitivity markers; however, the literature indicates that 5-15% of the cases of community-acquired pneumonia are due to aspiration.<sup>(1)</sup> Lung injury caused by aspiration of saliva or food particles can often result from dysphagia.<sup>(2,3)</sup> Dysphagia can be of neurogenic, mechanical, or psychogenic origin and manifests itself through a series of signs and symptoms, such as cough, choking, and pharyngeal globus, being a major risk factor for malnutrition, dehydration, and aspiration pneumonia.<sup>(4-6)</sup>

Evaluation of dysphagia involves clinical evaluation and speech pathology assessment, as well as ancillary tests, such as videofluoroscopic swallowing study (VFSS) and fiberoptic endoscopic evaluation of swallowing (FEES), which serve to aid in the diagnosis of swallowing disorders, such as aspiration.<sup>(7-9)</sup> In contrast, chest CT is used to evaluate pulmonary lesions, being of great importance in the diagnosis of aspiration disorders, since pulmonary symptoms can be the first manifestation of aspiration.<sup>(10)</sup>

Imaging findings of aspiration are numerous and usually nonspecific, pulmonary infection being the most serious complication of aspiration.<sup>(10,11)</sup> Therefore, knowledge about the different types of pulmonary aspiration is important for drawing correlations between the clinical information and the main CT findings, including diffuse aspiration bronchiolitis, aspiration pneumonitis, aspiration

pneumonia, foreign body aspiration, and exogenous lipid pneumonia.<sup>(11)</sup> By specifically detailing the imaging findings of aspiration pneumonia, segmental or lobar airspace consolidation can be observed, which may or may not be associated with pleural effusion.<sup>(11)</sup>

Knowledge about the CT findings of aspiration is essential for establishing the diagnosis of aspiration disorders and for attempting to prevent lung injury. Here, we aimed to perform a systematic literature review of chest CT findings that characterize pulmonary aspiration in patients with dysphagia, identifying the characteristics and the methods used.

## METHODS

### Research strategies

This systematic review followed the recommendations of the latest version of the Cochrane Handbook for Systematic Reviews of Interventions,<sup>(12)</sup> which involve formulating the research question, finding and selecting scientific articles, and critically assessing the selected articles. The research question used was: "What chest CT image findings are diagnostic markers of aspiration in patients with dysphagia?" The review was developed by three researchers, two of whom searched for articles independently and blindly and one of whom was assigned as a reviewer, being consulted in cases of uncertainty so as to establish agreement. All of the researchers involved—two speech-language pathologists and one

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radiologist who works in thoracic radiology—have over 10 years of clinical and practical experience in the study area. Studies were selected by using the following search terms: “*pneumonia aspirativa*” and “aspiration pneumonia”; “*aspiração*” and “aspiration”; “*pulmonar*” and “pulmonary”; and “*tomografia computadorizada*” and “computed tomography”. These search terms were obtained from DeCS and MeSH and were used to search the Brazilian Virtual Library of Health, LILACS, *Índice Bibliográfico Español de Ciencias de la Salud*, Medline, Cochrane Library, SciELO, and PubMed online databases. The search was carried out between June and July of 2016, on the basis of the intersection of the chosen search terms.

### Selection criterion

Studies in humans, written in English, Portuguese, or Spanish, regardless of the publication year, and whose title, abstract, or body of text contained any of the search terms chosen for this review were selected. Studies mentioning aspiration of food particles into the upper digestive tract and chest CT were included. Repeated studies were excluded, as were studies whose abstracts or full texts were not found in the databases consulted, review articles, dissertations, theses, case studies, and studies in which the underlying disease was tuberculosis. No search filters were applied. The article selection process is described as a flowchart in Figure 1, as recommended in the PRISMA statement.<sup>(13)</sup>

### Data analysis

After the abstracts of the studies found were selected, the full texts of the articles were retrieved. After full text reading, the following data were extracted: names of the authors; year of publication; country where the study was conducted; study design; study subjects;

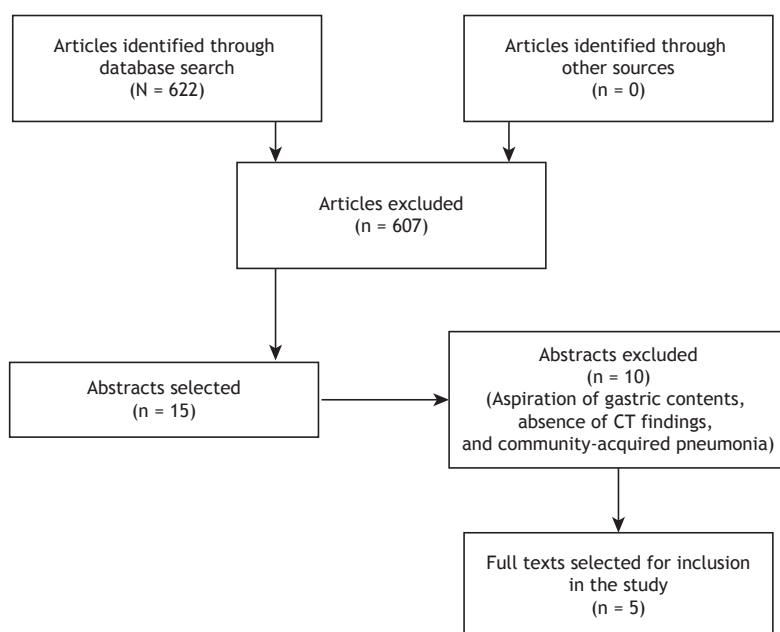
sample size; diagnostic tests used; underlying disease; and chest CT findings, which were defined in accordance with the glossary of terms for thoracic imaging from the Fleischner Society.<sup>(14)</sup>

## RESULTS

Five articles were selected for inclusion in the present systematic review, all of them carried out in the last 5 years, published in English, and coming from different countries (Italy, USA, Japan, China, and Brazil; Table 1). Sample sizes in the studies ranged from 43 to 56 patients, the predominant population being adults (19-59 years) and elderly subjects ( $\geq 60$  years).

Most of the studies evaluated in this review had a retrospective, cross-sectional design.<sup>(15-18)</sup> The sample characteristics varied. The patients studied had laryngeal cancer,<sup>(15)</sup> acute pneumonia associated with dysphagia,<sup>(16)</sup> or chronic aspiration,<sup>(17,18)</sup> and a study of healthy subjects assessed the presence or absence of aspiration.<sup>(19)</sup> The diagnostic tests used in the studies were VFSS,<sup>(15,16,18)</sup> FEES,<sup>(15,19)</sup> bronchoscopy,<sup>(17)</sup> HRCT,<sup>(15)</sup> and conventional CT.<sup>(16-19)</sup>

The CT findings in patients with dysphagia-related aspiration were varied, including emphysema,<sup>(15)</sup> bronchiectasis,<sup>(15,16,19)</sup> bronchial wall thickening,<sup>(15,16,18,19)</sup> nodules,<sup>(15,16,18)</sup> tree-in-bud pattern,<sup>(15,19)</sup> consolidation,<sup>(15-18)</sup> pleural effusion,<sup>(15-17)</sup> ground-glass attenuation,<sup>(15,16,18)</sup> septal thickening,<sup>(15,16)</sup> cavitory lesions,<sup>(15)</sup> lymph nodes,<sup>(15)</sup> atelectasis,<sup>(16-18)</sup> bronchiolectasis,<sup>(18,19)</sup> fibrosis,<sup>(19)</sup> and air trapping.<sup>(18,19)</sup> One of the studies demonstrated a higher frequency of findings in the right lung,<sup>(17)</sup> and two found changes that were more prevalent in lower lung zones.<sup>(16,18)</sup> In the study by Simonelli et al.,<sup>(15)</sup> it was not possible to describe the proportion of findings, because they



**Figure 1.** Article selection flowchart of the present systematic review.

**Table 1.** Characteristics of the selected articles.

Study	Year	Country	Population	Study design	Sample size and characteristics	Diagnostic tests used	Chest CT findings
Simonelli et al. <sup>(15)</sup>	2010	Italy	A/G	RS	45 patients after partial laryngectomy (mean age = 67 years; 92.2% men) and 45 controls (patients with COPD and normal swallowing)	FEES, VFSS, and HRCT	Emphysema; bronchiectasis; bronchial wall thickening; pulmonary nodules or cysts; tree-in-bud pattern; consolidation; pleural effusion; septal thickening; cavitory lesions; and lymph nodes
Komiya et al. <sup>(16)</sup>	2013	Japan	G	RS	53 patients admitted to the hospital with pneumonia and dysphagia (mean age = 84 years; 66% of men)	VFSS and conventional CT	Centrilobular nodules (74%); ground-glass attenuation (74%); peribronchovascular thickening (42%); airspace consolidation (34%); atelectasis (17%); septal thickening (13%); pleural effusion (13%); and traction bronchiectasis (2%)
Lin et al. <sup>(17)</sup>	2014	China	A/G	RS	43 patients with aspiration (G = 17; A = 26; mean age = 56 years; 70% of men)	Bronchoscopy and conventional CT	<sup>a</sup> Consolidation (93%/92%); atelectasis (14%/23%); high-density airway lesion (29%/4%); pleural effusion (0%/8%); foreign body – food particles – (21%/35%): left lung (35%/31%) and right lung (65%/69%)
Butler et al. <sup>(19)</sup>	2014	USA	G	PS	50 healthy patients divided into 2 groups: aspirators (n = 25; mean age = 77 years; 15 women) and non-aspirators (n = 25; mean age = 76 years; 16 men)	FEES and conventional CT	<sup>b</sup> Bronchiectasis (2%/8%); bronchiolectasis (10%/6%); bronchial wall thickening (22%/12%); parenchymal band (8%/4%); fibrosis (16%/16%); air trapping (20%/26%); intraluminal airway debris (6%/8%); and tree-in-bud pattern (6%/4%) p > 0.05 for all
Scheeren et al. <sup>(18)</sup>	2016	Brazil	A/G	RS	56 patients divided into 2 groups: non-aspirators and aspirators (n = 28 in each group; mean age = 65 years; 29 men)	VFSS and conventional CT	<sup>b</sup> Bronchial wall thickening (54%/53%)*; bronchiolectasis (15%/0%)**; centrilobular nodules (16%/4%)**; ground-glass attenuation (4%/0%)**; atelectasis (18%/2%)**; consolidation (6%/0%)**; and air trapping (54%/53%)* *p = 0.208; **p < 0.001

A: adult; G: geriatric; RS: retrospective study; FEES: fiberoptic endoscopic evaluation of swallowing; VFSS: videofluoroscopic swallowing study; and PS: prospective study. <sup>a</sup>G patients/A patients. <sup>b</sup>Aspirators/non-aspirators.

were reported by degree of aspiration. It is of note that, in two studies, aspirators and non-aspirators were compared.<sup>(18,19)</sup>

## DISCUSSION

The selection, reading, and analysis of articles revealed that there have been few studies attempting to define a pattern of chest CT findings related to dysphagia-related pulmonary aspiration. The five articles selected in the present review were published in the last 5 years, which may explain the recent concern over early

identification of patients with dysphagia who aspirate and over strategies that may intervene in the etiology. One study found a significant correlation between the degree of dysphagia and the relative risk of pneumonia, demonstrating that patients with tracheal aspiration are ten times more likely to develop pneumonia than individuals with normal swallowing.<sup>(20)</sup>

The most serious complication associated with aspiration in patients with dysphagia is pulmonary infection.<sup>(10)</sup> Studies indicate aspiration pneumonia as a cause of community-acquired pneumonia.<sup>(21,22)</sup> It is important to note that, in addition to the respiratory

complication, the swallowing disorder is a risk factor for malnutrition and functional decline.<sup>(23)</sup> Aspiration pneumonia is the leading cause of death in patients with dysphagia, a condition that affects 300,000-600,000 people per year in the USA.<sup>(1)</sup>

Simonelli et al.<sup>(15)</sup> addressed the relationship between dysphagia and aspiration in laryngectomized patients, compared with a control group of patients with COPD, and found no significant differences in radiological findings between the groups. It is currently known that patients with COPD have dysphagia symptoms related to airway protection because of changes in the breathing pattern and in the coordination of swallowing and breathing, leading to a greater likelihood of developing pneumonia.<sup>(24)</sup> It should be noted here that, of the 116 patients selected for the study,<sup>(15)</sup> only 45 had aspiration by VFSS and then underwent chest CT scans to assess the radiological manifestations of aspiration. In the two groups, the findings with the highest incidence rates were bronchial wall thickness, bronchiectasis, nodules, emphysema, consolidation, and septal thickening, with rates varying according to the degree of aspiration in the study group.

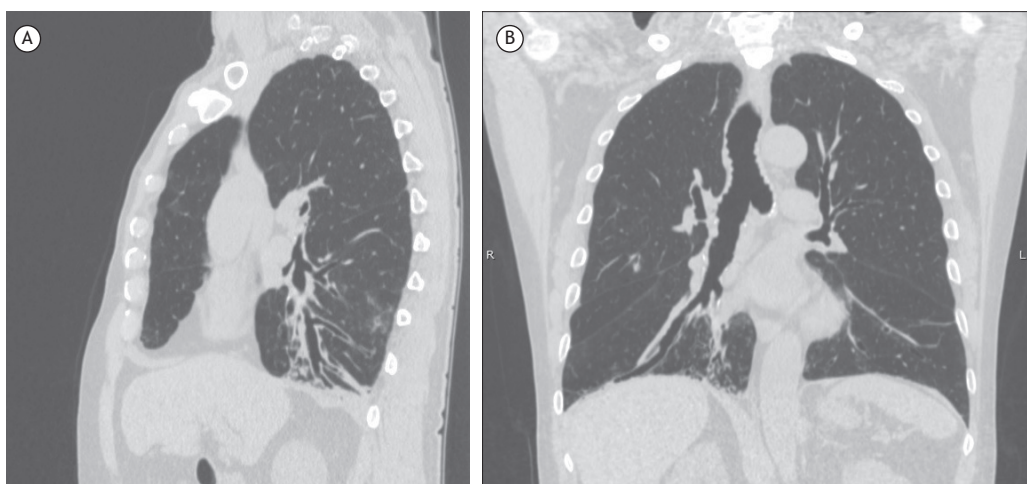
In the study by Komiya et al.,<sup>(16)</sup> the pulmonary CT findings were described in patients with an acute condition, that is, presenting with pneumonia at hospital admission, and dysphagia was confirmed by VFSS. The most frequent chest CT findings were airspace consolidation, ground-glass attenuation, centrilobular nodules, and peribronchovascular thickening. Pulmonary opacities predominated in lower or diffuse areas of the lung and were distributed posteriorly. The authors did not enroll a control group (without dysphagia/aspiration). In the study,<sup>(16)</sup> there was a predominance of elderly patients (geriatric population), among whom the risk of aspiration of oropharyngeal secretions and food particles is increased.<sup>(25)</sup> There is evidence in the literature that the frequency of dysphagia is higher in the elderly, and aspiration is an important etiologic factor leading to pneumonia in this population.<sup>(26)</sup>

One of the studies analyzed in the present review did not use ancillary tests to assess swallowing or detect dysphagia; the presence of acute aspiration of large food particles was identified solely by bronchoscopy.<sup>(17)</sup> The most prevalent chest CT findings in the study were consolidation, atelectasis, and high-density airway lesion, predominantly in the right lung and lower lobe.<sup>(17)</sup>

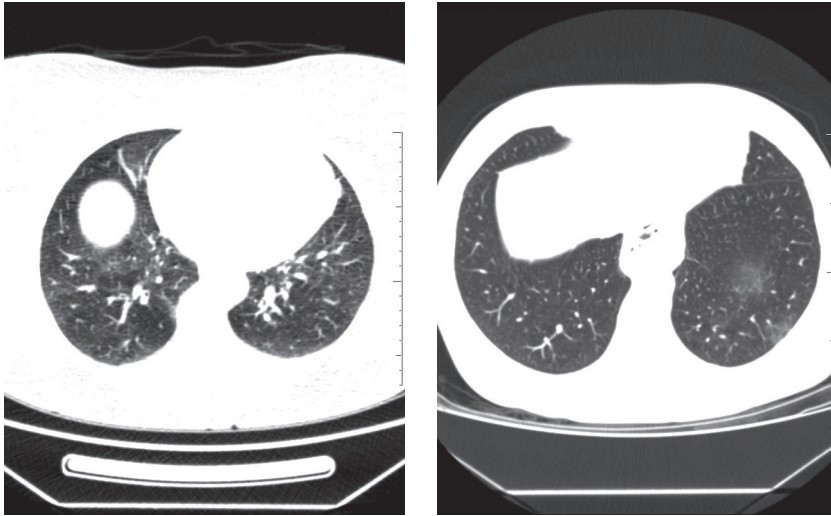
In the study by Butler et al.<sup>(19)</sup> aspiration status was prospectively evaluated by administering liquid boluses, and other bolus consistencies were not used, which could result in an increased number of pulmonary imaging findings. In addition, the authors did not use VFSS, which is considered the gold standard for detecting aspiration, choosing to use FEES. FEES is an exam that is performed with a nasal endoscope and allows direct observation and evaluation of laryngopharyngeal structures, as well as of swallowing; however, aspiration can only be observed after the swallow, through visualization of the presence of dyed food particles in the trachea.<sup>(27)</sup> The authors did not find significant differences in the radiological pattern between the case and control groups, the findings being bronchiectasis, bronchiolectasis, bronchial wall thickening, air trapping, and fibrosis.<sup>(19)</sup>

The most recent study addressing pulmonary findings in patients with chronic aspiration<sup>(18)</sup> included patients with and without aspiration diagnosed by VFSS who underwent chest CT. A comparison of the two groups revealed that the patients with aspiration had a higher frequency of changes such as atelectasis, centrilobular nodules, bronchiolectasis, consolidation, and ground-glass attenuation. Bronchial wall thickening and air trapping were the most prevalent findings in both groups; however, no significant differences were demonstrated. In addition, the authors reported that the findings were more prevalently distributed in lower lung zones. Figures 2 and 3 exemplify some of the CT findings described.

One of the limitations of the present systematic review was the lack of articles published on the subject,



**Figure 2.** In A, sagittal chest CT scan demonstrating bronchiolectasis, atelectasis, and areas of ground-glass opacity in the lower lobes. In B, coronal chest CT scan demonstrating better visualization of bronchiolectasis in the right lower lobe.



**Figure 3.** Axial chest CT scans showing areas of ground-glass attenuation in the left lower lobe.

as well as the varied sample characteristics. In this review, it was not possible to establish a consensus that could characterize a pattern of pulmonary aspiration in patients with dysphagia, and further studies on the subject are needed. Evidence suggests

that chest CT findings in patients with aspiration are diverse; however, the articles mentioning the location of pulmonary findings detected that the findings were more prevalently distributed in the right lung and in lower lung zones.

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