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WITHIN AND ACROSS SUBJECT REPRODUCIBILITY OF THE MULTI-ELECTRODE SURFACE EMG FROM THE EXTERNAL ANAL SPHINCTER.

Hypothesis / aims of study

Multi-electrode array surface EMG (S-EMG) technique has recently become available for recording and characterization of the electrical properties in the striated muscles in human. Application of this new technique to the external anal sphincter muscle would allow to address the question of its innervation patterns and the electrical properties of this muscle in healthy subjects. This would significantlz enhance our understanding of clinical findings in males and females with disorders of the pelvic floor.

Study design, materials and methods

A 16-channel multi-electrode array developed for large striated muscles (e.g. the biceps brachii) was arranged around the circumference of a cylindrically shaped probe to perform S-EMG recordings from within the external anal sphincter. (Dimensions of the probe: 14 mm in diameter, carrying an array of 16 silver bars: 1 mm diameter, 10 mm length, 2.75 mm apart). SEMG signals were recorded differentially between adjacent pairs of electrodes during rest and during maximal voluntary contractions (MVC) for 10 sec at each of three levels within the anal canal (1, 2, and 3 cm from the anal orifice). The EMG signals were amplified, sampled at 2048 Hz per channel and stored on a PC after 12 bit A/D conversion. The bandwidth of the EMG amplifier was designed to accommodate the spectrum of the striated muscle EMG. Slow signals produced by active smooth muscles (if any) were rejected by the high pass filter at 10 Hz. Together with a specially designed software, the probe was able to detect the generation point (Innervation zone: IZ), propagation, and extinction of motor unit action potentials (MUAP) produced by individual motor units (MU) of the external anal sphincter muscle. An IZ was defined as the region of a MU generation including the end-plates (or neuromuscular junctions), and its location was defined as the position of the electrode(s) under which the MUAP were generated and began their propagation in opposite directions towards the fiber endings. Criterion for identification of an IZ was if the same MUAP - identified by specific "signature" characteristics (shape, propagation, length) - or different MUAP were generated at the same location more than 30 times during 10 seconds of maximum voluntary contraction. The MUAP detection and extraction were performed with Wavelet techniques, and combined the information provided by the electrode arrays in the spatio-temporal domain.
We investigated 15 healthy subjects (6 male : 9 female, 30.5 years) twice within 2 months. The subjects were lying in the left side, and the probe was held in position (channel 1 oriented ventrally) by the investigator. The subject was instructed to relax completely, and to produce three maximum voluntary contractions sustained for 10 sec, at each of three levels within the anal canal (at the anal orifice and 1 and 2 cm proximal). SEMG was recorded also during 10 sec of rest at each level.

Results

The software output (Radon Correlation Transform) produced both graphical display as well as a digital reading of the SEMG parameters for each electrode position (or: pair of electrodes) of the probe. The IZ distribution was colour-coded with respect to the number of MUAP detected at each position. MU of the anal sphincter could be detected at different locations along the circumference. Potentials propagated from the IZ towards the fiber endings. With maximum contraction, IZs were detected at each of the three levels within the anal sphincter for every subject. In most cases, only one IZ could be clearly identified, whereas in only a few cases, two or more IZ were recognized the same level. Reproducibility of measurement was good between and within subjects after two months. The computed correlation between both measures was highly significant at level 1 and 3 ($r=0.44$ and $r=0.55$, resp. both $p<.01$), and significant for level 2 ($r=0.31$, $p= <.05$).

Interpretation of results, Concluding message

This multichannel SEMG system is an easy to perform, noninvasive new technique with good reproducibility, that allows to collect important information about the innervation patterns of the external anal sphincter. This will allow reinvestigating the role of innervation in the pathogenesis of fecal incontinence in the future.

Funding; grants from the EU – QLRT-2001-00218 – and the Deutsche Forschungsgemeinschaft, EN 50/21).

FUNDING: European Community: QLRT-2001-00218, and Deutsche Forschungsgemeinschaft: En 50/21