Difference of Electrical Impedance between Typical Benign Prostatic Hyperplasia Tissues and Beach Balls Retrieved after Holmium Laser Enucleation of the Prostate

Kim HW, Yun J, Shin DG, Lee WP, Choi ST, Yoon CSP, Oh THF, Chu WY, Chung MKY, Lee J, Lee JH
1. Pusan National University Hospital, 2. Gwangju Institute of Science and Technology, 3. Yonsei Institute of Radiation and Medical Science, 4. Kosin University College of Medicine, 5. BHS Han-nam Hospital, 6. Samsung Changwon Hospital, 7. Dong-A University Hospital, 8. Pusan National University Yangsan Hospital

BACKGROUND
- A measure of total resistance to alternating current, and is defined in the frequency domain (Hz).
- The electrical impedance of tissues is closely related to their physical and physiological states. Different impedance is measured from different type of tissues.

[Electrical Impedance] [Electrical impedance spectroscopy (EIS)]
- A measure of total resistance to alternating current, and is defined in the frequency domain (Hz).
- Sensitive characterizes different type of tissues in terms of impedance.

[EIS-on-a-Needle (EoN)]
- EIS added on a hypodermic needle.
- Can analyze the impedance of tissues in the frequency domain.

OBJECTIVES
- Different pathologic features between typical benign prostatic hyperplasia (BPH) tissues and beach balls which are retrieved after Holmium Laser Enucleation of the Prostate (HoLEP) may affect the electrophysiological characteristics of the two types of tissues.
- To investigate the difference of electrical impedance between the two types of prostatic tissues, our group has developed a needle sensor device by incorporating EIS sensor on a tip of a hypodermic needle, which we named ‘EoN’.

MATERIALS & METHODS
- Prostatic tissue samples from 10 patients who presented beach balls during morcellation after HoLEP were collected.
- A total of 10 respective pieces of typical BPH tissues and beach balls were prepared for the study by randomly selecting one piece of each type of tissues from each patients.
- EoN was fabricated by using the microelectromechanical system technology (Fig. 1a–1c) and was connected to an impedance analyzer to measure the impedance of the tissues.
- The impedance of the samples was measured at the frequency range from 100 Hz to 1 MHz by inserting EoN at the depth of 2 mm into the tissues.
- Once the impedance of the samples were measured, they were pathologically investigated.

[Experimental process] [Results]
- The mean magnitude of the beach balls were tended to be larger than that of the typical BPH tissues at all frequencies from 100 Hz to 1 MHz (Fig 2a).
- Notably, significantly larger mean magnitudes were measured in the beach balls compared to the typical BPH tissues at the frequencies higher than 15.9 kHz (p ≤ 0.02) at all frequencies higher than 15.9 kHz.
- Also, a significant negative correlation was presented between the measured magnitudes and frequencies in beach balls (p = 0.001) and typical BPH tissues (p < 0.001) which the correlation coefficient (r) was calculated as –0.28 and –0.29, respectively.
- When the measured magnitude of the tissues were log-transformed, the variation of mean log-transformed magnitudes according to the frequency was significantly different between the two types of prostatic tissues (p < 0.001, Fig 2b).
- The pathologic features of the beach balls presented pure stromal node of nodular hyperplasia (consisted of only stroma) while the typical BPH tissues presented mixed epithelial-stromal nodule of nodular hyperplasia (composed of stroma + epithelium) (Fig 3).

[Data analysis]
- The mean magnitude of impedance between typical BPH tissues and beach balls at each frequencies between 100 Hz and 1 MHz were compared, and the degree of correlation between the magnitude of impedance in each type of tissues were evaluated.
- Also, the variations of magnitude according to the frequency were compared between the two types of prostatic tissues.

RESULTS
- The needle device with EIS sensor could effectively discriminate between the typical BPH tissues and the beach balls by measuring their electrical impedance.
- The difference of impedance between the two types of prostatic tissues is assumed to be attributed by the amount of stromal content in the tissues.

CONCLUSION

DISCLOSURES STATEMENT
No competing financial interests exist.