Stent-in-stent technique under fluoroscopy for removal of embedded esophageal stent

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Abstract

Background: Treatment of complications after esophageal stent placement and methods for removal of stents need to be improved. The purpose of this study was to evaluate the safety and efficacy of stent-in-stent (SIS) removal of esophageal stent under fluoroscopy.

Methods: This study retrospectively analyzed the clinical data of consecutive patients undergoing esophageal stent removal by SIS under fluoroscopy. Under awake condition, local anesthesia, and fluoroscopic monitoring, a second esophageal stent was placed in the first esophageal stent. Four weeks later, both esophageal stents were removed by the SIS technique under fluoroscopy.

Results: A total of 12 patients were treated by the SIS removal technique. In 10 patients, the first esophageal stent was easily removed by the SIS method; in the other 2 patients, stent fracture occurred, and some residual nitinol wire had to be removed endoscopically. No serious complications occurred in any patient.

Conclusions: The SIS removal technique appears to be a safe and effective method for removal of embedded esophageal metallic stents.

Introduction

Esophageal metallic stent placement is an effective and widely used method for treatment of benign and malignant esophageal stenoses and fistulas¹⁻³. However, problems such as esophageal restenosis, stent fracture, complaints of retrosternal pain and foreign body sensation, gastroesophageal reflux, airway compression, or bleeding may necessitate stent removal in some patients^{4,5}. Removal can usually be safely performed via gastroscopic or interventional radiology approaches. However, because the stent acts as a foreign body, tissue overgrowth often occurs at both ends of the stent after long-term placement and makes stent removal difficult in some patients.

Several authors have reported successful gastroscopic removal of embedded esophageal stents using a stent-in-stent (SIS) technique⁶⁻⁸. Inspired by these descriptions, we applied the SIS technique under fluoroscopy. The purpose of this paper was to describe the SIS technique for removal of esophageal metallic stent under fluoroscopy and to retrospectively evaluate the safety and efficacy of the method.

Methods

Patients

The data of 15 consecutive patients who underwent metallic esophageal stent removal by the SIS technique under fluoroscopy from May 2016 to July 2020 were retrospectively analyzed. The technology has been approved by the ethics committee of the First Affiliated Hospital of Zhengzhou University. The

study was conducted in accordance with the principles of the Helsinki declaration. All patients provided written informed consent before the procedure.

Procedure

1. Placement of the second self-expanding metal stent

The degree and location of granulation tissue hyperplasia were first evaluated by chest CT, esophagogram, or/and gastroscopy. For the procedure, patients were admitted to hospital and fasted overnight for 6–8 hours. Diazepam and anisodamine were administered intramuscularly 30 minutes before the procedure, and lidocaine gel was given orally for local anesthesia.

The procedure was performed under fluoroscopy. The patient was placed supine on the digital subtraction angiography bed, and 37% ioversol (Jiangsu Hengrui Medicine Company, Lianyungang, China) was administered orally. The location and degree of esophageal stenosis were determined by fluoroscopy in the supine and the 45° left anterior oblique position. Then, under fluoroscopic monitoring, a 5F catheter and 0.035-in guide wire were cooperatively inserted through the mouth into the esophagus and advanced past the first stent until the tip of the guide wire was in the gastric cavity. Then, the second stent (Nanjing Micro-Tech Medical Company, Nanjing, China), along with the double-fold retrievable wire and transporter, was passed over the guide wire. The diameter of the second stent was the same as, or 2 mm larger than, the diameter of the first stent, and the length was 2–4 cm longer than that of the first esophageal stent. The second stent was released at the center of the original esophageal stent. After confirming correct placement of the stent, the double-fold retrievable thread was brought into the nasal cavity from the mouth with the help of a suction catheter and fixed at the side of the ear.

2. Removal of the stents

The second stent was removed 4 weeks after implantation. Preoperative preparation and esophagography were performed as before. The double-fold retrievable thread of the second stent was brought into the oral cavity. Under fluoroscopy, steady traction on the thread was used to pull the stent out. If undue resistance was encountered, an esophageal stent-removal sheath was passed along the double-fold retrievable thread up to the upper end of the stent. With the sheath fixed, the thread was pulled to stretch the upper end of the stent and make it cone shaped, then the double fold retrievable thread and sheath were together pulled to slowly extract the second stent.

The first stent was then removed. Under fluoroscopy, a catheter and guide wire were cooperatively inserted through the mouth into the esophagus and past the stent into the gastric cavity. An esophageal stent-removal sheath was passed along the guide wire up to the lower end of the stent. Then, an esophageal stent removal hook was inserted into the esophageal stent-removal sheath, and the nitinol wire of the lower part of the first esophageal stent was hooked and pulled out by the inversion technique.

Vital signs and bleeding were monitored during 24 h after the procedure. The patient was declared fit to go home 72 h after the procedure.

The tool and process of removing the stent are shown in Figures (1–4)

Results

The 15 patients (8 males and 7 females) were in the age range of 48–90 years (mean, 67 years). The reasons for esophageal stent placement included benign esophageal stenosis (4 patients), anastomotic stenosis after esophagectomy for esophageal cancer (6 patients), esophageal cancer complicated by esophagotracheal fistula (4 patients), and anastomotic stenosis after esophagectomy for corrosive esophageal stenosis (1 patient). The median indwelling duration of the first esophageal stent was 505.5 days (151–1473 days). The median indwelling duration of the second esophageal stent was 26 days (4–119 days). Table 1 summarizes the characteristics of the patients.

Table 1
Clinical characteristics of the patients

Patient	Sex	Age, years	Reason for stent placement	Time taken for stent removal, (minutes)	Indwelling time of the first stent, days	Indwelling time of the second stent, days
1	F	90	Benign stenosis	30	1119	495
2	F	90	Benign stenosis	8	495	51
3	M	71	Anastomotic stenosis (after esophageal cancer surgery)	10	1154	24
4	M	63	Esophagotracheal fistula (after esophageal cancer surgery)	7	516	119
5	F	54	Esophagotracheal fistula (after esophageal cancer surgery)	15	591	475
6	F	54	Esophagotracheal fistula (after esophageal cancer surgery)	15	475	11
7	M	78	Esophagotracheal fistula (after esophageal cancer surgery)	47	1473	9
8	M	64	Anastomotic stenosis (after esophageal cancer surgery)	23	407	17
9	M	72	Anastomotic stenosis (after esophageal cancer surgery)	28	428	4
10	F	54	Benign stenosis	10	151	28
11	F	48	Anastomotic stenosis (following corrosive injury)	10	271	21
12	M	70	Anastomotic stenosis (after esophageal cancer surgery)	7	770	32
13	M	65	Anastomotic stenosis (after esophageal cancer surgery)	8	400	64
F, female; M, male.						

Patient	Sex	Age, years	Reason for stent placement	Time taken for stent removal, (minutes)	Indwelling time of the first stent, days	Indwelling time of the second stent, days
14	F	70	Benign stenosis	11	505	39
15	M	66	Anastomotic stenosis (after esophageal cancer surgery)	14	392	29
F, female; M, male.						

In 9 patients, the second esophageal stent was successfully removed by pulling on the double-fold retrievable thread. In the other 6 patients, the help of the esophageal stent-removal sheath was required because strong resistance was experienced when pulling on the double-fold retrievable thread.

In 13 patients, the first esophageal stent was successfully removed at the first attempt by the inversion technique. In the other 2 patients, stent fracture occurred during removal as the wires were corroded because of the prolonged indwelling time of the stent. Most of the nitinol wires were removed during the procedure itself, but gastroscopy was required for removal of some residual wires.

The procedure time for removal of both esophageal stents was 7–47 minutes (median, 12.5 minutes). No serious complications such as esophageal mucosal necrosis, esophageal rupture, esophageal hemorrhage, or mediastinal abscess occurred in any patient.

Patients were followed up in the clinic or over the telephone for periods ranging from 1 month to 40 months (median, 12 months). Four patients died during the follow-up period of causes unrelated to stent removal: 1 patient died of multiple organ failure caused by tumor recurrence; 2 patients with esophagotracheal fistula died of exhaustion; and 1 patient died of gastrointestinal bleeding unrelated to the SIS procedure. Among the 11 patients who survived, 8 with grade 0 dysphagia remained normal till end of follow-up; 1 patient with grade 3 dysphagia survived on nasal feeding; 1 patient with grade 3 dysphagia needed esophageal diversion surgery; and 1 patient developed grade 3 dysphagia 1 week after stent removal and was sustained with transnasal feeding.

Discussion

Currently, the three commonly used methods for removal of esophageal stent are surgical resection⁹, removal under fluoroscopy¹⁰, and removal under endoscopy^{8,11}. Surgical resection is traumatic and can cause complications such as anastomotic stricture and anastomotic leakage; therefore, it is rarely used nowadays. Removal under fluoroscopy is easily performed for esophageal stents with short indwelling time, but it is difficult for stents with prolonged indwelling time, when there may be severe granulation hyperplasia. Endoscopic removal of esophageal stent can be performed through several approaches, including combined cryoablation and SIS technique¹², double-step invagination technique¹³, inversion

technique¹⁴, and rat-tooth forceps or rat-tooth forceps with a snare technique¹⁵. With extended periods of stent placement, the stent tends to get embedded in tissue, and the upper and lower ends of the stent may be severely narrowed. Direct removal of such embedded esophageal stents can cause serious complications such as esophageal mucosal tear, esophageal rupture, and massive hemorrhage. Thus, the endoscopic procedure can be complex and time taking, and so requires the services of an experienced endoscopic surgeon^{16,17}. In addition, endoscopic stent removal is usually carried out under general anesthesia, and so the patient also has to bear the anesthetic risks.

For patients with embedded esophageal stent and hyperplasia-induced stenosis, the SIS technique under endoscopy has been demonstrated to be effective and safe^{7,16,18}. We therefore adapted the SIS method for the interventional radiology approach. Under fluoroscopy, a second esophageal stent with a diameter slightly larger or equivalent to that of the original stent is placed. The radial force exerted by the second stent causes necrosis of the proliferating granulation tissue¹⁹, thus facilitating the removal of the original embedded stent.

In contrast to endoscopic esophageal stent removal, interventional radiology procedures are generally carried out under local anesthesia on conscious patients. The process is simple, with the stent being extracted by the guide wire or by a stent retrieval hook applied at the upper or lower end of stent. This minimally invasive method rarely causes serious complications such as esophageal rupture and massive hemorrhage. In our study cohort, no serious complications occurred, and the median time taken for stent removal was only 12.5 minutes.

In the present study, the second stent was placed for a median duration of 26 days before removal; this is consistent with the 2–3 weeks reported in previous studies. None of our patients developed severe granulation hyperplasia, though one patient did have mild granulation hyperplasia at the upper end of the second stent. In our series, one patient developed airway compression after placement of the second stent, necessitating its early removal. Because the indwelling time of the second stent was too short, the original stent remained embedded and was fractured during extraction. Some of the stent wires had to be removed under endoscopy.

Theoretically, the interventional technique under fluoroscopy has several advantages. First, there is no need for general anesthesia; as the procedure is carried out under local anesthesia on conscious patients, it is suitable even for patients with relatively poor general condition. Second, stent placement and removal is quickly and accurately completed under fluoroscopy, thus greatly reducing the patient's suffering. Third, the first stent is extracted by the inversion technique, a simple technique that minimizes damage to the esophagus. The disadvantages of the SIS method include the inability to directly observe the esophageal cavity and the risk of stent fracture, which may require endoscopy for removal of residual metal wires.

The main limitation of this study is its small sample size. Stronger evidence is needed to determine the optimal indwelling time for the second esophageal stent.

In conclusion, SIS under fluoroscopy appears to be a safe and effective method for the removal of esophageal metallic stent. The advantages and disadvantages of the SIS technique performed under fluoroscopy needs to be studied in greater detail in future research.

Declarations

Acknowledgments: No.

Author contributions

Study design: G, W.

Analysis and interpretation of data: S, W and G, W.

Collection of samples: M, Y. Y, M. M, W. Y, T. Y, Z. X, L. P, X.

Drafting of the manuscript: S, W.

Revision of the manuscript and approval of the final version of the manuscript: S, W. M, Y., Y, M. M, W. Y, T. Y, Z. X, L. P, X. and G, W.

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Figures

Figure 1

The esophageal stent removal hook (red arrow) (a). The esophageal stent removal sheath (black arrow) (a). The esophageal stent removal hook is sent into the esophageal stent removal sheath (b). The partial enlarged picture of the stent extractor (c).

Figure 2

Patient (No. 10) with esophageal stenosis. The first esophageal stent had been implanted 123 days earlier. Esophagography shows granulation tissue hyperplasia at the upper end of the stent (white arrow; a). The second esophageal stent (white arrow; b) was implanted for 28 days. Esophagography shows complete expansion of the second esophageal stent and disappearance of the esophageal stenosis (the blue arrow points to the first esophageal stent; b). The stent removal sheath was inserted over the double-fold retrievable thread, and traction was applied on the thread to stretch the upper end of the stent and make it cone shaped (c).

Figure 3

The second stent was removed and the granulation tissue on the top of the first stent subsided (white arrow). The lower end of the first stent was hooked (blue arrow; d), and the stent was pulled out by the inversion technique (e). After removal of the two stents, contrast can be seen passing smoothly through the esophagus (f).

Figure 4

Photograph of both esophageal stents after removal: the first stent (red arrow), the second stent (black arrow).

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