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THE SMART CATHETER: DETERMING CATHETER LOCATION WITHIN THE BILIARY AND PANCREATIC DUCTAL SYSTEMS

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INTRODUCTION: The smart catheter was developed to provide real-time information about the location of the catheter throughout the procedure, without injecting dye, exposing the patient to radiation and altering the duct environment.

Bile stones, pancreatitis, stenosis (narrowing of duct) and stricture (tightening of ducts) are common medical complications involving the pancreatic and biliary ductal systems. A manometry catheter is used to record the pressure measurements within the appropriate ductal system and diagnose the condition. The catheter is placed within the duct of interest via the opening in the duodenum. Anatomically this opening is a single tubular section of tissue, 5mm in length which is common to both systems and branches into the separate ducts. No visual information is available to the physician when the catheter is within this common section of the ducts, hence locating the correct ductal system is difficult. Currently, the physician places the catheter into the duct and takes pressure measurements. ERCP (Endoscopic Retrograde Cholangiopancreatography) is then used to determine the location of the catheter, involving the injection of a dye followed by a radiographic image. In 20% of cases the catheter is incorrectly placed. In which case it is removed and re-positioned. Pressure data is collected and imaging repeated with no guarantee it is correctly located.

METHODS: Optical techniques were employed to provide the necessary information regarding the location of the catheter in vivo. The manometry catheter was modified to incorporate optical components but still allow pressure measurements to be performed. Additional modifications to assist in optical measurements were added to the catheter tip. Two wavelengths of light were directed into the catheter and exposed to the fluid within the ductal system. Wavelength one is expected to behave in a known maner within the various environments the other is used as a reference. Using optoelectronic measurements and signal processing, the fluid within the vicinity of the catheter tip and hence the current location of the catheter can be determined.

RESULTS: Trials have been conducted with possum bile and pancreatic fluids in vitro. The system correctly identified bile presence or absence. In vivo trials have been conducted with animal models. Once again the system was able to distinguish between the pancreatic and bile ductal systems, hence determining the location of the catheter during the experiments.

DISCUSSION & CONCLUSIONS: The smart catheter in a clinical setting will remove the uncertainty in manometry catheter location by providing real time information about its position at all stages during the procedure. The smart catheter will eliminate the need to perform radiographic imaging and reduce occurrence of re-entry and repetition of data collection due to incorrect placement. Additionally it will reduce procedure time, reduce perfusate in the ducts and reduce associated morbidity.