Journal of Pediatric Surgery 52 (2017) 1210–1214

Contents lists available at ScienceDirect

Journal of Pediatric Surgery

journal homepage: www.elsevier.com/locate/jpedsurg

Operative Technique

Ultrasound-guided gastrostomy tube placement: A case series

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ARTICLE INFO

Article history:
Received 7 January 2017
Received in revised form 10 March 2017
Accepted 30 March 2017

Key words:
Gastrostomy
G-tube
Ultrasound

ABSTRACT

Purpose: Gastrostomy tubes (G-tubes) can be placed utilizing a variety of techniques. Here we present a case series to demonstrate feasibility of a novel method, ultrasound-guided G-tube placement (USGTP).
Methods: All cases of USGTP at our institution from September 2015–August 2016 were reviewed. Data included demographics, operative time, complications, time to first feeding, and 30-day readmissions. All steps of the procedure were carried out using ultrasound guidance, resulting in placement of a low-profile G-tube.
Results: Twelve patients underwent USGTP. Median age at operation was 2.6 years (IQR 0.9–5.3) and median weight 9.9 kg (IQR 7.2–18.4). Median operative time was 27 min. (IQR 20–44). First feeding occurred 8.8 ± 2.9 h after the procedure. The second patient in the series experienced the only operative complication. In this case, a linear probe was used with insufficient gastric distension, resulting in placement of the tube through a fold in the stomach wall. This was recognized and remedied intraoperatively. This prompted successful technique modification for future USGTPs. Only one patient was readmitted within 30 days, and this was related to urinary retention, an underlying problem.
Conclusion: US-guided G-tube placement appears initially to be safe, efficient and effective. Advantages include good anatomical delineation, a single incision, initial placement of a low-profile G-tube, and avoidance of endoscopy, laparoscopy, and radiation. This report illustrates feasibility of USGTP paving the way for further investigation and comparison to other existing gastrostomy insertion methods.
Level of evidence: IV.

Enteral access procedures, in particular gastrostomy tube (G-tube) placement, are some of the most common operations performed by pediatric surgeons [1]. G-tube placement can be performed by a variety of techniques, including open (Stamm) gastrostomy, laparoscopic gastrostomy, percutaneous endoscopic gastrostomy (PEG), and fluoroscopy-guided gastrostomy. These procedures are largely safe and effective, but not perfect, and the choice of procedure depends on both patient characteristics and surgeon decision-making.

Ultrasound-guidance has been reported as an effective means of both placing and replacing gastrostomy tubes percutaneously in adults, but has not been reported in children [2–5]. Ultrasound-guided gastrostomy tube placement (USGTP) therefore represents a novel approach to a common procedure in children. This technique offers the advantages of using single incision, providing good delineation of upper abdominal anatomy, obviating the need for laparotomy, laparoscopy, or endoscopy, and allowing for initial placement of a low-profile or "button" tube. Here we report our experience and outcomes with USGTP in a case series to support the feasibility of this method.

1. Methods

1.1. Data collection and analysis

After IRB approval (HUM00117537), all cases of USGTP at our institution from September 2015–August 2016 were retrospectively reviewed. Data collected included demographics, operative time, complications, time to first feeding, and 30-day ER visits and readmissions. Statistics were descriptive.

1.2. Procedure

After induction of general anesthesia, a curved ultrasound probe (C10–3 Curved-Phased Array, Zonare, Mountain View, CA) is used to delineate the upper abdominal anatomy (Fig. 1). In particular, the stomach, colon, small bowel, and liver are identified. An orogastric tube is passed and warm saline is instilled to fill the stomach. Gastric distension is observed with ultrasound as saline is infused. If maintaining this distention is difficult, glucagon 0.5–1 mg IV can be administered to delay gastric emptying. A standard site for the G-tube is then chosen, subcostal and at least one finger-breadth from the costal margin. The stomach should abut the anterior abdominal wall at the proposed site

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http://dx.doi.org/10.1016/j.jpedsurg.2017.03.061
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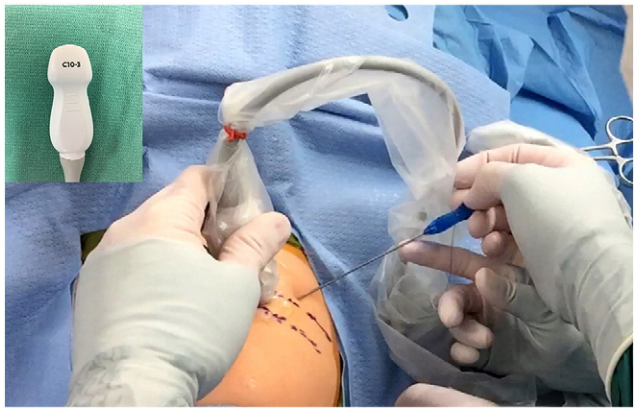

Fig. 1. Upper abdominal ultrasound. A curved ultrasound probe (inset) is used to delineate upper abdominal anatomy, identifying the locations of the stomach, colon, small bowel and liver. T-fasteners, the access needle, wires, and the G-tube are all placed under direct visualization with the ultrasound (T-fastener shown being placed here).

with no intervening structures. This site should be chosen expeditiously, as gastric emptying limits prolonged distention.

With ultrasound guidance, three T-fasteners (Gastrointestinal Anchor Set, Halyard Health, Alpharetta, GA) are placed through the abdominal wall and into the stomach surrounding the planned G-tube site (Fig. 2). Ideally, the T-fasteners triangulate the future G-tube site and are close enough to support the wall of the stomach during dilation and tube placement, but far enough away to avoid interference with the external portion of the G-tube. Each needle is seen entering the gastric lumen, and when the T-fasteners are deployed and traction applied, they can be seen with ultrasound securing the stomach flush to the abdominal wall. The stomach is then accessed with an 18G introducer needle placed between the T-fasteners under US guidance. A 0.035-in. 75-cm Amplatz super stiff wire (Boston Scientific, Marlborough, MA) is advanced through the needle and into the stomach, again under US guidance (Fig. 3). A small skin nick is made at the wire's entry point to accommodate the dilators and G-tube.

The needle is withdrawn, keeping the wire in place, and the tract is serially dilated to 16 or 18 Fr (Applied Medical Technology (AMT), Brecksville, OH). This will accommodate placement of a 14-Fr low-profile tube. The tract length is then sized using a stoma-measuring device (AMT, Brecksville, OH), placed over the wire and into the stomach, again, with ultrasound guidance (Fig. 4). A 14Fr G-tube of appropriate length is selected. A 7-Fr dilator is placed through the lumen of the tube, and the combination is advanced over the wire and into the stomach under US guidance. The balloon is inflated, and examined with the ultrasound to confirm intraluminal location: the mucosa lies flat against the muscularis (Fig. 5); if the mucosa is seen tented by the balloon, the tube has been placed intramurally.

Once intraluminal placement has been confirmed, the wire and dilator can be removed. The T-fasters are secured and generally left in place for 5 days. The tube is ready for use, though the protocols at the authors' institutions call for feeds to begin 6 h post-operatively.

2. Results

Twelve patients underwent USGTP. Patient characteristics and outcomes are summarized in Table 1. Indications for enteral access (with number of patients in parentheses) included genetic syndromes (4), cerebral palsy (2), myoclonic epilepsy (2), nutritional support after liver transplant (1), Dandy Walker (1), glycogen storage disease (1), and eosinophilic esophagitis (1). Two patients were tracheostomy-dependent but none were supported by long-term ventilator support.

The second patient in the series experienced the only operative complication. In this case, a linear probe was used with insufficient gastric distension, which resulted in placement of the tube through a fold in the stomach wall, resulting in a second gastrotomy. This was immediately recognized and remedied by conversion to an open Stamm gastrostomy. The patient did well following this procedure. Subsequent G-tube placements were performed with a curved probe. Only one patient was readmitted within 30 days, and this was related to urinary retention, an underlying problem, rather than the G-tube which was working well. One additional patient presented to the emergency room within 30 days with concerns regarding the appearance of the G-tube site, but upon evaluation it was found to be normal and the patient returned home.

3. Discussion

Gastrostomy placement is a mainstay of the pediatric surgeon's practice. These tubes can be placed by a number of techniques, including open (Stamm) gastrostomy, laparoscopic gastrostomy, percutaneous endoscopic gastrostomy (PEG), and fluoroscopic gastrostomy.

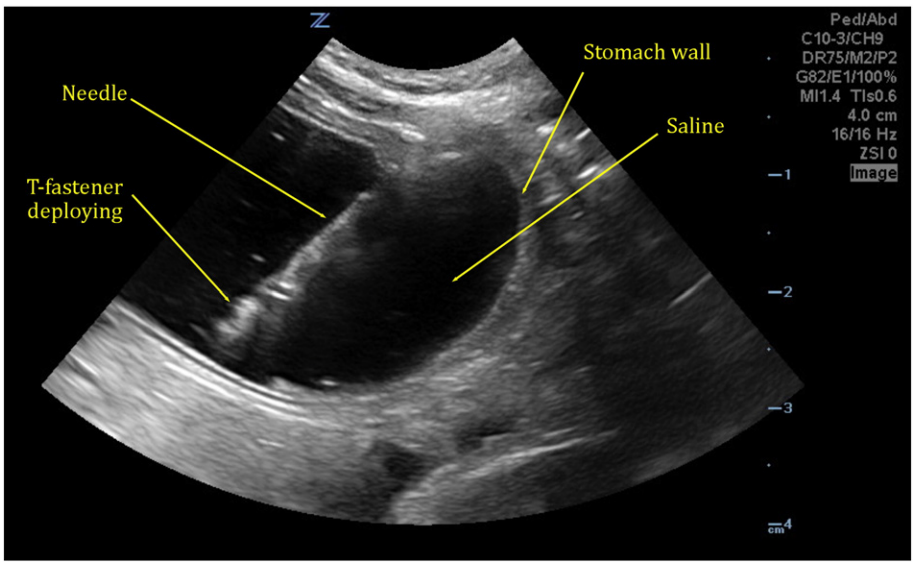

Fig. 2. T-fastener placement. T-fasteners are placed under the guidance of ultrasound. Here the needle, containing the T-fastener, is seen in the lumen of the stomach. The T-fastener can be seen deploying into the lumen of the stomach from the needle tip. The three T-fasteners will anchor the anterior stomach to the anterior abdominal wall.

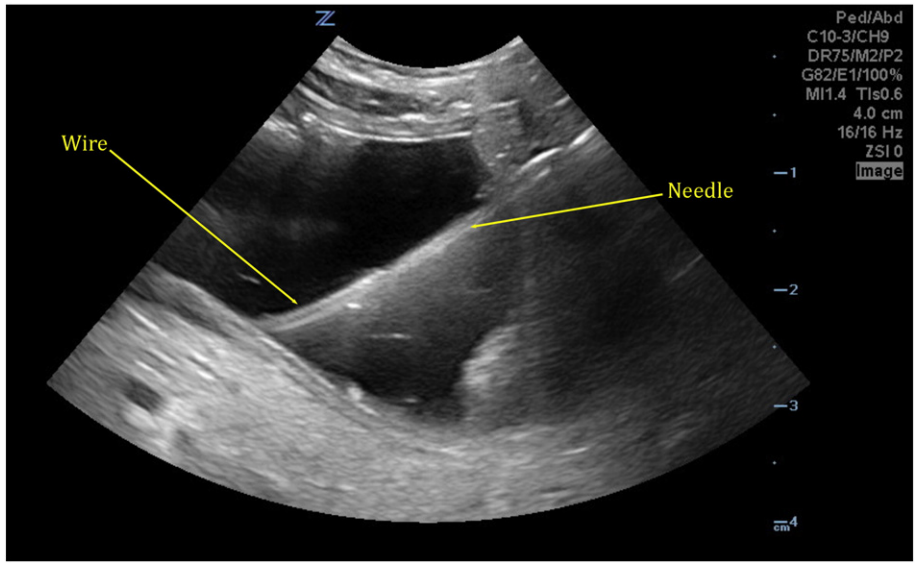

Fig. 3. Wire advancement. The Amplatz super stiff wire is placed through the needle into the stomach under ultrasound guidance.

Ultrasound-guided gastrostomy (USGTP) represents a novel technique that we believe offers a unique set of advantages.

Existing techniques for G-tube placement have advantages and disadvantages. The open, or Stamm, approach involves a small laparotomy and suturing of the stomach to the anterior abdominal wall to secure the G-tube tract. This technique has the advantage of direct visualization of abdominal anatomy, but usually requires general anesthesia, a larger incision, and longer operative times than other techniques. It has even been associated with higher rates of granulation tissue formation and tube dislodgement [6,7]. The laparoscopic approach has comparable outcomes to open gastrostomy while remaining minimally invasive, but still usually mandates general anesthesia, abdominal insufflation, and multiple incisions [8,9]. PEG utilizes a single incision, often does not require general anesthesia, and has been shown to result in shorter operative times [10,11]. However, it requires endoscopy, relies on indirect techniques for assessing proximity of the stomach to the abdominal wall, often requires a long G-tube which eventually must be exchanged for a low-profile g-tube at a subsequent procedure. In addition, PEGs have been linked to higher rates of complications requiring reoperation than the laparoscopic approach [11,12]. G-tube placement under fluoroscopic guidance is considered safe and does not require endoscopy, but does not allow clear delineation of upper abdominal anatomy, and exposes the patient to ionizing radiation [13].

Ultrasound-guided G-tube Placement (USGTP) offers many potential advantages and minimizes risk in gastric access. It requires only the single incision for the tube itself. Use of ultrasound allows for visualization of other upper abdominal organs such as the transverse colon and liver so that these can be avoided. It obviates the need for intraabdominal dissection either by laparotomy or laparoscopy. It enables placement of a low-profile G-tube at the initial procedure and it involves no ionizing radiation.

USGTP has been reported in adults. A 2001 case report described intercostal placement of a G-tube under US-guidance for gastric decompression [5]. Bleck et al. reported 38 cases of USGTP with no major complications and few minor complications [2]. While most reports, and our experience, have used administration of saline into the stomach via NG tube, Pugash et al. reported success without an NG tube with US-guided transabdominal gastric needle access and subsequent distention

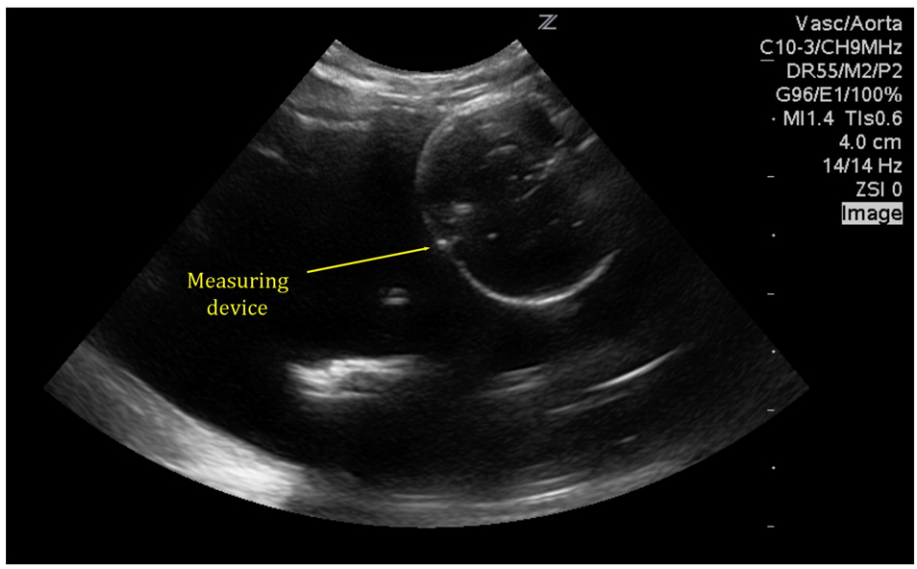

Fig. 4. Stoma measurement. Under ultrasound visualization the stoma measuring device is placed over the wire into the stomach after serial dilation of the tract. The balloon is inflated with saline and the stoma length for the low-profile G-tube is determined.

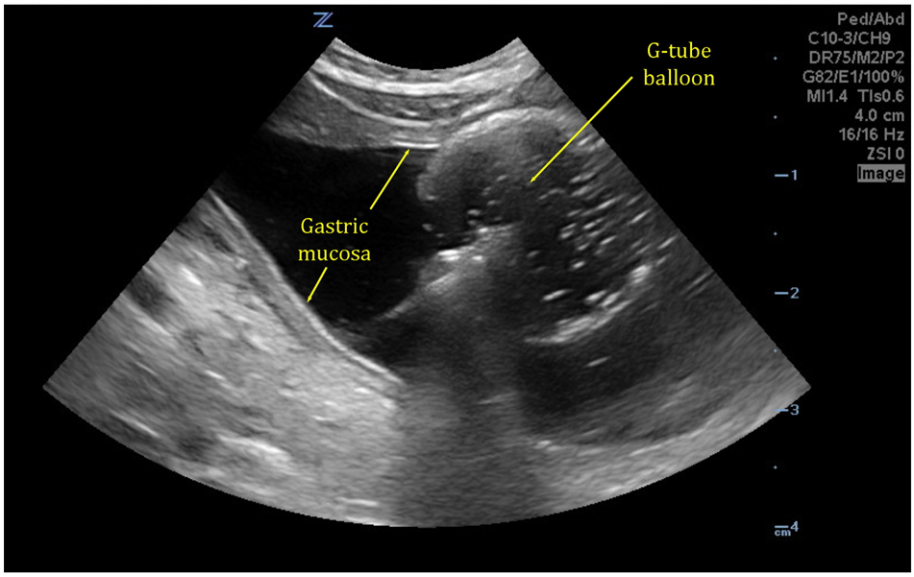

Fig. 5. G-tube placement. A low-profile G-tube is placed over the wire under direct ultrasound visualization. The gastric mucosa is easily seen and is not tented over the balloon. This confirms intraluminal placement, whereas tenting of the mucosa indicates intramural placement.

through the needle without complications in adults [3]. These reports supported USGTP as a safe and effective alternative technique, but the procedure had not been reported in children.

Our experience with USGTP supports the assertion that this technique is safe and effective in children. We have now performed 12 such procedures. Operative times have been short, with a median of 27 min. Feeding occurs early, and no patients have been readmitted within 30 days for complications related to their G-tube.

Of the 12 patients, only the second in the series experienced an intraoperative complication. In this patient, a linear array transducer was used, and gastric distention was difficult to maintain. This allowed the under-filled stomach to be distorted by the probe, and the access needle passed through a fold of the stomach wall, resulting in a through-and-through puncture injury on the anterior wall. This was recognized immediately, and repaired via conversion to an open procedure with placement of an open G-tube. The patient did well postoperatively. This complication prompted change from a linear to curved transducer to enable access of the abdominal wall/stomach in a perpendicular fashion rather than a tangential approach. We also began administering glucagon 0.5–1 mg as needed to delay gastric emptying and aid with gastric distention. Since implementing these changes we have not had any additional intraoperative issues.

Initially, aspiration from distension of the stomach with saline was a concern. At our institution, G-tubes are routinely placed under general anesthesia, so we opted to maintain consistent anesthetic techniques when performing G-tube placements under US-guidance. Though all of our patients have been intubated for the procedure, there has been very little issue with reflux into the oral cavity during the procedure and the stomach is emptied effectively with the orogastric tube after the G-tube is placed. With that said, the risk of aspiration remains unclear since the feasibility of performing this procedure under sedation alone was not assessed in this series.

Table 1
Summary of USGTP Patients and Outcomes.

Number of patients	12
Gender	5 M, 7 F
Age at operation (years)	3.8 ± 4.6 (range 12 days–17 years)
Mean weight at operation (kg)	13.6 ± 11.4 (range 2.2–44)
Median operative time (minutes)	27 (IQR 20–44)
Mean time to first feeding (hours)	8.8 ± 2.9
Patients with complications	1/12 (8.3%)

All the procedures in this study were performed by pediatric surgeons with training in the use of ultrasound. Given the prevalence of gastrostomy in pediatric surgical practice, we believe that with appropriate training in ultrasound-guided techniques, pediatric surgeons are well-qualified to perform USGTP. Interventional radiologists are also skilled in US-guided procedures as well as G-tube placement, and if appropriately trained would also be proficient in performing this technique.

Our study was limited by its small size, as it is only a case series of twelve patients, and lack of a comparison group. As such, it is meant to present the feasibility of this novel technique, but cannot be directly compared to alternative methods. Major complications arising from G-tube placement are rare [6], so a large study will be required to compare the outcomes of the US-guided technique to other more established techniques. However, our experience supports USGTP as a novel, safe, and effective procedure in children in need of gastric access.

4. Conclusion

Ultrasound-guided G-tube placement is a novel technique for gastrostomy tube placement in children and appears initially to be safe, efficient and effective. Advantages include good anatomical delineation, a single incision, initial placement of a low-profile G-tube, and avoidance of endoscopy, laparoscopy, and radiation. This report demonstrates the feasibility of USGTP, paving the way for further investigation and comparison to other existing methods.

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