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SENSORY EVOKED CORTICAL POTENTIALS OF THE LOWER URINARY TRACT IN HEALTHY MEN

Hypothesis / aims of study

The aim of the study was to examine the feasibility and reliability of recording sensory evoked cortical potentials (SEPs) from different localizations in the male lower urinary tract (LUT) to assess afferent LUT function. We hypothesized that SEPs can be reliably detected for all stimulation sites in the LUT with the best reliability values for latencies, particularly for the most prominent negative SEP component N1[1]. Assuming localization-specific innervations with different involvement of for example pudendal, sacral and hypogastric nerves, latencies were expected to depend on stimulation site as well as on age and body size. Longer latencies were expected for older and taller subjects. For amplitudes, no differences were expected regarding different localizations or age.

Study design, materials and methods

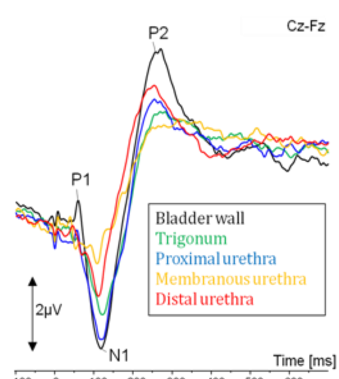
Ten healthy men (19-37 years old, 1.85±0.05 meters tall) were investigated twice at intervals of 1-3 weeks. During 64-channel electroencephalographic (EEG) recording (extended 10/20 electrode placement), one-millisecond, repetitive (0.5Hz), square wave electrical stimulation was applied to the distal, membranous, and proximal urethra, trigone and bladder wall. At the beginning of every measurement, current perception threshold (CPT) was determined as the first sensed stimulus when increasing the electrical current stepwise. Then, the stimulation intensity was increased as far as tolerable without being painful. After 0.5-30Hz band-pass plus 50Hz notch filtering and artifact rejection, EEG data were segmented and averaged per subject and localization. SEPs were analyzed in terms of the cortical components P1, N1, and P2 also with corresponding topographies. The component's latencies and amplitudes were determined using peak detection in the Cz signal referenced to the Fz electrode and peak-to-peak amplitudes were calculated for P1N1 and N1P2. Values are given as means ±standard deviation. Intraclass correlation coefficient (ICC) was used to evaluate re-test reliability of latencies and amplitudes. ICCs were categorized as follows: ICC>0.75 (excellent reliability), 0.6 – 0.75 (good reliability), 0.4 – 0.59 (fair reliability) and ICC<0.4 (poor reliability). In addition, linear regressions were calculated to examine the relation between SEP measures, age, body size and current perception threshold (CPT).

Results

All subjects were able to perceive electrical LUT stimulation with the power of a few milliamperes for all localizations. Three components, typically, could be detected in the LUT-SEPs, with a prominent N1 and P2 component and a much smaller P1 component in the Cz-Fz signal (Figure 1). While P2 revealed excellent reliabilities for the latencies of proximal urethra and bladder wall, the N1 revealed most reliable latencies across all stimulation sites (Table 1). For the membranous urethra, the SEP components of five subjects were not clearly identifiable and therefore did not enter the analyses of latencies and amplitudes. Significant relations were observed between N1 latency and age for bladder wall, membranous and distal urethra (all $p<0.01$) showing decreasing latency with age. There was no significant relation with body size and CPT.

Figure 1 Sensory evoked potentials for different electrical stimulation sites in the lower urinary tract.

Table 1: SEP latencies given in milliseconds per stimulation site of the lower urinary tract



Cz-Fz	P1				N1				P2			
	Mean	±	SD	ICC	Mean	±	SD	ICC	Mean	±	SD	ICC
Urethra												
distal	56.8	±	11.9	0.42	113.0	±	14.6	0.77	239.1	±	27.5	0.43
membranous	54.1	±	13.7	0.29	126.1	±	32.2	0.66	255.9	±	48.2	-0.27
proximal	57.4	±	6.1	0.37	130.8	±	17.9	0.60	254.4	±	36.3	0.80
Trigone	67.0	±	10.7	0.41	133.5	±	14.2	0.72	256.1	±	38.8	0.36
Bladder wall	66.9	±	11.3	0.54	127.1	±	18.6	0.63	231.5	±	36.9	0.89

The P1N1 amplitude was found quite variable between- but also within-subjects with reliabilities scoring from good to poor. Excellent reliabilities were found for the N1P2 amplitude for all stimulation sites (Table 2). In general, the amplitudes were significantly related to CPT, but, did not depend on age or body size.

Table 2: SEP amplitudes given in micro volts per stimulation site of the lower urinary tract

Cz-Fz	P1N1				N1P2			
	Mean	±	SD	ICC	Mean	±	SD	ICC
Urethra								
distal	2.9	±	1.4	0.43	7.1	±	3.9	0.91
membranous	2.8	±	2.1	0.81	6.8	±	5.2	0.89
proximal	3.5	±	1.7	0.32	7.7	±	4.6	0.90
Trigone	2.6	±	2.2	0.67	6.6	±	5.6	0.96
Bladder wall	5.0	±	2.7	0.76	9.5	±	5.8	0.90

Interpretation of results

Corresponding to previous data from healthy women[1], typical LUT SEPs could be induced in healthy men with reliable N1 responses showing good to excellent reliabilities across localizations (Table 1). The N1 seemed to occur earlier in men compared to women[1]. This might be due to gender-specific differences (e.g. composition of nerve types), but different stimulation intensities, electrical perception and pain perception thresholds, should also be taken into account. Regarding the age dependence, shorter instead of longer latencies were found in older subjects.

The additional stimulation site in the male membranous urethra revealed rather unreliable SEPs. Together with the poor responder rate (50% of the subjects) for the membranous urethra this result might be explained by the difficult positioning of the stimulating electrodes in this region of the urethra. In addition, different sizes of the prostate and distances to the sphincter, in some cases, might have lead to co-stimulation of the sphincter.

Concluding message

Typical and reliable LUT SEPs can be induced in healthy men. The between-subjects variability of SEPs is rather high compared to the within-subjects variability which currently limits the establishment of normative data. However, LUT SEPs together with CPTs provide promising measures to monitor treatment outcome and functional recovery. Further investigations are warranted in larger cohorts and patients.

References

1. Gregorini, F., et al., Sensory evoked potentials of the human lower urinary tract. J Urol 2012 in press

Disclosures

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