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Rapid communication

Bedside postpyloric enteral tube placement using Kangaroo IRIS technology: a single-center case series

Eva Cardona, Shameer Mehta MBBS, BSc, MRCP, AFHEA, MD(Res)*

GI Services Division, University College London Hospital, London, UK

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ABSTRACT

Objectives: Postpyloric enteral feeding tubes (PPTs) are often placed endoscopically. This carries cost and capacity implications for hospitals with additional strain on endoscopy units during the SARS-CoV-2 pandemic. The Kangaroo Feeding Tube with IRIS Technology (IRIS) uses optical visualization to guide bedside placement, obviating the need for endoscopy. We describe a case series of bedside postpyloric enteral feeding tube placement using the IRIS tube.

Methods: This was a prospective, single-center case series over 12 mo. Conscious and sedated adult participants were included. Exclusion criteria were altered anatomy and need for endoscopy for other indications. IRIS placement was confirmed by contrast radiograph.

Results: Twenty attempts were made in 19 participants (13 women). The primary indication was intolerance of gastric feeding. The overall success rate was 75%. In sedated participants, 5 (83%) of 6 tubes were successful in 5 participants. In conscious participants, 10 (71%) of 14 tubes were successful in 14 participants. Placement failure in conscious participants was due to intolerance of the camera tip during nasal passage. The median procedure time was 13.5 min. In all cases, correct position as deemed by the operator was confirmed with contrast radiograph. No complications were observed.

Conclusions: To our knowledge, this is the largest single series of bedside postpyloric enteral feeding tube placement using the IRIS tube to date. The success rate and safety profile reported here, together with the potential benefits (reduced feeding delays, costs, and need for endoscopy) suggest that further, large-scale studies are warranted.

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Introduction

Provision of artificial nutritional support to correct malnutrition is critical in securing optimal clinical outcomes in both intensive care [1,2] and non-intensive care inpatient settings [3–5]. Enteral nutrition carries a number of benefits over parenteral nutrition and is the preferred mode of delivery in the absence of intestinal failure [2,6,7]. Whereas gastric tube feeding is appropriate for the majority of individuals in whom oral nutritional supplements are inadequate or not tolerated, a significant proportion will require postpyloric feeding. Indications for postpyloric feeding include high gastric residual feed volumes, preexisting gastroparesis, recurrent aspiation with gastric feeding, and delivery of specific medications (e.g., levodopa-carbidopa intestinal gel [8]). In the short term, these feeds are best delivered using postpyloric tubes (PPTs) such as nasojejunal tubes.

Correct placement of enteral feeding tubes is crucial, since malposition is associated with complications such as pneumonia, pneumothorax, and death [9]. Short-term nasal PPTs are typically placed using upper gastrointestinal endoscopy. Gold-standard practice includes the use of fluoroscopic screening to ensure tip position in the small bowel. While this method is highly effective, it does carry some disadvantages. Reliance on endoscopic placement means patients often wait days for a procedure, with consequent delays in artificial nutritional support. There are also significant costs associated with endoscopic placement, when staff and equipment costs are considered. Furthermore, these procedures add strain to already-stretched endoscopy unit capacity, particularly at a time when hospitals face unprecedented challenges brought by the SARS-CoV-2 pandemic while continuing to provide a service for urgent indications.

Bedside insertions of nasal PPTs have the potential to overcome many of these shortcomings. These can be performed without...
delay (often on the same day, once the patient has been sufficiently starved to allow gastric emptying), reducing waiting times for nutritional therapy. These procedures are also potentially associated with lower costs and can reduce the burden on endoscopy capacity. Additionally, bedside placements obviate the need for endoscopy, which, while generally very safe, can be unpleasant for patients. The use of an electromagnetic tracking system to aid bedside placement has been shown to be an effective method [10], although misplacement may only be detected after the event. The Kangaroo feeding tube with IRIS technology (IRIS tube, Cardinal Health, Mansfield, MA, USA) uses a camera embedded within the tube tip to allow direct real-time visualization of anatomic landmarks during placement. Published reports to date focus predominantly on gastric placement and success rates, mainly in the intensive care setting [11,12]. The aim of this prospective case series was to document the efficacy of placement and safety of using IRIS tubes with the primary intention of small-bowel placement in consecutive patients referred for PPT placement, both in intensive care and general ward settings.

Methods

This was a prospective, single-center case series over 12 mo. Consecutive patients referred for PPT placement were eligible. Inclusion criteria were age > 18 y and capacity to consent to the procedure. Participants were provided with verbal and written information before they provided written informed consent. Exclusion criteria were abnormal upper gastrointestinal anatomy, requirement for endoscopy for other indications, nasal obstruction, naso-sinus trauma, intestinal perforation, and uncorrected bleeding diatheses. IRIS polyurethane tubes (10F gauge, 109 cm) with 3-mm tip cameras and EnFit-compliant adaptors were used in this series. Bedsides console allowed real-time visualization and de-identified image capture of important anatomical landmarks: vocal cords, gastric folds, pylorus, and small-bowel villi. A manual pump was used to deliver air insufflation. Topical xylocaine was used in all participants, with some non-sedated participants receiving additional conscious sedation where necessary with appropriate monitoring. An assessment of final tip position by the operator was documented at the end of each procedure. A confirmatory contrast radiograph was then performed to confirm tip position before tube use, and compared to the operator assessment. Placement of Kangaroo IRIS tubes was limited to two operators only (the authors), who were trained on models prior to first insertion. Placement was also limited to two clinical areas: the intensive care unit and the gastroenterology ward. This was in order to concentrate nursing exposure to a new device within the hospital trust and allowed appropriate and focused training of ward staff. Standard operating procedures were produced and disseminated to facilitate standardization of day-to-day tube care and management of potential complications.

Clinical data were collected from the first case for each operator. No power calculation for sample size was performed, given that this was a case series. For continuous variables, data are reported as mean and standard deviation or median and range. For categorical variables, data are reported as number and percentage. Permission was granted by the Trust Clinical Effectiveness Steering Group to introduce the device to the trust and collect data for service evaluation purposes.

Results

All referrals for PPTs in our center are made either through a central endoscopy booking team or via the enteral nutrition clinical nurse specialist (E. C.). The hospital trust is a large tertiary referral center for upper gastrointestinal cancer, hematological malignancies, neurology and neurosurgery. Consecutive referred patients were included in the study in the absence of any exclusion criteria. All conscious participants approached provided informed consent. Twenty attempts of PPT placement were made in 19 participants. Five participants were being managed in the intensive care unit and were sedated; the remaining participants were on the general wards and were all fully conscious. The primary indication for PPT placement in all participants was intolerance of gastric tube feeding. The underlying medical conditions were neurologic (stroke or autoimmune neuropathy), malignant (both solid organ and hematological), and preexisting idiopathic gastroparesis. Clinical characteristics of the participants are shown in Table 1.

Overall, successful small-bowel tube placement, as demonstrated by contrast radiography, was achieved in 15 (75%) of 20 attempts (Fig. 1). The success rate in sedated participants was higher at 5 (83%) of 6, with a lower rate of 10 (71%) of 14 in conscious participants. One participant underwent a second tube placement after the first tube became blocked. Procedure characteristics are shown in Table 2. PPT placement was attempted at a median of 2 d after receipt of referral. Typically, participants were approached and consent gained on the same day as referral, with a planned starvation period to allow placement the following day. Topical nasal and pharyngeal anesthetic was used in all participants. Three (21%) conscious participants required additional intravenous sedation with low-dose midazolam, with appropriate bedside monitoring. The median procedure duration was 13.5 min, with a fall in median procedure length between the first 10 and second 10 procedures from 20 to 13.5 min. Apart from unsuccessful tube placement, no complications were observed in any participant, including tracheal intubation.

The reason for placement failure in all participants was intolerance of the tube tip through the nasal cavity. Additionally, in every case in which the tube tip was considered to be placed within the small bowel by the operator based upon the console images, contrast radiography confirmed this finding (representative images shown in Fig. 1).

Discussion

The delivery of feed directly into the small bowel is an important aspect of nutritional care in a variety of clinical settings. Endoscopy is commonly used to place small-bowel feeding tubes but is limited by availability and carries cost implications. Bedside insertion of PPTs without the need for endoscopy is therefore an attractive alternative, with electromagnetic placement systems becoming increasingly popular. The IRIS tube, by contrast, is designed to allow real-time visualization during placement and has been studied and used primarily as a nasogastric feeding tool [11,12]. To our knowledge, this is the largest case series to date describing the clinical utility of IRIS technology with the primary intention of small-bowel, rather than gastric, tube placement.

Overall, placement success rates in this study were comparable to the limited available literature [11,12]. While the overall success

| Characteristic                        | Value                  |
|--------------------------------------|------------------------|
| Gender                               |                        |
| Male                                 | 6 (31.6)               |
| Female                               | 13 (68.4)              |
| Age, y                               | 37.5 (30)              |
| Clinical setting                     |                        |
| Intensive care                       | 5 (26.3)               |
| Medical ward                         | 14 (73.7)              |
| Consciousness                        |                        |
| Sedated                              | 5 (26.3)               |
| Conscious                            | 14 (73.7)              |
| Underlying medical condition         |                        |
| Hematological malignancy             | 6 (31.5)               |
| Cerebrovascular accident             | 4 (21.1)               |
| Solid organ malignancy               | 4 (21.1)               |
| Idiopathic gastroparesis             | 4 (21.1)               |
| Autoimmune neuropathy                | 1 (5.2)                |

Values are expressed as number (percentage) except age, which is expressed as median (interquartile range)
rate in all participants was 75%, a higher rate (83%) was observed in sedated participants. In the two published series to date, overall success rates for gastric placement have been reported as 90% (18/20) [11] and 91% [12], but only three tubes were postpyloric. Additionally, only sedated participants were included in either of those series. The principal reason for failure in conscious participants in our cohort was intolerance of the inflexible camera tip during nasal passage. This should be highlighted, given the larger number of conscious participants included in this study, but also because the potential clinical utility of bedside IRIS tubes applies to conscious as much as sedated patients.

While placement rates in our study were generally good, it should be noted that our participants were a carefully selected group, particularly in relation to the exclusion of those with abnormal anatomy. It is possible that the cohort of eligible patients could be widened in the future to include this group, but it should be noted that there is very little torque available in the device to aid tube passage. The procedure was very safe, however, with no complications observed. Importantly, tracheal intubation was avoided in every case. Additionally, operator opinion regarding small-bowel tip position correlated with contrast radiograph confirmation in every case. Differentiation between alimentary and bronchial placement was straightforward in every case, with the gastric folds the most reliably determined landmark. It is possible, therefore, that radiographic confirmation can be limited, but this requires larger-scale studies to demonstrate reproducibility and assess interoperator variance.

Another important observation is the learning curve for both operators, as demonstrated by decreasing procedure times as experience of tube placement grew. Some technical aspects of tube placement during the course of the study may have contributed to this: maneuvering the participant’s chin downward, applying topical anesthetic in the nares and pharynx, minimizing air insufflation within the stomach to aid duodenal intubation, and administering low-dose midazolam to conscious participants with appropriate monitoring.

This study carries a number of limitations. All tubes were placed by two operators only, and therefore reproducibility after relevant training among a wider group still requires demonstration. Overall numbers included were small, and a single-center experience cannot always be applicable to other units with variations in resources. The strengths of the study include its prospective design, the clinical case mix, inclusion of both conscious and sedated participants, and postpyloric placement as the primary intention.

One of the benefits of the IRIS tube is that real-time visualization allows immediate identification and correction of tracheal or bronchial intubation. It is also important to highlight some of the disadvantages, which principally include the cost of the tubes and console but also patient intolerance during nasal passage. Many of the other disadvantages are also present with other bedside PPTs: potentially lower effectiveness in patients with abnormal anatomy or requiring endoscopy for other clinical reasons or deep small-bowel intubation, and the requirement for initial and ongoing training.

**Conclusion**

In conclusion, the placement of bedside IRIS tubes appears to be feasible and safe in a single-center, preselected patient cohort. Further, larger-scale, multicenter studies assessing the clinical utility of IRIS tubes as small-bowel feeding devices are warranted. We suggest that these include conscious as well as sedated participants, and analyze both financial and patient-experience data.
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