

## **DISTRIBUTION OF INNERVATION ZONES OF THE EXTERNAL ANAL SPHINCTER: EFFECTS OF GENDER IN HEALTHY SUBJECTS**

### **Hypothesis / aims of study**

Information concerning the motor unit action potential (MUAP) distribution and their behavior in the external anal sphincter (EAS) would be very useful in a number of instances: for description of asymmetry, for investigation and quantification of muscle activity during stress, relaxation, and fatigue, and for the differentiation between myogenic and neurogenic pathologies of the muscle. We have previously described a new surface EMG (SEMG) system for identification of MUAP from the striated EAS muscle based on a 16-channel multi-electrode array recording technique. This system was linked to a novel software algorithm for automated identification of MUAP and their innervation zones for the description of normal patterns of innervation of the EAS for the first time.

### **Study design, materials and methods**

A cylindrical probe, 14 mm in diameter and carrying an array of 16 silver bars (1 mm diameter, 10 mm length, 2.75 mm apart) was specifically designed and built to record MUAP circumferentially along the muscle fibers of the EAS during voluntary contractions. SEMG signals were recorded differentially between adjacent pairs of electrodes of the array 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 amplifiers was designed to accommodate the spectrum of the striated muscle EMG. Included were 52 healthy subjects with no history of neurological or pelvic floor disorders (27 nulliparous females and 15 males, 20 – 55 years old) recruited in three clinical centers in Europe. After visual inspection of the tracings, each data set was analysed by a specifically developed algorithm (called Radon Correlation Transformation, RCT) for identification of propagating patterns of individual motor unit firings and automatic localization of the respective innervation zone (IZ) of each MUAP. An IZ was defined as the region of a motor unit including the end-plates (or neuromuscular junctions), and its location was defined as the position of the electrode under which the MUAP were generated and began their propagation in opposite directions toward the fiber endings. Criterion for identification of an IZ was, if the same MUAP identified by specific "signature" characteristics (shape, propagation, length), or different MUAPs, were generated at the same location more than 30 times during 10 seconds of maximum voluntary contraction.

### **Results**

a) An IZ of a MUAP could reliably be identified in all subjects only with maximum voluntary contraction of the anal sphincter but not during the resting state. b) With maximum voluntary contraction, out of the 15 male subjects 10 met the criterion at 1 cm depth, and 12 met it at the 2 cm and 3 cm level. c) Out of the 37 female subjects, 19 met this criterion at 1 cm, 27 at 2 cm, and 31 at 3 cm depth. In some cases two, but rarely three IZs were detected in an individual. d) In males, a dominant innervation in the right and left hemisphincters was evident, independent of the location within the anal canal. e) Female subjects showed a predominant right and left hemisphincter innervation at 1 cm depth only, but predominantly ventral and dorsal innervations at 2 cm and 3 cm within the anal canal.

### **Interpretation of results, Concluding message**

The distribution of IZ of MUAP from the EAS is differentially organized: gender differences contribute significantly to local variation within the anal canal.

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