Correlation between Timed Barium Esophagogram and the Eckardt Stage in Achalasia

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ABSTRACT

Objective: To evaluate the correlation of timed barium esophagogram (TBE) parameters and the Eckardt stage in patients with achalasia.

Methods: This prospective study was done in 29 adult achalasia patients who underwent TBE and were assessed for clinical symptoms according to the Eckardt stage. The association between the Eckardt stage and TBE parameters including the height and the width of barium column, esophageal emptying between 1 and 5 minutes, which was calculated by comparing the area of barium column and esophageal emptying between 0 and 5 minutes, which was calculated from the relative changes in ingested volume to estimated volume of barium column on the 5-min image and this was calculated by using Kruskal-Wallis test. Comparison of mean emptied volume at 1 min. image and mean emptied volume between 1 and 5 minutes was done by using paired samples t-tests.

Results: There was a significant difference in the amount of emptied volume at 1 min image (mean = 118.27, SD = 31.1) and emptied volume between 1 min and 5 min images (mean = 11.41, SD = 9.4); $t(27) = 15.375$, $p < 0.001$. Statistically significant difference in esophageal emptying between 1 and 5 minutes across the Eckardt stages was found ($H = 8.115$, 3 d.f., $p = 0.044$). The difference was statistically significant between the Eckardt stage 2 and 3 ($p = 0.039$). There were no statistically significant differences in other TBE parameters across the Eckardt stages.

Conclusion: No statistically significant difference in TBE parameters across the Eckardt stages was found in the present study. However, TBE is a useful objective method to assess esophageal emptying in patients with achalasia. Interpretation of TBE should be standardized. Calculation of esophageal emptying should include the amount of barium emptied from the esophagus in the first minute.

Keywords: Timed barium esophagogram; Eckardt stage; achalasia (Siriraj Med J 2018;70: 60-65)

INTRODUCTION

Achalasia is an esophageal motility disorder characterized by a failure of the lower esophageal sphincter (LES) to relax during swallowing and the absence of esophageal peristalsis. It is caused by a loss of inhibitory myenteric plexus ganglion cells for which the etiology is unknown.[1] Typical clinical manifestations included dysphagia, regurgitation of undigested food, retrosternal pain, and weight loss. Esophageal manometry is the gold standard for the diagnosis.[2,3] High-resolution manometry (HRM) of the esophagus is a new technique that provides a more precise assessment of esophageal motility than conventional techniques[4,5] which has improved the diagnostic accuracy as well as defined clinically relevant subtypes. Barium swallow is a complimentary diagnostic test and has long been used to diagnose achalasia if the classic radiologic findings are demonstrated. Treatments include medication, botulinum toxin injection, pneumatic dilatation and surgical myotomy. Current treatments aim to reduce the pressure at the LES which improves esophageal emptying and esophageal dilatation. No therapy restores esophageal peristalsis.

Esophageal function can be assessed by esophageal scintigraphy, manometry or barium study. Both esophageal

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scintigraphy and manometry are more expensive and not widely available, whereas timed barium esophagogram (TBE) is a simple, cheap, noninvasive and widely available method to assess esophageal emptying. TBE has been used as an objective measure of baseline and post-treatment esophageal emptying in achalasia patients. However, techniques and interpretation of TBE are varied and there is no standardized criteria to define treatment response. While some institutions used the height and the width of barium column, others used esophageal emptying calculated by comparing area of barium column on the 1- and 5-min images.[6,7] Prior study by Oezcelik A et al[8] used initial esophageal clearance by comparing area of barium column on the 1-min images obtained before and after myotomy and found that the degree of improved emptying on TBE correlates with clinical outcome. On the contrary, previous studies showed some discordance between symptom improvement and improvement of esophageal emptying on TBE.[9]

There are several disease-specific severity scoring systems in achalasia including HRM-based classification, the Adams's stages, the Eckardt score, and the Vantrappen classification. The Eckardt score tends to be the most useful system in clinical practice.[10] This system grades the four major symptoms of achalasia (dysphagia, regurgitation, retrosternal pain and weight loss). Total symptom scores can be converted to Eckardt clinical stages. Stages 0 and I indicate remission of the disease. On the contrary, stages II and III represent failure of treatment.

The purpose of the present study was to evaluate the correlation of TBE parameters (the height and the width of barium column, esophageal emptying calculated from area of barium column between the 1- and 5-min images and esophageal emptying calculated from the relative changes in ingested volume to estimated volume of barium column on the 5-min image) and the Eckardt clinical stage in patients with achalasia.

MATERIALS AND METHODS

This study was a prospective study which was approved by Institutional Review Board (Si 467/2015). From 1 September 2015 to 31 October 2016, all 33 consecutive adult patients (age >18 years) who were scheduled for TBE were recruited and informed consent was obtained at the time of making an appointment. Three patients were excluded from the study due to their diagnoses of achalasia were not confirmed by HRM. Another patient diagnosed as a nutcracker esophagus was also excluded. Finally, a total of 29 patients with confirmed diagnosis of achalasia by HRM criteria were included.

Demographic and clinical data of patients were recorded which included gender, age, previous treatment, the duration of symptoms and weight loss prior to treatment. The four major clinical symptoms of each patient were assessed by the author on the day of TBE. The frequency of each symptom (dysphagia, regurgitation, retrosternal pain) was graded on a scale ranging from 0 to 3 (0 = none, 1 = occasionally, 2 = daily, 3 = several times a day after each meal). The degree of weight loss was graded on a scale ranging from 0 to 3 (0 = none, 1 = < 5 kg, 2 = 5-10 kg, 3 = > 10 kg). A total symptom scores of 0-1 corresponds to the Eckardt stage 0, of 2-3 corresponds to the Eckardt stage 1, of 4-6 corresponds to the Eckardt stage 2 and score > 6 corresponds to the Eckardt stage 3.

TBE

Patients were advised overnight fasting prior to TBE. TBE was performed by using the fluoroscopic machine. Entire study was performed in the erect posture and left posterior oblique position. A ruler was placed on the left side of fluoroscopic table for the measurement calibration. A fixed volume (150 ml) of low density barium sulfate suspension (45% weight by volume; Solotop 140 mg/300 ml.) was ingested orally within 15-20 seconds. The position of spot film was confirmed under fluoroscopically to include barium filled esophagus, esophagogastric (EG) junction and the ruler. Spot films were taken on 1, 2 and 5 minutes after barium ingestion. If barium was completely emptied from the esophagus on 1-min or 2-min film, no additional spot film was obtained.

Radiological assessments were performed at PACS workstation by the author including measurements of the height and the maximum width of barium column, the mean width of the esophagus and the area of barium column (Fig1). All measurements in each image were calibrated by measuring 100 millimeters scale of a ruler put inside the fluoroscopic view. The height of barium column was measured from top of barium column to EG junction or location of bird-beak. If barium-foam interface was observed in dilated esophagus with retained food content and secretions, the measurement was done

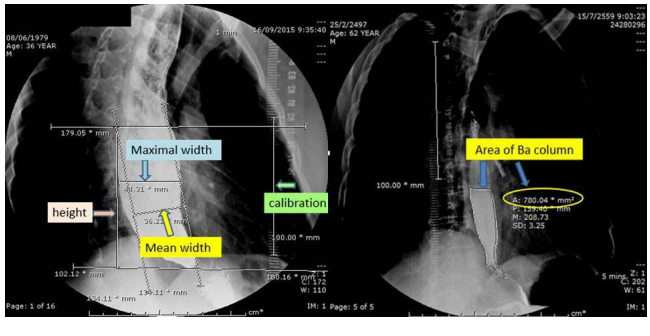

Fig 1. Calibration and measurement in TBE

at superior aspect of barium column which did not include foam. The maximal width was measured at widest part of barium column perpendicular to long axis of the esophagus. The mean width was measured by drawing two lines parallel to the respective outer margins of the barium column from the top to the bottom with the estimated contrast-containing area outside the line equal to the area not containing contrast inside the line. The mean width was recorded as the distance between these two lines. The area of barium column was drawn manually using a freehand tool.

Esophageal emptying between 1 and 5 minutes was calculated by comparing the area of barium column on the 1- and 5-min images. Esophageal emptying between 0 and 5 minutes was calculated from the relative changes in ingested volume (150 ml) to estimated volume of barium column at 5-mins. The estimated volume of barium column was calculated according to the cylindrical formula: (mean radius)^2*3.14 * height. Mean radius is a half value of the mean width.

Statistical analysis

Categorical data were summarized as frequencies and percentages. Continuous variables were summarized parametrically as mean and standard deviation or nonparametrically as box plots with median, 25th, and 75th percentiles (bottom and top of box).

Paired samples t-tests was used to compare the mean emptied volume at 1 min. image and mean emptied volume between 1 min and 5 mins.

Kruskal-Wallis test was used to assess the association between the Eckardt stage and TBE parameters including the height and maximum width of barium column on 5-min image, esophageal emptying between 1 and 5 mins calculated by comparing the area of barium column and esophageal emptying calculated from the relative changes in ingested volume to estimated volume of barium column on the 5-min image.

A p value < 0.05 was considered to be statistically significant.

RESULTS

Demographic and clinical data were shown in Table 1. Of a total 29 patients with achalasia, 55.2 % were female and 44.8 % were male with mean age of 48.6±13.6 years. Most of the patients (72.4%) already had previous treatment before TBE. The Eckardt clinical stages were stage 0 in 8 patients, stage 1 in 9 patients, stage 2 in 9 patients and stage 3 in 3 patients.

The amount of barium emptied at 1 min image

TABLE 1. Demographic and clinical data of 29 patients with achalasia

Age range (mean±SD)	19-70 years (48.6±13.6)
Gender, M/F	13/16
Duration of symptoms, range (mean±SD)	2 – 267 months (40.7±67.2)
Weight loss in 6 months, range (mean±SD)	0-24 kg (6.5±7.2)
Previous treatment, no. of patients (%)	
None	8 (27.6%)
Yes	21 (72.4%)
Open myotomy	1 (3.4%)
Open myotomy and POEM	2 (6.9%)
Pneumatic dilatation and POEM	2 (6.9%)
POEM	16 (55.2%)
Eckardt stage, no. of patients (%)	
Stage 0	8 (27.6)
Stage 1	9 (31.0)
Stage 2	9 (31.0)
Stage 3	3 (10.3)

Abbreviation: POEM = peroral endoscopic myotomy

(150 ml – calculated volume of barium column at 1 min) ranged from 44.9-150 ml. The amount of barium emptied between 1 min and 5 mins ranged from 0.35-37.9 ml. There was a significant difference in the amount of emptied volume at 1 min image (mean = 118.27, SD = 31.1) and emptied volume between 1 min and 5 mins (mean = 11.41, SD = 9.4); $t(27) = 15.375$, $p < 0.001$.

Relation of the Eckardt stage and the height of barium column, and relation of the Eckardt stage and the maximal width of barium column on 5-min image were shown in Figs 2 and 3. The height of barium column and the maximal width of barium column on 5-min image showed no statistically significant differences across the Eckardt stages (H=5.053, 3 d.f., p=0.168; and H=4.546, 3 d.f., p=0.208, respectively).

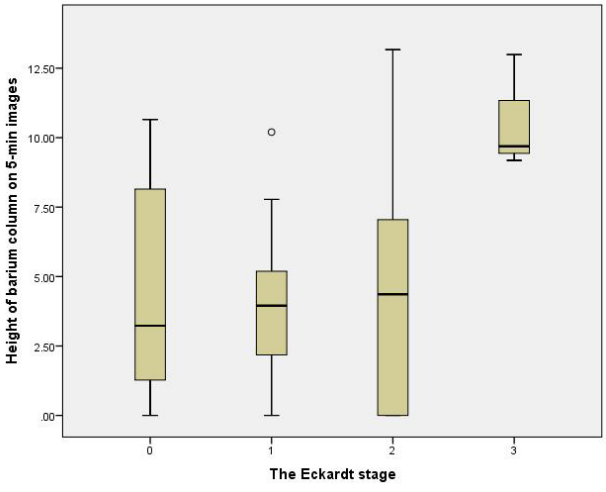

Fig 2. The Eckardt stage and the height of barium column on 5-min image relation. Box-and-whiskers plot represents ranges and the 25th to 75th percentiles, respectively. The horizontal thick lines denote group medians.

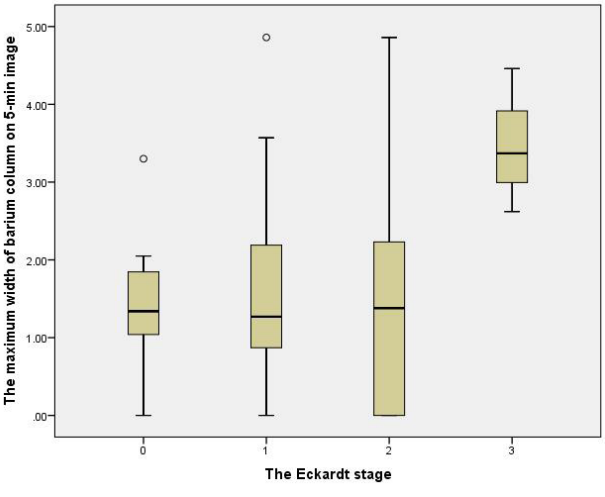

Fig 3. The Eckardt stage and the maximum width of barium column on 5-min image relation. Box-and-whiskers plot represents ranges and the 25th to 75th percentiles, respectively. The horizontal thick lines denote group medians.

Relationhip of esophageal emptying calculated by comparing the area of barium column on the 1- and 5-min images and the Eckardt stages in 28 patients was shown in Fig 4. One patient was not included because barium was completely emptied from the esophagus on 1-min image. There was statistically significant difference in percentage of emptied volume by comparing the area of barium column on the 1- and 5-min images across the Eckardt stages (H=8.115, 3 d.f., p=0.044). The difference was statistically significant between the Eckardt stages 2 and 3 (p=0.039).

Fig 5 showed the relationship of esophageal emptying calculated from the relative changes from ingested volume

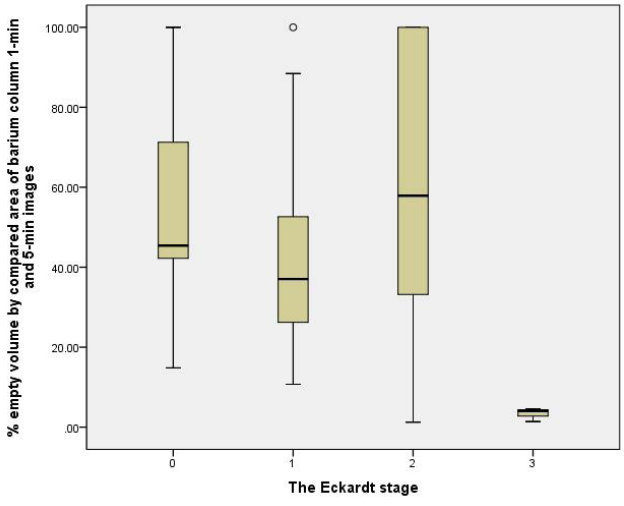

Fig 4. The Eckardt stage and percentage of emptied volume by compared area of barium column on 1-min and 5-min images relation. Box-and-whiskers plot represents ranges and the 25th to 75th percentiles, respectively. The horizontal thick lines denote group medians.

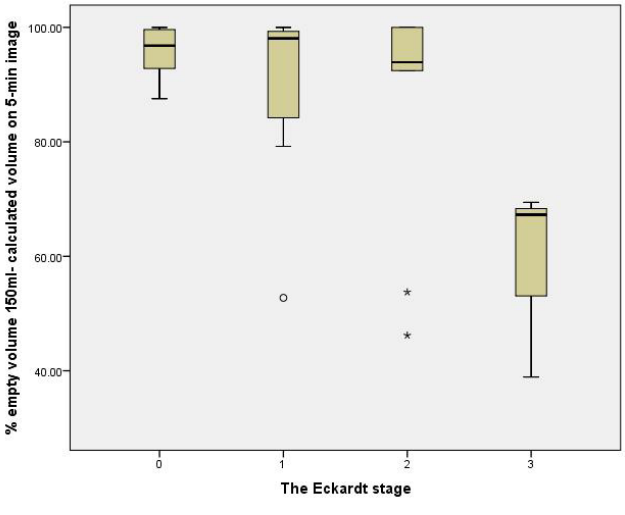

Fig 5. The Eckardt stage and percentage of emptied volume from the relative changes in ingested volume (150 ml) to calculated volume of barium column on the 5-min image relation. Box-and-whiskers plot represents ranges and the 25th to 75th percentiles, respectively. The horizontal thick lines denote group medians.

(150 ml) to estimated volume of barium column on the 5-min image and the Eckardt stages. There was no statistically significant difference in percentage of emptied volume by this method across the Eckardt stages (H=6.102, 3 d.f., p=0.107).

DISCUSSION

The goal of current treatments of achalasia is to reduce LES pressure which improves esophageal emptying, esophageal dilatation and clinical symptoms of patients. Improvement of clinical symptoms, post treatment LES pressure <10 mmHg and >50% improvement over baseline of barium column height at 1 min after swallowing are considered as positive predictors of treatment outcome.[2] Esophageal manometry is costly and lacks availability so that TBE is a widely useful objective tool to evaluate treatment response in patients with achalasia. However, there are some differences in TBE technique and interpretation among institutions and the criteria to define treatment response has not been standardized.

Most institutions used standard radiography machine while our institution used fluoroscopic machine to perform TBE. Standard radiography machine is widely available but fluoroscopic machine has some potential benefits. It can assess and adjust the coverage of barium-filled esophagus and EG junction prior to obtaining the first spot film at 1 min. after swallowing. In addition, if the film is taken while the esophagus is contracted, it can repeat another spot film immediately to get image while the esophagus is relaxed.

Volume of orally ingested barium sulfate suspension used in our institution is a fixed volume at 150 ml. for every patient. Some institutions used adjust volume of barium sulfate suspension range from 100-250 ml. as each patient can tolerate. Using a fixed volume is better to compared pre- and post-treatment TBE. However, the amount of barium sulfate suspension should be enough to adequately fil a dilated esophagus without regurgitation or aspiration. No patient had regurgitation or aspiration in the present study. However, we observed inadequately barium filled marked dilated esophagus in a few cases which caused difficulty in measurement of barium column.

Interpretation of TBE has also varied. Esophageal emptying by TBE can be assessed by measurement of the height, the width, area and volume of barium column. Similar to previous study[11], the present study found that emptying of barium suspension in the first minute is faster than barium emptying from 1min to 5 mins. The authors suggest that the emptied volume (150 ml-volume at 5 min.) represents esophageal emptying better than the emptied volume (volume at 1 min – volume at 5 mins). In addition, we agree with this prior study[11] that calculation of volume by cylindrical formula is better than using area of the barium column.

The present study found no statistically significant differences in TBE parameters across the Eckardt stages except the difference in percentage of emptied volume by comparing the area of barium column on the 1- and 5-min images between the Eckardt stage 2 and 3. However, the present study has some limitations especially the small sample size and the heterogeneity of patient population which included both newly diagnosed achalasia patient and patients with various treatment types. Prior study suggested that improvement of post-treatment clinical symptoms may not correlate to esophageal emptying.[9,12,13] However, Andersson M. et al.,[14] found significant correlations between the height of barium column and symptoms score (dysphagia and chest pain). Oezcelik A. et al[8] also found correlation between the degree of improved emptying on TBE and clinical outcome. Although correlation between clinical symptoms and TBE parameters is still unclear, poor esophageal emptying on TBE is considered as a predictor of treatment failure.[2,15] The further study should compare different patient groups; the newly diagnosed cases and the patients with prior treatment.

CONCLUSION

Although the present study found no statistically significant difference in TBE parameters across the Eckardt stages, TBE is a useful objective method to assess esophageal emptying in patients with achalasia. Interpretation of TBE should be standardized. Calculation of esophageal emptying should include the amount of barium emptied from the esophagus in the first minute.

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