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EVALUATION TOOL FOR ANAL SPHINCTER INTEGRITY: USE OF THE PUBORECTALIS AND SPHINCTERIC EMG AS A GUIDE FOR SURGERY

Hypothesis / aims of study

Puborectalis and anal sphincter muscles play important roles in maintaining fecal continence. Electromyography (EMG) of these muscles provides useful information in evaluating their muscle activity but the analysis is challenged due to complicated female pelvic anatomy. The aim of this study was to test a novel pelvic and sphincteric muscle surface EMG assessment approach using a minimally-invasive high-density 64-channel intra-rectal probe.

Study design, materials and methods

One healthy female volunteer was recruited to participate in this study with IRB approval. A high-density (8 rows by 8 columns; 64 channels) intra-rectal probe (Figure 1a) was placed in the subject's rectal space. The subject was asked to perform ten 1-second (short) voluntary contractions followed by ten 3-second (long) voluntary contractions with a span of 5 seconds between two consecutive contractions. The EMG signals were collected using the Refa136 system (Twente Medical Systems International, Enschede, Netherlands). After EMG acquisition, the EMG motor unit action potential (MUAP) decomposition was performed on the total 64-channel anorectal EMG signal using the K-means Clustering and Convolution Kernel Compensation (KmCKC) algorithm.

Results

EMG decomposition was performed based on the collected signals. Fifteen motor units were successfully identified. Figure 1(b) shows the spatial distribution of a typical MUAP propagation among 64 channels based on a transversely bipolar setting. Figure 2 shows the plot of all identified motor units with their innervation zones and action potential propagation distances illustrated.

Interpretation of results

The position of the innervation zone in Figure 1(b), marked by the red rectangle, is identified by checking the phase change during propagation: the MUAPs in the neighboring two channels in the transverse direction present opposite phases, indicating that the action potential, originated from the location (innervation zone) between the two neighboring electrodes, travels in the opposite directions. Please note that some noise exists in the MUAP map during EMG measurement (e.g., probe-tissue contact movement artifact).

Conclusion

Damage to the anal sphincter muscle (e.g. due to childbirth) is one main cause of post-obstetric fecal incontinence (FI) and FI adversely affects the quality of life for women. Previous studies have demonstrated that the level of voluntary contraction of the puborectalis muscle is associated with the outcome of sphincter repair surgery. In this study, we successfully decomposed the MUAP propagations of these muscles through the high-density intra-rectal surface EMG probe and obtained the positions of their innervation zones. We believe this knowledge could provide valuable diagnostic information for surgeons to consider in women with FI and serve as a guide for sphincter repair surgery.

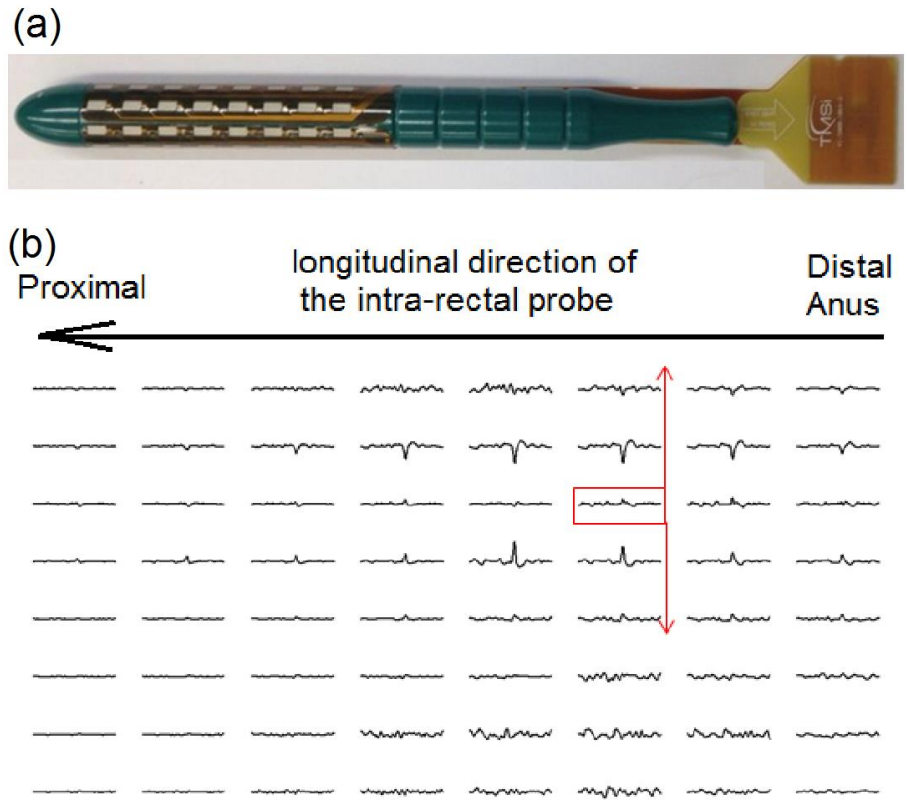

Figure 1 (a) Intra-rectal high-density 64-channel EMG Probe and (b) a typical MUAP bipolar map on all 64 channels. (Position of innervation zone is marked by the red rectangle)

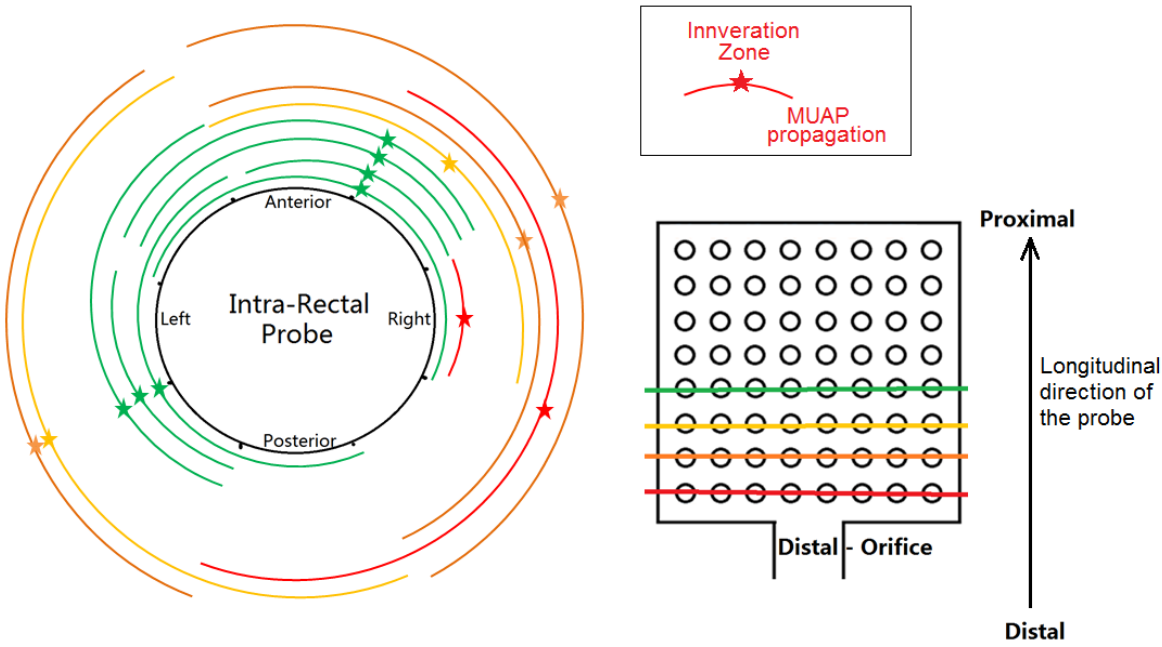

Figure 2. Illustration of the position of the innveration and the action potential propagation distances for each motor unit. The depth of each innervation zone is shown by its curve color.

Disclosures
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