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INTERVENTIONAL RADIOLOGY

# Transnasal stent-assisted targeting technique for percutaneous jejunostomy placement in patients with hiatal hernias

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## Abstract

**Purpose** To report the transnasal stent-assisted targeting technique for percutaneous jejunostomy placement in patients with hiatal hernias.

**Materials and methods** Four patients, including three (75%) females and one (25%) male, with mean age of 77.5 years (range 73–78 years), and with a hiatal hernia and intrathoracic stomach precluding gastrostomy placement and loop snare placement into the mid-jejunum underwent the transnasal stent-assisted targeting technique for percutaneous jejunostomy placement. In all patients, a duodenal stent was inserted into the jejunum in a transnasal fashion. The stent was partially unsheathed in an anterior loop of jejunum and percutaneously targeted using an 18-gauge needle through which a guidewire was advanced, trapped within the stent, and removed through the nose. The tract was serially dilated and a jejunostomy was placed. Technical success, procedure time, fluoroscopy time, radiation exposure, complications, time to enteral feeding, and follow-up were recorded.

**Results** Technical success was 100% (4/4) with all four patients requiring only one needle pass before successful jejunal cannulation. Mean procedure time was 108 min. Mean fluoroscopy time was 44 min. Mean dose area product was 3969.3 μGym$^2$. No minor or major complications occurred. All four patients received enteral feeding one day after the procedure. Mean follow-up was 366 days.

**Conclusion** The transnasal stent-assisted targeting technique is a novel method for primary jejunostomy placement in patients with hiatal hernias.

**Keywords** Primary jejunostomy · Percutaneous jejunostomy · Transnasal stent-assisted targeting · Wallflex targeting · Hiatal hernias

## Introduction

Direct percutaneous jejunostomy placement is indicated for patients requiring long-term enteral nutrition with surgically altered gastric anatomy, abnormal gastric position, or chronic aspiration [1, 2]. Percutaneous jejunostomy is performed by placing a transnasal catheter into a proximal jejunal loop close to the anterior abdominal wall. Under fluoroscopic-guidance, the air-contrast-filled bowel is punctured percutaneously with a Chiba-needle technique, followed by gastropexy and insertion of a feeding tube. Percutaneous jejunostomy placement is more difficult than gastrostomy because of increased mobility and compressibility of the jejunum with the failure rate for placement of a jejunostomy ranging from 14 to 32% with a complication rate of 12 to 22.5% [3, 4].

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Debilitated patients with hiatal hernias and multiple medical or surgical comorbidities, including an intrathoracic stomach, post-surgical anatomy, and altered distance to the jejunum, that preclude surgical repair may require long-term jejunal enteral nutrition [5, 6].

Hiatal hernias are often associated with dysphagia, aspiration, and regurgitation of enteric contents. In certain cases, a hiatal hernia may lead to volvulus, incarceration, strangulation, or perforation of the bowel and even death [7].

Transnasal snare techniques have been described to overcome some of the difficulties with placement of a percutaneous jejunostomy, particularly in patients with altered surgical anatomy [8]. The longest commercially available snare with a diameter of > 20 mm is only available in a 120 cm length which limits placement into the jejunum for targeting in patients with normal anatomy. Given the limited length of commercially available snares in larger loop diameters, the authors sought to determine if a commercially available duodenal stent on a 270-cm shaft could be utilized as a targeting device for percutaneous placement of a jejunostomy in patients with hiatal hernia.

This purpose of this report is to describe the transnasal stent-assisted targeting technique for jejunostomy placement in patients with hiatal hernias.

## Clinical cases

### Patient selection

This study was conducted with Institutional Review Board approval and complied with the Health Insurance Portability and Accountability Act.

All patients with hiatal hernias who underwent the transnasal stent-assisted targeting technique for retrograde primary jejunostomy placement were included (N = 4). Patients who underwent the transnasal snare technique were excluded [8].

### Technique

*The transnasal stent-assisted targeting technique for retrograde primary jejunostomy placement is shown in Fig.* 1. All procedures were performed under general anesthesia with the patient supine on the angiographic table. All procedures were performed by two attending Interventional Radiologists. A 5-French, 100-cm angled Glidecath (Terumo Medical Corporation, Somerset, NJ) and Glidewire (Terumo) were inserted into the naris and navigated through the intrathoracic stomach into the jejunum (Fig. 2a). A 260-cm-length Amplatz guidewire (Boston Scientific; Marlborough, MA) was then placed and the catheter exchanged for a 12-French, 80-cm-length sheath (Cook Medical; Bloomington, IN) which was advanced into the duodenum. A 125-cm vertebral tip catheter (Merit Medical Systems, Inc., South Jordan, UT) was then advanced through the 12-French sheath further into the jejunum. Contrast was injected through the catheter and rotational fluoroscopy performed to identify an anterior jejunal loop. This was further confirmed with ultrasound. In instances of redundancy of the wire within the stomach or small bowel, a 9-French, 100-cm-length, 32-mm-diameter Coda balloon (Cook, Bloomington, IN) was advanced into the small bowel, inflated, and the entire system retracted to reduce any redundant loops (Figs. 2b, 3a, b, c).

The Glidewire was then exchanged for a 450-cm Jagwire High Performance Guidewire (Boston Scientific; Marlborough, MA) which was placed distally into the jejunum. Over this, a 22-mm diameter × 90 mm length WallFlex Duodenal stent (Boston Scientific) on a 270-cm working length shaft was placed into the targeted anterior loop of jejunum. The stent was partially deployed (Fig. 2c) and targeted under fluoroscopy using an 18-gauge × 15 cm Chiba needle (Cook) to gain access into the small bowel (Figs. 2c, 3d). Through the needle, a second 450-cm Jagwire High Performance Guidewire was placed through the partially deployed stent (Figs. 2d, 3e). The stent was resheathed and the entire system was retracted (Fig. 2e, 3f), gaining through-and-through access from the percutaneous puncture of the jejunum through the nose (Fig. 2f).

Once this access was gained, the Jagwire High Performance Guidewire was exchanged for a 260-cm length Amplatz Super Stiff Guidewire (Fig. 2g). The tract was serially dilated using progressive dilators and a 20-French Peel-Away sheath (Cook Medical) was placed (Fig. 3g). A modified 16-French MIC jejunostomy tube (Halyard Medical; Alpharetta, GA) with extra sideholes was placed with the tip in the proximal jejunum (Figs. 2h, 3h). Contrast injection confirmed adequate positioning. The retention balloon was inflated with 3–4 mL of a mixture of contrast and sterile water.

### Variables, definitions, and outcomes

Technical success, procedure time, fluoroscopy time, radiation exposure, complications, time to enteral feeding, and follow-up were recorded. Technical success was defined as successful placement of a jejunostomy using the transnasal stent-assisted targeting technique. Procedure time was recorded in minutes. Fluoroscopy time was recorded in minutes. Dose area product was recorded in $\mu Gym^2$ and reference air kerma in mGy. Complications were classified based upon the *Society of Interventional Radiology* Standards of Practice Committee [9]. Time to enteral feeding was recorded in days. Follow-up was recorded in days.

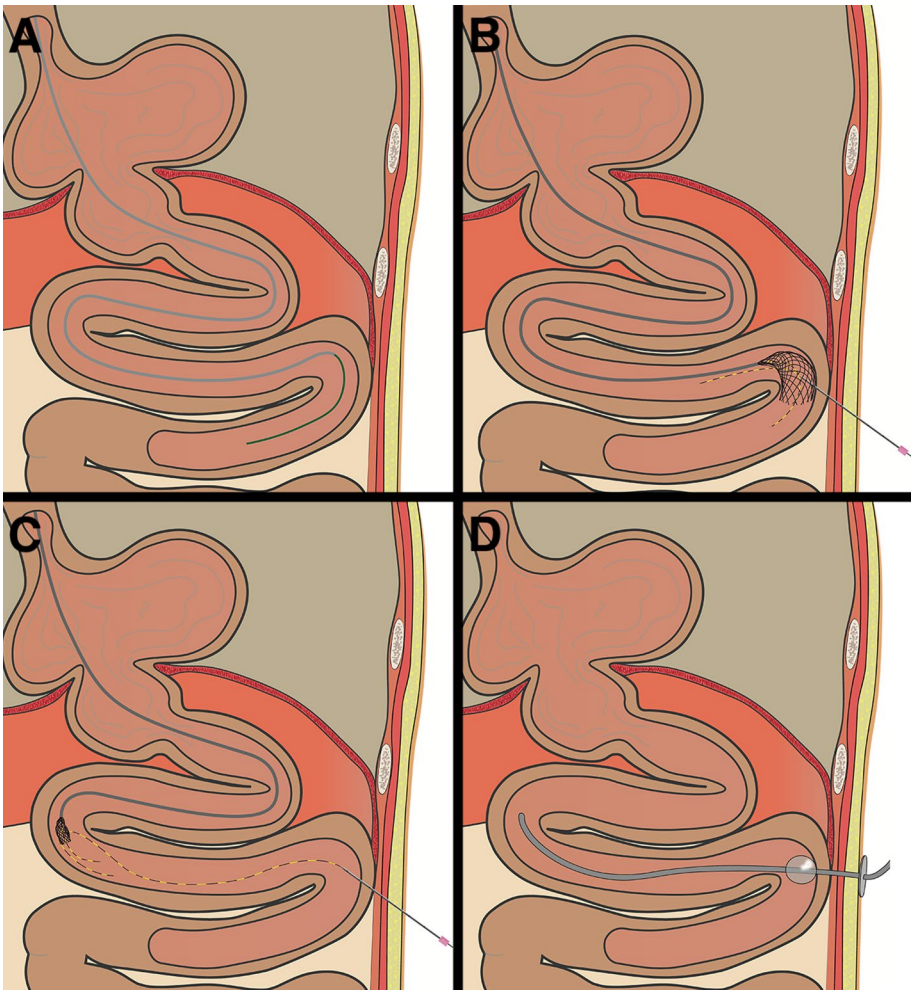


**Fig. 1** Schematic diagram showing the transnasal stent-assisted targeting technique for percutaneous jejunostomy placement. **a** Transnasal cannulation of the intrathoracic stomach with placement of a sheath and Glidewire into the duodenum. **b** A WallFlex Duodenal stent is advanced into the small bowel over a Jagwire High Performance Guidewire and partially deployed within an anterior jejunal loop and a single pass with an 18-gauge needle is made through the interstices of the partially deployed stent. **c** A second Jagwire High Performance Guidewire is advanced through the needle, the needle removed, and the partially deployed stent is recaptured. The stent and sheath are removed as a unit achieving through-and-through access from the nose to the jejunum. **d** A modified 16-French jejunostomy tube is placed with the tip in the proximal jejunum

## Patients

### Patient demographics

*Patients are summarized in Table* 1.

#### Patient 1

A 73-year-old woman with trismus and an inability to masticate secondary to a maxillary squamous cell carcinoma treated with surgical debulking and radiation presented with poor nutritional intake after having failed gastrostomy placement at an outside hospital. Computed tomography of the chest demonstrated a large mixed type-hiatal hernia with organoaxial and mesenteroaxial rotation of a complete intrathoracic stomach. Using the transnasal stent-assisted targeting technique, a modified 16-French jejunostomy tube with extra sideholes was placed with the tip in the proximal jejunum. Only one needle pass was required to successfully access the jejunum. Enteral feeding was initiated one day after the procedure and no complications occurred after 458 days of follow-up.

#### Patient 2

An 87-year-old woman with dementia, coronary artery disease, hypertension, hyperlipidemia, and a recent ischemic stroke presented with poor nutritional intake after having failed gastrostomy placement at an outside hospital. A swallow evaluation showed oropharyngeal dysphagia and aspiration. Computed tomography of the chest demonstrated a large-sized paraesophageal hiatal hernia with a complete intrathoracic stomach. Using the transnasal stent-assisted targeting technique, a modified 16-French jejunostomy tube with extra sideholes was placed with the tip in the proximal jejunum. Only one needle pass was required to successfully access the jejunum. Enteral feeding was initiated one day after the procedure and no complications occurred after 339 days of follow-up.

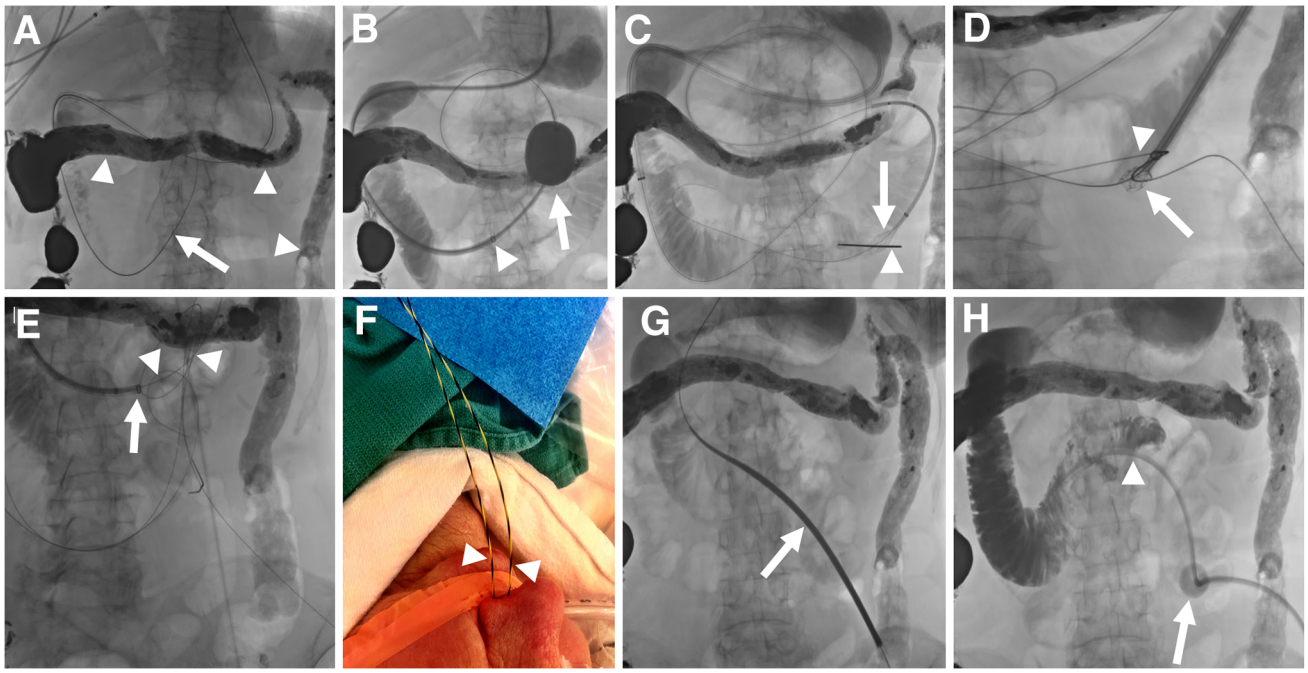


**Fig. 2** *Patient 2*. **a** An Amplatz Super Stiff Guidewire is advanced into the duodenum (white arrow) from a transnasal approach. Retained barium contrast can be seen within the colon (white arrowheads) from a prior fluoroscopy study. **b** A transnasal Coda balloon catheter (white arrow) is used to reduced redundant loops within the small bowel and facilitate advancement of a 12-French × 80 cm sheath (white arrowhead) further into the small bowel. **c** A 22-mm × 90 mm × 270 cm WallFlex Duodenal stent is advanced into the small bowel over a 450-cm Jagwire High Performance Guidewire and partially deployed (white arrow) within a superficial jejunal loop after confirmation by multiplanar fluoroscopy and ultrasound. A single pass with an 18-gauge Chiba needle (white arrowhead) is made through the interstices of the partially deployed stent. **d** A second 450-cm Jagwire High Performance Guidewire (white arrowhead) is advanced through the needle, the needle removed, and the partially deployed stent is recaptured (white arrow). **e** The resheathed stent and 12-French sheath are removed as a unit (white arrow) achieving through-and-through access with the Jagwire High Performance Guidewire (white arrowheads) from the nose to the abdomen. **f** Two Jagwires (white arrowheads) can be seen exiting the left nares, one traveling antegrade and one retrograde. **g** The antegrade Jagwire High Performance Guidewire is removed. A 4-French Glidecath is advanced from the jejunal puncture over the retrograde Jagwire High Performance Guidewire up and out the nose (not pictured) and then wire exchanged for a 260-cm Amplatz Guidewire. Dilation of the tract (white arrow) is performed over the Amplatz wire into the small bowel while maintaining tension on both ends of the through-and-through wire and providing a fixed rail. Ultimately, a 20-French Peel-away Sheath Introducer is placed. **h** A 16-French MIC jejunostomy tube cut short with additional sideholes is placed within the proximal jejunum (white arrowhead). The balloon is inflated (white arrow) and retracted with cautious force, thereby pulling the bowel loop up against the abdominal wall

### Patient 3

A 75-year-old man with esophageal cancer presented with gastric recurrence of the cancer and poor nutritional intake, after having failed gastrostomy placement at an outside hospital. Computed tomography of the chest demonstrated a large-sized paraesophageal hiatal hernia with a complete intrathoracic stomach. Using the transnasal stent-assisted targeting technique, a modified 16-French jejunostomy tube with extra sideholes was placed with the tip in the proximal jejunum. Only one needle pass was required to successfully access the jejunum. Enteral feeding was initiated one day after the procedure and no complications occurred after 333 days of follow-up.

### Patient 4

A 75-year-old woman with recent ischemic stroke presented with oropharyngeal dysphagia and poor nutritional intake, after having failed gastrostomy placement at an outside hospital. Computed tomography of the chest demonstrated a large-sized paraesophageal hiatal hernia with a complete intrathoracic stomach. Using the transnasal stent-assisted targeting technique, a modified 16-French jejunostomy tube with extra sideholes was placed with the tip in the proximal jejunum. Only one needle pass was required to successfully access the jejunum. Enteral feeding was initiated one day after the procedure and no complications occurred after 333 days of follow-up.

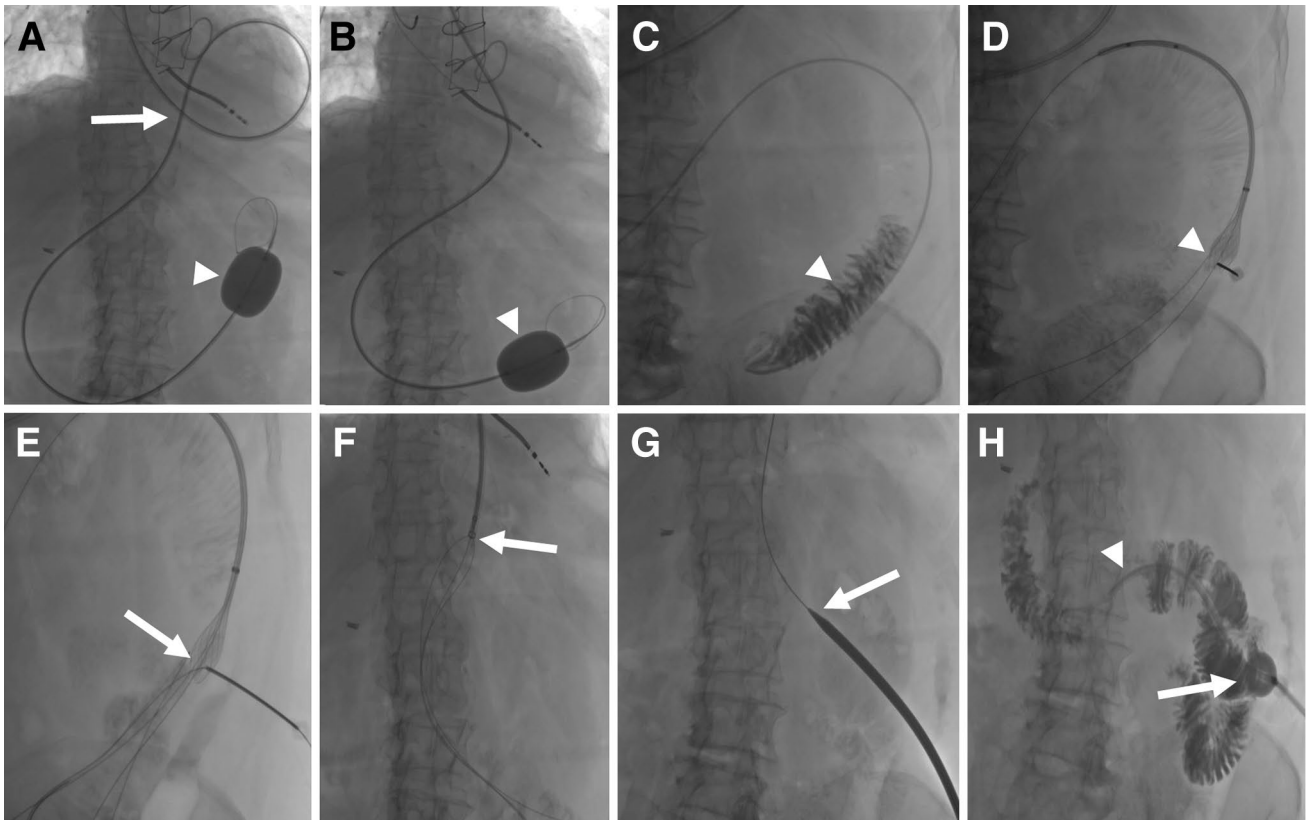


**Fig. 3** *Patient 4*. **a** A redundant loop in a hiatal hernia sac is visualized (white arrow). A Coda balloon has been placed in the small bowel (white arrowhead) to facilitate reduction of the redundant loop. **b** Following reduction of the loop, the Coda balloon (white arrowhead) and catheter course are noted to be straight without looping. A 12-French, 80-cm sheath was then advanced towards the duodenum. **c** Contrast injection through a 5-French catheter demonstrating filling of a superficial small bowel loop (white arrowhead) confirmed by multiplanar fluoroscopy. **d** A 22 mm × 90 mm WallFlex Duodenal stent is partially deployed within the jejunum and then targeted with an 18-gauge Chiba needle (white arrowhead). **e** A Jagwire is advanced through the needle into the stent interstices (white arrow) and then the stent is recaptured, thereby capturing the wire. **f** The stent is retracted along with the sheath (white arrow) and through-and-through access from the nose to the small bowel is achieved. **g** The tract is dilated with serial dilators (white arrow) until a 20-French Peel-Away Introducer sheath is ultimately placed. **h** A 16-French MIC jejunostomy cut short with multiple additional sideholes is placed (white arrow) in a retrograde fashion. Contrast injection confirms appropriate positioning (white arrowhead)

## Results

Results are shown in Table 1. Technical success was 100% (4/4) with all four patients requiring only one needle pass before successful jejunal cannulation. Mean procedure time was 108 min. Mean fluoroscopy time was 44 min. Mean dose area product was 3969.3 μGym$^2$. No minor or major complications occurred [9]. All four patients received enteral feeding one day after the procedure. Mean follow-up was 366 days.

## Discussion

This report describes four patients with large hiatal hernias and complete intrathoracic stomachs in which a novel transnasal stent-assisted targeting technique was used for placement of a percutaneous jejunostomies. Due to the inability to precisely target the mobile and decompressible jejunum, the standard method of direct percutaneous jejunostomy placement is often technically difficult [1, 4, 10, 11]. Even though it may appear that the needle is intraluminal under fluoroscopy, confirmation of opacification of the lumen with contrast may be challenging, which often leads to multiple attempts to target the jejunum, placing the patient at higher risk for complications such as postoperative pain, bleeding, infection, and peritonitis in addition to prolonging the procedure time [10–12]. Although the reported technical success rates for percutaneous jejunostomy ranges from 85 to 100%, there may be a selection bias due to more experienced operators reporting their data [10, 12].

Although transnasal snare techniques have been developed to overcome difficulties associated with primary jejunostomy placement in patients with a surgical

**Table 1** Patient demographics and results

| Patient | Age (years) | Gender | Presenting illness | # of needle passes to successful cannulation | Hiatal hernia | Technical success | Complications |
|---|---|---|---|---|---|---|---|
| 1 | 73 | Female | Squamous cell carcinoma | 1 | Yes | Successful | None |
| 2 | 87 | Female | Ischemic stroke | 1 | Yes | Successful | None |
| 3 | 75 | Male | Esophageal carcinoma | 1 | Yes | Successful | None |
| 4 | 75 | Female | Ischemic stroke | 1 | Yes | Successful | None |
| Mean | 77.5 | | | | | | |
| Range | 73–78 | | | | | | |

| Patient | Procedure time (min) | Fluoroscopy time (min) | Air kerma (mGy) | Dose (μGym$^2$) | Initiation of feeding (days) | Follow-up (days) |
|---|---|---|---|---|---|---|
| 1 | 218.0 | 107.0 | 346.0 | 8270.3 | 1 | 458 |
| 2 | 114.0 | 36.9 | 133.0 | 2581.7 | 1 | 339 |
| 3 | 43.0 | 12.6 | 49.0 | 984.5 | 1 | 333 |
| 4 | 57.0 | 19.3 | 137.8 | 4040.8 | 1 | 333 |
| Mean | 108.0 | 44.0 | 166.5 | 3969.3 | 1 | 365.8 |
| Range | 43.0–218.0 | 12.6–107.0 | 49.0–346.0 | 984.52–8270.3 | | 333–458 |

gastrojejunostomy [8], there are no commercially available medium-to-large caliber (> 20-mm) over-the-wire snares longer than 120-cm, limiting the use of the transnasal jejunal snare technique to patients with shorter distances to the jejunum. Although longer length snares do exist, they have small loop diameters that may make percutaneous targeting difficult. Some longer length large loop snares are available; however, they cannot be placed over-a-wire, and therefore this limits navigation into the jejunum. For example, Boston Scientific offers their *Sensation* and *Profile* Single-Use Short Throw Snares that are 240-cm long with a 27–30-mm-diameter loop, but they cannot be advanced over-a-wire. Furthermore, Terumo Interventional Systems offers many snares, including the *EN1003004, EN1003008, ONE200, ONE201, ONE400, ONE401, ONE700, and ONE701*, but none have a working loop diameter greater than 8-mm.

This brief report describes using a partially deployed duodenal stent in place of the snare. It has previously been demonstrated that partially deployed Wallstents (Boston Scientific) may be used for stent targeting in venous interventions [13, 14]. This new technique, however, describes a similar approach, using a partially deployed duodenal stent for stent targeting, in gastrointestinal interventions, specifically percutaneous jejunostomy placement. Stent targeting offers a three-dimensional expanded target and may allow for easier targeting when compared to a two-dimensional snare [8]. The main advantage of this technique for jejunostomy placement is its ability to successfully target the jejunum overcoming difficulties with traditional jejunostomy techniques and anatomic jejunal distance abnormalities such as a hiatal hernia. In addition, this technique offers improved success in targeting the jejunum. By confirming intraluminal location with the stent-assisted trapping of a wire, the need for contrast injection for confirmation is obviated. In the traditional direct percutaneous puncture technique, there is potential for a large amount of intraperitoneal contrast to be used if multiple attempts are made, which may obscure further attempts at access [13–15]. By avoiding this complication, the transnasal snare technique allows for fewer attempts at access, increasing patient safety and procedural efficiency.

In all four patients with difficult gastrointestinal anatomy, percutaneous jejunostomy was technically successful after prior gastrostomy placement had failed. Access was achieved into a jejunal loop in one needle pass in all four patients. All patients received enteral nutrition the day after placement without complication.

Limitations to this report include small sample size (four patients). Moreover, all four procedures were performed at a single institution by two operators which may limit generalization to others operators unfamiliar with these techniques. Additionally, this technique is contraindicated in patients with abnormalities of the nasal passages, significant facial trauma, or severe upper digestive tract obstruction.

## Conclusion

The transnasal stent-assisted targeting technique is a novel method for primary jejunostomy placement in patients with hiatal hernias.

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non-financial interest (such as personal or professional relationships, affiliations, knowledge, or beliefs) in the subject matter or materials discussed in this manuscript.

**Author contributions** All authors have read and contributed to this manuscript.

## Compliance with ethical standards

**Conflict of interest** There are no conflicts of interest.

**Ethical approval** All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

**Informed consent** Informed consent was obtained from all individual participants included in the study.

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