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DEVELOPMENT AND UTILITY EVALUATION OF NEW UROFLOWMETRY DEVICE USING 40KHZ AIRBORNE ULTRASOUND AND K-BAND (24 GHZ) WEARABLE CONTINUOUS WAVE DOPPLER SYSTEM FOR EXTERNAL URODYNAMICS STUDY

Hypothesis / aims of study

In urological field a patient's voiding behaviour is very important diagnostic information for his or her lower urinary tract symptoms. Such examination in non-contact mode is called external urodynamics study, e.g. conventional uroflowmetrty (UFM) where traditionally a mess-cup or a turbine generator forming a toilet-like instrument accepts patient's urination to record quantity-time curve and uroflow rate mechanically. However, patients must go to such instrumentation toilet at limited installation such as hospital. Natural, undisturbed urination of patients' own condition can't be monitored in this way. The objective is to perform a comparative external urodynamics study by the Doppler measurement method based on airborne ultrasound (ABUS) and millimeter wave (MMW) wearable continuous wave (CW) Doppler system and evaluate its efficacy.

Study design, materials and methods

We previously developed a system to quantitatively measure total voided volume, maximum and average flow rate of ABUS wearable CW Doppler system (fig. A) and have now reached the stage of clinical application [ref. 1,2]. With this system, patients can autonomously monitor their own urination, anytime and anywhere in an easy, natural and repeated manner. This innovation is expected to open up new opportunities in medical diagnosis and health care. Our system employs a wearable device; patients urinate wearing a finger-mount Doppler sensor, and transmission, processing, analysis and measurement, as well as archiving of Doppler signals of the urinary flow obtained, are performed in the network cloud environment via personal digital assistants carried by patients. As finger-mount wearable CW Doppler sensors, we devised two prototypes with 40 KHz ABUS and K-band (24 GHz) MMW (fig. B). Finger-mount Doppler units based on ABUS and MMW systems were mounted side by side, and urination was simultaneously measured with both devices. We assessed which unit would be more useful in clinical practice under various conditions.

Results

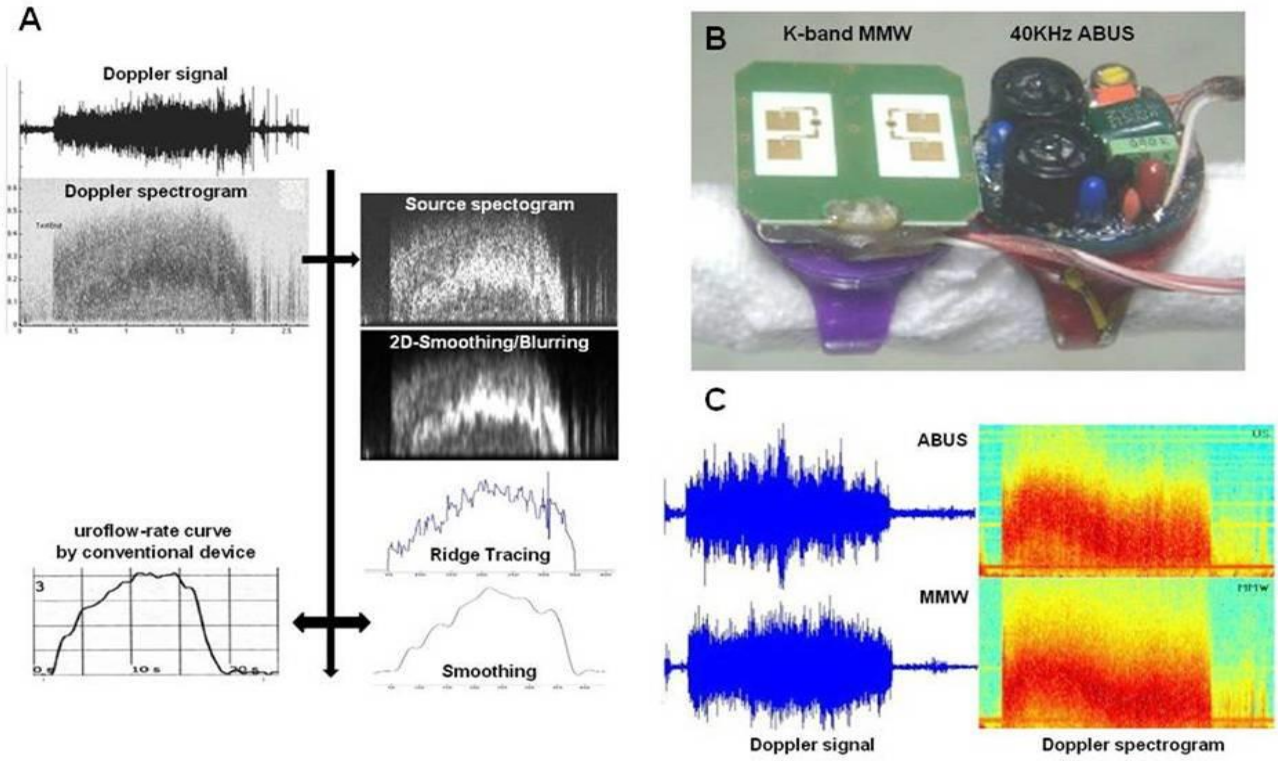
The results of simultaneous monitoring of urination by ABUS and MMW systems are presented in Doppler signal and spectrogram. For each Doppler spectrogram, the scale of the vertical axis is presented to correspond to the line of sight velocity (fig. C). In terms of the objective of this study, ABUS and MMW are fully compatible in practical applications, and it is highly likely that measurement software can be shared with calibration. Various results showed that MMW Doppler sensors can be made drip-proof with a very simple thin plastic wall structure, whereas it is difficult to make ABUS Doppler sensors drip-proof without sacrificing transmission and reception performance sound characteristics.

Interpretation of results

While comparable data could be obtained from the two devices, the possibility of making MMW Doppler sensors drip-proof was found to be potentially advantageous.

Concluding message

We were able to develop a novel diagnostic modality through the application of remote sensing using ABUS and MMW wearable CW Doppler systems for studying external urodynamics in the clinical practice of urology. Although the two systems are compatible in terms of practical use, the MMW system was considered to be more useful than ABUS for clinical application because its structure can be made washable for sterilization and disinfection.



References
1. Hinyokika Kiyo. 2012;58(9):465-469.
2. Neurourol. Urodyn. 2015;34;S3,S263-S264.

Disclosures
Funding: This study was supported by 2011-2012 Adaptable and Seamless Technology transfer Program through target-driven R & D (A-STEP: AS232Z01208F) of Japan Science and Technology Agency (JST) and 2013-2014 Coordination, Support and Training Program for Translational Research from the Ministry of Education, Culture, Sports, Science and Technology / Japan Society for the Promotion of Science, and 2013-2015 Grant in aid for Innovative Research in Life Science from Asahikawa Medical University. **Clinical Trial:** Yes **Public Registry:** No **RCT:** No **Subjects:** HUMAN **Ethics Committee:** Asahikawa Medical University **Helsinki:** Yes **Informed Consent:** Yes