Diyabetik Gastroparezi Olan Hastalarda Elektrogastrografi

Electrogastrography in Patients with Diabetic Gastroparesis

Abdullah al Kafee[1], Sevim Eryiğit[2], Aydın Akan[3]

[1]Biyomedikal Mühendisliği Programı, İstanbul Üniversitesi, İstanbul, Türkiye
a_alkafee@yahoo.com

[2]Sağlık Bilimleri Yüksekokulu Fizyoterapi ve Rehabilitasyon Bölümü, Gelişim Üniversitesi, İstanbul, Türkiye
seryigit@gelisim.edu.tr

[3]Biyomedikal Mühendisliği Bölümü, İzmir Katip Çelebi Üniversitesi, İzmir, Türkiye
aydin.akan@ikc.edu.tr

Abstract— **Electrogastrography (EGG) is an experimental non-invasive method that reflects the myoelectrical activity of the diabetic gastroparesis (D-GP) and healthy subjects gastric system. In clinical world, endoscopy and delayed gastric emptying diagnosis test are using for understand the D-GP patient's condition which are invasive, quite expensive and uncomfortable. Therefore our aim is to evaluate the Electrogastrography (EGG) features to discriminate the healthy subjects from patients with D-GP in real clinic. Total 25 patients D-GP and twenty 25 healthy subjects (HS) were included in this study. The recordings EGG parameters dominant frequency (DF) were analyzed and compared. The results we obtained from analysis of EGG signals proved that pre-fed (p= 0.048) and post-fed (p= 0.003) DF values were statistically significant between the D-GP and HS groups. This study proved that it is possible to distinguish D-GP patients from healthy subject's with a high accuracy and a great success from the EGG signals recording correctly in real clinic.**

Keywords — diyabetic gastroparesis; myoelectric activity; electrogastrography.

I. INTRODUCTION

The stomach is a muscular organ located between the esophagus and small intestine in the left side of the upper abdominal cavity. Stomach physiological functions include storing, mixing and digesting previously swallowed food and liquid. The stomach muscle itself has a rhythmic electrical activity which controls the motility of the stomach and aids in the digestive process simultaneously [1]. This automatic rhythmic electrical activity is called "gastric myoelectric activity" [2, 3]. Regular slow wave activity is estimated to be 3 cycles per minute (cpm) or 0.05 Hz in healthy subjects [4].

Although there are many studies from different geographical locations have investigated that great numbers of people have been affected worldwide diabetic gastroparesis diseases D-GP. Until now the pathogenesis of D-GP remain obscure therefore many studies focusing on the genetically reasons such as polymorphism, psychosocial factors or some other issues as like as bacterial flora. Most illnesses of the gastroparesis patients were found to be correlated to various gastric and abdominal motility irregularities activity [5, 6, 7].

Electrogastrography (EGG) is a rather new method which is accomplished by using electrodes in the upper abdominal wall of the patients [2, 4]. Where EGG signals main diagnosis purposes is to make a clinical standard test to understand the origin of the different patient's gastro intestinal disorders. Until now many studies had been done for EGG practice where they found important information to differentiating the patients group from healthy group. However still EGG is not using in real clinic because there are no standard test period, filtering systems, signal processing system [1, 2, 4, 8]. Recently, expectations for the clinical application of EGG stands out as a promising investigative method for D-GP because of its non-invasive, cost effective and simple examination way [1, 9]. Many research proved that it can make an important guides that that indicate the presence of D-GP disease [5, 10 - 13].

The aim of this study is to evaluate the EGG signal analysis to investigate the correlation between EGG and gastric emptying test in patients with D-GP and healthy subject. Therefore, large scale subjects are included in this study. Finally, the extracted findings were analyzed statistically by using student t-test method.

II. MATERIAL AND METHODS

A. Study Subjects

This study included total 50 subjects, 25 patients with D-GP and 25 HS, all the patients of D-GP who applied to the Gastroenterology out-patient polyclinic of the Bezmialem Vakıf University. The selected 25 HS group without any diseases moreover clinical objection and no past history of gastric dysrhythmic diseases were included as the healthy group. All participants had nearly 6 months chronic history, complaints and symptoms were examined by doctor the participants who had all the test reports were in normal range included in healthy subject. All participant demographic data as like as age, height, weight and gender were taken after physical examination.

	HS Group Mean ± SD F(25)	D-GP Group Mean ± SD F(25)	P value
Age	40.04 ± 5,5	42.4 ± 2,7	0.814
Height	160.44 ± 5,1	158.3 ± 2,4	0.485
Weight	65.4 ± 8,4	68.4 ± 5,4	0.721
BMI	22.4 ±4,5	24.4±2,7	0.25

Table 1. The demographic characteristics of the D-GP and HS groups

All Diabetic gastroparesis patients had recognized by long term insulin dependent diabetic mellitus and diagnosis of the delayed gastric emptying test or scintigraphy diagnosis test. In scintigraphy diagnosis test a gamma camera that produces images from radiated gamma radiation which was take the images of the patient's stomach between front and back side, within every minute period anterior and posterior. The radioactivity activity of the food inside of the stomach was outlined by area of interest during the image acquisition time. Scintigraphy test was performed to measure the D-GP patients delayed gastric emptying parameters were defined as there percentage of gastric two hour retention rate (2HRR). All subjects provided written approval for participation in this study. Ethics approval for conducting this study was obtained from the Ethical Committee of the Bezmialem Vakif University, Faculty of Medicine (Istanbul, Turkey). Ethics Approval No: 71306642/050-01-04/31.

Figure 1. Scintigraphy test

B. Analysis of Gastric Myoelectrical Activity

First 30 minutes EGG signal (Pre-fed) recording was performed in before taking the standard meal. After that, the subjects were given standard test meal (Standard test meal included 500 kcal of protein, fat and carbohydrate. The meal contained of two portions breads, one fried egg and 330 ml of sour cherry juice) after the eating the test meal EGG signals were recording 60 minutes (Post-fed). The gastric myoelectrical activity were measured by EGG device a non-invasive method using surface electrodes placed on the stomach abdomen wall. To reduce the impedance of the skin electrode interface we used special gel and removed the abdominal hair. The first electrode was placed in the midline between xiphoid and umbilicus, while the second one was positioned on the left side of the body, between the lower rib and the first electrode. The reference electrode was placed in the left lower quadrant, at the left costal edge. To avoid motion artefacts all subjects were told not to talk and try to not change their position. In this study we used 3 CPM companies EGG device and software which have approval from international Food and Drag Administration (FDA).

Figure 2. EGG signals recording condition

III. RESULTS

In this study, EGG signals feature extraction purposes, a fast Fourier transform (FFT) based method called running spectral analysis (RSA) was applied. RSA method, being commonly applied for EGG signal analysis in many studies, it also gives information about frequency spectrum and its change in time. In this method, EGG signal is divided into predefined segments and FFT is performed for each segment [14, 15].

The frequency at which the power spectrum of a total recording had a peak power in the range of 0.5- 9.0 cpm was defined as the dominant frequency (DF). For normal subjects DF is nearly 3 cpm, Normal electrical activity was defined as a frequency of between 2.4-3.4 cpm is normal. The abnormalities of the EGG informed in these investigations included tachygastria (3.5–9 cpm) and bradygastria (0.5–2.3cpm) [1, 4]. The DF was computed for each subject in both pre and post feeding states. All the signal processing and statistical analysis were carried out using MATLAB software (Math Works Inc., Natick MA, USA).
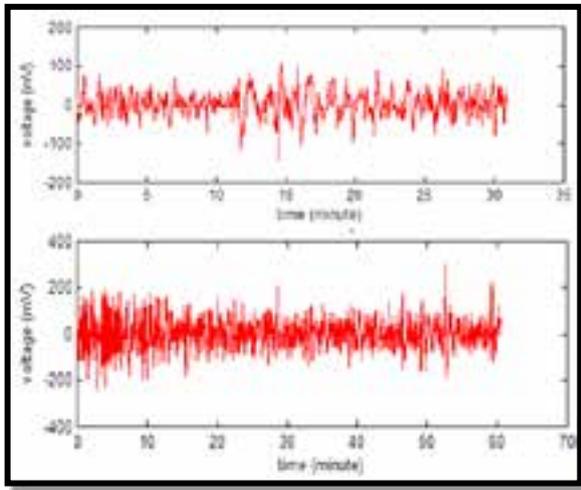
Figure 3. 30 minutes Pre-fed and after test meal, post-fed 60 minutes EGG signals recording

A. Pre-fed EGG signal analysis

Even though, the D-GP group demonstrated lower incidence of normal subjects according to healthy subject (D-GP =4(16%) and HS=20(80%) respectively) and higher incidence of bradygastria than the control group (D-GP =21(84%) and HS=5 (20%), respectively), Moreover the dominant frequency value of the D-GP (2.14±0.38) cpm group was lower than that of the healthy subjects (2.45 ± 0.321) cpm group and statistically significant difference was found p= 0.048* (Table-3).

B. Post- fed EGG signal analysis

We also calculated the EGG signal after food condition dominant frequency values , the rate of the normal patients in the D-GP group was lower than in the healthy group (D-GP =5(20%) and HS=22(88%) respectively), whereas the rate of bradygastria (D-GP =20(80%) and HS=3(12%), respectively)(Table-2). Although, the D-GP (2.23±0.45) cpm group showed lower incidence of DF than the healthy group (2.58 ± 0.49) cpm moreover statistically significant difference was found p= 0.003*. (Table-3).

EGG		HS	D-GP
Pre-fed	**Normal n(%)**	20(80%)	4(16%)
	Bradygastria n (%)	5(20%)	21 (84%)
Post-fed	**Normal n (%)**	22(88%)	5(20%)
	Bradygastria n (%)	3(12%)	20(80%)

Table 2. The comparison between the groups with respect to pre-fed and Post-fed EGG parameters

Group		HS Mean ± SD	D-GP Mean ± SD	*P* values
Dominant frequency(DF)	**Pre-fed**	2.45 ± 0.321	2.14±0.38	0.048*
	Post-fed	2.58 ± 0.49	2.23±0.45	0.003*

Table 3. The comparison between the groups with respect to pre-fed and Post-fed DF

IV. DISCUSSION

In the world many people are suffering stomach dysrhythmias connected with gastric motility disorders as like functional dyspepsia, nausea, vomiting, stomach's ulcer and gastro esophageal reflux sicknesses. Clinicians are diagnosing this type problem by using endoscope or scintigraphy test which are invasive discomfort to the patients. Therefore recently, Electrogastrography (EGG) has received more and more attention. Although gastroenterologists are interested in its clinical application, concerns remain to the reliability and analysis of the EGG and the correlation between the EGG and Gastric emptying test.

Moreover, this study presents an up-to-date of EGG signal analysis and gastric emptying test acquisition. We found that healthy groups have (12-20) % abnormalities and (80-88) % normal gastric myoelectric activity. In patients group 25 subjects delayed gastric emptying diagnostic test results proved all patients have delayed gastric emptying but in EGG results we found (80-84)% subjects have abnormal EGG. Among (16-20)% patients who had normal EGG, So it's clear that delayed gastric emptying test and EGG process have close relationship to evaluate the patient's diabetic gastroparesis but this procedure is not used in real clinic because there are no standard EGG test period, filtering and signal processing system. Many researchers found different correlation between them. Some other study found that EGG gastric emptying in 72 patients with diabetic gastro paresis and they found 22 patients have delayed gastric empty but 11 have EGGs abnormal and 50 patient have normal gastric emptying, only 11 have abnormal EGGs [15]. Therefore EGG has received important interest among researchers to promote a diagnostic test for clinic evaluation of patients with unexplained gastric disorders illness such as ulcer, functional dyspepsia, gastritis, chronic mesenteric ischemia and other dyspeptic symptoms [4, 16].

Based on all the results and literature on the EGG and gastric emptying analysis, we can fairly conclude that the gastric emptying test have positive correlation between the EGG signal of the gastric function. Nowadays, the EGG measurement instrumentations and diagnosis criteria have not been still standardized. But EGG recording features can discriminate the healthy subjects from diabetic gastroparesis patients in real clinic. We believe that these finding results and discussion would offer an objective

and quantitative evaluation of EGG. In future Electrogastrography method can be used in different types of patients group.

ACKNOWLEDGMENT

REFERENCES

[1]   Jieyun Y and Jiande D Z Chen, "Electrogastrography: Methodology, Validation and Applications", *Neurogastroenterol Motil*.,19(3) :5 – 17, 2013.

[2]   Levanon D, Zhang M, Chen JDZ, "Efficiency and efficacy of the electrogastrogram", Dig Dis Sci, 40: 1445–50, 1998.

[3]   Lin Z, Chen JD, Schirmer BD, McCallum RW, "Postprandial response of gastric slow waves: correlation of serosal recordings with the electrogastrogram", Dig Dis Sci., 45:645-651,2000.

[4]   Riezzo G, Russo F, Indrio F., "Electrogastrography in adults and children: the strength, pitfalls, and clinical significance of the cutaneous recording of the gastric electrical activity", Biomed Res Int, 282-297, 2013.

[5]   Chen JDZ, Lin Z, Pan J, McCallum RW, "Abnormal gastric myoelectrical activity and delayed gastric emptying in patients with symptoms suggestive of gastroparesis", Dig Dis Sci,; 41(6):1538–1545,1996.

[6]   Liza K. Phillips, Adam M. Deane,   Karen L. Jones,   Chris K. Rayner, Michael Horowitz., "Gastric emptying and glycaemia in health and diabetes mellitus", Nature Reviews Endocrinology, 11:112 -128, 2015.

[7]   Mauro B., "Gastric electrical stimulation for gastroparesis: A goal greatly pursued, but not yet attained", World J Gastroenterol,17: 273–282, 2011.

[8]   Gregory O'Grady, MBChB, FRACS, Thomas L. Abell., "Gastric Arrhythmias in Gastroparesis: Low- and High-Resolution Mapping of Gastric Electrical Activity", Gastroenterology Clinics of North America, 44: 169-184, 2015.

[9]   Koch K.L, Stern R.M., Stewart W.R, Vasey M.W., "Gastric emptying and gastric myoelectrical activity in patients with diabetic gastroparesis effect of long term domperidone treatment", Am. J. Gastroenterol, 84: 1069–1075,1989.

[10] Morello R, C De Capua, F Lamonaca,. "Diagnosis of Gastric Disorders by Non-invasive Myoelectrical Measurements", I2MTC, 10: 1324-1328, 2013.

[11] Geldof H, van der Schee EJ, van Blankenstein M, Grashuis JL., "Electrogastrographic study of gastric myoelectrical activity in patients with unexplained nausea and vomiting", Gut,27:799–808,1986.

[12] Feldman M, Schiller LR., "Disorders of gastrointestinal motility associated with diabetes mellitus", Ann Intern Med, 98:378–384, 1983.

[13] Z. Lin, J.D. Chen, "Time-frequency representation of the electrogastrogram—application of the exponential distribution", IEEE Trans. Bio. Med. Eng. 41: 267–275, 1994.

[14] H.P. Parkman, W.L. Hasler, J.L. Barnett, E.Y. Eaker,, "Electrogastrography: a document prepared by the gastric section of the American Motility Society Clinical GI Motility Testing Task Force", Neurogastroenterol. Motil., 15:89–102, 2003.

[15] Leahy A, Besherdas K, Clayman C, Mason I, Epstein O, "Abnormalities of the electrogastrogram in functional gastrointestinal disorders", Am J Gastroenterol, 94(4):1023-8, 1999.