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PROTOTYPE OF A NOVEL UROFLOWMETER SYSTEM UTILIZING DIAPER-EMBEDDED SENSOR FOR IMPEDANCE PATTERN

Hypothesis / aims of study

Method for non-invasive recording of micturition is limited in infants before potty-training or severely disabled bed-riddedn adults.[1-3] We devised a prototype of novel uroflowmeter system utilizing a sensor for urine soaking to be embedded in diaper, and investigated whether this system can effectively record electrolyte fluid as surrogate of urine.

Study design, materials and methods

The architecture of our prototype is presented in Figure 1. Sixty-fout pairs of electrodes are arranged in an 8x8 matrix on a glass epoxy circuit board. This sensing system multiplexes the electrodes' pairs to acquire an impedance value of each pair. Electric impedance through a diaper is highly capacitive (insulated) under dry condition. On the other hand, when urine soaks and makes the diaper wet, it's internal impedance changes conductance. Hence, by embedding the impedance distribution sensor in the diaper, the diffusion of urine can be traced. For evaluating the sensor system, multiple cotton cloths are placed on the sensor board as an absorbing layer, and 1% phosphate buffered saline (PBS) as a test liquid was dropped on it. The dropping flow rate was congrolled with a custom-made syringe pump and change in impedance distribution was recorded.

Results

In Figure 2, admittance value (inverse of impedance) is plotted for each electrode pair. The plotted values are normalized from 0 to 255. The figure shows time variations of captured impedance (admittance) distribution when the flow rates are 1.5 ml/s and 3.5 ml/s, and demonstrates that, (1) admittance distribution varies along with the diffusion of the test liquid, and (2) diffusing speed of the admittance distribution conforms to the flow rate.

Interpretation of results

Our sensor system enables recording of electrolyte fluid soaking as a change in impedance pattern, This prototype can be applied in flexible materials such as polyimide foils or conductive cloths, to create diaper-embedded sensor system.

Concluding message

This principle would enable novel and non-invasive system for evaluating uroflow in individuals who are not eligible for conventional urloflowmeter. Such devise may enable more precise analysis of normal post-natal development of micturition, detailed analysis of congenital neurogenic bladder, and pre-and post natal evaluation of hypospadias surgery performed in infancy, as well as micturition analysis of severely disabled, bed-riddedn adult patients.

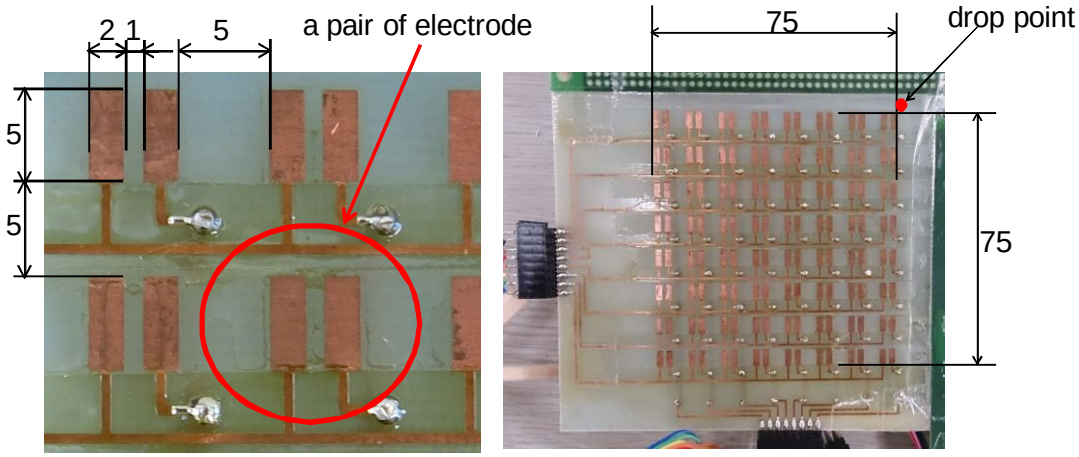

Figure 1. A prototype 2D electrode array of diaper-embedded uroflometry.

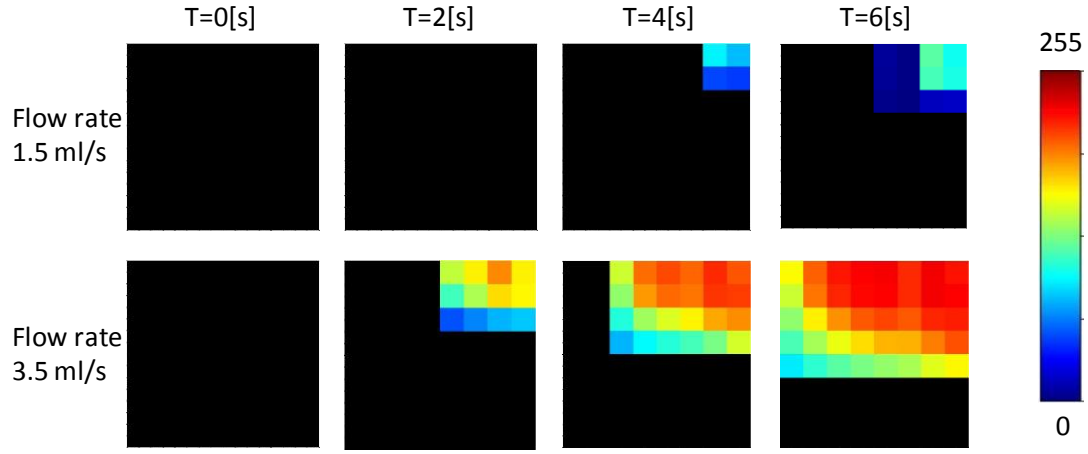

Figure 2. Admittance distribution in each flow rate.

References
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