BIOMECHANICS OF GASTROPARESIS

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Biomechanical activity of the human stomach including peristalsis, accommodation and relaxation reflexes, the gastric pump, among others, is controlled by the intrinsic myentric nervous plexus (MNP). It is formed by multiple neurons that are arranged into a network of ganglia embedded in the wall of the organ. Morphostructural and functional abnormalities in its function result in gastroparesis – a disorder that produces symptoms of gastric retention in the absence of physical obstruction. Pathophysiological mechanisms of the condition remain inconclusive; however, hypoganglionosis and reduction in the interstitial cells of Cajal (ICC) have been suggested. The aim of this study was to investigate the electromechanical wave activity and dynamics of stress-strain distribution in the gastroparetic human stomach.

A mathematical model of the stomach based on the anatomical, mechanical and physiological data was developed [1]. The organ was modeled as a thin soft biological shell. The material possessed general properties of curvilinear electromechanical orthotropy. Deformations were finite. Active forces of contractions were triggered by electrical signals and changes in intraluminal pressure. Electrical signals were originated in interstitial cells of Cajal that were spatially distributed along the surface of the bioshell. The governing nonlinear system of combined hyperbolic and parabolic equations was solved numerically. The algorithm of second order of accuracy in time and space variables was used.

Numerical results showed that under normal physiological conditions the bioshell responded with strong contractions in the body and the antrum region with development of maximum stresses, while the fundus underwent passive distension, both in the axial and circumferencial directions. In the case of hypoganglionosis there was a decrease in the velocity of the spread of excitation within the bioshell with a subsequent delay in the development of forces. A reduction in the number and the firing rate of ICC decreased the amplitude of electrical waves and the strength of contractions throughout the organ. Conjoint simulation of hypoganglionosis and reduction in ICC had a detrimental effect on the stress-strain distribution in the stomach. It remained relaxed and low intensity forces were produced.

The model reproduced a variety of biomechanical phenomena observed *in vivo* and *in vitro*.It showed a satisfactory correlation in the dynamics of electromechanical patterns and changes in shape of the organ under normal and pathological conditions. The results confirm that hypoganglionosis and reduction in ICC contribute to pathogenesis of gastroparesis.

REFERENCES

[1] R.N. Miftahof and H.G. Nam, *Mathematical foundations and biomechanics of the digestive tract* Cambridge University Press, 2010.