Proceedings IRF2018: 6th International Conference Integrity-Reliability-Failure
Lisbon/Portugal 22-26 July 2018. Editors J.F. Silva Gomes and S.A. Meguid
Publ. INEGI/FEUP (2018); ISBN: 978-989-20-8313-1

PAPER REF: 7067

BIOMECHANICS OF THE HUMAN STOMACH AFTER DIABETIC VAGOTOMY

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ABSTRACT

The mathematical model of the human stomach has been used to investigate the effect of damage to the vagal nerve on biomechanics of the organ. The results have clearly demonstrated: i) no significant variations in the frequency but a reduction in the amplitude and the irregular pattern of slow waves, ii) a decrease in number of spike bursts, and iii) diminished or absent mechanical waves of contraction. These findings correlate strongly with the degree of vagal denervation and are more conspicuous after truncal and selective vagotomy. Electromechanical processes have occurred haphazardly and no coordinated peristaltic waves have been formed.

***Keywords*:** biomechanics, human stomach, mathematical model, vagotomy.

INTRODUCTION

The coordination of electromechanical processes in the stomach is determined by the interplay between the myenteric plexus (MP) and the vagal input. Diabetic neuropathy and damage to the vagus nerve lead to gastroparesis *diabeticorum* - a severe medical condition, the pathophysiology of which is obscure.

The aim of the study is to analyze the effect of “diabetic vagotomy” on gastric motility. A mathematical model of the human stomach (ABS Technologies®) is employed to simulate electromechanical processes in the organ. The human stomach is modeled as a thin soft shell, incorporating real anatomical, histomorphological and electrophysiological data [1]. The myenteric plexus is treated as a two-dimensional ganglionic neural network with dispersed interstitial cells of Cajal - pacemakers.

RESULTS AND CONCLUSION

The results of numerical simulations show that subsequent stimulation of mechanoreceptors in the stomach induces the generation and propagation of excitatory waves in the MP. These organize local electromechanical reflexes within discrete ganglia, and can be traced as far as the axonal projections of motor neurons. Myogenic responses appear sporadic - the occurrence of slow waves is indiscriminate and associated contractions are disorganized. In the absence of vagal inputs, the MP cannot sustain the propagation of excitation and interconnectivity among ganglia. No areas of firing pacing emerge and no strong connectivity among MP, interstitial cells of Cajal or smooth muscle across the organ develop.

Electromechanical processes occur haphazardly and no coordinated peristaltic waves are formed.

The concomitant distension of the stomach with the "ingested" meal and the subsequent stimulation of mechanoreceptors induce the generation and propagation of waves of depolarization in the sensory-motor neuronal chain. These organize local electromechanical reflexes within discrete myenteric ganglia and can be traced as far as the axonal projections of motor neurons. Myogenic responses appear sporadic and temporal, (spatially discordant), i.e. the occurrence of slow waves is indiscriminate and associated contractions are disorganized (see Figure 1 below).

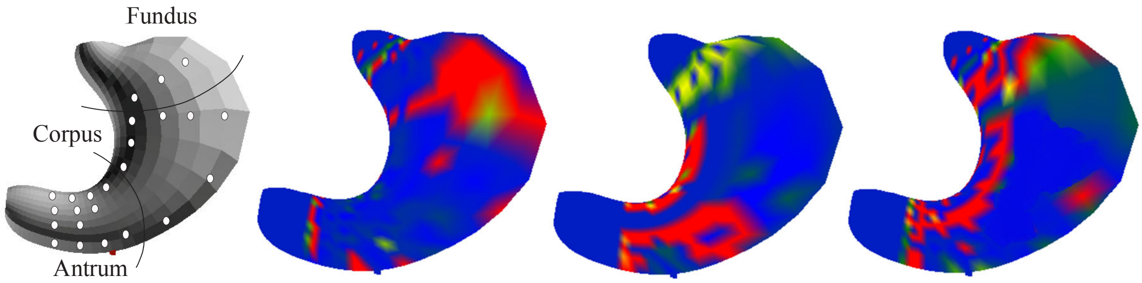

Fig. 1 - A pattern of electrical activity in the human stomach after vagotomy

The findings correlate with postoperative recordings of the gastric myoelectrical and motor activity in patients who have undergone different extents of vagotomy, and demonstrate: (i) a reduction in the amplitude and an irregular pattern of slow waves, (ii) a decrease in number of spike bursts, and (iii) diminished or absent mechanical waves of contraction after vagotomy.

ACKNOWLEDGMENTS

The authors gratefully acknowledge the funding by the Arabian Gulf University and Al Baraka Banking Group, Manama, Bahrain.

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