

## The Normal Variations of the Caliber of Oesophageal Hiatus in Adults

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### ABSTRACT

Gastroesophageal reflux disease (GERD) is one of the most frequent benign disorders of the upper gastrointestinal tract and can be seen at any age<sup>[1]</sup>. The esophageal hiatus and its function have been described extensively, but an exact anatomical determination of its normal size is lacking. It seems important to define the normal size, as crural closure is an important part of surgical treatment of gastroesophageal reflux disease (GERD) and hiatal or paraesophageal hernias<sup>[2]</sup>. **The aim of this study:** was to determine normal values for the size of the esophageal hiatus. in order to improve operative technique in the control of gastric reflux in hiatus hernia by more exact knowledge of the normal size of esophageal hiatus in adults. **Methods:** This study was conducted on 100 patient ,where the size of the oesophageal hiatus was measured in normal population through a calibrated 36 French bougie with a balloon. **Results:** (40 male, 60 female) with a mean age of (40.2) years with a standard deviation (SD) of ( $\pm 12.4$ ) years. Ranging from (12) years to (68) years. In our study the mean value of the diameter of esophageal hiatus was (2.2) cm with SD ( $\pm 0.3$ ) cm ranging from 1.6 cm to 2.9 cm. **Conclusion:** There is a strong positive correlation between length of esophagus till cardia and length of esophagus till hiatus, length of abdominal esophagus. Also there is a strong positive correlation between height and length of esophagus till cardia, length of esophagus till hiatus and length of abdominal esophagus. Also there is a negative correlation between BMI and length of esophagus till cardia, length of esophagus till hiatus.

**Keywords:** Hiatus hernia, Gastroesophageal reflux disease (GERD), fundoplication, laparoscopic.

### INTRODUCTION

Symptoms of reflux disease can be present in up to 40 % of the community and lifelong drug treatment may be required in 15–50 % to relieve these symptoms when surgery is not undertaken<sup>[3]</sup>.

The laparoscopic use of the fundoplication surgery, originally defined by Nissen, for the first time in 1991 has made fundoplication a favorable option for the definite treatment of reflux disease, and it has become the standard surgical treatment for the disorder with a well-documented high rate of success in increasing both the general and disease related quality of life together with proven reliability<sup>[4]</sup>.

Dysphagia is frequently encountered after this surgery, although it is temporary in 95 % of the cases, and has a negative effect on the patient's quality of life. Moreover, dysphagia can also lead to dangerous results such as food impaction and aspiration<sup>[5]</sup>.

Almost all surgeons now routinely repair the hiatus during laparoscopic fundoplication procedures. Hence, it is important to understand how to repair the hiatus in such a way that the risk

of recurrent hernia is minimized and new dysphagia does not develop following surgery<sup>[6]</sup>.

While the size of the hiatus is not reported in recent studies, there were also no normal values existing for comparison to determine the need for further closure or reinforcement.

### MATERIALS AND METHODS

This prospective study was carried out on 100 patients under going abdominal surgery either open or laparoscopic at the surgical department of kasr el ainy hospital at the period from April till july 2016.

Patients with ages ranging between 17 and 65 years were included in the study. Written informed consent from patients was taken before starting procedure.

Any adult patient undergoing abdominal surgery were included while patients with history of GERD or previous operations involving the hiatus were excluded.

All patients were instructed to fast for at least 6 hours before induction of anesthesia. Fasting is required to ensure operating on an empty stomach

besides having a safe anesthetic induction & recovery.

### Operative technique

The patient lies supine on the operating table. Inspection of esophageal hiatus: After insufflation of abdomen in laparoscopic abdominal surgery or in open surgery, esophageal hiatus is inspected as regard presence of masses or accidentally discovered hiatus hernia.

Introduction of bougie: A calibrated 36 French bougie with balloon is introduced to the stomach through the mouth after being fully lubricated. Detection of bougie in the stomach: In open surgery the bougie is palpated in the stomach but in laparoscopic surgery the bougie is seen while entering the stomach.

Insufflation of the balloon: the balloon is at first insufflated near maximum by about 30 cc air. Then the bougie is pulled out through the mouth until it hangs at the cardia, then the length of the whole esophagus is measured from the central incisores till the cardia.

The balloon is then deflated gradually until it passes through the cardia. Now the bougie is pulled furtherly till the balloon re-hangs at the hiatus.

The length from central incisores to the hiatus is now measured. The length of the intra abdominal part of the esophagus is calculated by subtracting the difference in length from central incisores to the cardia and the hiatus.

Now the balloon is again gradually deflated until it passes through the hiatus and observing the maximum volume that can pass through it. The bougie is then extracted out of the mouth after being completely deflated.

### Calculation of the size of the hiatus

1. The circumference of the balloon is measured when it is insufflated with the maximum volume that can pass through the hiatus.
2. The diameter of the esophageal hiatus can be calculated from the following formula:

$$\text{Circumference} = \pi \times D$$

$$\text{So } D = \frac{\text{Circumference}}{\pi}$$

$$\text{As } D: \text{ diameter } \pi = 3.14$$

### Statistical analysis:

All collected data were revised for completeness and consistency. Precoded data was

entered on the computer using "Microsoft Office Excel Software" program (2010) for windows. Data was then transferred to the Statistical Package of Social Science Software program, version 21 (SPSS) to be statistically analyzed.

Data was summarized using mean and standard deviation or Median and percentiles for quantitative variables and frequency and percentage for qualitative variables.

Comparison between groups was done using independent sample t-test for quantitative variables and chi square test or Fisher's exact test for qualitative variables.

Repeated measures were analyzed using paired t test for quantitative variables & marginal homogeneity test for qualitative variables.

Spearman correlation coefficient was calculated to test the association between the quantitative & ordinal variables.

P values equal to or less than 0.05 were considered statistically significant. Graphs were used to illustrate some information.

## RESULTS

### Descriptive statistics

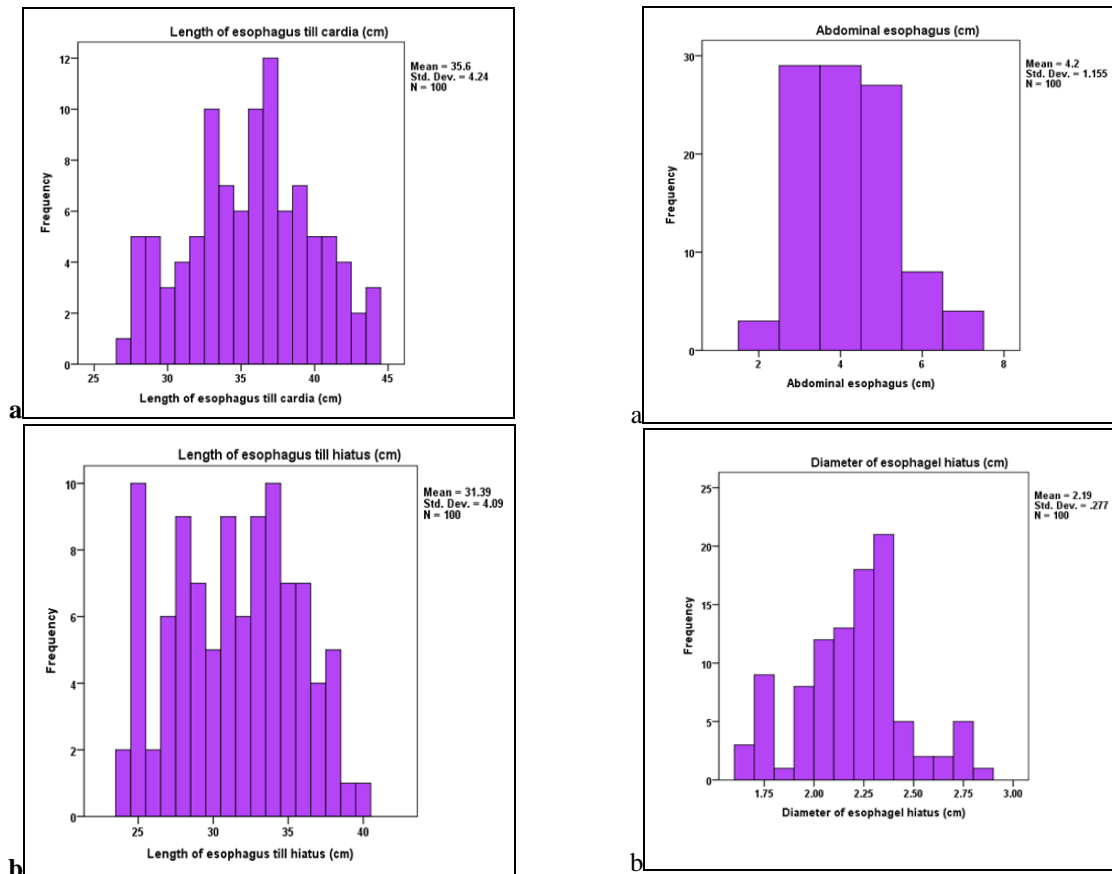
Our study was carried on 100 patients. 40% of them were males and the remainder 60 % were females with age ranging from 12 years to 68 years with a mean age 40.2 ( $\pm$  12.4) years, and With a median age of 41 years.

Patients weight, ranged from 49 kg to 200 kg with a mean weight of 100.6 ( $\pm$  25.3) kg, and With a median weight of 98 kg. While height ranged from 140 cm to 185 cm with a mean height of 166 ( $\pm$  11) cm, and with a median height of 167 cm.

BMI, Ranged from 19.9 to 67.6 with a mean value of 36.7 ( $\pm$  9.4) cm, and with a median value of 34.6. Chest circumference, Ranged from 65 cm to 145 cm with a mean value of 107 cm ( $\pm$  19.3) cm, and with a median value of 110 cm.

We had 95 patients undergone laparoscopic surgeries (25 Sleeve gastrectomies, 66 Cholecystectomies, 1 Antral GIST 2 Inguinal hernia, 1 Varicocelelectomy) and 5 patients undergone open surgeries (3 cancer colon and 2 incisional hernias)

### Analytic statistics



**Fig. 1:** a:Patients according to length of oesophagusFrom central incisors till cardia. b:Patients according to length of oesophagus from central incisors till hiatus

Figure (1a) shows distribution of patients according to length of esophagus from central incisors till cardia, Ranging from 27cm to 44 cm with a mean value of 35.6cm ( $\pm 4.2$ ) cm, and with a median value of 36 cm. Figure (1b) shows distribution of patients according to length of esophagus from central incisors till hiatus, Ranging from 24cm to 40 cm with a mean value of 31.4cm ( $\pm 4.1$ ) cm, and with a median value of 31.5cm.

**Fig.2a:** patients according to length of abdominal esophagus. **Fig.2b:** patients according to diameter of esophageal hiatus in cm

Figure (2a) shows distribution of patients according to length of abdominal esophagus, Ranging from 2 cm to 7 cm with a mean value of 4.2 cm ( $\pm 1.2$ ) cm, and with a median value of 4 cm.

Figure (2b) shows distribution of patients according to diameter of esophageal hiatus, Ranging from 1.6 cm to 2.9 cm with a mean value of 2.2 cm ( $\pm 0.3$ ) cm, and with median value of 2.2 cm.

**Table (1):** Correlations esophageal parameters with each other & with other demographic parameters

		Length of esophagus till cardia	Length of esophagus till hiatus	Abdominal esophagus	Diameter of esophageal hiatus in cm
Length of esophagus till hiatus	r	0.962			
	P	<0.001			
Abdominal esophagus	r	0.267	0.018		
	P	0.007	0.855		
Diameter of esophageal hiatus in cm	r	0.051	0.042	0.078	
	P	0.612	0.680	0.442	
Age	r	0.008	-0.025	0.104	-0.012
	P	0.936	0.807	0.304	0.906
Weight	r	0.167	0.149	0.106	-0.100
	P	0.097	0.139	0.292	0.321
Height	r	0.786	0.739	0.293	0.119
	P	<0.001	<0.001	0.003	0.240
BMI	r	-0.206	-0.207	-0.003	-0.159
	P	0.040	0.038	0.979	0.114
Chest circumference	r	0.160	0.168	-0.006	-0.030
	P	0.112	0.095	0.954	0.770

r= Spearman correlation coefficient.

As shown in table (1), there is a strong positive correlation between length of esophagus till cardia and length of esophagus till hiatus, length of abdominal esophagus as P value  $\leq 0.05$ . Also there is a strong positive correlation between

height and length of esophagus till cardia, length of esophagus till hiatus and length of abdominal esophagus. Also there is a negative correlation between BMI and length of esophagus till cardia, length of esophagus till hiatus

**Table (2):** Comparison of all parameters regarding sex

	Male		Female		P value
Age	42.9	± 11.9	38.4	± 12.6	0.076
Weight	102.3	± 33.5	99.5	± 18.3	0.593
Height	165.9	± 10.9	166.2	± 11.1	0.903
BMI	37.1	± 11.1	36.4	± 8.2	0.734
Chest circumference	108.1	± 21.5	106.2	± 17.7	0.634
Length of esophagus till cardia	35.8	± 4.4	35.5	± 4.2	0.738
Length of esophagus till hiatus	31.4	± 4.2	31.4	± 4.1	0.945
Abdominal esophagus	4.3	± 1.2	4.1	± 1.1	0.379
Diameter of esophageal hiatus in cm	2.2	± 0.3	2.2	± 0.3	0.268

As shown in table (2), there is no correlation between age, weight, height, BMI, chest circumference, length of esophagus till cardia, length of esophagus till hiatus, abdominal esophagus, diameter of esophageal hiatus and sex.

A hiatal hernia is defined as the protrusion of intra-abdominal organs through a dilated esophageal hiatus. The esophageal hiatus and its function have been described extensively, but an exact anatomical determination of its normal size is lacking. It seems important to define the normal

size, as crural closure is an important part of surgical treatment of gastroesophageal reflux disease (GERD) and hiatal or paraesophageal hernias.

## DISCUSSION

This study was conducted on 100 patient (40 male, 60 female) with a mean age of (40.2) years with a standard deviation (SD) of ( $\pm 12.4$ ) years. Ranging from (12) years to (68) years.

While the size of the hiatus is not reported in recent studies, there were also no normal values existing for comparison to determine the need for further closure or reinforcement.

In our study the mean value of the diameter of esophageal hiatus was (2.2) cm with SD ( $\pm 0.3$ ) cm ranging from 1.6 cm to 2.9 cm.

In 1999, Chen et al. recorded radiographic findings from barium esophagrams in 91 patients (47 women, 44 men) with a mean age of 52 Years (range 17-80 years), the mean diameter of the hiatus was 19 mm measured on the full-column view with the patient in the prone horizontal position<sup>[7]</sup>.

In our study the mean value of hiatal surface area was 3.8 cm<sup>2</sup> ranging from 2 cm<sup>2</sup> to 6.6 cm<sup>2</sup>.

In 2010, Shamiyeh et al. In their study which was performed on 50 cadavers (24 male/26 female) and all measurements were obtained. Mean age was 74 years (40-90 years), mean height was 1.68 m (1.39-1.83 m), mean weight was 71 kg (40-120 kg), and mean body mass index (BMI) was 25 kg/m<sup>2</sup> (14-40 kg/m<sup>2</sup>). Mean chest circumference was 101 cm (75-178 range). The mean esophageal hiatal surface area was 5.84 cm<sup>2</sup> ranging from 3.62 cm<sup>2</sup> to 9.56 cm<sup>2</sup><sup>[2]</sup>.

In our study there was no correlation between the mean length of the esophagus, and an individual's sex.

In 1999, Awad et al. in their study on esophagus among normal control subjects and patients with esophageal disorders concluded that mean length of the esophagus, is not related to an individual's sex<sup>[8]</sup>.

However, Li et al. in his study in which candidates with achalasia were excluded noted that males had a significantly longer mean esophageal length (23.6 +/- 0.3 cm) than females (22.4 +/- 0.3 cm)<sup>[9]</sup>.

In 2011, Kaisha et al. in their study found that the esophagus was longer in males compared to

females<sup>[10]</sup>. Also, in 1997, Scapa et al. In their study had similar conclusions, in which esophageal length was significantly longer in male patients. It thus suggests that interpretation of the length of the esophagus for various interventions requires that gender be considered<sup>[11]</sup>.

In our study there was no correlation between esophageal length and weight. Most studies like ours did not find any correlation between esophageal length and weight<sup>[9,11,12]</sup>.

Of the parameters considered in our study the individual's height. Was the parameter that best correlated with esophageal length. Linear correlation was found between esophageal length and height,

This finding is similar to that of several studies by other authors<sup>[8,11,12,13,14]</sup>. In 1999, Awad et al. in their study which was conducted on 617 patients, which included 51 normal control subjects (27 males and 24 females) and 566 patients (297 males and 269 females) with esophageal disorders (50 with achalasia, 6 with diffuse esophageal spasm, 64 with strictures, 38 with nutcracker esophagus, 398 with gastroesophageal reflux disease (GERD) with positive 24-hour pH monitoring, and 66 with possible GERD but negative 24-hour pH monitoring). In his analysis, he concluded that the length of the esophagus was related to the individual's height<sup>[8]</sup>. Similar conclusions were made by Scapa et al.<sup>[11]</sup>, Song et al.<sup>[14]</sup> and Yau<sup>[13]</sup>.

In 2005, Yang et al. while studying the esophagus in children had similar conclusions on the effect of height. They derived an equation to estimate the length of the esophagus to be:  $1.048 + 0.167 \times \text{height}$  (in centimeters)<sup>[12]</sup>.

In our study the mean esophageal length from central incisors till the cardia was 35.6 with SD ( $\pm 4.2$ ).

In 1989, Zhonghua. In his study the length of the esophagus in 104 patients with gastric disease was measured by a WX-C3 type fiberoendoscope. The result of measurement showed that the average length from the upper incisors to the cardia was 44.4 cm<sup>[15]</sup>.

In 1997, Scapa et al. in their study, The esophageal length from incisors to esophagogastric mucosal junction was measured endoscopically in 758 patients, found that Fifty-three percent of the examined population had

esophageal length shorter than 38 cm, whereas 99% of patients with normal endoscopy had esophageal length of 38-40 cm<sup>[11]</sup>.

## CONCLUSIONS

- The size of esophageal hiatus in normal adults ranges from 1.6 to 2.9 with a mean of 2.2 cm ( $\pm 0.3$ ) cm, and with a median value of 2.2 cm.
- The normal length of esophagus from central incisors till cardia ranges from 27cm to 44 cm with a mean value of 35.6cm ( $\pm 4.2$ ) cm, and with a median value of 36 cm.
- The normal length of esophagus from central incisors till hiatus Ranges from 24cm to 40 cm with a mean value of 31.4cm ( $\pm 4.1$ ) cm, and with a median value of 31.5cm.
- The normal length of abdominal esophagus Ranges from 2 cm to 7 cm with a mean value of 4.2 cm ( $\pm 1.2$ ) cm, and with a median value of 4 cm.
- There is a strong positive correlation between length of esophagus till cardia and length of esophagus till hiatus, length of abdominal esophagus. Also there is a strong positive correlation between height and length of esophagus till cardia, length of esophagus till hiatus and length of abdominal esophagus. Also there is a negative correlation between BMI and length of esophagus till cardia, length of esophagus till hiatus.
- There is no correlation between sex and age, weight, height, BMI, chest circumference, length of esophagus till cardia, length of esophagus till hiatus, abdominal esophagus, diameter of esophageal hiatus.
- Further studies are needed to evaluate hiatal size in patients with GERD and by comparing the results with the normal range of esophageal hiatus surgeons can decide the need for crural repair.

## REFERENCES

1. Karl HF, Benjamin B, Wolfarm B et al (2014) EASE recommendations for the management of gastroesophageal reflux disease. *SurgEndosc* 28:1753-1773.
2. Shamiyeh A, Szabo, K, Granderath F A, et al (2010) The esophageal hiatus: what is the normal size?. *SurgEndosc* 24:988-991.
3. Ronkainen J, Aro P, Storskrubb T, et al (2006) Gastro- esophageal reflux symptoms and health-related quality of life in the adult general population—the Kalixanda study. *Aliment Pharmacol Ther* 15:1725-1733.
4. Pessaux P, Arnaud JP, Delattre JF, et al (2005) Laparoscopic antireflux surgery: five-year results and beyond in 1340 patients. *Arch Surg* 140:946-951.
5. Watson DI, Pike GK, Baigrie RJ, et al (1997) Prospective double-blind randomized trial of laparoscopic Nissen fundoplication with division and without division of short gastric vessels. *Ann Surg* 226:642-652.
6. Chew CR, Jamieson GG, Devitt PG, Watson DI (2011) Prospective Randomized Trial of Laparoscopic Nissen Fundoplication With Anterior Versus Posterior Hiatal Repair: Late Outcomes. *World J Surg* 35:2038-2044.
7. Chen D, Gelfand M, Ott (1999). Reflux evaluation: correlation between pH results, esophagitis, esophageal dysmotility, patient age, and esophageal caliber. *Diseases of the Esophagus, J. Morphol., ISDE/Blackwell Science Asia* 12:303-305.
8. Awad, Z. T.; Watson, P.; Filipi, C. et al (1999). Correlations between esophageal diseases and manometric length: a study of 617 patients. *J. Gastrointestinal. Surg.*, 3(5):483-8.
9. Li Q, Castell A, Castell D (1994). Manometric determination of esophageal length. *Am. J. Gastroenterol.*, 89(5):722-5.
10. Kaisha O, Mute T, Kioko (2011). The correlation of Esophageal body length with measure of external body parameters. *Int. J. Morphol.*, 29(3):895-898.
11. Scapa E, Broide E, Waron M et al (1997). Esophagogastric mucosal junction (EGMJ): its location as measured by endoscopy. *Surg. Laparosc. Endosc.* 7(2):159-61.
12. Yang G, Bishop P, Smith B et al (2005). Radiographic and endoscopic measurements of esophageal length in pediatric patients. *Ann. Otol. Rhinol. Laryngol.*, 114(8):587-92.
13. Yau P, Watson D, Jamieson G et al (2000). The influence of esophageal length on outcomes after laparoscopic fundoplication. *J. Am. Coll. Surg.*, 191(4):360-5.

14. SongJ, KimH,Ryu H (1991). Correlation of esophageal lengths with measurable external parameters. Korean J. Intern. Med., 6(1):16-20.

15. Zhonghua W,Zhi k.(1989). Measurement of the length of the adult esophagus using a fibero gastroscope . U S national library of surgery Jul;27(7):407-8, 444-5.

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