International Journal of Bioelectromagnetism
Vol. 13, No. 4, pp. 245-248, 2011

Measuring Gastroesophageal Region Frequencies for Long time: Preliminary Results

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Abstract Measurements registered in the gastro-esophageal section with a implemented biomagnetic modality is presented, this procedure is based on magnetic markers and magnetometers system. It is shown that with this biomgneti modality of evaluation, the gastric-esophageal activity can be monitored per prolonged times and in well defined regions. Registered frequencies in specific zones agree with the values traditionally reported in literature and it is also shown that with this biomagnetic modality it is possible to measure the speed of transit of the alimentary bolus in the esophagus.

Keywords: gastroesophagica motility, esofágical activity, magnetic markers, magnetometers.

1. Introduction

The main aim in this work is to show a new biomagnetic modality in order to measure gastro-esophageal motility. Several studies have been performed with this purpose, evaluating the contractions through the gastrointestinal (GI), as well as studies of gastric emptying carried out in our Lab [Cordova *et al.,* 2004, Cordova-Fraga *et al*., 2005, De la Roca *et al*., 2007, and Cordova-Fraga *et al*., 2008]. In these studies were used ferromagnetic particles as magnetic tracers, they have shown a great utility to describe the gastric emptying and gastric contractions. Unfortunately, this is the only segment of the GI tract where motor function information is measured, this can be because of magnetic particles are not concentrated in a small space, so the magnetic intensity signal is not enough to be recorded by a magnetometer who works at room temperature. Nevertheless, some advantages in using magnetic techniques are ability to assess gastric activity as gastric peristalsis, half time of gastric emptying, influence of stress in the gastric emptying and colon transit time in different stages of the menstrual cycle, as well as the gastric transit that can be evaluated with other techniques like MRI technique. (NMR). [Di Pace *et al*., 2011]. Although is possible to monitor the esophageal activity taking place, in the same way that in manometry, placing two sensors, in different positions from the esophagus.

In this study is presented an implementation of a magnetic marker and a fluxgate sensor, the first one was fixed through esophagus and gastric segments while the magnetic signal was recorded outside of the human body.

2. Material and Methods

In this study 6 healthy subjects without GI diseases were evaluated, they gave their written consent prior to participation in this study, which was performed according to the Treaty of Helsinki. The measurement procedures begin with the positioning of two magnetic particles in bottom of the stomach helped with an endoscope, so the starting point of magnets was well defined. Magnets were united to a

graduated thread that allowed moving them in a proximal direction, then magnet positions through GI tract were known in each time. Distal displacement was made giving freedom to the particles of such form that the contractile activity of the GI system moved the particles.

Peristalsis measurements were carried out in two gastric states of distension. First measurement was after that magnets have been placed in the region of fundus in basal state. Then, measurements were taken in two positions within the stomach, fundus and antrum. After those measurements in basal state were done, subject ingested a test meal that included bread, chicken, vegetables and water. Then measurements were taken again in fundus and the antrum. Finally the magnets were moved esophagus section, and measurements were taken in three sections crossing in a proximal direction.

Evaluations taken in each of distension states were made with temporal separations of 10 min. As long as in measurements in gastric section had a separation of around 2 hours. Measurements in postprandial state, in stomach and in esophagus had a 20 minutes separation.

The magnetic marker were identical, they include neodymium-iron-boron (NdFeB) and they had a cylindrical shape (d = 3 mm, h = 4 mm, diameter and height and magnetic moment m = 1.42x10-2 J/T). These magnet markers generate a magnetic field that is detectable by fluxgate sensors Model 539 (Applied Physics Systems). Two fluxgate sensors were arranged to coincide with their "y" axis and were separated a distance of 10 cm and they were registering a rate frequency of 30 samples per second.

3. Analysis

To eliminate high frequencies, a routine of Fast Fourier Transform was implemented in Matlab, it was used a band-pass filter, leaving only the contributions of low frequencies, from 1 to 5 cpm (cycles/minute), consequently cardiac activity and the breathing noises were eliminated. Frequencies of contraction in different sections of the GI tract were used to analyze each one of the two states. The spectra of the signals were analyzed to search for the peak corresponding to the main contraction frequencies of each one of the monitored sections. In many cases there were several frequencies characteristics of the signal (several peaks in the graph) but the maximum peaks were only considered, which were considered as the most representative frequency.

4. Results

The registered signals showed, in the majority of the registries the contractile activity of the subjects in the different sections from the gastro esophageal tract (See Figure 2).

4.1. Basal activity

The contractile activity for this relaxed state of distension was between the 1,5 and 3 cpm.

4.2. Postprandial activity

The contractions are better defined by less noisy signals, with the frequencies that went from the 1,5 to 3 cpm, being more recurrent frequencies of 2,5 cpm or grader. Unlike the shown activity in the basal state, in the after-lunch state are fewer harmonics for the main frequency of contractions in the different sections from the stomach.

4.3. Esophageal activity

The predominant activity of this region was around the 1,5 cpm, although in some subjects were shown harmonic frequencies of around 3 cpm. In figure 2 the behavior of the main frequencies of contraction for a subject can be observed in each one of the gastric states of distension (basal and postprandial) and for each of the regions (stomach and gullet). In figure 2 the variation of the main

contraction frequencies can be appreciated, and how they change depending of the GI section, and the distention states in which it is.

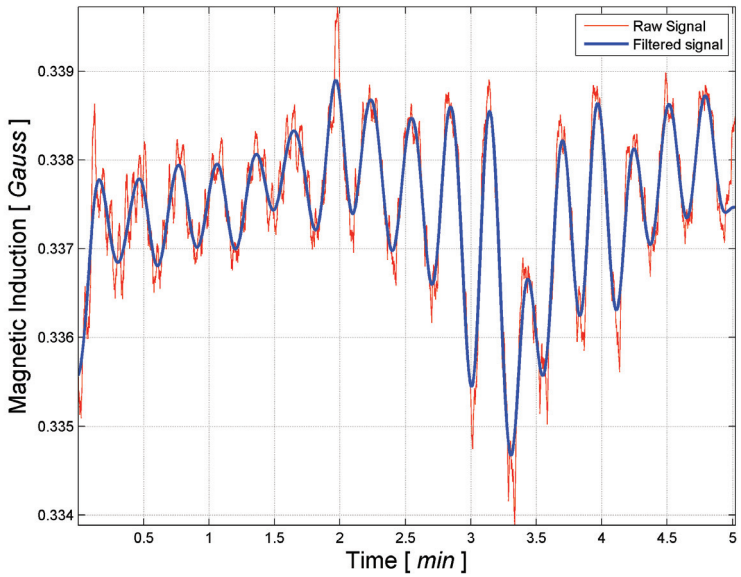

Figure 1. *Contractil activity of the stomach after the food ingestion. It is possible to appreciate that the contractions in the stomach are around three contractions per minute.*

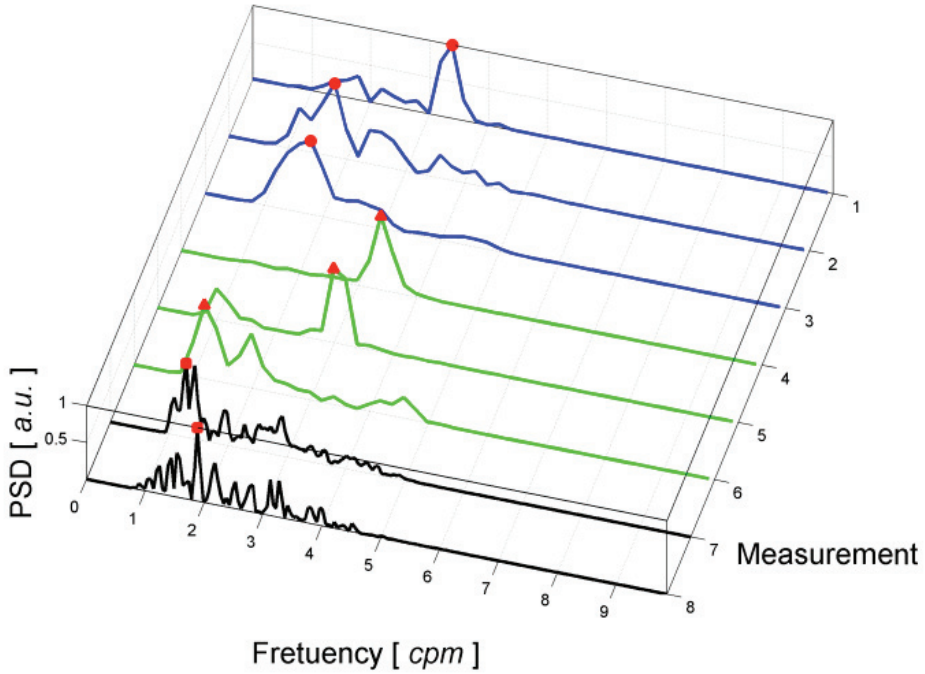

Figure 2. *Graphic of the spectral densidades indicating the main frequencies in the different regions from the GE tract, from the antrum region (measurement 1) to the middle esophagus (last measurement). This graphic contains all the measurements realised in a subject. The blue lines show the measurements in basal state. It is observed in these measurements how the contractions frequency were slowing while the stomach went away relaxing. In the green lines were shown the frequencies after the subject ingested food. It is easily perceivable that as the stomach has more luminar containing the gastric activity returns smoother and as the empty stomach the activity becomes much noisy.*

5. Discussion

The frequencies of contraction for the different distention states presented a wide range of frequencies, in particular the stretched state. This is clearly because while the particles move throughout tract GI in proximal direction the frequencies are mixed, which is a high influence in the esophageal activity. Besides this phenomenon, other factors can be considered to have influence in results. Some of them are that we are considering the characteristic frequencies to be the frequencies that correspond to the maximum tips in our spectral densities of power, and since the stomach behaves in different forms for different subjects, in particular in the state to base, the characteristic tips in this state of distension are not always is the same.

Different modalities to measure gastro esophageal activity have been used, among them emphasize the manometry, Radionuclide Imaging, magnetic resonance (to secure references of these techniques) with which have obtained registries. On the other hand measurements were made during the food ingestion; hopefully the sharp variation alteration of the magnetic moments direction of the markers originates a great change in the amplitude of the magnetic induction. This shows the potential to register gastro esophageal regions frequencies.

Acknowledgements

Authors want to thank DAIP under grant number 000017/10, FESE 2010 and UDLSBajio 2010, for their partial support in this study.

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