Original Article

Comparison of Sonographically Evaluated Pre and Postprandial Gastric Antral Area in Type 2 Diabetics and Healthy Control Subjects

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Abstract

Background: *Gastric motility associated with delayed gastric emptying occurs frequently in patients with diabetes mellitus. Ultrasonography play an important role by which the structure and function of the stomach can be assessed in an accurate and reproducible manner. Ultrasonographic measurement of antral cross sectional area provides a valid, cheap alternative to other costly modalities for early measurement of gastric emptying . Increased gastric antral area reflects delayed gastric emptying and gastroparesis in type 2 diabetic. Post prandial antral area is also increased in healthy subjects. But there is a significant difference in sonographically measured postprandial gastric antral area in type 2 diabetics and healthy control subjects. No such study was done previously with Bangladeshi diabetic subjects.*

Aims & Objective: *This study was performed to compare pre and postprandial gastric antral area in type 2 diabetics and in healthy controls by ultrasonography in Bangladeshi subjects.*

Materials and methods: *A total number of 45 consecutive type 2 diabetic subjects referred in the Department of Radiology and Imaging, BIRDEM, Dhaka, for ultrasonography of whole abdomen as routine check-up and 45 healthy subjects who underwent ultrasonography for whole abdomen for the period of one year, were enrolled in this study and were considered as group I and group II respectively. Smokers, snuff users, patients with connective tissue, cerebrovascular & endocrine diseases, receiving any drug affecting gastrointestinal motility, any previous gastriontestional tract surgery except appendisectomy were excluded from the study. All the selected subjects underwent B mode ultrasonogram of whole abdomen before and 90 mins after solid breakfast (two slices of bread and an egg). Unpaired t-test was done to compare pre and postprandial gastric antral area between type 2 diabetics and healthy controls and a P value <0.05 was taken as significant. Paired t-test was done to compare pre and postprandial gastric antral area of type 2 diabetic subjects and healthy controls and a P value <0.05 was taken as significant.*

Results: *Majority (40.0%) of patients were in 5th decade in group I and most (31.1%) of the healthy subjects were in 4th decade. Females were predominant in both groups, which was 64.4% in group I and 66.7% in group II and female to male ratio was almost 2:1 (in the whole study subjects). In this present series it was observed that the mean preprandial gastric antral area (measured by ultrasonography) was 392.29 ± 70.48 mm^2 with range from 220 to 569 mm^2 in group I and 245.27 ± 60.59 mm^2 with range from 115 to 387 mm^2 in group II. On the other hand, the mean post-prandial gastric antral area (measured by ultrasonography) was 551.71 ± 190.04 mm^2 with range from 305 to 1134 mm^2 and 307.82 ± 80.87 mm^2 with range from 159 to 545 mm^2 in group I and group II respectively. The mean pre-prandial and post-prandial gastric antral area were significantly (P<0.05) higher in type 2 diabetic subjects and healthy control subjects.*

Conclusion: *This study concluded that there is statistically significant difference between pre and postprandial gastric antral areas measured by B-mode ultrasonography in type 2 diabetics and healthy control Bangladeshi subjects which is similarly found in other studies. Thus ultrasonography may be routinely used to detect gastroparesis earlier in type 2 diabetics. However, whether duration of diabetes mellitus is a factor, should be studied with larger population.*

Key words: *Gasric antral area, ultrasonography, type 2 diabetes mellitus, healthy adult.*

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Introduction

Diabetes Mellitus (DM) is now recognized as a global health challenge of the 21st century. Current projections estimate that prevalence of DM worldwide may double over the next two decades. Asia is emerging as the epicenter of diabetes epidemic. Like all other developed and developing countries prevalence and incidence of type 2 DM is also increasing in Bangladesh.[1] The incidence rate of type 1 and particularly type 2 diabetes are increasing in all societies and in all countries. Type 2 diabetes accounts for more than 90% of all diabetes. Type 2 diabetes reduces remaining lifespan by 5-10 years and constitute the fourth or fifth leading cause of death.[2]

Several studies were done on the prevalence of gastrointestinal symptoms in diabetic patients. Upper gastro-intestinal symptoms more common in patients with type 2 diabetes than in well matched control subjects.[3-7] Gastroparesis is a syndrome characterized by delayed gastric emptying in absence of mechanical obstruction.[8-12] The cardinal symptoms include postprandial fullness (early satiety), nausea, vomiting and bloating.[13] The prevalence of delayed gastric emptying in patients with diabetes in between 28% to 65%.[14] Women constitute the majority of patients with a female: male ratio of 4:1 and the mean age of onset is 34 years.[15] There are several methods to estimate gastric emptying of solids in humans and have their advantages and disadvantages. These are scintigraphy, ultrasonography, barium contrast examination, magnatic resonance imaging, epigastric impedence measurements, applied potential tomography, tracer method (e.g. paracetamol) and breath tests.[16-20]

Ultrasonography is non-invasive, cheap, widely available, safe, less time consuming, painless method. It is an effective means by which the structure and function of the stomach can be assessed in an accurate and reproducible manner.[21-22] Ultrasonographic measurement of antral cross sectional area provides a valid alternative to scintigraphy for the measurement of total gastric emptying of a solid meal.[23] Delayed gastric emptying is now recognized to be a common and clinically important problem, potentially leading to upper gastrointestinal symptoms, malnutrition, unpredictable absorption of orally administered drugs, poor control of blood glucose concentration in patients with diabetes mellitus and impaired quality of life scores on all domains assessed including physical, emotional, mental, social and bodily functions.[15]

Methodology

This case-control study was carried out in the Department of Radiology and Imaging, BIRDEM (Bangladesh Institute of Research and Rehabilitation in Diabetes, Endocrine and Metabolic Disorders) General Hospital from January to December 2012. A total of 45 consecutive type 2 diabetic subjects, referred for ultrasonography of whole abdomen as routine check-up and 45 healthy subjects who underwent ultrasonography of whole abdomen, were enrolled in this study and were considered as group I and group II respectively. Smokers or snuff users, patients with psychiatric, connective tissue, cerebrovascular or endocrine diseases, and patients receiving any drug affecting gastrointestinal motility, any previous gastro-intestinal tract surgery except appendisectomy were excluded from the study.

All the selected subjects underwent B mode ultrasonogram of whole abdomen before and 90 minutes after solid breakfast (two slices of bread and an egg). Proper counseling and reassurance to the patients regarding the examination procedure was done to reduce their apprehension and to get full cooperation. Informed consent was taken from each of the patient. No other specific preparation was required. The examinations were performed using standard gray-scale B-mode imaging with a 3.5-MHz curvilinear transducer. For obese subjects 2.5 MHz transducer was used. The examination was done by the researcher at first and then confirmed by consultant radiologist of the Department of Radiology and Imaging of BIRDEM.

At first the subjects were examined after an 8 hour fast. Gastric antral area was measured by determining the longitudinal (D1) and antero-posterior (D2) diameters of a single section of the gastric antrum, using the abdominal aorta and the left lobe of the liver as internal landmarks to obtain the same standardized scanning level consistently. At each observation three measurements were done. Using the mean values of the longitudinal (D_{1mean}) and antero-posterior (D_{2mean}) diameters the antral area was calculated. At this level, the scan showed the stomach shaped as either a circle or an ellipse, so the antral cross-sectional area (A_{Antrum}) was calculated in all subjects using the following formula:

$$\text{Area of Antrum } (A_{Antrum}) = \eth \times D_{1mean} \times D_{2mean} / 4$$

The measurements of the gastric antrum (on average lasting between 1 and 3 min) were taken from the outer

profile of the wall and obtained between antral contractions to provide a measure of the relaxed width of the antrum. Depending on what would optimize the quality of the image in each subject, the subjects consistently either held their breaths in inspiration or breathed normally (during all measurements, to avoid changes in antral diameters related to inspiration and expiration). In all subjects, measurements were taken before and 90 min after the end of meal ingestion.

Results

The mean age was 52.64±8.59 years in group I and 48.13±10.68 years in group II. In group I, 18 (40.0%) patients age belonged to 51-60 years and in group II 14 (31.1%) subjects age belonged to d"40 years. The mean duration of diabetes was 13.16±5.64 years with range from 6 to 26 years. In 20 (44.4%) patients duration of diabetes was 11-20 years.

The mean pre-prandial gastric antral area measured by ultrasonography was found 392.29 ± 70.48 mm^2 with range from 220 to 569 mm^2 in group I and 245.27 ± 60.59 mm^2 with range from 115 to 387 mm^2 in group II. The mean post-prandial gastric antral area measured by ultrasonography was 551.71±190.04 mm^2 with range from 305 to 1134 mm^2 in group I and 307.82±80.87 mm^2 with range from 159 to 545 mm^2 in group II. The mean difference was statistically significant ($p < 0.05$) between two groups (Table I). In type 2 diabetic subjects, the mean pre-prandial gastric antral area was 392.29 mm^2 and post-prandial antral area was 551.71 mm^2 and the mean difference was statistically significant ($p < 0.05$) (Table II). In healthy control subjects, the mean pre-prandial gastric antral area was 245.27 mm^2 and post-prandial antral area was 307.82 mm^2 and the mean difference was statistically significant ($p < 0.05$) (Table III).

Table I

Comparison of pre and post-prandial gastric antral areas in Group-I and Group-II

Parametersgastric antral area	Group I (n=45) Mean ±SD	Group II (n=45) Mean±SD	*P* value
Pre Prandial (mm^2)	392.29 ± 70.48	245.27 ± 60.59	0.001^s
Range (min-max)	(220-569)	(115-387)	
Post Prandial (mm^2)	551.71 ± 190.04	307.82 ± 80.87	0.001^s
Range (min-max)	(305 -1134)	(159-545)	

Group I=Type 2 Diabetes; Group II= Healthy subjects

s= significant

P value reached from unpaired t-test

Table II

Comparison of pre and post-prandial gastric antral areas in Group-I

Parametersgastric antral area	Group I (n=45) Mean±SD
Pre Prandial (mm^2)	392.29±70.48
Range (min-max)	(220-569)
Post Prandial (mm^2)	551.71±190.04
Range (min-max)	(305-1134)
P value	0.001^s

Group I=Type 2 Diabetes

s= significant

P value reached from paired t-test.

Table III

Comparison of pre and post-prandial gastric antral areas in Group-II

Parametersgastric antral area	Group II (n=45) Mean±SD
Pre Prandial (mm^2)	245.27±60.59
Range (min-max)	(115-387)
Post Prandial (mm^2)	307.82±80.87
Range (min-max)	(159-545)
P value	0.001^s

Group II= Healthy control subjects

s= significant
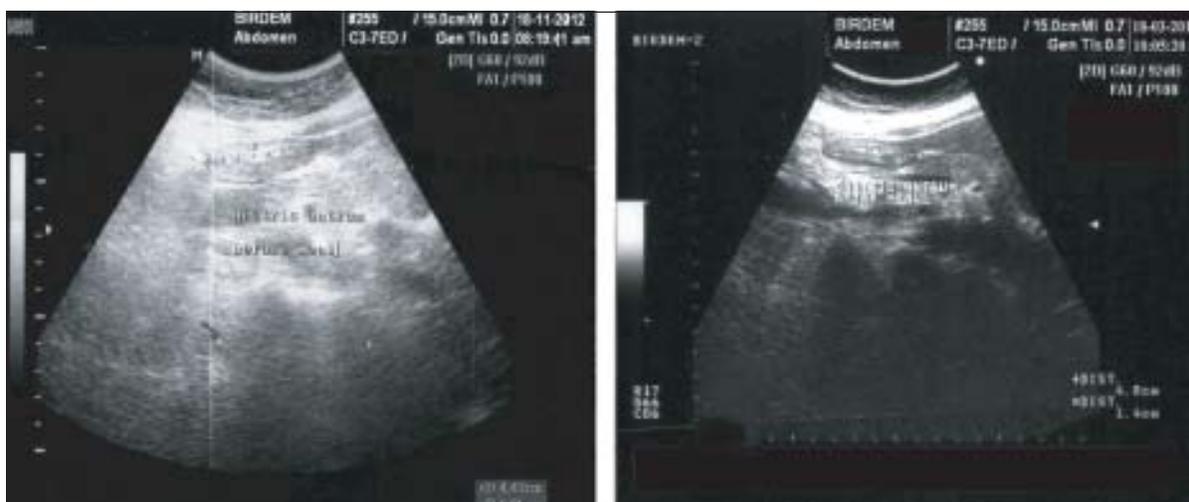
P value reached from paired t-test.

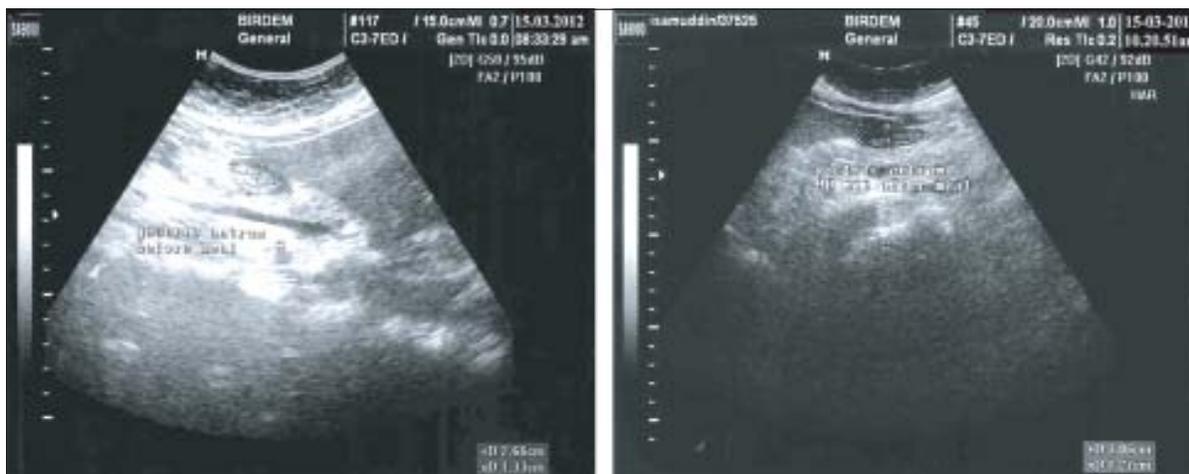**Fig. 1a and 1b:** *Sonographic Image of gastric antrum of type 2 diabetics before meal 90 minutes after breakfast*

Fig. 2a and 2b: *Sonographic Image of gastric antrum of healthy subject before meal and 90 minutes after breakfast*

Discussion

Several recent developments have come to enrich our clinical acumen and technical expertise, among which Osgood is the most popular one. Present study was limited to type 2 diabetics and healthy subjects and comprises of 90, who had undergone ultrasonography of abdomen as routine check-up. In this current study, it was observed that the mean age was around 50 years. Darwiche et al. showed the mean age of patients with diabetes was 55±9 years with range from 40 to 71 years and 37±18 years with range from 18 to 77 years in healthy subjects, which is consistent with the current study.[24] On the other hand, Berry et al. observed higher mean age of patients having insulin dependent diabetes

mellitus, which was 72.1±1.9 years.[ref] The higher age range may be due to increased life expectancy and geographical influences may have significant impacts on DM.

It was observed that female was predominant in both groups, which was 64.4% in group I and 66.7% in group II and female to male ratio was almost 2:1 in the whole study subjects. Darwiche et al. showed female to male ratio was 1.3:1 in DM and 1.4:1 in healthy subjects.[24] Akhter et al. and Kim et al. found female to male participants ratio was 1:1.3 and 1:3 respectively.[25,3] In this current series it was observed that majority (44.4%) patients had duration of diabetes 11-20 years and the mean duration of diabetes was 13.16±5.64 years with

range from 6 to 26 years. Darwiche et al enrolled patients' diabetes mean duration varied from 20 to 51 years with mean duration of diabetes was 34 ± 10 years, which is higher with the current study.[24]

The mean pre-prandial gastric antral area in this present study was 392.29 ± 70.48 mm^2 with range from 220 to 569 mm^2 in group I and 245.27 ± 60.59 mm^2 with range from 115 to 387 mm^2 in group II. The mean pre-prandial gastric antral area was significantly (P<0.05) higher in type 2 diabetic subjects. On the other hand, the mean post-prandial gastric antral area was 551.71 ± 190.04 mm^2 with range from 305 to 1134 mm^2 and 307.82 ± 80.87 mm^2 with range from 159 to 545 mm^2 in group I and group II respectively. The mean pre-prandial and post prandial gastric antral area were significantly (P<0.05) higher in type 2 diabetic subjects. The mean pre-prandial and post-prandial gastric antral area were also significantly (P<0.05) higher in healthy control subjects. Darwiche et al. obtained mean pre-prandial and post-prandial gastric antral area of diabetes patients were 301.0 ± 137.0 mm^2 (range: 114 to 432 mm^2) and 514.4 ± 294.3 mm^2 (range: 188 to 1052 mm^2) respectively.[24] On the other hand the mean pre-prandial gastric antral area of healthy subjects was 203.6 ± 71.7 mm^2 (range: 97 to 293 mm^2) and post-prandial gastric antral area 186.9 ± 89.6 mm^2 (range: 68 to 389 mm^2). Pre-prandial and post-prandial gastric antral area was significantly higher in diabetes patients, which is closely resembled with the current study. Moldovan et al[26] mentioned in their study that fasting antral areas were larger in diabetes mellitus than in controls without reaching statistical significance (p>0.05). Post-prandial antral areas were significantly larger in diabetes than in controls (p<0.05). Where the authors found mean pre-prandial gastric antral area in diabetes was 4.2 ± 3 cm^2 and 3.4 ± 0.9 cm^2 in healthy subjects. Similarly, mean post-prandial antral area were 17.5 ± 6.3 cm^2 and 10.7 ± 4.4 cm^2 in diabetes and healthy subjects respectively, which support the current study.

This study was carried out in our department by ultrasonography with small number of cases and healthy control Bangladeshi subjects. Duration of diabetes was not included in the study. It could be concluded that the cheap and easily available ultrasonography may be routinely used to detect early gastroparesis in type 2 diabetics than by other costly methods. However, further study can be carried out by including large number of population and duration of diabetes mellitus.

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