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## Esophageal stents in benign and malignant diseases

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## ABSTRACT

Esophageal stenting was originally offered to patients with advanced esophageal malignancy, for whom it was considered as a costly modality of palliation. Advances in stent design and technology have resulted in more varieties of stents like the fully covered and removable metallic stents as well as self expanding plastic stents. As a result, the use of esophageal stents has been expanded to various benign conditions as well as to neoadjuvant settings in malignancy. This article tries to outline the current status of stenting in a variety of benign and malignant conditions of the esophagus.

## 1. Introduction

It is believed that the word 'stent' originates from the surname of Dr Charles Stent, a British dentist who first used a compound to create dental models made from impressions of teeth and oral structures[1]. His name later became synonymous with any material or device that can hold tissue in place or provide support for biologic materials. Use of metallic stents in esophagus probably dates back only to 1990, when Fujiwara *et al* reported the use of esophageal stents in experimental dogs[2]. Prior to this, crude stents made from polyvinyl plastic or rubber were used but they had several drawbacks. The first endoscopically placed metallic stent for malignant esophageal stricture was reported by Neuhaus *et al* in 1992[3]. In the same year, Song *et al* reported the technique of esophageal stent placement under fluoroscopic guidance in benign and malignant lesions[4]. In the last two decades, the field of esophageal stenting has witnessed several refinements in

technique and stent design, and indications of stenting have widened. This review attempts to define the current status of esophageal stenting in both benign and malignant lesions of the esophagus.

## 2. Types of stents

Stents can broadly be divided into metallic and plastic stents. Metallic stents in use currently are all self expanding metallic stents (SEMS). The initial types of stents tried were all uncovered stents, but tumour in-growth became a significant problem with such stents. Hence partially covered stents were designed, using silicone or plastic covering. Fully covered self expanding metallic stents (FCSEMS) and self expanding plastic stents (SEPS) are newer designs which attempt to overcome problems like tissue hypertrophy and in-growth at stent edges. Covered stents have higher risk of migration, but are useful in benign conditions where stent removal may be needed once the stricture expands. The important types of stents that are in use currently are given in Table 1[5-7].

Esophageal stenting can be broadly divided into two

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**Table 1**  
Different types of esophageal stents commercially available.

Type of stent	Name	Manufacturer	Special features
Stainless steel stents	Gianturco Z stent	Cook	Partially covered stent woven in interlocking Z configuration
Stainless steel stents	Dua antireflux stent	Cook	Z stent with a polyvinyl “windsock” extension of the wrap at the distal end
Stainless steel stents	Flamingo stent	Boston Scientific	Asymmetric, funnel-shaped, with greater radial expansion proximally, to reduce migration across the esophagogastric junction
Nitinol stent	Ultraflex stent	Boston Scientific	Partially covered with polyurethane at the mid portion, flexible knitted loop design
Nitinol stent	Wallstent	Boston Scientific	Available in partially and fully covered versions (silicone covering) with progressive step flared edge design
Nitinol stent	Evolution	Cook	Having an internal and external silicone membrane to resist tumor and granulation tissue on the one hand and to facilitate food passage and also having uncoated flanges (dogbone shape)
Nitinol stent	Alimaxx EE	Alveolus	Laser cut nitinol stent with polyurethane cover, with antimigration struts
Nitinol stent	Niti S	Tae Woong Medical	Uncovered second layer over silicone covered first layer to prevent migration
Nitinol stent	Choo stent	MI tech	Polyurethane covered, and also having an antireflux variant
Nitinol stent	Bona stent	Standard Sci Tech	Silicone covered, having a fixed flexible and stable inner antireflux valve (Shim’s modification)
Polyester stents	Polyflex stent	Boston scientific	Made of polyester mesh and covered with a silicone membrane

types: 1) stents used in various benign conditions of the esophagus; 2) stents used in esophageal malignancy.

### 3. Esophageal stenting in benign conditions of the esophagus

Esophageal stenting has been tried in several benign conditions of the esophagus especially benign strictures, post esophagectomy leaks, esophageal perforations, and esophageal fistulae. The two broad types of stents tried in these cases are the FCSEMS and the SEPS.

#### 3.1. FCSEMS

There is recent interest in the use of FCSEMS in benign lesions. A commercially available version called Alimaxx E (Alveolus Inc., Charlotte, NC) has been studied in small series of benign conditions in at least 3 series, by Eloubeidi *et al*[8], Bakken *et al*[9] and Senousy *et al*[10]. Other FCSEMS commercially available include the Wallflex esophageal stent (Boston Scientific Inc, Natick, Mass), Bonastent esophageal stent (Standard Sci–Tech, Seoul, Korea), and Evolution esophageal stent (Cook Medical Inc, Winston–Salem, NC). Buscaglia *et al*[11] recently reported their experience with all the above 4 types of FCSEMS in benign lesions. All these authors reported good procedural success, with removability rates ranging from 95%–100%, with little tissue reaction. But the major limiting factor was the high

rates of stent migration, upto 35% and low clinical success, (especially in strictures) lowest being 29%[8–12]. Preliminary data on experimental animals provide hope for emerging therapeutic modalities like drug eluting stents to overcome these limitations[13].

#### 3.2. SEPS

SEPS has been studied by several authors in various benign disorders of the esophagus especially strictures. Table 2 summarizes some of the data available from larger series in this regard.

SEPS also has high migration rates and though immediate clinical success may be achieved in strictures, long term success rates continue to be low. A pooled data analysis concludes that clinical success is achieved in 52% patients only and the rates are lower for high level strictures. Stent migration is seen in about 24% cases and life threatening complications and even death may occur[19].

#### 3.3. Issues to be considered in stenting for benign conditions

Stenting for benign conditions has the following limitations: 1) In absence of a stenosis, in conditions like leaks and perforations, the stents may not hold and tend to migrate; 2) If SEMS with uncovered ends are used, tissue hyperplasia at the ends tends to prevent migration, but can induce esophageal stenosis later after stent removal.

Some authors advocate that stents placed for benign

**Table 2**  
SEPS in benign esophageal disorders.

Author, year	Number of patients	Clinical improvement/success	Migration rate	Other significant complications
Karbowski, 2008 [14]	27	90%	29.6%	One trachea esophageal fistula
Evrard, 2004 [15]	21	80.9%	14.3%	One case of tracheal compression
Dua, 2008 [16]	40	66%	22%	One case of massive bleeding and mortality
Holm, 2008 [17]	30	92.8%, (only 6% long term improvement after removal)	62.1%	Perforation, tracheal compression
Ott, 2007 [18]	13	92%	37%	One case of esophageal perforation

conditions should be removed after 6 weeks, but the lesion may not be corrected by this time and removal *per se* may cause severe bleeding<sup>[20]</sup>. Another method is to deploy a SEPS inside a SEMS in benign conditions to facilitate easy removal when required. A recent retrospective analysis provides the largest data available so far on stenting in benign conditions, where 153 stents were deployed in 88 patients. This centre used a SEMS to treat the primary lesion like a perforation or a leak. Tissue hyperplasia at stent edges causes difficult removal, hence a SEPS was deployed inside the SEMS, which would expand and cause pressure necrosis of the area of hyperplasia and facilitate easy removal of the SEMS. This technique produced clinical success in 77.6% cases, with low migration rates of 11.1%<sup>[21]</sup>.

#### 4. Benign esophageal lesions requiring stenting

The various benign conditions of the esophagus which necessitate stenting include benign strictures, post esophagectomy leaks and strictures, esophageal perforations and esophageal fistulae.

##### 4.1. Benign strictures

Benign strictures may arise in the esophagus secondary to a variety of causes like peptic esophagitis, corrosive ingestion, post radiation strictures, *etc.* The initial therapy of choice in such cases is serial endoscopic dilatation. But there are cases of tight strictures that are recurrent to repeated balloon dilation with patient refusal of or inability to undergo surgical correction. These cases may be considered for placement of esophageal stents of various types<sup>[5]</sup>. There are no randomized controlled trials in literature comparing different types of stents in benign esophageal strictures. Hence, data available in this regard have their own limitations. The available data on FCSEMS and SEPS have already been discussed. The clinical success rates like 29% are among the lowest for this group when compared to other benign conditions.

##### 4.2. Post esophagectomy leaks and strictures

Intrathoracic anastomotic leak after esophagectomy for benign or malignant conditions is an important cause of morbidity. Placement of endoluminal stents has been reported to be effective in controlling these leaks<sup>[21–24]</sup>. In a large series, upto 77.6% of patients with post operative leaks responded to stenting with a median duration of FCSEMS treatment of 83 days<sup>[20]</sup>. Polyflex type of SEPS has also been used in such situations with equally good success rates<sup>[25,26]</sup>.

Similarly, small case series also report the use of FCSEMS in the management of post esophagectomy anastomotic strictures<sup>[27]</sup>. Improvement in quality of life and symptomatic relief is achieved in patients who undergo stenting when initial few attempts at dilatation of post operative strictures fail.

##### 4.3. Esophageal perforations

Esophageal perforations are most commonly iatrogenic, but some may also be spontaneous, as in Boerhaave's syndrome. Irrespective of the etiology, they carry a poor prognosis. Esophageal stenting is evolving as a less morbid option in the management of these conditions. Various case series show healing rates upto 97%<sup>[20,28]</sup>. There are no randomized controlled trials comparing surgical management and stenting. However, some retrospective data show that outcome of iatrogenic perforations is significantly better if stenting is done immediately after the perforation<sup>[29]</sup>.

##### 4.4. Esophageal fistulae

Esophageal stenting has also been reported with good success rates in healing of trachea esophageal fistulae in critically ill ventilated patients who are not otherwise candidates for any other form of surgical management<sup>[30]</sup>.

In short, esophageal stenting is a definite treatment modality in the management of various benign conditions of esophagus like post surgical leaks, iatrogenic perforations, strictures and fistulae, which have a high mortality rate with surgical management. However, data are limited to case series and randomized controlled trials are lacking.

#### 5. Esophageal stenting in malignancy

Esophageal stenting for cancer can broadly be divided into two types: 1) those for palliation in advanced cases; 2) those for neoadjuvant therapy.

##### 5.1. Palliative esophageal stenting in malignancy

Data from several large series show that SEMS placement is a safe technique to achieve good symptom palliation in patients with advanced esophageal cancer<sup>[31–36]</sup>. Stenting may be done under either endoscopic or fluoroscopic guidance. Successful stent placements are achieved in upto 98% cases<sup>[31]</sup>. Minor procedural complications which lead to morbidity were seen in upto 26% to 45% in various series<sup>[31–36]</sup>. Complication rates have traditionally been considered to be higher in patients with proximal esophageal cancers. But a recent study showed stent related complications in 26.9% of patients with proximal cancers, which was not significantly different from that in patients with distal cancers<sup>[37]</sup>. Apart from malignant strictures, esophageal fistulae secondary to advanced malignancy also respond well to placement of covered SEMS<sup>[33,38]</sup>. Airway stenting may also need to be added in some of these patients<sup>[39]</sup>.

Esophageal stenting is a mode of palliation and in advanced malignancies it has been shown to improve quality of life indices<sup>[40]</sup>. Data from our centre show significant improvement in quality of life post stenting in a cohort of 30 patients with advanced esophageal malignancy<sup>[41]</sup>. However, it is controversial whether there is any survival benefit in

**Table 3**

Randomized controlled trials comparing different types of stents in esophageal malignancy.

Author, year	Number of patients	Stents compared	Result
Siersema, 2001 [51]	100	Ultraflex stent, Flamingo wallstent, Gianturco Z stent	Similar degree of palliation, Gianturco Z associated with more complications
Sabharwal, 2003 [52]	53	Ultraflex, Flamingo wallstent	Both are equally effective
Conjo, 2007(53)	101	Polyflex, Ultraflex	Similar degree of palliation, migration more with Polyflex
Verschuur, 2008 [54]	125	Ultraflex, Polyflex, Niti S	Similar degree of palliation, Polyflex associated with increased migration and difficult placement

patients treated with radiotherapy and or chemotherapy after stenting[42–45].

### 5.2. Esophageal stenting in the neoadjuvant setting

Due to the presence of dysphagia, nutritional compromise is extremely common in patients undergoing neoadjuvant therapy for esophageal cancers, which results in worse outcomes in surgery. SEMs insertion if done in this setting was classically thought to be associated with risk of stent related complications as well as difficulties in surgery later on. However, with the advent of self expanding removable metallic stents (SERMS), *i.e.* the FCSEMS, there is a renewed interest in this regard.

Studies have shown that SERMS in the neoadjuvant setting is safe and improves symptoms as well as nutrition[46–48]. There was significant fall in dysphagia scores and performance status after stenting in these series. However, stent migration is a problem in this setting also, with migration rates upto 43.8%[48]. Tissue reaction to stents occurs but does not appear to impair removability. The above series showed 100% removability, but one of these authors[47] reported ulcerations at the proximal or distal edge of stents on removal in 75%, polyps in 50%, and granulation in 75%. There was no increased risk of perioperative complications due to stenting in all these series. However, all available data in this regard are limited to prospective studies and randomized controlled trials in this regard are necessary.

### 5.3. Which esophageal stent to choose in esophageal malignancy?

Either covered, uncovered or plastic stents may be used in the esophagus. There are a few studies available, which compare the different commercially available types of stents. Eickhoff *et al* in their study on 150 patients found that the major complication rate of the Gianturco Z stent was significantly higher when compared to the complication rate of the Ultraflex stent and the Flamingo Wallstent[49]. Verschuur *et al* found that the complication rates are higher for the Gianturco Z stent if the large diameter version is used[50].

Table 3 summarizes the results of some of the randomized controlled trials available in literature between different types of esophageal stents.

### 5.4. SEPS or SEMS?

As noted in Table 3, Polyflex stents are technically more difficult to place and have higher chance of migration. But, they achieve almost equal degree of palliation and are useful in management of patients with tissue in-growth after SEMs placement[55].

A meta-analysis of available data suggests that SEMs are superior to SEPS in terms of stent insertion-related mortality, morbidity, and quality of palliation. The uncovered variety of stents is disadvantaged by high rate of tumor in-growth[56]. These facts should be considered in choosing the type of stent to be used in a particular patient.

### 5.5. Antireflux stents

In patients with distal esophageal malignancy, severe reflux symptoms are common with conventional stents. Antireflux stents which incorporate a valve or windsock like mechanism at the distal end have been tried in these cases. Randomized controlled trials have shown that antireflux stents lead to improvement in symptoms of reflux compared to conventional stents, although palliation of dysphagia and improvement in quality of life are similar in both groups[57–59].

## 6. Cost effectiveness

Although esophageal stenting has been shown to be a safe and effective modality of palliation in patients with advanced esophageal malignancy, an important factor in its use, especially in developing countries, is the high cost. However, recent studies on cost effectiveness have also shown that covered metallic stents are more cost effective when compared to uncovered stents as well as plastic stents in these patients[60].

## 7. Conclusion

Esophageal stenting has a definite role in the management of a variety of benign conditions of the esophagus like strictures, post esophagectomy complications, esophageal perforations and fistulae. In patients with esophageal malignancy, they produce significant improvement in symptoms and help patients to achieve better quality of life. Advances in stent design and technology should hopefully pave the way for cheaper stents which would be a boon for patients in developing countries where esophageal malignancies are rampant.

## Conflict of interest statement

We declare that we have no conflict of interest.

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