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CURRENT PERCEPTION THRESHOLDS OF THE HUMAN LOWER URINARY TRACT

Hypothesis / aims of study

Assessment of current perception thresholds (CPTs) of the human lower urinary tract (LUT) seem to be an interesting and feasible method to objectively investigate the afferent function of the LUT. However, little information is available on reliability of the method and differences in gender and CPTs of different LUT sites.

We aimed to investigate sensory information from various LUT localizations in men and women using CPTs.

We hypothesized that the absolute values of the CPTs depend on the localization, i.e. with lower thresholds in the urethra than in the bladder. In addition, except for bladder wall, gender effects were expected due to anatomical differences (e.g. longer urethra in men)

Study design, materials and methods

CPTs were investigated with regard to reliability and specificity to different LUT localizations using two types of electrical stimulation protocols, which were different in frequency and stimulus pulse width. Young healthy adults (mean age 24.9±5.6 years, n=20, 10 women) were measured twice within a period of 1.5-4 weeks. Repetitive square wave current stimulation was applied to the bladder wall, trigone, proximal, membranous (in men only) and distal urethra by means of a special transurethral 8 F catheter, which was positioned under fluoroscopic control. Cycles of fast (3Hz – 0.2ms) and slow stimulations (0.5Hz – 1ms) were used alternately. The CPT was identified using the method of limits. Before every stimulation cycle, the bladder was emptied and refilled with 60mL of contrast agent. Repetitive measurements were assessed using analysis of variance (ANOVA) with between-subjects factor “gender” and within-subjects factors “localization” of the stimulation electrode (4), “stimulation” (2), and “visit” (2). Intraclass correlation coefficient (ICC) was used to evaluate reliability. Additional analyses were calculated per stimulation frequency and, considering gender-specific anatomical structures in the LUT, for the men’s and women’s groups separately. CPTs are presented as mean ± standard deviation.

Results

All subjects were able to perceive electrical LUT stimulation with the power of a few milliamperes for both types of stimulation and all localizations (Table 1). Across all subjects and measurements, the ANOVA including all factors mentioned above revealed significant main effects for localization ($F(1.4,26)=33.5$, $p<0.001$) and stimulation ($F(1,18)=26$, $p<0.001$). There was no significant effect for visit, gender, or any interaction (p>0.2). For both types of stimulations, CPT was significantly influenced by localization (slow: $F(1.3, 23.8)=19.1$, $p<0.001$; fast: $F(1.5,27.4)=28.5$ $p<0.001$). Separate analyses in men and women revealed significant effects for localization (men: $F(1.4,12.4)=4.57$, $p=0.044$; women: $F(1.5,13.3)=25.7$, $p<0.001$) and stimulation (men: $F(1,9)=5.21$, $p=0.048$; women: $F(1,9)=14.6$, $p=0.004$) with lower CPTs for the slow compared to the fast stimulation.

Table 1: Current perception thresholds for slow and fast stimulation of the lower urinary tract

CPTs [mA]	Bladder wall	Trigone	Proximal urehtra	Membranous urethra	Distal urethra
Women					
0.5Hz – 1ms	8.2±3.9	2.9±3.6	2.2±2.5	Not available	2.0±1.5
3Hz – 0.2ms	11.4±5.9	4.3±4.0	4.3±3.7	Not available	4.5±3.1
Men					
0.5Hz – 1ms	9.0±8.8	3.9±4.0	3.6±3.9	8.1±10.6	3.1±3.2
3Hz – 0.2ms	9.1±5.1	5.5±5.1	4.8±3.3	10.8±12.3	3.8±3.1

Regarding posthoc comparisons for localizations in men, CPTs were significantly higher for bladder wall compared to proximal ($p=0.019$) and distal urethra ($p=0.014$). No significant difference was found between the remaining localizations. Stimulation-wise analyses revealed only one significant difference for the fast stimulation, with significantly higher CPTs for bladder wall than distal urethra ($p=0.027$). In women, CPTs were significantly higher for bladder wall compared to all other localizations ($p<0.004$) also when analysed for slow and fast stimulation separately.

The reliability analyses including all CPT measurements revealed excellent ICC for all localizations, except the bladder wall (Table 2). Both genders revealed similar reliabilities. However, men demonstrated a little less in trigone and women demonstrated a little less in distal urethra.

Table 2: Intraclass correlation coefficients for current perception thresholds for the lower urinary tract

ICC	Bladder wall	Trigone	Proximal urethra	Membranous urethra	Distal urethra
Total (N=20)	0.08	0.80	0.84	Not available	0.90
Women	-0.01	0.91	0.85	Not available	0.74
Men	0.13	0.72	0.83	0.95	0.93

ICC>0.75: excellent, 0.6 – 0.75: good, 0.4 – 0.59: fair, <0.4: poor reliability

Interpretation of results

All stimulations could be easily detected by all subjects already at low stimulation intensities (<20mA). This indicates that CPT assessments are feasible for both slow and fast stimulations in the LUT and in particular the urethra. As expected, bladder CPTs were higher than urethral CPTs. The fact that CPTs depend on the stimulation type and localization may indicate qualitatively and quantitatively distinct sensory fiber types and innervations of the LUT with assumed differences between bladder and urethral localizations.

Concluding message

Although CPTs might reflect the level of responsiveness of nerve afferents, this method remains semi-objective and requires a certain amount of attention and compliance from the subject, which limits clinical applications. Nevertheless, CPTs may become a valuable add-on for investigations of LUT sensory functions towards a more objective assessment of LUT afferents and a better understanding of different clinical conditions. This could also be helpful for individualized treatment strategies. Further investigations combined with neurophysiological assessments are needed in larger cohorts and patients.

Disclosures

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