First experience using a wireless oesophageal pH monitoring system in children in Hong Kong: three case reports

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Twenty-four–hour pH monitoring is indicated for evaluation of gastroesophageal reflux symptoms in children, as well as part of a preoperative work-up for those who require long-term nasogastric tube feeding or a gastrostomy. Its use is nonetheless restricted by the need to keep a nasal catheter in place for at least 24 hours. This can cause great discomfort and may be poorly tolerated by children, especially those with behavioural issues. Wireless pH monitoring can improve patient satisfaction and the overall sensitivity of diagnosing gastroesophageal reflux (Fig 1). Despite its rising popularity among adults, its use has been limited in children. This report documents the first experience in Hong Kong of a wireless oesophageal pH monitoring system in children with gastrointestinal symptoms and feeding problems.

Case presentations

Case 1

A 9-year-old girl with good previous health and normal development presented to a surgical clinic in March 2023 with recurrent epigastric pain and heartburn. She was prescribed a proton pump inhibitor without symptom improvement. As her parents were keen to determine the cause of her symptoms, upper endoscopy and a pH study were offered. With consideration of patient comfort and the sensitivity of the test, wireless oesophageal pH monitoring was arranged. Endoscopy under general anaesthetic revealed mild antral gastritis but was otherwise unremarkable. An antral biopsy confirmed mild gastritis without *Helicobacter pylori*. The oesophagogastric junction (OGJ) was measured as 34 cm from the incisor, and a wireless pH monitoring capsule (Bravo; Medtronic Inc, Minneapolis [MN], United States) was inserted at 30 cm under direct endoscopic visualisation (Fig 2a). Post-insertion endoscopy confirmed secure placement at a satisfactory position (Fig 2b). An X-ray after the procedure further confirmed the good position of the capsule (Fig 2c). pH monitoring lasted 96 hours, with a DeMeester score of 6.8. The girl initially complained of mild chest discomfort and a globus sensation during swallowing on the first 2 days post procedure but this resolved spontaneously after 4 days. The capsule passed spontaneously within 3 weeks of the procedure. The diagnosis of gastritis was made after excluding gastroesophageal reflux by pH monitoring; the patient was prescribed a short course of a proton pump inhibitor that resolved the symptoms.

FIG 1. Wireless pH monitoring capsule system

Case 2

A 6-year-old girl with known glucose phosphate isomerase deficiency, cerebral ataxia and mild intellectual impairment presented to the same surgical clinic in January 2023. She had feeding problems with failure to thrive and needed supplemental milk feeding via a nasogastric tube. Given her medical background and neurodevelopment, she could not tolerate nasogastric tube insertion during her regular revision and required frequent sedation during the procedure. Owing to the anticipated requirement for long-term tube feeding, her parents were advised of the need for gastrostomy tube insertion and a

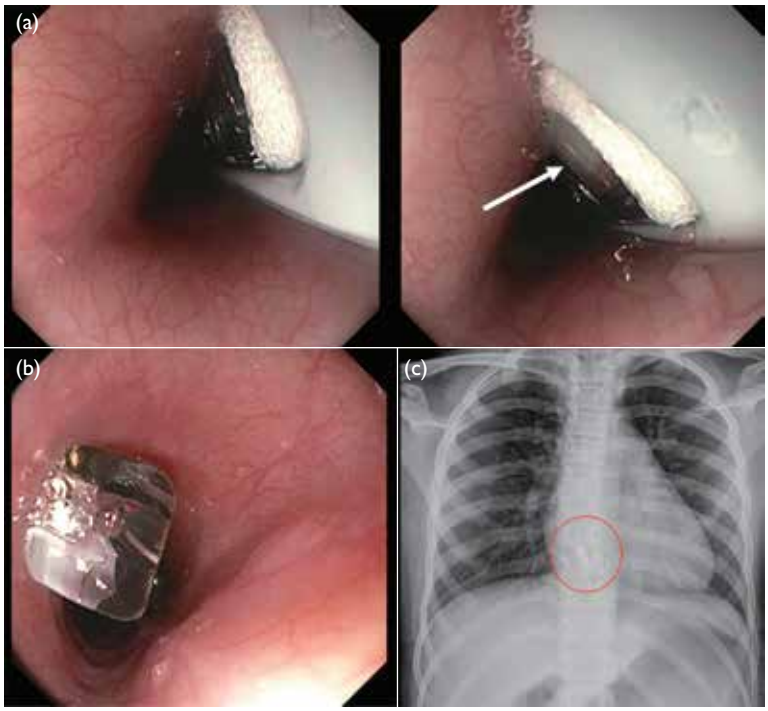

FIG 2. Case 1. (a) Deployment of wireless oesophageal pH monitoring capsule under endoscopic view (arrow showing a piece of mucosa in the suction chamber). (b) Endoscopic view following successful deployment of wireless oesophageal pH monitoring capsule. (c) Chest X-ray showing the position of the wireless oesophageal pH monitoring capsule (circle)

preoperative pH study. As both the patient and parents could not accept a conventional 24-hour pH study, a wireless oesophageal pH monitoring system was inserted under monitored anaesthetic care. The upper endoscopy was unremarkable with no sign of oesophagitis or gastritis. Bravo was inserted at 25 cm from the incisor (ie, 5 cm from the OGJ). Monitoring continued for 96 hours, with a DeMeester score of 0.7. The capsule passed without any complications within 3 weeks of the procedure. The patient was well and there were no adverse events during the study period. In view of the negative pH study, an anti-reflux procedure was deemed unnecessary and subsequently only a laparoscopic gastrostomy was performed.

Case 3

A 16-year-old boy with recurrent postprandial heartburn and vomiting presented to the same surgical clinic in March 2024. Medical treatment with proton pump inhibitors elicited no improvement and he was referred for work-up for an anti-reflux procedure. At the time of referral, as capsule pH monitoring was not available locally, a catheter-based 24-hour pH-impedance probe was attempted. Nonetheless the patient could not tolerate the procedure with repeated vomiting and failure of catheter insertion. Given the parents' wish to have a definitive diagnosis prior to initiating an anti-reflux procedure, pH study was rearranged with the wireless oesophageal pH monitoring system under monitored anaesthesia care. The procedure was well tolerated and the patient was able to complete a 96-hour pH study. The overall DeMeester score was 16.1. During the study period, Day 2 was the patient's worst day, with acid exposure time at 5.9% and DeMeester score at 22.1. There was significant improvement following resumption of a proton pump inhibitor on Day 3 with acid exposure time at 1% and DeMeester score at 3.5. With the diagnosis of significant gastroesophageal reflux disease confirmed, the parents agreed to proceed with laparoscopic fundoplication.

Discussion

According to the joint updated guidelines of the North American Society for Pediatric Gastroenterology, Hepatology and Nutrition and the European Society for Paediatric Gastroenterology, Hepatology and Nutrition in 2018,[1] 24-hour pH monitoring is indicated in children with persistent symptoms of gastroesophageal reflux disease despite proton pump inhibitor treatment. The aim is to correlate persistent troublesome symptoms with acid gastroesophageal reflux events, clarifying the role of acid reflux and determining the efficacy of acid suppression therapy.[1] Twenty-four–hour pH monitoring is also recommended as pre-gastrostomy work-up in children to guide patient selection for a concomitant anti-reflux procedure.[2] Nonetheless conventional transnasal catheter pH monitoring, although still widely used, is frequently criticised for causing great patient discomfort, limiting the patient's mobility during the test and, more importantly, being neither tolerable nor inducing compliance by children with neurodevelopmental and behavioural issues,[3] as illustrated by Case 2. Not only is the quality of life of patients jeopardised, the unpleasant experience may also restrict reflux-provoking activities, limiting the accuracy and sensitivity of the test and yielding false lower values, as illustrated by Case 3.

To overcome these difficulties, the wireless oesophageal pH monitoring system uses a capsule attached to the mucosal wall of the oesophagus for pH monitoring (Fig 1). It consists of a 6.0×6.3×26.0 mm^3 capsule-based device, equipped with an internal battery and a pH electrode. The device is attached to the distal wall of the oesophagus, approximately 4 to 6 cm from the OGJ, under direct endoscopic visualisation.[3,4] It transmits pH data to a mobile phone–sized recorder via radio telemetry, thus obviating the need for a transnasal pH probe. The capsule enables data to be recorded for at least 48 hours and up to 96 hours, with minimal patient discomfort. The capsule detaches from the

oesophageal mucosa and is expelled in stools, with spontaneous sloughing of the oesophageal mucosa and uneventful healing, usually over 3 to 7 days. Its clinical use in children has been established in the United Kingdom and the United States, demonstrating a high success rate, with better tolerance than standard transnasal pH monitoring in children with behavioural issues and an improvement in the detection rate of gastroesophageal reflux disease by 16% through extended recording time.[3,4] As illustrated by Case 3, not only is the procedure tolerated, the successful extension of study for a duration of 96 hours may result in a higher diagnostic yield and provision of more information, eg, effect of pump on and off (whether patient was on proton pump inhibitor).[5] Currently, the wireless pH monitoring system is intended to be used in adults and children from 4 years of age but is contraindicated in those with bleeding diathesis, strictures, severe oesophagitis, varices, obstructions, pacemakers or implantable cardiac defibrillators. In situations where the wireless pH capsule needs to be removed, for instance in patients with severe discomfort or failure of spontaneous passage, cold snare and hot snare (when cold snare is not sufficient) can be applied to safely remove the capsule with only thin superficial oesophageal mucosal tissue.[6]

To the best of our knowledge, our centre is the first to introduce and report the use of the wireless oesophageal pH monitoring system in children in Hong Kong. The procedure was smooth, with no equipment or technical failure, and all patients could be discharged on the same day of the procedure. Since Case 1 was the first patient at our centre to receive the device, a chest X-ray was taken to double confirm its position. Nonetheless a post-procedure chest X-ray is not routine for the paediatric population since the device position can be confirmed with endoscopy, as in the adult population. All patients tolerated the pH study well except for the complaint of a self-limiting globus sensation in one patient (Case 1). All parents reported no difficulty in utilising the mobile pH recording system. All capsules were expelled from the patients within 3 weeks of the procedure without any complication.

Wireless oesophageal pH monitoring cannot easily diagnose some conditions such as functional belching and rumination syndrome due to the lack of impedance monitoring. Nonetheless these cases highlight that it is well tolerated and feasible in evaluating gastroesophageal reflux symptoms in children and provides a sensible alternative to standard transnasal pH monitoring. In addition, it may result in a higher diagnostic yield and more comprehensive clinical information. As clinicians, we are obliged to keep track of technological advancements and strive to provide holistic and optimal care for children, improve patient satisfaction and shorten their hospital stay.

Author contributions

Both authors contributed to the concept or design, acquisition of data, analysis or interpretation of data, drafting of the manuscript and critical revision of the manuscript for important intellectual content. Both authors had full access to the data, contributed to the study, approved the final version for publication, and take responsibility for its accuracy and integrity.

Conflicts of interest

As an editor of the journal, KKY Wong was not involved in the peer review process. The other author has disclosed no conflicts of interest.

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Ethics approval

The patients were treated in accordance with the Declaration of Helsinki. Verbal consent was obtained from the patients for the publication of the case reports.

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