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DEVELOPMENT OF A FLEXIBLE MEASUREMENT-SYSTEM FOR COMBINED URODYNAMIC AND NEUROPHYSIOLOGIC INVESTIGATIONS

Hypothesis / aims of study

With the development of a flexible measurement system we want to be able to measure both urodynamic and neurophysiologic parameters simultaneously and with high precision in time and amplitude. The system shall open the research on various connections between urodynamic tract and nervous system and allow getting a better insight into the underlying mechanisms.

Study design, materials and methods

There are many clinical systems commercially available either for investigations on urodynamics or on neurophysiology. However, they usually are closed systems, built for standardised experimental protocols in each field and can't be connected to other devices for synchronisation or data analysis purposes. To analyse data only standardised processing routines are available, which often is not enough for research purposes.

The developed measurement system now covers all requirements of measurement, stimulation, analysis, and presentation of both urodynamic and neurophysiologic parameters in one modular and flexible system with a time resolution from 0.01 ms to 1 s.

It is based on an portable personal computer with data acquisition hardware and an 8 channel isolation unit in which preamplifiers for microtip pressure transducers, electromyogram (EMG) or other sensors can be plugged. The preamplifiers convert the physical values like e.g. pressures to corresponding voltages and amplify them close to the sensor to make them immune from artefacts. These signals are fed into the isolation unit that is developed according to the rules for medical devices and certified as component. This is important to protect the patient from possible hazards from the nonmedical PC. The data acquisition hardware consists of a analogue-to-digital converter in PC-card format that is inserted into the notebook computer. There the analogue signals are digitised and afterwards stored on the harddisk and ready for the analysis.

Over an adapter it is possible to connect the pressure sensors to a clinical urodynamic system which then allows acquiring scientific data in parallel to the clinical examination. This is convenient and helps to save time and resources.

Measurement and analysis is done by a software toolkit specialised for research with physiological data called "SOLEASY", which can be used as well for controlling external stimulation devices like electrical or magnetic stimulators. It is based on LabVIEW and can be configured graphically.

For electrical stimulation an isolated current source is used that was developed according to the rules for medical devices and certified as component. The stimulation current is controlled by an analogue voltage that allows stimulating with arbitrary waveforms (max. +/-100 mA; max. +/-200 V). On two analogue outputs the effectively applied current and voltage can be determined und saved together with the pressure and EMG signals. So, exact synchronisation is achieved and allows latency analysis, biofeedback etc.

To apply magnetic stimulations we use the clinical device "MagPro" from Medtronics. The strength of the magnetic field can be controlled directly on the device and the important timing and interval of the magnetic pulses can be configured and triggered remotely through the measurement system.

Measured data and results can be replayed and presented together with video recordings through the "SOLEASY Player" software. It is possible to set markers with comments and change the speed from slow-motion to time-lapse.

Results

The developed system delivers accurate measurements of both urodynamic and neurophysiologic parameters. In experiments we acquired pressure of bladder, external urethral sphincter, abdomen, and external anal sphincter together with surface EMG, needle EMG, EMG of external urethral sphincter, and ECG simultaneously with a sample rate of 2000 Hz. Thanks to the EMG-preamplifiers, we acquired nice EMG-signals which were

resistant to 50 Hz noise. We stimulated electrically and magnetically, synchronously and repetitive with varying rates and were able to record all parameters at baseline and their responses to the stimulation.

Interpretation of results

With this system we are able to measure and analyse both urodynamic and neurophysiologic parameters in a new quality and quantity. Its modular design fits well in clinics and scientific labs that need a open, flexible, and powerful system to measure, stimulate, analyse, and present physiologic data. The player software is a useful and attractive tool for both internal teaching and the presentation on congresses.

Concluding message

This modular system bridges the gap between urology and neurophysiology, clinic and research, and allows the investigation of new methods and phenomena in both clinical and basic research. It is well suited for studies in humans and animals.