Detection of Recovery Times in Gastric Extracellular High-Resolution Electrical Recordings

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Introduction

Mechanical contractions of the stomach wall which help digest the food we eat is governed by an underlying bio-electrical activity known as slow waves. Abnormalities in slow wave activity have been linked to major stomach disorders such as gastroparesis, where the stomach is in a state of partial or complete paralysis.

The activation time of the slow wave event is usually used to study extracellular stomach recordings. In this study, a novel method in this field to detect the recovery time of the gastric slow wave event (Figure 1) is presented. Quantifying the activation and recovery phase of slow wave activity is pertinent to understanding stomach disorders such as gastroparesis.

Methods

High-resolution (HR) mapping[1] of gastric slow waves was performed in four pigs after laparotomy (Figure 1). Ethical consent was granted by the University of Auckland Animal Ethics Committee.

The raw signals from HR mapping were processed using a validated method[2]. A two-step algorithm was developed to detect the recovery time in the slow wave event. In the first step, the derivative of the signal was computed using a low-pass digital differentiator using the Savitzky-Golay derivative algorithm. In the second step, a linear search was performed from 1.5 to 6 seconds after each activation event to identify the point of maximum upstroke to represent the recovery time in the slow wave event.

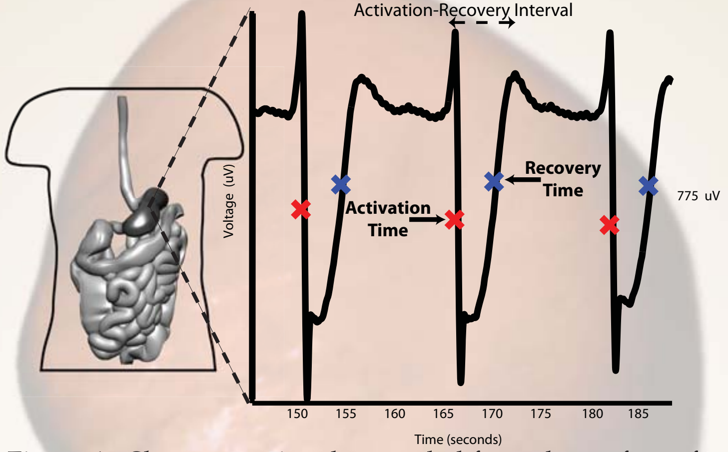

Figure 1 - Slow wave signals recorded from the surface of the stomach. Red crosses are the activation time, while the blue crosses are the recovery times of the slow wave event.

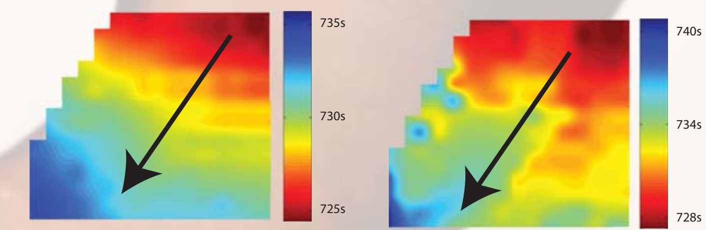

Figure 2 - Normal linear slow wave propagation.

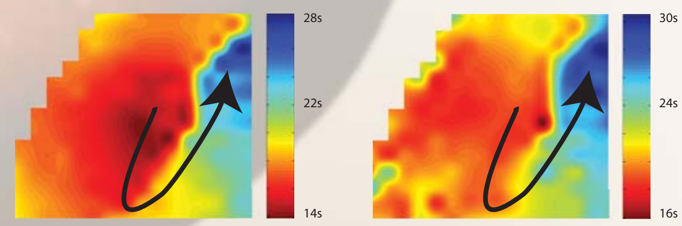

Figure 3 - Abnormal re-entrant slow wave propagation.

Results

The activation and recovery phase of the slow wave propagation was mapped and identified as normal and abnormal slow wave propagation as seen in Figure 2 and 3.

For each experimental recording, average activation-recovery intervals of slow wave were computed and displayed as a box plot for normal and abnormal slow wave propagations (Figure 4).

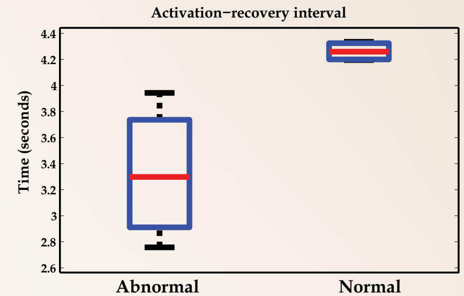

Figure 4 - Box plot showing the average slow wave interval for normal and abnormal activity.

Conclusion

- The spatial pattern of the slow wave recovery phase is similar to that of the activation phase in stomach slow wave recordings.
- Abnormal slow wave activity in the stomach has a shorter activation-recovery interval than normal slow wave activity.

Detecting and quantifying the activation and recovery phase of slow waves in high-resolution mapping can be used as a potential diagnosis tool for detecting stomach disorders.

References

1. Du et al. High-resolution mapping of in-vivo gastrointestinal slow wave activity using flexible printed circuit board electrodes: methodology and validation. Ann Biomed Eng 2009
2. Paskaranandavadivel et al. Improved signal processing techniques for the analysis of high resolution serosal slow wave activity in the stomach. Conf Proc IEEE Eng Med Biol Soc 2011

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