

Introduction

Esophageal cancer is frequently unresectable at the time of diagnosis because of local invasion or metastatic disease. Therapy is therefore usually palliative in nature, with the major aims being relief of dysphagia, maintenance of nutrition and occlusion of tracheoesophageal fistula. Palliative surgery eventually offers the best palliation for esophageal obstruction symptoms and signs such as dysphagia and vomiting. However because of the very poor prognosis, the short median survival time and the considerable morbidity and mortality rate of surgery, this approach cannot be justified in preference to less invasive nonsurgical techniques.

There are numerous nonsurgical palliative treatments, including radiation therapy (external or intracavitary), endoscopic stenting, chemotherapy, endoscopic tumor ablation with BICAP electrocoagulation and argon plasma coagulation (APC), injection of necrolytic agents, Nd:YAG laser photocoagulation and photodynamic therapy. Recently various self-expandable metal stents (SEMS) have been developed for palliation of malignant obstruction of the esophagus.

The major impact of these stents is associated with the ease of insertion and the potential for fewer complications compared with plastic stents. Because SEMS offer many advantages, endoscopists have in recent times preferred to use SEMS for the treatment of esophageal obstruction. In spite of the many advantages of SEMS, limitations and difficulty are sometimes encountered in esophageal stenting because of complete luminal obstruction; sharp angulation of the esophagus due to tortuous tumor growth; previous surgery; previous radiotherapy and severe

kyphoscoliosis; the tumor's being unusually soft and necrotic or excessively hard and scirrhous; the presence of fistula in the absence of appreciable luminal constriction starting at the upper or lower end of the malignancy; and extension of the tumor to the upper esophageal sphincter.

Esophageal Stenting in the Cervical Esophagus

Esophageal stents have been employed for several decades for the palliation of unresectable middle and distal esophageal cancers. Their use has received a major boost recently with the introduction of expandable metal stents that have eliminated much of the discomfort and risk associated with the placement of the earlier plastic models.

Tumors in the cervical portion of the esophagus (7–10% of all esophageal cancers) have traditionally been more difficult to manage. Palliative resection, radiotherapy and laser therapy are frequently associated with local treatment failure. The use of esophageal stents in this area was considered to be relatively contraindicated because of concerns about an increased risk of perforation, pulmonary aspiration, migration of the prosthesis into the hypopharynx, and (perhaps most importantly) an intolerable foreign body sensation.

Recently, however, this traditional view has begun to be challenged, as witnessed by a few small and preliminary reports. Lorken et al. [1] have added to this experience by using the Montgomery salivary bypass tube (MSBT) to relieve dysphagia in 44 patients with a variety of hypopharyngeal and cervical esophageal diseases. The MSBT is a soft and flexible polyethylene tube, original-

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ly used for the management of fistulae occurring after head and neck surgery. Spinelli et al. [2] described seven patients with nondilatable malignant strictures of the high cervical esophagus who benefited from MSBT. Warren et al. reported similar results in seven patients using the same tube. Other types of endoprosthesis have also been used. Loizou et al. [3] used the Celestin endoprosthesis, a latex rubber tube incorporating a nylon spiral, for palliation in eight patients with high tracheoesophageal fistulae. Goldschmid et al. [4] successfully placed a polyvinyl (Tygon) prosthesis in eight out of ten patients with pharyngoesophageal stenosis.

Today, there is no doubt that use of self-expandable metal stents is a well established palliative treatment for stenotic malignant disease of the esophagus. However, their implantation in the cervical esophagus is a technically demanding procedure and only a few successful cases are reported in the literature. Macdonald et al. [5] reported their experience of treating 22 patients for malignant stricture of the cervical esophagus using self-expandable metal stents. They reported a 93% technical success rate, but 28% of patients complained of a foreign body sensation.

We have modified the self-expandable metal stent for use in cervical esophageal cancer stenting. In order to decrease the foreign body sensation and to prevent migration of the stent, we reduced the length of the proximal funnel of the stent to 7 mm, the fully expanded diameter being 18 mm (Figure 1). We have treated five patients with inoperable cervical esophageal stricture by implantation of this modified self-expandable metal stent, inserted perorally under endoscopic and fluoroscopic guidance. The placement of the stent was successful in all patients. Four of the five patients had no serious complication such as perforation, pulmonary aspiration, stent migration or foreign body sensation.

It appears, therefore, that the location of a lesion within 2 cm of the cricopharyngeal muscle should no longer be considered a contraindication for the palliative use of a stent. Further studies are needed to compare stenting with other palliative modalities in the management of pharyngoesophageal cancers, as well as to determine the best type of prosthetic device for to be used under these circumstances.



Figure 1 Newly designed self-expanding metal stent (SEMS) for the cervical esophagus. In order to decrease the foreign body sensation and to prevent migration of the stent, we reduced the length of the proximal funnel to 7 mm. The expanded diameter is 18 mm.

Management of Tracheoesophageal Fistula

Tracheoesophageal fistula is relatively uncommon in malignant diseases of the esophagus, occurring in about only 5–15% of patients with esophageal cancer or other mediastinal malignancies. Nevertheless, the clinical implications for these patients are dramatic because of recurrent aspiration with subsequent and eventually lethal infections. Any type of endoluminal palliation of dysphagia due to malignant tumor stenosis may increase the incidence of esophagorespiratory fistulae: Laser desobliteration, local hyperthermia, endoluminal high-dose afterloading and photodynamic therapy are equally effective as commonly used methods for recanalization. Therapeutically induced necrosis of the esophageal wall at the tumor-bearing site may promote the formation of a transmural leakage. Once a tracheoesophageal fistula has developed, the general condition of the patient declines rapidly due to aspiration pneumonia and malnutrition. Because the tumor stage is generally advanced and life expectancy is short, the major interest of any therapeutic procedure in these cases must be a rapid and successful palliation, reducing the duration of inpatient hospital stay, have a low cost and a low rate of therapy-induced complications.

Palliative surgery is an invasive procedure with a high mortality rate and a short survival period. With the combination of cervical esophagostomy and feeding gastrostomy the patient cannot swallow and the risks of surgery are high, with a mortality rate of up to 50%. Surgical bypass operations can acceptably restore the ability to swallow, but are invasive procedures that have a mortality rate of between 34% and 41.5%. Surgical intubation with a prosthesis involving the pull-through technique also has a high mortality rate of 18% to 36%. Hence, noninvasive palliative measures must be given preference in these situations.

For the closure of a small tracheoesophageal fistula, the use of rapidly hardening solutions of amino acids or tissue adhesive have been described. The peroral endoscopic introduction of a standard prosthesis is an established treatment of inoperable malignant strictures of the esophagus, and has a success rate of more than 90% and a mortality rate of less than 5%. However, in the case of tracheoesophageal fistula it is often difficult to obtain complete sealing with a standard tube and the mortality rate associated with the procedure can rise to 15%, along with a complication rate of 42.5% [6]. To provide a better seal between the endoprosthesis and the esophagus, several modifications to plastic stents have been described, including wrapping the tube with Ivalon sponge, embossing the tube with spiral indentations, and anchoring the stent with adhesive, as have two different designs involving inflatable cuffs [7]. Although these modifications have achieved varying degrees of clinical success, no design has ensured consistent closure of the perforation or leak as well as relief of dysphagia.

In recent years, several types of self-expanding metal stents, namely the Wallstent, Ultraflex, Endocoil, Gianturco-Z stent, Song's stent and Choo's stent, have been developed and used in the palliative treatment of malignant stenosis caused by incurable tumors of the esophagus and the cardia. Uncoated stents are not suitable for the treatment of fistula or perforation because esophageal contents can pass easily through the mesh

and into the esophageal defect. A number of reports with several different SEMS designs have suggested that these stents are at least as effective as plastic stents, while avoiding the high initial morbidity and mortality.

Tracheoesophageal fistula in advanced, malignant stenosis of the esophagus represents a fatal complication associated with the patient's rapidly decreasing functioning. Stenting by using a self-expandable covered device is a safe and easily applicable technique for successfully sealing of these fistulae, thus ensuring that the patient may be comfortable for the remainder of their life. Due to the low rate of complications and the quick relief from symptoms, a marked reduction in the duration of hospital stay is achieved. Palliative local pretreatment of the esophagus does not negatively affect the application of a covered expandable stent in the case of fistula, provided the leakage does not occur immediately after the intervention.

Antimigration Stents

Stent migration is a recognized complication of esophageal SEMS use. Experience with SEMS has revealed an increased risk of migration when either covered stents are used or a stent is implanted across the gastroesophageal junction. In cases of stent migration, extraction of the stent is strongly advocated because of the risk of bowel obstruction or perforation. However, extraction of a migrated esophageal stent may be extremely difficult with a substantial risk of complications including esophageal perforation and hemorrhage.

Data from several studies evaluating various types of SEMS indicated that the overall migration rates range from 2% to 8%, but the migration rate with membrane-covered metal stents is higher, presumably due to reduced friction between the membrane and the esophageal wall. The migration rate with these stents ranges from 10% to 35% in reported series. Kozarek et al. [8] reported a 27% migration rate for covered Z-stents (Wilson-Cook Inc., Winston-Salem, North Carolina, USA) at a mean duration of 1 month.

It should be noted that the manufacturers of the stent (Wall-stent; Microvasive, Boston Scientific Corporation, USA), recommend that it should not be used in lower esophageal strictures, as it may be prone to migration. Displacement or misplacement may also result from miscalculating the stricture length or from failing to control SEMS movement during deployment.

Recently, various types of new stents and several methods aimed at preventing stent migration have been tried. In 1997, a North American multicenter trial prospectively studied a 25-mm flanged covered Z-stent to assess dysphagia palliation and whether the increased diameter of the flange affected placement or migration problems. Wu et al. [9] reported only four migrations in 32 patients treated for malignant dysphagia or fistula using the modified covered self-expanding Gianturco-Rösch Z stent with a 22-mm diameter flange.

To prevent migration of the stent, we made a modified covered self-expandable esophageal metal stent that could be held in

place by means of a silk thread attached from the edge of proximal end of the stent to the patient's ear via the nares (Figure 2). In fact, in 1885, Sir Charles Symonds [10] originally proposed the idea of using a silk thread via the nares to tie the proximal end of a stent to the patient's moustache, if one was available, to prevent migration of the stent. However, external fixation using a silk thread to prevent migration has not received wide attention to date.

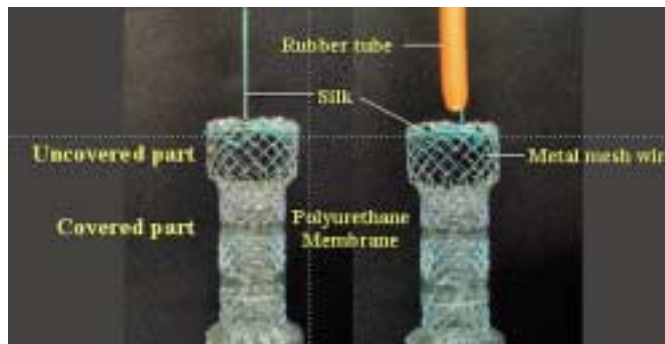


Figure 2 Newly designed esophageal stent, with Shim's modification for preventing stent migration. To prevent migration, we made a modified covered SEMS that was held in place by means of a silk thread fixed to the edge of the proximal end of the stent, and leading via the nares for attachment to the patient's ear.

The structural and functional characteristics of this modified membrane covered self-expandable esophageal stent are as follows. The uncovered proximal flange tends either to embed or to elicit growth of granulation tissue wherever exposed wires are in contact with mucosa. If the uncovered proximal flange of the stent is completely embedded into the esophageal mucosa after several days of stent insertion, this will prevent the migration of the stent. During this period, a silk thread tethering the proximal end of the stent to the patient's ear has the main role in preventing the early migration of the stent that may occur within 7 days after insertion of the stent.

In our study, no stent migration occurred during the mean follow-up period of 7.5 months (range 1–17) among the 61 patients. This result is very remarkable and an important point in our study. The authors believe that this modification of the stent effectively prevented distal migration [11]. In conclusion, use of modified covered esophageal stents appears to prevent stent migration and ameliorate dysphagia in patients with malignant tumor stenosis at the esophagogastric junction, a short segment of tumor stricture less than 5 cm in length, a soft tumor stenosis, or a tracheoesophageal fistula.

Antireflux Stents

With the rising incidence of carcinoma involving the distal esophagus and gastric cardia, SEMS are increasingly being deployed across the gastroesophageal junction. This can predispose to significant gastroesophageal reflux, which can in turn adversely affect the quality of remaining life. To resolve this problem, a few attempts have been made in the past to develop esophageal stents with an antireflux mechanism. Nunes & Val-

buena attached latex sleeves to rigid plastic esophageal stents. Mizumoto used a cylindrical gortex modification to prevent reflux.

Dua [12] recently designed a modified self-expanding metal esophageal Z-stent to prevent reflux. The polyurethane coating was extended beyond the lower metal cage so as to form a “windsock”-type valve. Dua reported that this antireflux stent was effective in preventing reflux without interfering with antegrade flow. However the Dua stent has some limitations. First, stent insertion is more difficult than with conventional stents. In addition the antireflux valve can be inverted under high pressure gradients, for instance with belching, vomiting or coughing.

We evaluated the usefulness of a newly designed antireflux esophageal stent (Dostent; M.I. Tech., Seoul, Korea). It is a fully covered esophageal stent which has a tricuspid antireflux valve in a larger distal band in order to prevent reflux. Most patients experienced relief of the reflux symptoms, but some showed evidence of acid reflux on 24-hour pH monitoring and a reversed or distorted valve upon endoscopic examination. We therefore designed a new model. This modified antireflux stent is a fully covered esophageal stent which has an S-type antireflux valve with a long leaflet inside the stent body, and we fixed the antireflux valve to the stent wall in order to minimize acid reflux and to prevent inversion of the valve (Figure 3).

We compared this model with conventional SEMS and the Dostent, for reflux symptoms, dysphagia score and ambulatory 24-hour pH monitoring results. The dysphagia score improved significantly with all stents. Among the three stents, the newly designed S-type stent with the antireflux valve, was found to be best at preventing acid reflux according to the pH monitoring results (Table 1). The modification does not appear to interfere with the primary function of the stent, that is, relieving dysphagia. From our limited experience with the new antireflux valve stents, we believe that, the long S-shape type valve is most effective in preventing acid reflux and valve inversion.

Table 1 Comparison of various types of esophageal stents with antireflux mechanisms

	Conventional n = 8	Tricuspid valve n = 9	Double tricuspid valve n = 2	S-type valve n = 15
Insertion technique	Shim	Shim	Shim	Shim
Dysphagia score				
Pretreatment	3.38	3.1	3.5	3.0
Post-treatment	1.0	1.1	1.0	1.0
pH monitoring				
Total pH < 4	17%	31%	14%	2.6%
DeMeester score	71	105	52	10

Benign Esophageal Stricture

The efficacy of SEMS has been well established in the treatment of malignant esophageal stricture. On the other hand, SEMS are used only rarely in benign esophageal stricture, for several reasons. First, most metal stents cannot be removed without surgery and therefore cannot be used on a temporary basis. Second, the long-term consequences of metal stent placement are unknown. Third, results from animal studies as well as experience gained from using metal stents in other benign gastrointestinal strictures suggest that mucosal hyperplasia may eventually occlude the stent in some cases. Finally, a more aggressive surgical approach such as esophagectomy is often justified in patients with benign disease who have good functional status.

There are far fewer reports of the use of SEMS in the treatment of benign conditions, and most of these reports describe an unacceptably high complication and mortality rate, either because of the stent itself or the necessary later treatment. The most common complications include stent migration, formation of new strictures, chest pain and gastroesophageal reflux. Stent migration has been shown to be a particular problem with the use of covered stents. The formation of new strictures is more commonly seen with uncovered stents. With the use of covered stents, strictures can develop at either or both ends, but with uncovered stents there is also the potential for stricturing along the length of the prosthesis, because of tissue ingrowth between the wires.

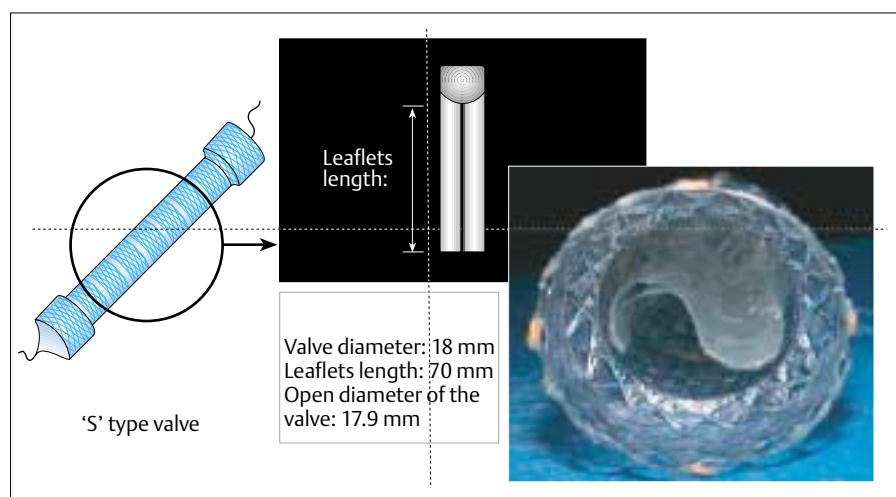


Figure 3 Newly designed esophageal stent with an S-type antireflux valve. The modified antireflux stent is a fully covered esophageal stent which has a S-type antireflux valve with a long leaflet inside the stent body; the antireflux valve is fixed to the stent wall in order to minimize acid reflux and to prevent inversion of the valve.

However, several studies have reported that the temporary use of SEMS may be a reasonable option in patients with benign esophageal stricture. Song et al. [13] reported that three of the four stents that migrated within 2 months after placement caused recurrence of the stricture, but none of the four stents that migrated more than 2 months after stent placement caused stricture recurrence. Song et al. believe that benign esophageal strictures can be treated effectively if a covered stent is removed after the stricture is healed. These authors are unsure about the best time to remove the stent but believe that 4–8 weeks after placement might be optimal, not only because formation of new strictures above or below the stent was not common during that period but also because recurrence of strictures was rare during that period.

We adapted the fully covered self expandable metal stent for use in benign esophageal stricture. In order to prevent migration of the stent and to easily remove the stent, we made three small rings of silk thread, at the proximal end of the stent. The silk ring is fixed to the esophageal mucosa by hemoclipping in order to prevent migration of the stent. When the stent is removed, the silk ring is cut easily using scissor forceps. However, fixation of the stent to the esophageal mucosa by hemoclipping has some inherent problems, such as premature loosening and slippage of the clips, which has already been demonstrated in some cases. It is necessary that some modification of current techniques should be developed to address these issues, so as to prevent stent migration.

Conclusions

There is a variety of endoscopic palliative therapies for patients with dysphagia due to inoperable esophageal cancer. Each offers potential advantages in particular patients. When appropriately selected and employed, they are safe and effective for the palliation of obstructive symptoms. The keys to successful endoscopic palliative therapy are appropriate patient selection and device selection, stricture characterization, and communication of expectations between the physician, the patient and the patient's family.

Only a few years ago, several clinical situations were considered to contraindicate stent insertion, such as severe angulation of strictures, location of lesions less than 2 cm from the upper esophageal sphincter, tumors lacking a proximal shelf to prevent migration, lesions having the risk of airway compression by the stent, luminal obstruction that could not be dilated, and horizon-

tal orientation of a stricture at the gastroesophageal junction that would not allow good flow through a stent. However, this is a field of rapid technological and functional advances, and SEMS have made a significant contribution to the management and palliation of dysphagia in a group of patients in whom treatment has traditionally proved extremely difficult.

A multidisciplinary team approach to the palliation of inoperable esophageal cancer is very important. Both metallic endoprostheses and photodynamic therapy may be used in conjunction with other palliative treatments such as radiotherapy and chemotherapy.

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