

The Relationship of Anatomical Localizations of Hiatal Clamp and Oesophagogastric Junction with Body Mass Index

Relación entre las Localizaciones Anatómicas de la Pinza Hiatal y la Unión Esofagogástrica con el Índice de Masa Corporal

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SUMMARY: In our study, we aimed to reveal the relationship between the anatomical localizations measured and the Body Mass Index (BMI) in patients scheduled for upper gastrointestinal endoscopy. In this study, anatomical localizations of the hiatal clamp and oesophagogastric junction in 189 female and 137 male patients who applied to the hospital with different gastrointestinal system complaints and underwent esophagogastroduodenoscopy (EGD) were investigated depending on BMI. In addition, the data were compared with the patients' complaints before EGD and the diagnoses they received after EGD. SPSS Statistics 22 (IBM Corp. Turkey) program was used for statistical analysis and $p < 0.05$ value was considered significant. There was no statistically significant correlation between the patients' BMIs and the anatomical localizations of the hiatal clamp and oesophagogastric junction ($p > 0.05$). On the other hand, it was determined that the hiatal clamp distance and the distance of the oesophagogastric junction increased as the height and weight increased ($p < 0.001$). In male patients, these anatomical structures were found at a statistically greater distance than female patients ($p < 0.001$). As a result of the Receiver operating characteristic (ROC) analysis, both hiatal clamp and EGD localization were found to have a statistically significant relationship with the diagnosis of ulcer, and the cut-off value for both localizations was determined as > 38 . As a result of the study, it can be said that BMI values, hiatal clamp distance and oesophagogastric junction localizations may change in relation to height and weight.

KEY WORDS: Esophagogastroduodenoscopy; Hiatal clamp; Oesophagogastric junction; Body Mass Index.

INTRODUCTION

Esophagogastroduodenoscopy (EGD) is a widely used diagnostic method considered the gold standard in the diagnosis of upper gastrointestinal system diseases. Upper gastrointestinal system endoscopy is the most reliable diagnostic method in the diagnosis of diseases of the esophagus, stomach, and proximal duodenum. The EGD procedure starts with the entrance from the lips and continues with the cheek, gingiva and teeth, followed by the pharynx and then the oesophagus. The gastroscope reaches the stomach by passing through the hiatus oesophagus (clinically called hiatal clamp) at the T10 vertebra level. The junction of the oesophagus and the stomach is located at the level of the T11 vertebra, just below the diaphragm at the oesophagogastric junction (Z line) and is usually 40 cm away from the anterior incisors. After the stomach, the gastroscope is advanced to the duodenum, and the second part of the duodenum is the end

of the endoscopic imaging (Moore & Dalley, 1999; Kahraman & Cingi, 2016).

Obesity is an epidemic disease that has an increasing prevalence worldwide. According to the World Health Organization estimations, more than 1.9 billion adults aged 18 years and older were overweight in 2016, and among these, more than 650 million adults were obese. Also, the prevalence of obesity worldwide nearly tripled between 1975 and 2016 (Baysal *et al.*, 2015). Obesity, which is very common today, and therefore, the resulting increase in Body Mass Index, causes many diseases such as Type 2 Diabetes Mellitus, hypertension, dyslipidemia, coronary artery disease, some cancers, sleep apnea syndrome, Gastroesophageal Reflux Disease, and esophageal motility disorders. Also, it was reported in various publications that it causes an endoscopic abnormal finding, comorbidity, and

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helicobacter pylori positivity in these individuals (Carabotti *et al.*, 2014; Baysal *et al.*, 2015).

It especially draws our attention that the relations between the anatomical localization of the hiatal clamp and oesophagogastric junction with Body Mass Index (BMI) and demographic features were not evaluated extensively enough, and the existing studies on this subject are limited. For this reason, we plan to uncover the relations between anatomical localizations and BMI in patients scheduled for upper gastrointestinal endoscopy to clarify this situation in our study. In addition, we also aimed to reveal the relationship between BMI and the complaints of patients before EGD and the diagnoses of patients after EGD.

MATERIAL AND METHOD

The data of 326 patients who underwent EGD between January 2020 and December 2022 were prospectively analyzed in this study. It was planned to investigate the anatomical localizations of the hiatal clamp and oesophagogastric junction based on BMI in these patients. Patients under the age of 18, patients with signs of tumors in the upper gastrointestinal tract or who had undergone surgery, and patients who underwent percutaneous endoscopic gastrostomy were not included in the study. Before the endoscopy, the demographic data such as height, weight, age, sex, as well as complaints and diagnoses were noted.

The procedure of EGD and how it functions: Patients who decided to apply EGD due to gastrointestinal complaints were informed about the process. After a full 6-hour oral intake restriction, verbal and written consent was obtained from the patient and necessary information was given. Topical pharyngeal anesthesia with 10 % lidocaine spray was applied before the procedure. Then, the patient was positioned to the left of the endoscopist, with the head slightly flexed and the chin closer to the chest. The Olympus GIF-Q scope was advanced by providing direct vision. The structures in the mouth were roughly evaluated, and the esophagus was entered by seeing the piriform sinuses. The esophagus was evaluated by providing adequate insufflation and the scope was pushed distally in a controlled manner. In the most distal part of the esophagus, the squamocolumnar epithelial region (transition zone), Z line, where the squamous epithelium of the esophagus ends and the columnar epithelium of the stomach begins. The distance between the anterior incisors and the Z line was measured as the distance to the anatomical localization of the oesophagogastric junction (Fig 1). The hiatal clamp (hiatus esophagus) is the place where the diaphragm crus

is seen approximately 1 cm after the oesophagogastric junction. The distance from the anterior incisors to this point was measured as the distance to the anatomical localization of the hiatal clamp (Fig. 2). The stomach was entered by passing the hiatal clamp. After the evaluation of the structures in the stomach, the duodenum was evaluated by passing the pylorus. The distal end of the duodenum was the second continent and was advanced until the scope reached this point. Afterwards, a detailed controlled examination was performed at the exit and the procedure was terminated by aspirating the air given during the procedure. All measurements were made by the same investigator. After the procedure, the patients were informed that they should not take solid or liquid food for two hours.

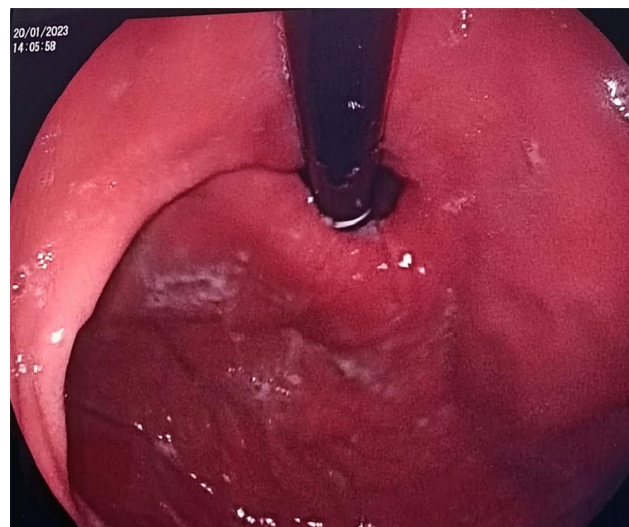


Fig. 1. Hiatal clamp (Esophagogastrroduodenoscopy image).



Fig. 2. Oesophagogastric junction, Z line (Esophago gastroduodenoscopy image).

The classification of the BMI scores of the patients were made according to the classification set by the World Health Organization (Table I) (Sciorio *et al.*, 2022).

Table I. Obesity classification according to BMI

Classification	BMI (kg/m ²)
Weak	< 18.5
Underweight	<18.5 kg/m ²
Normal weight	≥18.5 to 24.9 kg/m ²
Overweight	≥25.0 to 29.9 kg/m ²
Obesity	≥30 kg/m ²
Class I	30.0 to 34.9 kg/m ²
Class II	35.0 to 39.9 kg/m ²
Class III	≥40 kg/m ²

Statistical analysis: The conformity of the variables to the normal distribution was examined using the Shapiro Wilk test. Continuous variables were expressed as median (minimum:maximum) and mean±standard deviation. Categorical variables were expressed as n (%). Independent sample t test or Mann Whitney U test was used for comparisons between two independent groups according to the results of the normality test; Kruskal Wallis test was used for comparisons between three independent groups. Multiple comparison procedures were applied using the Dunn-Bonferron approach to identify the group or groups that differed in comparisons between three independent groups. Pearson chi-square and Fisher-Freeman-Halton tests were used for intergroup comparisons of categorical variables. Relationships between continuous variables were analyzed by correlation analysis and Spearman correlation coefficient was calculated. In order to investigate the use of Hiatal clamp and Oesophagogastric junction measurements, which are thought to have a role in the diagnosis made after endoscopy, ROC analysis was performed and the relevant cut-off point values were calculated. For statistical analysis SPSS (IBM Corp. Released 2012. IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp.) and MedCalc Statistical Software version trial version 16.4.3 (MedCalc Software bvba, Ostend, Belgium; <https://www.medcalc.org>; 2016) programs were used and p<0.05 was considered statistically significant.

RESULTS

This study was conducted with 326 patients, 42.02 % (n=137) male and 57.98 % (n=189) female, who underwent EGD. The ages of all patients ranged from 18 to 78 years, with a mean of 48.84±14.91 in women and 47.84±15.12 in men. The height of the patients included in the study ranged from 150 cm to 195 cm, and their weights were between 50 kg and 130 kg. BMI values of female

patients ranged from 19.8 to 47.7, and it ranged from 18.3 to 40.1 in males. According to the classification by the World Health Organization, the classification of our patients according to their BMI: 0.61 % (n=2) were underweight, 26.07 % (n=85) were normal weight, 42.02 % (n=137) were overweight and 31.29 % (n=102) were obese. It was observed that 66.67 % (n=68) of the patients in the obesity classification were Class I, 21.57 % (n=22) Class II and 11.76 % (n=12) Class III.

The majority of the patients, 45.09 % (n=147) were admitted to the hospital with the complaint of dysphagia, followed by 38.04 % (n=124) abdominal pain, 12.27 % (n=40) dyspepsia. 4.6 (n=15) of them applied to the hospital due to cancer screening. After EGD, 150 (46.01 %) patients were diagnosed with gastritis, 97 (29.75 %) patients with reflux, 79 (24.23 %) patients with loose LES and 39 (11.96 %) patients with ulcer. On the other hand, after the procedure, the results of 70 (21.47) patients were normal.

The relationship between BMI, height and weight values of the patients, and hiatal clamp distance and oesophagogastric junction distance (cm) is given in Table II. A statistically significant correlation was found between both height and weight of the patients included in the study and hiatal clamp distance and oesophagogastric junction distance (p<0.001). Accordingly, it was determined that the hiatal clamp distance and the oesophagogastric junction distance increased as the height and weight increased (Table III). A statistically significant inverse relationship was found between the ages of the patients and both the Hiatal clamp distance and the oesophagogastric junction distance (respectively, p=0.044 ; p=0.018). It was observed that the distance of the localization of these two parameters to the anterior incisors decreased as the age increased (Table III).

Table II. Descriptive Statistics For Stature, Body Weight, BMI and Hiatal clamp & Oesophagogastric junction.

Age (years)	48 (18:78)
Height (cm)	165 (150:195)
Weight (kg)	75 (50:130)
BMI (kg/m ²)	27.60 (18.30:47.70)
Oesophagogastric junction distance (cm)	37 (29:45)
Hiatal clamp distance (cm)	38 (34:46)

The data are expressed as the median (minimum:maximum).

The BMI groups of the patients, hiatal clamp distance (cm), oesophagogastric junction distance (cm), complaints before and after EGD, and the relationship between these parameters are given in Table IV. There was no statistically significant difference between BMI groups and hiatal clamp distance and oesophagogastric junction distance (cm)

Table III. The relationship between BMI, Height and Weight of the patients and the Hiatal clamp and Oesophagogastric junction

(n= 326)	Oesophagogastric junction distance (cm)		Hiatal clamp distance (cm)	
	r _s	p	r _s	p
BMI (kg/m ²)	-0.105	0.058	-0.096	0.085
Height (cm)	0.565	<0.001	0.576	<0.001
Weight (kg)	0.231	<0.001	0.243	<0.001
Age (years)	-0.131	0.018	-0.112	0.044

rs: Spearman correlation coefficient.

(p=0.473 and p=0.441, respectively). Since there were not enough patients in the underweight group, they were not included in the comparisons between the groups. Comparisons were made between the Normal weight, Overweight and Obesity groups.

A statistically significant difference was found

between BMI groups according to dysphagia complaint in comparisons between body mass index groups and pre-EGD complaints (p=0.017). In order to find out that which groups were responsible for the difference occurred, the groups were compared in pairs. There was a statistically significant difference between Normal weight and Overweight groups according to dysphagia complaint

Table IV. Comparisons between BMI (kg/m²) groups.

		Underweight (n=2)	Normal Weight (n=85)	Overweight (n=137)	Obesity (n=102)	p
Oesophagogastric junction distance (cm)		39 (37:41)	38 (32:45)	38 (29:45)	37 (32:44)	0.441 ^a
Hiatal clamp distance (cm)		40 (38:42)	39 (34:46)	38 (34:46)	38 (34:45)	0.473 ^a
Indications						
Cancer screening						
	Yes	2 (%100)	36 (%42.35)	64 (%46.72)	45 (%44.12)	0.489 ^b
	No	0	49 (%57.65)	73 (%53.28)	57 (%55.88)	
Stomachache						
	Yes	0	12 (%14.12)	14 (%10.22)	14 (%13.73)	0.674 ^b
	No	2 (%100)	73 (%85.88)	123 (%89.78)	88 (%86.27)	
Dyspepsia						
	Yes	0	31 (%36.47)	50 (%36.50)	43 (%42.16)	0.633 ^b
	No	2 (%100)	54 (%63.53)	87 (%63.50)	59 (%57.84)	
Dysphagia						
	Yes	0	6 (%7.06)	9 (%6.57)	0	0.017 ^b
	No	2 (%100)	79 (%92.94)	128 (%93.43)	102 (%100)	
Diagnoses						
Gastritis						
	Yes	2 (%100)	32 (%37.65)	69 (%50.36)	47 (%46.08)	0.113 ^b
	No	0	53 (%62.35)	68 (%49.64)	55 (%53.92)	
Reflux						
	Yes	0	25 (%29.41)	35 (%25.55)	37 (%36.27)	0.288 ^b
	No	2 (%100)	60 (%70.59)	102 (%74.45)	65 (%63.73)	
Loose lower oesophagus						
	Yes	0	17 (%20)	40 (%29.20)	22 (%21.57)	0.315 ^b
	No	2 (%100)	68 (%80)	97 (%70.80)	80 (%78.43)	
Ulcer						
	Yes	0	11 (%12.94)	20 (%14.60)	8 (%7.84)	0.425 ^b
	No	2 (%100)	74 (%87.06)	117 (%85.40)	94 (%92.16)	
Normal						
	Yes	0	27 (%31.76)	24 (%17.52)	19 (%18.63)	0.064 ^b
	No	2 (%100)	58 (%68.24)	113 (%82.48)	83 (%81.37)	

The data are expressed as n (%) and median (minimum:maximum). a: Kruskal Wallis Test. b: Fisher-Freeman Halton Test.

($p=0.008$). The incidence of dysphagia in the normal weight group is higher than in the Overweight group. A statistically significant difference was found between the Overweight and Obesity groups according to dysphagia complaint ($p=0.0011$). The incidence of dysphagia in the Overweight group is higher than in the Obesity group. Statistically significant differences were not found in other pairwise comparisons ($p>0.05$). There were no statistically significant differences between body mass index (BMI) groups and patients' complaints related to other reasons for endoscopy, such as screening, abdominal pain, and dyspepsia (Table III). Similarly, no statistically significant differences were observed between BMI groups and the diagnoses made after endoscopy (Table IV).

The relationship between the patients' sex and height, weight, BMI, hiatal clamp distance, and esophagogastric junction distance (cm), as well as the association between sex and pre-EGD complaints and post-EGD diagnoses, is presented in Table V. There is a statistically significant difference between the sex of the included patients and their height and weight ($p<0.001$). Male patients had higher median heights and weights compared to female patients (Males were taller and heavier than females). Based on BMI values, a statistically significant difference was observed between sexes ($p=0.005$). Female patients had a higher median body mass index compared to males. Both hiatal clamp distance and esophagogastric junction distance (cm) showed a statistically significant difference between sexes ($p<0.001$). Male patients had higher median lengths for both parameters

compared to female patients. There was no statistically significant difference between sex and pre-EGD complaints ($p>0.05$). When comparing sex with post-EGD diagnoses, the proportion of ulcer diagnoses was higher in males ($p=0.003$). There was no statistically significant difference between sex and other diagnoses ($p>0.05$) (Table V).

The relationship between age, pre-EGD complaints, and post-EGD diagnoses is presented in Table VI. There was no statistically significant difference between age and post-EGD diagnoses ($p>0.05$). Regarding pre-EGD complaints based on age: The median age value in the screening complaint group was higher compared to those without screening complaints ($p<0.001$). The mean age value in the dyspepsia complaint group was lower compared to those without dyspepsia complaints ($p<0.001$). There was no statistically significant difference in age between individuals with and without complaints of abdominal pain and dysphagia ($p>0.05$) (Table VI).

Table V. Comparisons between sexes.

(n=326)	Female (n=189)	Male (n=137)	p
Age (years)	48.84±14.91	47.84±15.12	0.552 ^d
Height (cm)	160 (150:182)	172 (150:195)	<0.001 ^e
Weight (kg)	72 (50:123)	80 (52:130)	<0.001 ^e
BMI (kg/m ²)	28.10 (19.80:47.70)	27.20 (18.30:40.10)	0.005 ^e
Oesophagogastric	37 (29:44)	39 (33:45)	<0.001 ^e
Hiatal clamp distance (cm)	38 (34:45)	40 (34:46)	<0.001 ^e
Indications			
Cancer screening			
Yes	81 (%42.86)	66 (%48.18)	0.341 ^c
No	108 (%57.14)	71(%51.82)	
Stomachache			
Yes	28 (%14.81)	12 (%8.76)	0.100 ^c
No	161 (%85.19)	125 (%91.24)	
Dyspepsia			
Yes	70 (%37.04)	54 (%39.42)	0.662 ^c
No	119 (%62.96)	83 (%60.58)	
Dysphagia			
Yes	10 (%5.29)	5 (%3.65)	0.485 ^c
No	179 (%94.71)	132 (%96.35)	
Diagnoses			
Gastritis			
Yes	84 (%44.44)	66 (%48.18)	0.505 ^c
No	105 (%55.56)	71 (%51.82)	
Reflux			
Yes	59 (%31.22)	38 (%27.74)	0.498 ^c
No	130 (%68.78)	99 (%72.26)	
Loose lower oesophagus			
Yes	48 (%25.40)	31 (%22.63)	0.565 ^c
No	141 (%74.60)	106 (%77.37)	
Ulcer			
Yes	14 (%7.41)	25 (%18.25)	0.003 ^c
No	175 (%92.59)	112 (%81.75)	
Normal			
Yes	40 (%21.16)	30 (%21.90)	0.873 ^c
No	149 (%78.84)	107 (%78.10)	

Data are expressed as n(%), median(minimum:maximum) and mean±standard deviation.

c: Pearson Chi-Square Test d: Independent Sample t Test. e: Mann Whitney U Test

To assess the relationship between the ulcer diagnosis received by the patients after EGD and the localization of the esophagogastric junction, a ROC analysis was performed, and the results are shown in Figure 3. The cutoff value for the esophagogastric junction measurement as a predictor of ulcer diagnosis was determined to be >38. It was found that if the esophagogastric junction is located 38 cm or further from anterior incisors, there was a high probability of an ulcer. The area under the curve for the esophagogastric junction measurement was 0.635 (Sensitivity = 59 %; Specificity = 67.2 %; $p=0.004$) (Fig. 3). Similarly, a ROC analysis was conducted to assess the relationship between the ulcer diagnosis received after EGD and the localization of the hiatal clamp, and the results are presented in Figure 4. The cutoff value for the hiatal clamp measurement as a predictor of ulcer diagnosis was

determined to be >38. It was observed that if the hiatal clamp is located 38 cm or further from the anterior incisors, there is a high probability of an ulcer. The area under the curve for the hiatal clamp measurement was 0.630 (Sensitivity = 66.7 %; Specificity = 54 %; $p=0.005$) (Fig. 4).

Table VI. Relationship between age and patients' indications and diagnoses.

(n=326)	Age	p
Indications		
Cancer screening		
Yes	55 (18:78)	<0.001 ^e
No	43 (19:77)	
Stomachache		
Yes	47.50 (22:74)	0.929 ^e
No	48 (18:78)	
Dyspepsia		
Yes	40.50 (19:77)	<0.001 ^e
No	54 (18:78)	
Dysphagia		
Yes	47 (21:72)	0.591 ^e
No	48 (18:78)	
Diagnoses		
Gastritis		
Yes	49.26±15.59	0.351 ^d
No	47.70±14.45	
Reflux		
Yes	47 (18:72)	0.130 ^e
No	50 (20:78)	
Loose lower oesophagus sphincter		
Yes	49 (19:77)	0.359 ^e
No	48 (18:78)	
Ulcer		
Yes	45 (20:74)	0.227 ^e
No	48(18:78)	
Normal		
Yes	45.50 (20:74)	0.534 ^e
No	49 (18:78)	

Data are expressed as median (minimum:maximum) and mean±standard deviation. d: Independent Sample t Test. e: Mann Whitney U Test. t Sample t Test. e: Mann Whitney U Test

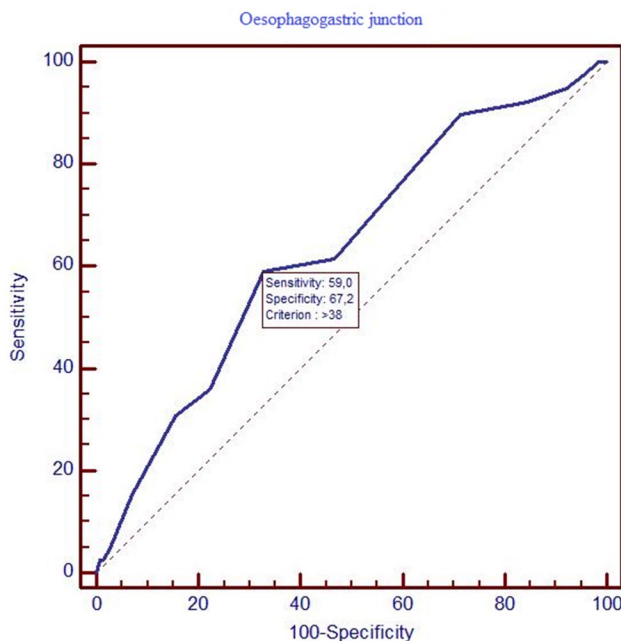


Fig. 3. Evaluation of oesophagogastric junction localization with ROC curve in the differentiation of ulcer diagnosis after esophagogastroduodenoscopy

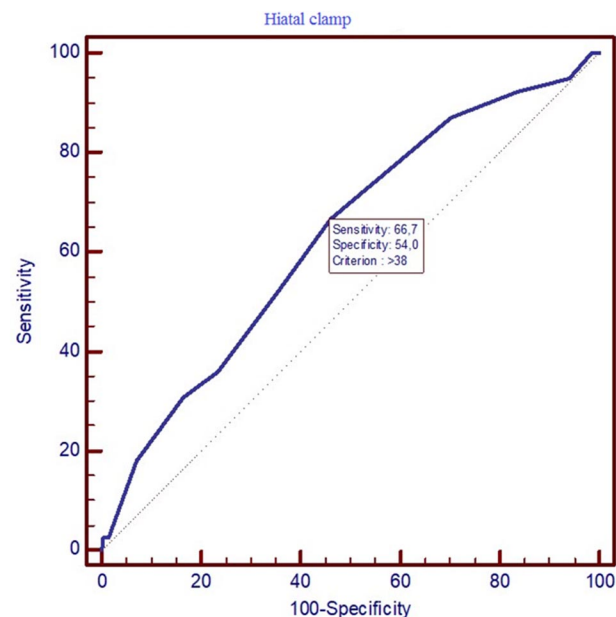


Fig. 4. Evaluation of hiatal clamp localization with ROC curve in the differentiation of ulcer diagnosis after esophagogastroduodenoscopy.

DISCUSSION

Obesity has become a serious health problem with an increasing prevalence worldwide. The most commonly used measurement method for defining and classifying obesity is BMI. To calculate the BMI, the individual's body weight (in kilograms) is divided by the square of their height (in meters). Due to its association with type 2 diabetes mellitus (DM), metabolic syndrome, hypertension (HT), dyslipidemia, and various cancers, obesity is considered a chronic disease that needs to be prevented and treated (World Health Organization, 2020; Flegal *et al.*, 2012). The rising prevalence of obesity in recent times has also led to an increased frequency of obesity-related diseases. The incidence of conditions such as reflux disease, gallstones, fatty liver, and non-alcoholic steatohepatitis (NASH) is closely associated with obesity (Flegal *et al.*, 2012).

The most common symptoms of upper gastrointestinal disorders include dysphagia, retrosternal burning/pain, epigastric burning/pain, bleeding, dyspepsia, weight loss, nausea, and vomiting. These symptoms can indicate both benign and malignant conditions (Loffeld & van der Putten, 2003). Endoscopic examinations are widely accepted as the gold standard for evaluating the gastrointestinal system. EGD involves visualizing the oropharynx, oesophagus, stomach, and proximal duodenum, and it is important to observe the presence of the hiatal clamp and oesophagogastric junction during routine procedures (Kahraman & Cingi, 2016). In our study, we aimed to investigate the relationship between the anatomical localization of the hiatal clamp and oesophagogastric junction with BMI in patients scheduled for upper gastrointestinal endoscopy. Additionally, when reviewing the literature, we found studies indicating an association between BMI increase and the occurrence of gastrointestinal disorders. For example, studies have reported an increased frequency of reflux with higher BMI values (Hampel *et al.*, 2005). Based on this notion, we also aimed to explore the relationship between the diagnoses received by patients after EGD and BMI.

The hiatal clamp is located at the level of the 10th thoracic vertebra and is approximately 38 cm from the anterior incisors. This anatomical structure is defined as the structure formed by the right and left crura of the diaphragm in the clinical setting. Bozdag *et al.* found the mean distance between the hiatal clamp and the anterior incisors to be approximately 38.6 cm, and they noted that this distance was statistically longer in males (mean: 39.77 cm) compared to females (mean: 37.8 cm) (Bozdag *et al.*, 2022). Similarly, in our study, the hiatal clamp value in male patients (median: 40 cm, range: 34-46 cm) was statistically longer than

in females (median: 38 cm, range: 34-45 cm). The median value of the hiatal clamp distance in our study was 38 cm, ranging from 34 to 46 cm. While the hiatal clamp distance was found to be associated with height, weight, and age, there was no statistically significant relationship with BMI. It was observed that as the height and weight of the patients increased, the hiatal clamp distance also increased, but with increasing age, this distance shortened. This phenomenon can be explained by the fact that taller individuals generally have longer limbs, similar to how increased food intake in overweight individuals leads to an expansion of the gastrointestinal system to accommodate the increased volume, including the hiatal clamp. Similarly, it is believed that with age, there are overall decreases in height and limb length, which may have similar effects on the gastrointestinal system. There are studies in the literature that support these thoughts and explain the relationship between intestinal length and obesity. In a study conducted by Roberto M., among a total of 443 patients who underwent laparotomy, with 78 % of them being female, a positive relationship between height and intestinal length was demonstrated ($p=0.00001$). They also showed a correlation between intestinal length and sex (Tacchino, 2015). Similarly, in the studies by Backman & Hallberg (1974), which included a total of 78 participants, including 56 obese individuals, they argued that obese individuals had longer intestines in both males and females. Guzman *et al.* (1977) in their study with 272 obese and 121 non-obese patients, reported similar findings to Backman & Hallberg (1974), stating that obese individuals had longer intestines, and additionally, obese males had longer intestines compared to obese females (Guzman *et al.*, 1977). Indeed, when examining the data obtained in our study, it can be interpreted that the distances of the hiatal clamp and oesophagogastric junction, which were passed during EGD and measured in our study, varied depending on height and weight, thus supporting the existing literature on their association with obesity. However, we did not come across another study in the literature that specifically correlated the anatomical localization of these structures with obesity, making it difficult to directly compare our findings with existing research. The definition of the oesophagogastric junction may vary among specialty groups. Surgeons and endoscopists generally define it as the point where the endoscope transitions from the oesophageal mucosa to the gastric mucosa, marked by a sudden change in mucosal appearance. This jagged line is referred to as the "Z-line." This distance is typically around 40 cm after the anterior incisors. Oesophagogastric junction is usually studies have shown that this distance is on average 38-40 cm in males and 36-38 cm in females (Moore & Dalley, 1999; Shamiyeh *et al.*, 2010). At birth, this distance is 18 cm, at 3 years old it is 22 cm, and at 10 years old it is 27 cm (Freha *et al.*, 2020). In the study by Bozdag *et al.*, the mean

length of the oesophagogastric junction was found to be 37.5 cm, with males having a longer distance (mean: 38.66 cm) compared to females (mean: 36.7 cm) (Bozdag *et al.*, 2022). In our study, consistent with the literature, the oesophagogastric junction value in male patients (median: 39 cm, range: 33-45 cm) was found to be at a greater distance compared to females (median: 37 cm, range: 29-44 cm). The oesophagogastric junction lengths of the patients included in the study ranged from 29 cm to 45 cm, with a median value of 37 cm, which is shorter than reported in the literature. Furthermore, while the oesophagogastric junction distance was found to be associated with height, weight, and age, there was no statistically significant relationship with BMI. It was observed that as the height and weight of the patients increased, the oesophagogastric junction distance also increased, but with increasing age, this distance shortened. As mentioned earlier, we believe this phenomenon is attributed to the adaptation of gastrointestinal structures to accommodate the process, where taller individuals generally have longer limbs and overweight individuals have increased food intake, similar to how the stomach adapts to increased volume.

According to the BMI categories defined by the World Health Organization, there is no significant relationship between BMI groups and the hiatal clamp and oesophagogastric junction distances. However, a significant relationship has been found between BMI and sex. Female patients have been observed to have higher BMI values compared to males. Obesity is a multifactorial condition, and this result is also important for identifying sex-specific risk factors. It should be taken into consideration that basic anamnestic and sex-specific data related to the hormonal lives of women, starting from menarche and continuing through pregnancy to menopause, can have an impact on increased BMI. In particular, menopause represents a turning point and is characterized by hormonal changes. Taking all these effects into account, we can say that our results are consistent with the literature (Crane *et al.*, 2023; Meloni *et al.*, 2023).

There are many pre-diagnoses that require an indication for EGD, but studies comparing these diagnoses with hiatal clamp and esophagogastric junction distances and BMI are quite limited. In their study, Bozdag *et al.* (2022), compared the complaints of patients presenting to the hospital with the hiatal clamp and esophagogastric junction distances, and they reported no significant relationship between these complaints and both anatomical localizations. They also stated that the most common complaint among patients presenting to the hospital before EGD was dyspepsia (Bozdag *et al.*, 2022). In our study, when looking at the most common pre-diagnoses of patients before

EGD, it was observed that the majority of patients presented with dysphagia (45.09 %). Additionally, a significant relationship was found between BMI groups and the complaint of dysphagia. Accordingly, dysphagia was observed more frequently in individuals with normal weight compared to overweight and obese individuals, and it was also more common in overweight individuals compared to obese ones. Based on this result, we can say that although increasing weight affects the hiatal clamp and esophagogastric junction distances, it does not have an impact on the complaint of dysphagia. Togashi *et al.* (2022) support the results of our study by demonstrating a higher occurrence of dysphagia complaints in patients with a BMI < 20.0 kg/m².

It was observed that there is an association between the variable of age and the complaint of dyspepsia among patients presenting to the hospital with this complaint, and it was found that the number of patients with dyspepsia increases as age decreases. The gastrointestinal system is normally the main site for nutrient and calorie absorption. Better understanding the role of the GI tract in obesity can help develop strategies to reduce obesity and its associated healthcare costs. EGD is widely accepted as the gold standard diagnostic method for identifying gastrointestinal diseases worldwide. There are many studies investigating the relationship between diagnoses made after EGD and BMI. In one study, it was found that individuals with morbid obesity (mean BMI > 50 kg/m²) were three times more likely to experience reflux symptoms compared to individuals with a BMI > 30 kg/m² (Locke 3rd *et al.*, 1999). However, in our study, no statistically significant relationship was found between BMI groups and reflux. We believe that this difference may be due to racial variations or differences in the study population.

Some studies argue that while the lower esophageal sphincter (LES) pressure is similar in individuals with morbid obesity and normal weight individuals, the frequency of loose LES increases with increasing BMI and waist circumference (Corley & Kubo, 2006; Pandolfino *et al.*, 2006). However, in our study, no significant relationship was found between BMI groups and loose LES. We believe that the difference may be due to the limitation of the study, as the evaluation of weight circumference and waist-to-hip ratio was not included.

This study, it was found that the most common diagnosis given to patients after EGD was gastritis (46.01 %). This was followed by reflux in 29.75 % of patients, loose LES in 24.23 % of patients, and ulcer diagnosis in 11.96 % of patients. Interestingly, despite the indication for EGD, 21.47 % of patients had normal evaluation results. No

statistically significant relationship was found between the diagnoses given to patients and BMI groups.

Ulcer is histopathologically defined as a superficial defect involving only the mucosa with a diameter smaller than 5 mm and a depth of less than 1 mm, which can progress to involve the submucosa or even the muscularis propria layer by breaching the muscularis mucosae (Freidman *et al.*, 2007). Peptic ulcers are ulcers that develop in areas exposed to peptic fluid (acid-pepsin). The risk of occurrence in males is 11-14 %, while in females it is 8-11 % (Spechler, 2002; Chan & Leung, 2002). Factors that affect the hiatal clamp and esophagogastric junction distances can also trigger ulcer formation. Based on this assumption, a ROC analysis was performed to determine the relationship between the ulcer diagnosis patients received after EGD and the hiatal clamp distance, with the aim of using the hiatal clamp distance as a clinical marker. The analysis revealed a statistically significant relationship between the hiatal clamp distance and ulcer diagnosis, with a cutoff value of >38 cm for the hiatal clamp distance in making the ulcer diagnosis. Therefore, it can be stated that the likelihood of ulcer occurrence increases in patients with a hiatal clamp distance greater than 38 cm starting from the incisal teeth. Similarly, when examining the relationship between the esophagogastric junction distance and ulcer, a statistically significant relationship was found between the two. Looking at the results of the ROC analysis, the cutoff value for the esophagogastric junction distance in making the ulcer diagnosis was determined to be >38 cm. Therefore, it can be said that the likelihood of ulcer occurrence increases in patients with an esophagogastric junction distance greater than 38 cm starting from the incisal teeth. When looking at the results of our study, a significant relationship was found between sex and ulcer diagnosis, with a higher incidence observed in males. In contrast, in the study by Bozdag *et al.* (2022), the opposite was reported, with a higher incidence observed in females. In the study by Chan & Leung (2002) it was found that ulcers were equally prevalent in both females and males, and the incidence increased with age. In our study, however, no significant relationship was found between age and ulcer diagnosis. We believe that this difference may be due to racial variations.

In conclusion, while there are existing studies that reveal the association between gastrointestinal diseases and BMI, there is a scarcity of research investigating the significance of anatomical structures by examining the hiatal clamp distance and oesophagogastric junction localization. In this regard, we believe that our study can contribute to the literature. Although our study statistically established that there is no relationship between BMI and hiatal clamp distance and oesophagogastric junction localization, there is

a relationship between height and weight differences and the distances of these two anatomical localizations. Furthermore, there is an observed connection between changes in both hiatal clamp distance and oesophagogastric junction distance and the diagnosis of ulcers in patients. Based on the results of our study, we believe that considering the hiatal clamp distance and oesophagogastric junction distance according to BMI can guide physicians in both the pre-diagnosis of gastrointestinal diseases and the diagnostic phase after EGD.

Additionally, evaluating the waist-to-hip ratio alongside BMI could provide more effective results in establishing the relationship between these anatomical localizations and obesity. Furthermore, our results are based on data from a single-center hospital, and we believe that conducting multicenter studies to expand the results would lead to more meaningful conclusions.

Ethical statement: The study was performed in accordance with the provisions of the Declaration of Helsinki 1995 (as revised in 2013). The approval of the Ethics Committee regarding the study was obtained (IRB: 19.12.2019/056). **Declaration of Competing Interest:** The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

KARACA BOZDAG, Z.; BOZDAG, E.; KÜRKÇÜOĞLU, A.; ÇANDIR, B. N. & MACUNLUOĞLU, A. Relación de las localizaciones anatómicas de la pinza hiatal y la unión esofagagástrica con el índice de masa corporal. *Int. J. Morphol.*, 42(1):117-126, 2024.

RESUMEN: En este estudio, buscamos revelar la relación entre las localizaciones anatómicas y el Índice de Masa Corporal (IMC) en pacientes programados para endoscopia digestiva alta. Se investigaron las localizaciones anatómicas de la pinza hiatal y la unión esofagagástrica en 189 mujeres y 137 hombres que acudieron al hospital con diferentes problemas del sistema gastrointestinal los cuales fueron sometidos a una esofagagastro-duodenoscopia (EGD) dependiendo del IMC. Además, los datos se compararon con las quejas de los pacientes antes de la EGD y los diagnósticos que recibieron después de la EGD. Se utilizó el programa SPSS Statistics 22 (IBM Corp. Turquía) para el análisis estadístico y el valor de $p < 0,05$ se consideró significativo. No hubo correlación estadísticamente significativa entre el IMC de los pacientes y las localizaciones anatómicas de la pinza hiatal y la unión esofagagástrica ($p > 0,05$). Por otro lado, se determinó que la

distancia de la pinza hiatal y la unión esofagogastrica aumentaba con la altura y el peso corporal ($p < 0,001$). En los hombres estas estructuras anatómicas se encontraban a una distancia estadísticamente mayor que en las mujeres ($p < 0,001$). Como resultado del análisis ROC, se encontró que tanto la pinza hiatal como la localización de la unión esofagogastrica tenían una relación estadísticamente significativa con el diagnóstico de úlcera, y el valor de corte para ambas localizaciones se determinó como >38 . Como resultado del estudio, se puede decir que los valores de IMC, la distancia de pinzamiento hiatal y las localizaciones de la unión esofagogastrica pueden cambiar en relación con la altura y el peso.

PALABRAS CLAVE: Esofagogastroduodenoscopia; Pinza hiatal; Unión esofagogastrica; Índice de masa corporal.

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