Sensor platforms for bladder and bowel research

Methods

• Functional studies of pelvic organs require measures of neural and organ activity under physiologic conditions
• Few tools exist to enable conscious monitoring of bladder and bowel activity in specific animal models
• Custom wireless sensors for animal studies
  • Sensing organ pressure & volume
  • Form factor appropriate for the anatomy
• Initial studies used wired sensors
  • Focus on surgical implantation, sensor modalities, and device form factor\textsuperscript{1,2}
  • Wireless functionality demonstrated previously\textsuperscript{3}
• For bladder sensor
  • Lumen pressure
  • Urine volume & concentration
• For bowel sensor
  • Dual pressure sensors in separate regions
  • Stool volume & composition
  • Pressure sensing using a gel-filled compliant media interface
  • Dielectric measurements of organ contents using platinum mesh electrodes

Results – Bladder Sensor

Volume sensor variation with feline urine concentration (a) was partly corrected with a concentration sensor (b). Low overall volume accuracy was sufficient to estimate bladder state (e.g. bladder half full vs bladder empty).

Results – Bowel Sensor

Prototype wired bowel sensors were tested acutely in pigs (a). Sensors were held in place in the bowel using mucosal clips (b).

Conclusions

• In vivo demonstration of wireless bladder and bowel sensor platforms confirmed feasibility of surgical insertion
• Multiple sensor modalities can be used to assess organ function and correct for physiologic variance

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\textsuperscript{1}I McAdams et al. IEEE Eng Med Biol Conf. 2018
\textsuperscript{2}A Smiley et al. IEEE Eng Med Biol Conf. 2018
\textsuperscript{3}A Basu et al. Jour Eng Medicine, 2018

Abstract

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Wireless bladder sensor (a) designed for suprapubic insertion into a feline bladder. The bowel sensor (b) was longer with a flexible form factor that is more appropriate for porcine models.

Chronic implantation of sensor in small (20 mL) feline bladder (a) showed retention at 30 days (b). A 25% loss in bladder capacity occurred with no change to animal behavior, possibly due to tissue adhesion post-surgery.

Pressure sensor calibration curve with linear response and 1.9 cm H\textsubscript{2}O root mean square error.

Bowel sensor detected contractions evoked by stimulation in proximal colon (a) and local phasic contractions in transverse colon separately from a distal manometry catheter (b). Data from anesthetized adult male Yucatan pig. Data generated in collaboration with Drs Larauche and Million et al. (SPARC, UCLA).