

# Association of esophageal dilatation in chest CT scan with gastroesophageal reflux disease: A case control study

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## Abstract

The presence of increased air bubble in the lumina of esophagus on a chest CT scan may be associated with esophageal disorders. The purpose of this study was to determine the association between the appearance of air bubbles on chest CT scan and gastroesophageal Reflux Disease (GERD). In this case-control study, thirty-two patients with endoscopically proved GERD and 32 subjects without GERD underwent

chest computed tomography (CT) scanning. Esophageal dilatation (ED) was defined as the presence of air bubbles greater than 10 mm in the supra ventricle (SV) and ventricle (CV), and air bubbles >15 mm in the ventricle to the lower esophageal sphincter (V-LES). The results were compared between the two groups. The GERD patients included 16 (50%) males with a mean age of 58.5±11.2 years and the control group included 17 (54.8%) males and 14 (45.1%) females with a mean age of 66.7±10.5 years. There was a significant relationship between the presence of GERD and esophageal dilation (ED) in the V-LES sections on the CT scan (P=0.002). The mean size of the air bubbles in the V-LES section was 11.73 mm in the case group in comparison to 4.32 mm in the control group (P<0.001). The size and location of the air bubbles in the esophagus can vary and be important. The possibility of GERD increases in the presence of esophageal dilation on CT scan.

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Key words: Esophageal diseases; gastroesophageal reflux; computed tomography; chronic cough.

Contributions: SJH, data collection, interpretation and analyses, manuscript drafting; SAJM, EI, study design, analyses and interpretation of data; AJ, data collection, analyses and interpretation of data; HR, study design, data collection, analyses and interpretation, manuscript drafting. All authors read and approved the final manuscript.

Conflict of interest: The authors declare no competing interests.

Funding: This study was funded by Alimentary Tract Research Center (ATRC), Ahvaz Jundishapur University of Medical Sciences and Health Services.

Acknowledgments: The trial protocol was approved by the Institutional Ethical Review Board at Ahvaz Jundishapur University of Medical Sciences (AJUMS). The cooperation of all participants in this study is greatly appreciated.

Received for publication: 23 February 2018

Accepted for publication: 21 May 2018

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Tipografia PI-ME Editrice, Italy

Monaldi Archives for Chest Disease 2018; 88:914

doi: 10.4081/monaldi.2018.914

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## Introduction

Gastroesophageal reflux disease (GERD) is one of the most common gastrointestinal (GI) diseases that creates a major impact on the quality of life and imposes high burdens and financial costs on the world population [1,2]. It affects 10-20% of the western and 20% of the Iranian population [3]. Heartburn is the most common symptom of GERD but a broad spectrum of extra-esophageal manifestations, including laryngitis, dental erosions, hoarseness, chronic cough, non-cardiac chest pain, recurrent pneumonia, asthma, subglottic stenosis, and laryngeal cancer have been reported [4]. Esophageal computed tomography (CT) scan is not the standard of care for the evaluation of GERD, but it is an essential modality for respiratory disorders. The presence of air bubbles on chest CT scan of such patients is a matter of debate. The air is commonly detected on radiological exams of the normal esophagus. It has been reported that an air column is visible in 64% of normal esophagus CT scans [5]. Esophageal dilatation (ED) was determined as the presence of an air column greater than 10 mm in the coronal plane [6]; the definition then changed to the presence of air bubbles greater than 10 mm in the supra ventricle (SV) and ventricle (CV), and air bubbles >15 mm in the ventricle to the lower esophageal sphincter (V-LES) [7]. The clinical significance of incidental esophageal dilatation seen on the chest CT scan of a patient without any GI symptoms is challenging. In a recent study, the appearance of esophageal air bubbles on the CT scan was associated with an increased frequency of GERD symptoms [8]. Respiratory disorders including asthma and pulmonary fibrosis have been reported as a com-

plication of GERD; on the other hand, ED is a well-known entity in some systemic disorders that affect respiratory and GI systems. The presence of ED on the chest CT scan may be a sign of esophageal or systemic disorders such as GERD and systemic sclerosis [9]. In the present study, we evaluated the association between endoscopy proven GERD and ED or the size and location of air bubbles on esophageal CT images.

## Materials and Methods

### Study population

We carried out this case-controlled study in Imam Khomeini Hospital affiliated with Ahvaz Jundishapur University of Medical Sciences (AJUMS) between December 2012 and May 2014. A total of 32 GERD patients that were diagnosed by upper GI endoscopy were enrolled in a prospectively. The control group comprised patients without GERD and GI symptoms who were admitted to the pulmonary ward. All patients and controls underwent chest CT scan. Due to the association between hiatal hernia and GERD, the patients who had hiatal hernia on upper GI endoscopy or CT scan were excluded from the study. The CT images were reviewed by a trained pulmonologist who was not aware of the GERD status of the patients. The presence of the air was characterized by its location, quantity, diameter on the CT scan, and the presence or absence of ED. Informed consent was obtained from the case group. Ethics Committee of AJUMS approved this study.

### Radiologic measurement

The patients were scanned at full inspiration using a Siemens scanner with 1- to 2-mm collimation. The images were reconstructed to a 512-pixel matrix using a sharp kernel and a 26-cm display field of view. They were transferred to an image analysis workstation. Just standard mediastinal windows (width, 450 HU; level, 50 HU) and paranchymal windows (width, 1300 HU; level, -290 HU) were viewed. We used the guidelines given by Schraufnagel; the measurements were all limited to the thoracic esophagus. The presence of air in the esophagus and esophageal dilatation (ED) were scrutinized.

In each transvers section the largest linear measurement of the esophageal air column was measured until the esophagus adhered to the stomach, which was usually in the first abdominal CT section. If

the esophagus was folded and included two air densities, we measured only the largest one because the measurement line was restricted to the air only. The internal measurements were recorded for each section. The esophagus was divided into 3 sections, including the supra ventricle (SV), ventricle (CV) and ventricle to lower esophageal sphincter (V-LES) and the normal air column was assessed in different parts of the esophagus by CT scan. ED was defined as the presence of air bubbles >10 mm in the SV and CV, and greater than 15 mm in the V-LES (Figure 1 A,B).

### Statistical analysis

SPSS software version 16 (Chicago, IL, USA) was used for statistical analysis. The data is expressed as mean  $\pm$  SD. independent T test was used to compare all continuous variables and categorical variables were compared with Pearson chi-square test or Fisher's exact test. The difference between grade A, B, and C in ED was assessed by the analysis of covariance. Significant p-values were considered less than 0.05.

## Results

A total of 32 GERD patients with a mean age of  $58.5 \pm 11.2$  years including 16 (50%) males and 16 (50%) females were enrolled in this study. In the GERD group, 4 patients had hiatal hernia and according to Los Angeles (LA) classification of esophagitis, 46.8% (95% CI: 29.09-65.25) had esophagitis grade A, 50% (95% CI 31.88-68.11) had esophagitis grade B, and 4.2% (95% CI: 0.7-20.8) had esophagitis grade C. There was no significant correlation between age and the grade of esophagitis ( $p=0.447$ ).

Thirty-one subjects without GERD with a mean age of  $66.7 \pm 10.5$  years, including 17 (54.8%) males and 14 (45.1%) females were enrolled in the control group. There was no significant difference in female and male gender between the two groups ( $p=0.208$ ). ED in the V-LES section was seen in 15 (46.9%) GERD patients and 3 (9.7%) individuals in the control group subsequently ( $p=0.02$ ) (Table 1). The mean size of the esophageal air bubble in the V-LES section was significantly larger in the GERD group than the control group (11.73 mm *versus* 4.32 mm,  $p<0.001$ ) (Table 2). Exclusion of cases with hiatal

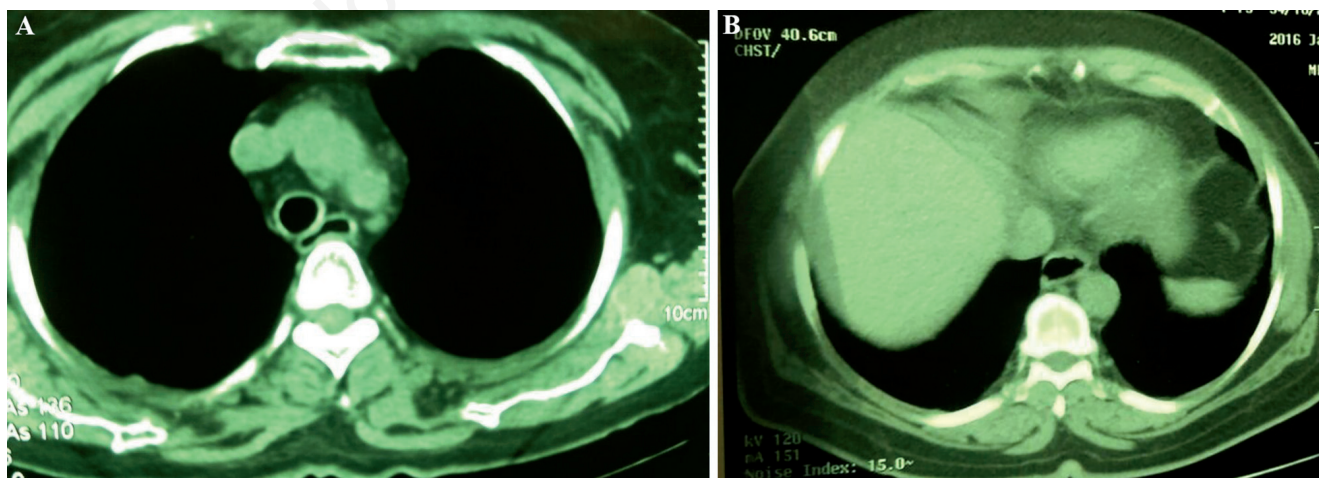


Figure 1. A) CT scan in 52-year-old man, with esophageal dilatation in supra ventricular section; the greatest direct distance of air bubble of esophagus was measured; the soft tissue was not included in the recording line; scale is in millimeters. B) Lumen of air bubble at V\_LES section in the same patient.

hernia (reported on CT scan or upper GI endoscopy) did not change the results after data reanalysis. There were no significant differences in the mean size of esophageal air bubbles in SV and CV sections between the two groups. There is a decreasing measure of the ED rate from the upper esophageal section to the middle and distal sections in the con-

trol group (51.6%, 22.6%, and 9.7%, respectively). But the rate of ED in the distal section of the esophagus was higher than the middle section in the GERD group (Figure 2). There was no significant difference between esophageal dilation and the grade of esophagitis by covariance analysis (Table s 3 and 4).

Table 1. Comparison of the frequency (%) air bubble (mm) size in case and control group.

		Case	Control	p-value
SV (mm)	≥10	21 (65.6%)	16 (51.6%)	0.3
	<10	11 (34.4%)	15 (48.4%)	
CV (mm)	≥10	11 (34.4%)	7 (22.6%)	0.4
	<10	21 (65.6%)	24 (77.4%)	
V_LES (mm)	≥15	15 (46.9%)	3 (9.7%)	0.002
	<15	17 (53.1%)	28 (90.3%)	

SV, supra ventricle; CV, cardiac ventricle; V\_LES, ventricle to lower esophageal sphincter.

Table 2. Comparison of the air bubble (mm) size in case and control group.

	Patients n=32	Controls n=31	p-value	95% CI
SV (mean ±SD)	9.15±6.6	9.09±8.5	0.9	-3.7-3.9
CV	5.68±7.6	3.72±6.1	0.2	-1.5-5.4
V_LES	11.73±6.67	4.32±6.2	<0.001	4.5-10.6

SV, supra ventricle; CV, cardiac ventricle; V\_LES, ventricle to lower esophageal sphincter.

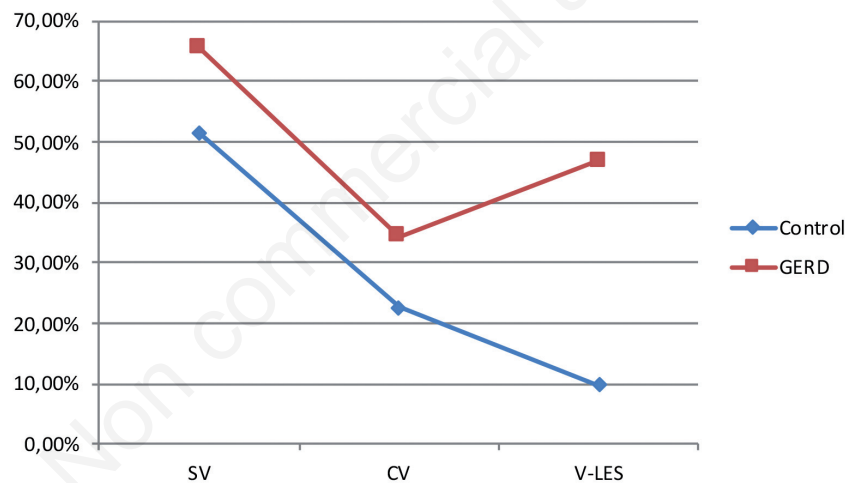


Figure 2. Rate of esophageal dilatation at different level of esophagus.

Table 3. Comparison air bubble (mm) size in V\_LES section due to GERD staging.

		GERD			p-value
		A	B	C	
V_LES	<15 mm	8(47.1%)	8(47.1%)	1(5.9%)	0.9
	≥15 mm	6(40%)	8(53.3%)	1(6.7%)	

V\_LES, ventricle to lower esophageal sphincter.

Table 4. Comparison between air bubble (mm) size due to GERD severity.

	GERD A	GERD B	GERD C	p-value
SV (mm)	8.9±6.2	9.2±6.5	10.0±14.0	0.9
CV (mm)	5.3±7.9	5.4±7.0	10.0±14.0	0.7
V_LES (mm)	11.0±6.5	11.8±7.04	15.0±7.07	0.7

SV, supra ventricle; CV, cardiac ventricle; V\_LES, ventricle to lower esophageal sphincter.

## Discussions

The presence of air bubbles in the esophagus is frequently detected on radiological examination of at least 60% of normal patients with various sizes and locations. Less than 3% of the subjects have air in the lower two sections, that indicates the normal lower esophageal sphincter is closed. According to a study by Schraufnagel [7], distension of the esophagus up to 15 mm should be considered normal in the position below the ventricles until above the diaphragm or V-LES, but any measurement of 20 mm or more should be considered abnormal. The presence of increased esophageal air bubbles or dilation of the esophageal lumen on a chest CT scan may be correlated with esophageal disease and may be a clue for diagnosing states such as scleroderma, esophageal cancer, achalasia, or other benign distal esophageal strictures [6,10-13]. Most of diseases that result in esophageal dilatation present with dysphagia or regurgitation but respiratory symptoms may be the essential complains of patients with GERD.

For the first time, Moosavi *et al.* evaluated the association between the presence of air bubbles on thoracic CT scan and GERD symptoms in a cross-sectional study; they showed a significant relationship between the presence of ED in the V-LES and heartburn (76.9% versus 32.3% in patients with and without ED) [8]. That study was cross-sectional and included patients with major and minor GERD symptoms *via* a checklist and had no control group, so we performed this case-control study on endoscopically proven GERD patients to address this correlation.

In the present study, we found a correlation between the presence of air bubbles at the V-LES sections on CT scan and GERD. Esophageal dilatation was observed in about 47% of GERD and 10% of control subjects ( $p=0.02$ ) (Table 1). The mean size of the esophageal air bubbles in the V-LES section was significantly larger in the GERD versus the control subjects. There were no significant differences in the mean size of esophageal air bubbles in the upper esophageal sections between the two groups (Table 2). We realized a decreasing measure of the ED rate from the upper esophageal section to the middle and distal sections in the control group (51.6%, 22.6%, and 9.7%, respectively). The rate of ED in the distal section of the esophagus was higher than the middle section in the GERD group (Figure 2). This finding is compatible with the observation of Schraufnagel [7], indicating that air bubbles in the upper esophageal sections may be secondary to air swallowing whereas increased air bubbles in the distal sections are related to GERD.

Esophageal dilatation in the V-LES section might be a consequence of or transient lower esophageal relaxation (TLESR) or lower esophageal sphincter (LES) dysfunction. TLESR is an important issue in the pathophysiology of GERD [14,15]. Sifrim *et al.* showed that in mixed reflux events, liquid often precedes gas reflux. They observed that gas reflux occurred as the primary event in only a minority of acid reflux episodes [16]. Mixed reflux of liquid and gas is more frequent than pure liquid reflux, both in healthy subjects and in GERD patients. Bredenoord and Weusten reported a significant correlation between gas reflux and air swallowing. Air swallowing did not provoke the reflux of the liquid or mixed gas-liquid gastric contents in healthy volunteers. They found no correlation between the size of the gastric air bubble and different reflux parameters [17].

In spite of recent advances in continuous imaging with 320 row area detector CT scan as described by Fukazawa *et al.* [18], and positron emission tomography/computed tomography (PET/CT) as reported by Wu *et al.* [19] for gastrointestinal disorders, these imaging modalities are not standard of care for diagnosis of GERD, so detection of ED on chest CT scan or high-resolution chest CT scan (HRCT) is an incidental and challenging finding. Firstly, esophageal stasis may predis-

pose the patient to the recurrent microaspiration and different respiratory complications including lung abscess, asthma and interstitial lung disease (ILD) [1,20-23]. Secondly, ED might be correlated with the severity of lung disease or may be a clue for diagnosis of a serious underlying disorder. Carrie Richardson *et al.* in a cross-sectional study on 270 cases of systemic sclerosis found that esophageal dilatation on HRCT is correlated with more severe ILD. Affected patients had more severe imaging and functional abnormality including lower lung volume and lower DCLO predicted [21]. Since esophageal motility disorder and TLESR are common in GERD, it is reasonable to see esophageal dilatation with its respiratory complications [24].

Our results suggest that CT scan could be potentially useful in detecting thoracic esophageal dilatation in patients who have GERD; however, our study did not support any correlation between ED and the severity of GERD. This study is the first prospective research showing a correlation between air bubbles on CT scan and GERD.

Our study has certain limitation; this study was designed to evaluate reflux esophagitis and patients with non-erosive reflux disease (NERD) were not included; therefore, further studies using 24 h pH-monitoring as gold standard of GERD diagnosis may be helpful.

## Conclusions

In conclusion, our findings demonstrated that esophageal dilatation and increased air bubbles in the esophageal lumen in the V-LES sections of chest CT scan were more common in patients with esophagitis than normal individuals. We found no relationship between the size of the esophageal air column and the severity of esophagitis.

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