# Esophageal Strictures Refractory to Endoscopic Dilatation

2

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## Introduction

Esophageal stricture is a common issue faced by clinicians who care for patients with foregut disorders. Generally, strictures can be effectively managed using endoscopic techniques such as dilation. Improved control of the primary pathology, in most cases gastroesophageal reflux disease (GERD), is also typically effective in limiting recurrence of a stricture after therapy. However, while many strictures are effectively managed with simple dilatation, a minority remain refractory to treatment, posing a particularly difficult challenge to both the patient and the physician. We define such a "refractory" esophageal stricture if one or more of the following criteria are met: (1) failure to achieve an adequate luminal diameter to allow intake of solid food without dysphagia despite up to four repeat dilatations at 2-week intervals or (2) stricture which requires surgical intervention at any point. While such strictures can be challenging to manage, a thoughtful and systematic approach can allow the restoration of good swallowing function for the patient.

## Etiology of Esophageal Strictures

Esophageal strictures form as the result of injury to the esophageal wall with the subsequent development of scar tissue and secondary tissue contraction. The vast majority of the time, stricture formation is associated with long-standing GERD and may be seen in combination with a primary motor disorder of the esophagus. However, approximately 20–30% of cases are unrelated to GERD. These strictures may be associated with surgical anastomoses (such as following esophagectomy), scar formation after antireflux surgery, caustic ingestion, prior radiation treatment, or malignancy.

Typical esophageal strictures are characterized by a cicatricial, anatomic narrowing of the esophagus, which we define as either simple or complex strictures. Simple strictures are short (<2 cm) and focal, straight, and can be traversed with an adult endoscope prior to dilatation. In contrast, complex strictures are long (>2 cm), irregular, angulated or difficult to traverse with an endoscope [1].

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## Treatment

There are a variety of nonsurgical and surgical treatment options for esophageal strictures. The choice of approach depends upon the etiology and complexity of the stricture and the response to prior treatment. First-line therapy for esophageal strictures is endoscopic dilation, with serial intervention often required. More aggressive surgical therapy is typically reserved for those patients who fail an endoscopic management strategy.

## Treatment of Benign Esophageal Strictures

With the exception of congenital strictures, the pathogenesis of all benign esophageal strictures is transmural cellular injury; the inflammation that ensues leads to collagen deposition and fibrosis and ultimately causes a cicatricial narrowing of the lumen. Consequently, treatment strategies for benign strictures are designed to (1) establish patency of the esophageal lumen, (2) disrupt and displace the fibrotic tissue of strictures to restore a satisfactory diameter of the lumen, (3) minimize or prevent reorganization of the fibrotic tissue (and hence recurrence of) the stricture, and (4) minimize or prevent ongoing cellular injury.

### Nonsurgical Options

#### Endoscopic Dilatation

Esophageal dilation has been performed for nearly 400 years. It was first described in the seventeenth century when a sponge was affixed to a piece of carved whalebone and used to dilate a patient with achalasia [2]. Alexis Boyer performed the first bougienage (as it is performed today) in 1801 to dilate an upper esophageal stricture [3]. Since then, a number of materials have been utilized to construct bougies. The word "bougie" is derived from a town in Algeria (Boujiyah) that was a medieval center for wax candle trade; the original bougies were made of wax and cloth [3].

There are two broad categories of dilators: bougie dilators (i.e., Maloney, Savory-Gilliard®, and American Dilation System® dilators) and balloon dilators. Bougie and balloon dilators have slightly different mechanisms of action. Bougie dilators exert both longitudinal and radial force. In contrast, balloon dilators exert only radial force. Based on data from randomized controlled trials, there is no proven difference between either system with regard to safety and efficacy [4, 5]. Consequently, the choice of dilator is usually simply based on the endoscopist's preference, though there are certain situations where one dilator system may be preferable [6].

In general, we prefer to dilate strictures using Savory dilators over a guidewire under real-time fluoroscopic guidance. However, this approach does not work well for complex, distal, angulated strictures (e.g., a complex distal anastomotic stricture after colonic interposition) due to the inability to pass the relatively rigid tip of a bougie dilator beyond such strictures. In these situations, balloon dilators are a better option since they can be guided and deployed across an angulated strictured segment. Before classifying a stricture as "refractory," it is important to assure that it was properly treated.

In general, our goal is to dilate esophageal strictures to a level that allows patients to tolerate a regular diet without dysphagia. As a general, safe guide to dilating strictures, the "rule of threes" is useful to minimize the risk of perforation. The rule states that once moderate resistance is encountered when passing serial dilators at three French intervals, no more than three serial dilatations should be performed in a single session (beginning with the dilator that was associated with moderate resistance). We also perform regular interval repeat endoscopies when performing multiple repeat dilatations in a single setting to assure that it is safe to proceed with further dilatation. A superficial or moderate thickness mucosal tear (due to disruption of fibrosis) is indicative of an "adequate" dilatation and serves as our stopping point. A low threshold should be adopted to obtain a postprocedure barium esophagram prior to discharge if a full

thickness tear cannot be ruled out on completion endoscopy.

Patients with tight strictures who have near-complete obliteration of their esophageal lumen should be approached cautiously. These strictures can function as a one-way valve. Consequently, if excessive endoscopic insufflation is used, massive gastric distension can ensue and, in extreme circumstances, may result in gastric necrosis. For such strictures, we recommend cautious endoscopic insufflation and passing a guidewire under both endoscopic and real-time fluoroscopic guidance prior to antegrade dilatation.

For patients who continue to have dysphagia after dilation, we perform a repeat endoscopy and dilation in 2 weeks to allow the mucosal tear sufficient time to heal yet reintervene before the stricture can fully reorganize. Some patients (especially those with anastomotic or caustic strictures) require an aggressive schedule of multiple repeat dilatations at 2-week intervals.

Stricture recurrence is common. The likelihood needing a single recurrence is 40–80 % [7–10]. For patients who have a single recurrence, up to 90 % develop another recurrence [9]. For motivated, select patients who require frequent dilatations, self-dilatation is well-tolerated, effective strategy [11, 12]. Alternatively, for strictures that fail to respond to simple bougie or balloon dilatation, adjunctive endoscopic measures may be considered.

## Steroid Injection

Because benign esophageal strictures result from the production of fibrous tissue and collagen deposition, endoscopic intralesional injection of steroids has been utilized as an adjunct to dilatation for refractory strictures. The mechanism of action of intralesional steroids in the reduction of fibrosis is poorly understood but may involve inhibition of fibrogenic cytokines (i.e., IL-1, TNFα and TGF-β), reduction in procollagen and fibronectin synthesis, and reduction in the synthesis of collagenase inhibitors (i.e., α2-macroglobin) [1, 13].

There are a number of small observational studies that suggest a possible benefit for treating refractory benign esophageal strictures from various causes. These studies demonstrated an improvement in dysphagia [14, 15], an increase in the symptom-free interval between dilatations [16, 17], an increase in the maximal diameter achieved on subsequent dilatations [17, 18], and a decrease in the need for subsequent dilatations [14].

There is little randomized data on the use of intralesional steroid injection. One randomized trial compared steroid injection (0.5 cc/quadrant of triamcinolone [40 mg/cc]) plus balloon dilatation ($n=15$) versus sham injection and balloon dilatation ($n=15$) for patients with peptic strictures who continued to have at least weekly dysphagia. For patients who underwent steroid injection, there was a statistically significant reduction ($p=0.02$) in the need for repeat dilatation (13 %) as compared with the control group (60 %). There was also a significant increase ($p=0.01$) in the interval between dilatation [19]. Another (smaller) randomized trial reported similar results [20].

## Esophageal Stenting

Esophageal stents maintain patency of the esophageal lumen by exerting radial force on the stricture. Due to the risk of granulation tissue in-growth and over-growth and the resultant risk of obstruction and difficulty removing the stent, we do not use self-expanding metal stents. Self-expanding plastic stents, however, are a potential option for middle and distal esophageal strictures. One systematic review pooled the results for 130 patients (from 10 studies) with benign esophageal strictures that were treated with self-expanding metal stents. Dilatation-free remission was achieved in 52 % of patients [21]. That study also highlighted one of the major limitations of plastic stents—high migration rates (approximately 25 %) [21]. Consequently, reintervention for stent migration is common. Migration into stomach is easily managed (by stent removal and [if needed] replacement); migration into the duodenum can be dangerous. Given the limitations of metal and plastic stents, biodegradable stents are an interesting development [22]. However, further investigation is needed to define their role in the treatment of benign esophageal strictures.

Self-expanding plastic stents are a temporary treatment strategy. If used, repeat endoscopy should be performed at 2-week intervals to assess the need ongoing stenting. If still needed, the stent should be removed (preferably through an overtube) and replaced. We primarily use self-expanding plastic stents for patients with benign middle and distal esophageal strictures that sustain a perforation during dilatation. For refractory strictures near the cricopharyngeus, we prefer silicone salivary bypass (Montgomery) stents due to the risk of proximal migration, globus sensation, and tracheal compression (and resultant risk of airway compromise or tracheoesophageal fistula) from the radial expansile forces associated with self-expanding plastic stents [23, 24]. Covered, flexible stents that exert a low degree of radial force (e.g., Ultraflex stents) are an alternative to Montgomery stents.

### Rendez-Vous Procedure

Some patients develop complete loss of the patency of the esophageal lumen from a variety of benign and malignant disorders. Standard antegrade dilatation can be dangerous in such patients. For these patients, combined antegrade and retrograde dilatation (a "rendez-vous procedure") is a safe, useful technique that restores patency of the lumen in 80–100 % of patients [25–30].

We perform the procedure under general anesthesia. A standard adult (9.8 mm) flexible endoscope is advanced antegrade down the esophagus under direct vision to the level of the obstruction. If a gastrostomy tube was previously placed, the gastrostomy tube is removed and a pediatric (5.5 mm) flexible endoscope is advanced retrograde up the esophagus to the distal aspect of the occlusion. Alternatively, if a gastrostomy tube is not in place, we perform a mini-laparotomy and place one. The orientation of the lumen is determined using a combination of endoscopy and fluoroscopy. Next, the lumen is punctured retrograde using a guidewire, brought out through the mouth, and used for antegrade dilation.

### Incisional Therapy

As an alternative to repeat dilatations, some endoscopists have explored the use of incisional therapy. These techniques use electrocautery with [31] or without dilatation [32], electrocautery combined with argon plasma beam coagulation [33], needle-knife techniques [34], or endoscopic scissors [35]. However, based on data from a randomized trial, there is no significant difference in the success rate of incisional therapy as compared with Savary bougienage [36]. Consequently, we prefer dilatation to incisional therapy.

## Surgical Options

### Antireflux Surgery for Peptic Strictures

First-line treatment for peptic strictures is esophageal dilatation and use of proton pump inhibitors (PPIs). However, a significant number of patients with peptic strictures fail conservative (first-line) treatment of peptic strictures, evidenced by failure of their esophagitis to heal, inability to achieve symptom relief (or development of worsening symptoms), and the need for repeat dilatations. In fact, 30–40 % of patients with peptic strictures need repeat dilatations within a year of their initial dilatation [37–39]. Peptic strictures are a complication of GERD. For GERD patients who fail maximal medical therapy, laparoscopic antireflux surgery is a time-proven, safe, and effective treatment with low associated morbidity and mortality [40, 41]. Consequently, for patients with peptic strictures who are otherwise appropriate surgical candidates and who fail a trial of dilatation and PPI therapy, antireflux surgery should be offered.

To date, there are no randomized trials comparing maximal medial therapy with laparoscopic antireflux surgery. One retrospective study compared a group of 42 patients treated with antireflux surgery with a control group of 78 patients treated medically (with H2 blockers and bougienage) over a 3-year period and found that patients treated surgically required fewer dilatations [42]. Furthermore, there are single institutional series that have demonstrated that laparoscopic antireflux surgery is safe and effective in appropriately selected patients with peptic strictures that have failed to respond to conservative therapy. It

results in improvement in both dysphagia scores and quality-of-life measures while reducing the need for dilatations [43, 44].

Special consideration needs to be given to patients with peptic strictures who undergo esophagectomy. Peptic strictures are the result of transmural inflammation which can cause esophageal dysmotility (in approximately 20% of patients) and the resultant need for a partial fundoplication [43]. Transmural inflammation can also cause esophageal foreshortening. If inadequate intraabdominal esophagus is present at the completion of the lower mediastinal dissection, a Collis gastroplasty should be performed.

### Esophagectomy

Some patients with benign esophageal strictures from failed prior fundoplications [45, 46], use of synthetic mesh to repair a hiatal hernia [47], and corrosive injuries that fail to respond to dilatation [48–50] are best served by esophagectomy, which can be performed with a morality rate under 1% [51]. We prefer to use a tubularized gastric conduit for esophageal replacement, and use a colonic conduit when the stomach is not usable.

As an alternative to esophagectomy, some investigators have described the esophagoplasty with myocutaneous flaps [52], a vascularized colonic patch [53], and extracellular matrix scaffolds [54]. However, patch esophagoplasty is prone to anastomotic leak, graft necrosis, and donor site complications. Consequently, we prefer standard esophagectomy and reconstruction techniques.

Finally, some have advocated bypass (rather than esophagectomy) for corrosive esophageal injuries due to a perceived increased risk of bleeding, tracheobronchial injury, and recurrent laryngeal nerve injury secondary to dense periesophageal adhesions [55]. However, based on retrospective studies, there is no significant difference in morbidity or mortality between bypass and esophagectomy [48, 56]. Furthermore, there is a 3–13% chance of developing cancer within the bypassed esophagus (which is not accessible for routine endoscopic examination) [55, 56]. Consequently, we do not perform an esophageal bypass.

## Malignant Esophageal Strictures

### Endoscopic Treatment

#### Dilatation

Though it may require repeat intervention, simple dilatation is an effective method to treat dysphagia secondary to malignant esophageal strictures, especially when external beam radiation therapy with or without chemotherapy is planned.

#### Stent Placement

Esophageal stent placement provides rapid relief of dysphagia and is the most commonly used modality to palliate dsyphagia secondary to malignant esophageal strictures. A variety of esophageal stents are available, which differ in their design, length, diameter and flexibility as well as the amount of radial force they exert. We do not use uncovered metal stents due to the risk of tumor and granulation tissue in-growth, which results in a partial obstruction and recurrent dysphagia. Most of the available self-expanding metal stents in the United States are made of nitinol and are available in partially covered (i.e., Ultraflex stent [Boston Scientific, Natick, MA]) and fully covered designs (i.e., Alimaxx-E stent [Merit Medical Systems, South Jordan, UT] and Niti-S stent [TaeWoong Medical, Seoul, Korea]). Some stents are available in both partially and fully covered designs (i.e., Wallflex stent [Boston Scientific] and Evolution stent [Cook Medical, Bloomington, IN]).

A limitation of partially covered self-expanding metal stents is recurrent dysphagia (in approximately 30% of patients) due to stent migration, tumor in-growth, granulation tissue in-growth, or food impaction [57]. Fully covered stents are more resistant to tumor or granulation tissue in-growth (and hence are easier to remove) but are more prone to stent migration. Both partial and fully covered stents are equally effective. There is no evidence in the literature to suggest that one particular stent offers optimal outcomes.

As an alternative to covered metal stents, the Polyflex stent (Boston Scientific, Natick, MA) is a fully covered plastic stent that is made of silicone and is encapsulated with a polyester mono-

filament braid. Given its success in the treatment of benign strictures, its role in the treatment of malignant strictures has been explored. As compared with self-expanding metal stents, it provides comparable relief of dysphagia. However, it is associated with a higher rate of complications (migration, hemorrhage, and tumor over growth) [58]. In our study, we noted a 63 % migration rate of Polyflex stents [59].

Stenting across the gastroesophageal junction (GEJ) poses a particular problem—reflux. Consequently, all patients with GEJ stents should be placed on proton pump inhibitors. With the rising incidence of esophageal adenocarcinoma, malignant strictures in the distal esophagus and GEJ and their attendant stent-related complications will likely continue to increase [22]. To minimize reflux, stents with an antireflux valve have been developed and have produced mixed results in the literature [60, 61].

### Laser Therapy

Neodymium yttrium-aluminum-garnet (Nd:YAG) laser is best suited for exophytic tumors that are less than 6 cm and located in the mid-esophagus. Nd:YAG lasers should not be used for circumferential tumors because it can cause stricture formation. Multiple treatments (at 4–6-week intervals) are usually required to achieve palliation [62]

Photodynamic therapy (PDT) involves administering light (at a 620 or 630 nm wavelength) endoscopically to patients who are given a photosensitizer (e.g., Photofrin [Axcan Pharma, Quebec, Canada]) 48 h before treatment. It has 5–6 mm of tissue penetration. In our series of 215 patients, PDT was 85 % effective in improving dysphagia and 93 % effective in controlling bleeding [63]. It is also effective at treating tumor in-growth of previously placed stents [64].

As compared with self-expanding metal stents, laser therapy provides similar improvement in dysphagia. However, laser therapy is expensive, requires repeat intervention, is not widely available, and has higher rates of perforation, fistula formation, and stricturing [65]. PDT is also associated with photosensitivity for 4–6 weeks.

### Brachytherapy

Brachytherapy is a safe and effective treatment option that involves the administration of a radiation source (e.g., Iridium-192) down the esophagus over a guidewire. The highest rates of palliation are achieved when 7.5–20 Gy is administered in 1–3 fractions [62, 66]. As compared with stent placement, brachytherapy provides slower (but longer lasting) relief of dysphagia, has a lower complication rate, and results in improved quality of life [67]. Brachytherapy is best suited for patients who do not require immediate relief of dysphagia and will survive long enough to benefit from it (> 3 months) [68].

## Chemotherapy and Radiation Therapy

As compared to esophageal stents and other endoluminal therapies, there is no evidence that chemotherapy and radiation therapy (alone or in combination) provides better palliation of dysphagia [65]. As such, patients with dysphagia secondary to a malignant esophageal stricture who are undergoing chemotherapy and/or radiation therapy should also be treated with endoluminal therapy (i.e., dilatation or stent placement).

## Surgical Treatment

Esophagectomy (as part of a multimodal approach) is the treatment of choice for localized esophageal cancer. Consequently, esophagectomy is a treatment option for malignant strictures in medically fit patients with localized disease if an R0 resection can be achieved with an acceptable risk of morbidity and mortality.

The 5-year survival rate for patients with stage IV esophageal cancer is less than 5 % [69]. Given the success of endoscopic palliation and the morbidity, mortality, and negative immediate impact on quality-of-life, esophagectomy (or bypass) is rarely indicated for palliation of malignant dysphagia. In select patients, esophagectomy is an option for those patients who fail endoscopic palliation of dysphagia, bleeding, or tracheoesophageal fistulas [62].

## Conclusion

The management of esophageal stricture poses a significant clinical challenge. First-line therapy involves careful endoscopic characterization of the lesion and a trial of therapeutic bougienage in nearly all cases. More aggressive interventions should be reserved for patients who do not respond to dilatation or the presence of malignancy or other primary motility disorders of the esophagus (i.e., achalasia) which may respond well to primary surgical therapy. Novel techniques such as submucosal steroid injection for benign lesions or intraluminal photodynamic therapy or Nd-Yag laser debridement for malignancy should be reserved for use in selected patients by practitioners with specific experience with the techniques. Self-expanding metal stents may afford excellent palliation for malignant stricture, but may have issues related to migration and erosion and frequent surveillance may be needed. Further, a commensurate increase in reflux should be anticipated when stents are used in the palliation of foregut strictures.

Surgical management of refractory stricture is the treatment of choice in the setting of a localized esophageal cancer for which a complete resection is felt to be feasible. For patients with advanced malignancy, endoscopic palliation may provide a reasonable option with limited morbidity. An aggressive surgical approach may also be warranted in situations where the stricture is the result of an anatomic abnormality created as a result of prior antireflux surgery. Careful operative planning and intraoperative evaluation are crucial. For all lesions, a thorough understanding of the underlying pathology is paramount in determining the appropriate treatment course.

## Key Points for Avoiding Postsurgical Esophageal Strictures

1. For patients who undergo an esophageal anastomosis:
   a. Construct an appropriately sized, tension-free anastomosis
   b. Minimize risk factors for esophageal anastomotic strictures (e.g., ischemia and anastomotic leak)
2. For patients who undergo fundoplication and repair of a hiatal hernia:
   a. Avoid iatrogenic constriction (constructing a tight wrap and closing the hiatus tightly)
   b. Avoid use of a synthetic mesh to close the hiatus
3. Use proton pump inhibitors for patients at risk for ongoing mucosal injury

## Key Points for Managing Esophageal Strictures

1. Endoscopic dilatation is the first-line treatment of esophageal strictures. Surgery should be reserved for failure of maximal nonoperative therapy.
2. Serial dilatations at 1–2-week intervals may be needed to maximize the potential of dilatation and to achieve a satisfactory outcome
3. Stenting is a temporary treatment option, especially for benign strictures.
4. For patients with complete loss of the patency of the esophageal lumen, a rendez-vous procedure is an excellent option
5. Always have a backup plan if the first choice of treatment fails or results in a complication.

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