CHAPTER 100

Esophageal Dilation: An Overview

Parth J. Parekh and David A. Johnson
Department of Internal Medicine, Eastern Virginia Medical School, Norfolk, VA, USA

Summary

Esophageal strictures may develop from both benign and malignant causes. Patients with esophageal strictures typically present with progressive dysphagia for solids, which if left untreated may progress to include liquids. Esophageal dilation is frequently required for the symptomatic management of dysphagia. There are a number of available options for successful dilation of most strictures, as well as adjunctive techniques reserved for more "refractory" cases. In order to optimize therapy and minimize risk, it is essential to fully understand the underlying cause and anatomy of the stricture. Careful selection of dilation technique and establishment of the goals for luminal restoration are important as, in each case, these factors may need to be altered to suit the etiology and pathology of the stricture.

Case

A 58-year-old female presents with a 3-month history of intermittent but not progressive solid food dysphagia. Food seems to be catching in the mid-sternal area. She has not noted this with liquids or soft foods, but has symptoms in particular with meats, fresh vegetables, doughy bread products, and pasta. She has no associated heartburn. Her medications include alendronate, a multivitamin, and rare-use aspirin, but no other non-steroidal anti-inflammatory drugs (NSAIDs).

Physical exam is normal. The physician alertly notes that the patient is taking bisphosphonate and is concerned about a pill-induced stricture. Barium X-ray is considered, but as this seems to be a non-complex stricture, the patient is instead referred for endoscopy. The goals of therapy are discussed: the target is to re-establish normal dietary habits.

Endoscopy shows a luminal narrowing estimated (using the open biopsy forceps) to be 14 mm. The stricture is immediately above the esophagogastric junction and there is no evidence of esophagitis. A hydrostatic balloon is chosen and dilation is performed using the graduated 15–18 mm dilator. Care is taken to deflate the stomach before the dilation and to deflate the balloon between size increments in order to assess for mucosal disruption. With the 18mm balloon, there is a slight mucosal tear in the area of luminal narrowing.

The patient is counseled to avoid her bisphosphonate for a month and to discuss alternative therapy with her primary physician. She is given a proton pump inhibitor (PPI) for 8 weeks and advised to follow a soft diet (cutting food into small pieces) for several weeks, before slowly advancing to a more normal diet as tolerated. She is instructed to notify the gastroenterologist if persistent or recurrent dysphagia is evident or if she develops heartburn.

Introduction

Esophageal strictures arise from an intrinsic disease (such as inflammation, fibrosis, or neoplasia) that narrows the esophageal lumen, an extrinsic disease compromising the esophageal lumen by direct or indirect invasion, or diseases disrupting esophageal peristalsis and/or lower esophageal sphincter (LES) function. Esophageal strictures are further subdivided into those with a benign and those with malignant origin. The etiologies of benign strictures include gastroesophageal reflux esophagitis, Schatzki's ring, radiation, caustic ingestion, nasogastric intubation with acid reflux, primary or secondary pill-induced injury, anastomotic stricture with related ischemia or history of an anastomotic leak, "ringed" strictures associated with eosinophilic esophagitis, and several rare disorders. Malignant strictures may develop as a result of local tumor growth or metastatic disease [1].

For centuries, the cornerstone of therapy has been esophageal dilation. This dates back to the 17th century, when carved whalebone was used to treat achalasia. Bougienage was first reported in the early 1800s, and since then the equipment used to treat esophageal strictures has evolved considerably to include flexible bougies, wire-guided dilators, and through-the scope balloon catheters [2].

The goal of therapy is ultimately to provide adequate symptomatic relief and prevent the recurrence of stricture formation. The patient's dietary habits and nutritional needs must be considered when constructing an appropriate treatment plan. Additionally, it is important to differentiate the structural characteristics between simple and complex esophageal strictures. This chapter will provide an update on the categories of esophageal stricture, categories of esophageal dilator, and techniques used for esophageal dilation.

Categories of Esophageal Stricture

Esophageal strictures are categorized by structural anatomy as being simple or complex depending on size, symmetry, and the passage of a diagnostic upper endoscope [3]. Simple strictures are concentric (with a luminal diameter of ≥12 mm) or symmetric (easily

Practical Gastroenterology and Hepatology Board Review Toolkit, Second Edition. Edited by Nicholas J. Talley, Kenneth R. DeVault, Michael B. Wallace, Bashar A. Aqel and Keith D. Lindor.
© 2016 John Wiley & Sons, Ltd. Published 2016 by John Wiley & Sons, Ltd. Companion website: www.practicalgastrohep.com

Table 100.1 Characteristics of simple versus complex strictures.

	Simple	Complex
Allow for passage of endoscope	Yes	No (typically)
Length	Short (<2 cm)	Long (>2 cm)
Focal	Yes	No
Angulation/irregularity	No	Yes (typically)
Etiology	Peptic Shatzki's ring Anastomotic Pill-induced	Caustic ingestion Malignancy Photodynamic therapy Radiation
Preferred dilation method	Balloon or rigid dilator	Rigid dilator
Fluoroscopy	Rarely needed	Recommended
Dilations	1–3 (typically)	≥3
Risk of recurrence	Low	High

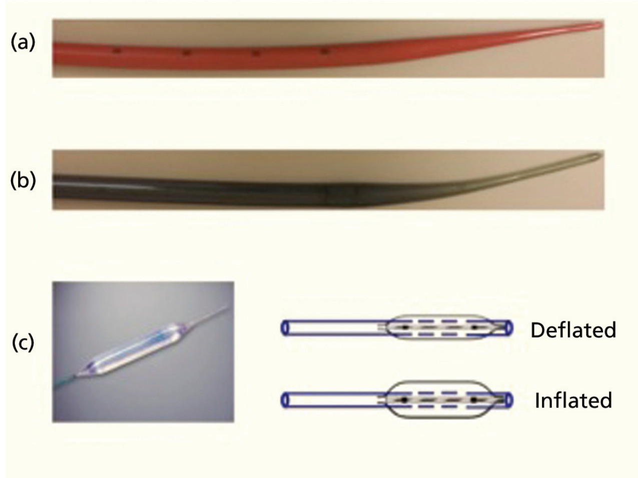

Figure 100.1 (a) Bougie dilator. (b) Wire-guided polyvinyl dilator. (c) Through-the-scope balloon dilator.

allow passage of a diagnostic upper endoscope). Conversely, complex strictures are defined as having a luminal diameter of ≤12 mm, as being asymmetric with angulation, or as not having the ability to pass a diagnostic upper endoscope. Table 100.1 summarizes the differences in characteristics between a simple and a complex stricture.

Simple esophageal strictures tend to be short, focal, and straight, or to have a diameter that is sufficient to allow the passage of a normal-diameter endoscope. Common etiologies of simple esophageal strictures include gastroesophageal reflux disease (GERD) (up to 70% of cases), Schatzki's ring, and membranous webs. Typically, these strictures are amenable to the standard technique of bougie or through-the-scope balloon dilation. In most cases, one to three dilations are required for symptomatic relief, but in up to 35% of patients a repeat dilation is required [2, 4]. For dilation of a Shatzki's ring, which does not contain any muscularis propria and is composed entirely of mucosa and submucosa, the results of a single dilation (15–18 mm dilator) are typically sufficient [2].

Complex esophageal strictures tend to be long (>2 cm), tortuous, or associated with a severely narrowed diameter that precludes the passage of an endoscope. Common etiologies of complex esophageal strictures include caustic ingestion, radiation, surgical anastomosis (with related local vascular compromise), photodynamic or sclerotherapy, and severe peptic injury (particularly related to reflux in patients with prolonged use of a nasogastric tube). Complex strictures require the use of fluoroscopic guidance in order to plan and execute safe and effective dilation. They typically require repeat dilations for symptomatic relief and, depending on the underlying pathogenesis, are associated with high recurrence rates. Refractory complex strictures are those that cannot be dilated to a sufficient diameter to allow passage of solid food, that recur within a time interval of 2–4 weeks, or that require ongoing (more than 10) dilation sessions [2]. There are several novel treatment modalities available for refractory strictures, including incisional therapy (particularly to refractory Shatzki's ring) and temporary placement of a covered stent (particularly for longer complex strictures) [5]. Malignant strictures are typically more definitively treated by dilation followed by a thermal destructive therapy (e.g., laser, photodynamic, brachytherapy, cryotherapy) with or without esophageal stenting.

Categories of Esophageal Dilator

There are three categories of esophageal dilator currently in use: bougies filled with mercury or tungsten, wire-guided polyvinyl dilators, and through-the-scope balloon dilators [6] (Figure 100.1). The expansive force generated by these dilators differs based on the delivery of the device and the mechanisms of action. Radial dilation is key to attaining effective dilation of a stricture. Most bougie and wire-guided polyvinyl dilators are designed so that they can be reused. Users should therefore refer to the manufacturer's instructions for guidance on reprocessing.

Bougie Dilators (Maloney dilators, Medovations Inc.)

Bougie dilators are a series of flexible dilators of increasing thickness filled with mercury or tungsten, with a tapered tip that can be passed either blindly or fluoroscopically [7]. They offer both radial and longitudinal dilation as they are passed, according to the nature of the passage [6, 8].

Wire-Guided Polyvinyl Dilators (Savary-Gilliard, Cook Medical)

Wire-guided dilations offer greater assurance to the operator that the dilator is following the lumen of the esophagus, thus reducing the risk of perforation [9]. Fluoroscopy is recommended, to monitor the position of the guidewire, which should be targeted at least 30 cm below the lowest point of the stricture. Typically, the distal tip is positioned in the gastric antrum along the greater curvature of the stomach [9]. Recent reports suggest that the use of wire-guided dilators without fluoroscopy is safe and effective in the treatment of esophageal strictures [10, 11], though this is not our current practice. Wire-guided dilators offer the potential effects of both radial and longitudinal dilation, depending on whether additional to-and-fro movement is performed after the initial static radial dilation.

Through-the-Scope Balloon Dilators (Controlled Radial Expansion (CRE), Boston Scientific)

Through-the-scope balloon dilation is performed under direct endoscopic visualization, utilizing a balloon dilator passed down the working channel of the endoscope [9]. The mid-portion of the balloon should typically be centered at the tightest point in the stricture, with dilating pressures ranging between 30 and 45 psi, varying in relation to balloon size. Recent studies indicate that a

Table 100.2 Relative and absolute contraindications to esophageal dilation.

Relative	Absolute
Bleeding diathesis	Acute abdomen
Use of anticoagulants (ASGE guidelines for stopping anticoagulation prior to the procedure should be followed)	Acute or incomplete healing of esophageal or GI perforation
Severe pulmonary disease	
Recent myocardial infarction	
Pharyngeal or cervical deformity	
Recent laparotomy	
Large thoracic aneurysm	

ASGE, American Society for Gastrointestinal Endoscopy; GI, gastrointestinal.

lower inflation time (as little as 10 seconds) may be as efficacious as a longer one (in this case, 2 minutes) when used in the treatment of benign strictures [12]. Through-the-scope balloon dilators do not exert longitudinal sheer forces, provided they are held in a static position within the stricture during the dilation. It is important to know the complete anatomy (length, angulation, etc.) before balloon dilation is performed. The balloon should completely traverse the stricture, so as to avoid asymmetric pressures across the strictured areas, which may be more of a risk for perforation.

Complications and Contraindications

Esophageal dilation is a safe and effective procedure for the management of benign and malignant strictures, though esophageal perforation is a recognizable risk [13]. Perforation typically occurs at or immediately above the proximal margin of the stricture, which is why some experts recommend endoscopic reevaluation upon completion of the dilation procedure. The literature suggests that perforation rates range from 0.1 to 2.6%, with a mortality rate of up to 1% [4, 8, 9, 14, 15]. There is a propensity toward high complication rates in complex and malignant strictures. Complex strictures are a clear risk, particularly in patients with strictures related to surgery or radiation, or with strictures with more than just mucosal fibrosis. Table 100.2 summarizes both the absolute and the relative contraindications.

Dilation with bougie dilators is very safe and effective, with a success rate of up to 90% [16]. Recent data suggest that patients may be able to perform home self-dilation on recurrent strictures with these dilators [17]. Wire-guided dilations offer a safer approach than bougie dilators by insuring that the dilator remains in the axis of the lumen and does not buckle or bend laterally into the wall of the stricture and create an increased risk of perforation [8]. This technique is conducted under fluoroscopy, to allow visualization of the dilator passing through the stricture. Wire-guided dilations are preferred for complex and longer strictures in particular, especially if there is any angulation or if there are any diverticular changes that might create a misdirected pathway for a bougie passed blindly. There are certain circumstances, however, in which a longitudinal shearing force should be avoided, such as when strictures are caused by epidermolysis bullosa or when a tracheoesophageal puncture voice prosthesis is present. In such cases, balloon dilation should be the preferred method [2, 18]. Additionally, the literature suggests an increase in mucosal fragility and tissue remodeling in patients with eosinophilic esophagitis, which predisposes them to esophageal mucosal tears. Though this was initially thought to increase the risk of perforation [19–22], subsequent reports have not shown such an increased risk [23–27]. Recognizably, these patients have at times profound disruptions with dilation, so the selection of dilator size, dilation target, and schedule should be well considered. We routinely reassess the extent of mucosal disruption after each balloon size insufflation. When mucosal disruption is evident, the risk/benefit of further dilation in the current session should be carefully weighed. Mucosal disruption to the level of muscularis exposure is an absolute contraindication to further dilation. Chest pain is very common after esophageal dilation in this group of patients, being reported in 75% of patients in one prospective study [25]. Unfortunately, there are no prospective trials comparing dilation techniques in these patients, but esophageal balloon dilation rather than rigid dilators seems to be preferable [25, 28, 29].

Techniques of Dilation

The "Rule of Three"

The "rule of three," as it applies to bougie dilators, has become the standard guide to the number of dilators passed per session [3, 30]. This rule suggests that in a single session, no more than three dilators of sequential size should be passed once moderate or greater resistance is evident. Dilators passed with no or mild resistance do not count toward this total. Accordingly, the rate of dilation should be carefully planned to meet the needs and defined goals for each individual patient. A caveat here is that this rule is best applied to the blind bougie passage. Savary dilators may (though this is more typically done using a wire-guided technique) or may not offer the same tactile resistance. In these cases, the starting size of the lumen at the stricture should be estimated, and the optimal target for luminal patency should be determined by the underlying etiology, pathologic features, duration, initial stricture lumen diameter, and the patient's dietary needs and preferences. In general, diet tolerance may be predicted based on luminal diameter, as shown in Table 100.3 [3, 31, 32].

Endoscopy/Fluoroscopy

After any imaging studies have been reviewed, esophagoscopy should be performed to further delineate the anatomy of the stricture – including the lumen diameter – in order to assist in selecting the appropriate initial dilator size. To this end, the endoscopist can estimate the measurement using an open biopsy forceps in the narrowest lumen of the stricture (standard open biopsy jaws = 7 mm). The initial dilator is typically 1–2 mm larger than the estimated luminal diameter (correlation of luminal size with dilator size is 1 mm = 3 French). The use of fluoroscopy is helpful; it is recommended for most complex stricture dilations and is a requisite for positioning of the balloon for achalasia dilation.

Table 100.3 Tolerable diet consistency as it relates directly to lumen diameter.

Esophageal lumen	Type of diet[a]
7 mm	Liquid/pureed
10 mm	Pureed/soft[b]
13 mm	Soft[b]
15 mm	Modified with exclusions[c]
18 mm	Regular, with care

[a]In all cases, emphasis should be placed on the appropriate cutting of food, paced chewing and swallowing, foods to avoid, and the importance of liquid flushes.
[b]With emphasis on cutting food into small pieces.
[c]Exclusion of tough meat, hard raw vegetables (e.g., carrots), hard fresh fruits (e.g., apples), large bites of doughy bread or pasta, and fruit and vegetable skins (e.g., potato).

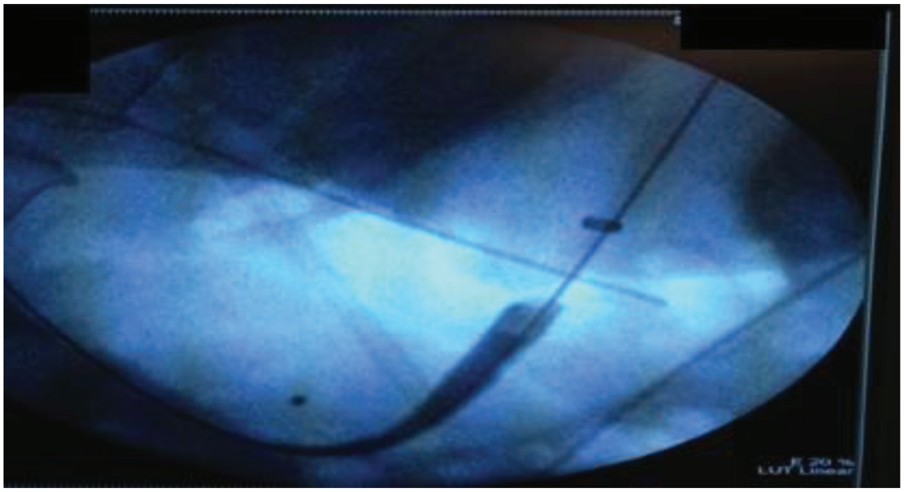

Figure 100.2 Fluroscopic image of the correct positioning of the wire during pneumatic achalasia dilation. Note the gentle bend of the wire along the gastric wall, with the wire pointed toward the gastric antrum – and not in a direction in which it could penetrate the gastric wall.

Rigid Dilators

Ideally, the mouthpiece should be removed for dilation and lubrication should be applied to the lips in order to minimize resistance of passage. When a mouthpiece is in place, the dilator is forced to enter perpendicular to the posterior pharyngeal wall, and must therefore follow a 90° turn against the posterior pharyngeal wall in order to enter the hypopharynx. This sharp turn as the dilator traverses between oropharynx and hypopharynx may cause considerable pressure on the tissues anterior to the cervical spine, which accordingly increases the risk of pain, contusion, or possible crush injury with perforation. This may be a particular problem when large-diameter dilators are used, as these have a greater resistance to bending. The potential for pressure-related injury can be minimized by removing the mouthpiece, moving the dilator shaft into one corner of the mouth, and keeping the extraoral segment of the dilator shaft elevated (in the direction of the upper posterior molars) and more parallel to the axis of the hypopharyngeal lumen. Antegrade dilation force should be directed more closely into the direct lumen axis between the hypopharynx and the stricture beyond. This "in-axis" orientation allows the operator to more accurately appreciate the true stricture resistance, rather than sense the angulated bending resistance of the dilator impinging against the posterior pharyngeal wall [31].

The patient's head position should be chin-neutral or –down, and never extended with the head back. This flexed position reduces the natural cervical spine lordosis and helps to open the hypopharynx. With passage of either Maloney or Savary dilators, the oropharyngeal curve can also be reduced by positioning the index and middle fingers in the oropharynx to guide the dilator with anterior displacement. The shaft of the dilator should be gripped firmly for pushing with the thumb and first three fingertips of the right hand and not by a full, closed, tight hand grasp. This technique allows for better tactile sensation with which to judge stricture or other structural resistance during dilator passage. Additionally, the nurse assistant should support the distal end of the dilator so that there is no backward weighting and the endoscopist can have a better tactile sense of any resistance as the dilator is passed per os. Assessing the distance measurement numbers on the rigid dilator shaft should be standard procedure to insure that the dilator is passed through the extent of the stricture as measured during the endoscopic exam. Fluoroscopy may also be needed in selected cases and is always required during wire-guided dilation. During passage of over-the-wire dilators, either the operator or an assistant should provide slight wire retraction and avoid antegrade or retrograde wire displacement. This is most easily achieved by fluoroscopic observation or using distance marks etched on the Savary guidewire. Dilators should be removed slowly and carefully following each passage, taking particular care in the area of the oropharyngeal curve. Additionally, it is critical to visualize the tip of the wire in the stomach as the dilator is passed. There should be a gentle curvature of the wire against the greater curvature of the stomach to insure that the tip does not create a force for perforation through the gastric wall (Figure 100.2). Similarly, it is key to avoid a sharp angulation in the wire along the axis from the esophagus to the anterior gastric wall. It is therefore important to image this area and the location of the distal tip of the wire, in order to avoid wire-induced perforation risks.

Balloon Dilators

Balloon dilation should only be used in strictures when the balloon dilator can be positioned to traverse the entire stricture and the exact anatomy of the stricture has been defined by endoscopy or X-ray. Dilation with the balloon still within the stricture may introduce a "shoulder effect," with an asymmetric delivery of the radial dilation, and theoretically increase the risk of perforation. Complex strictures typically do not respond well to hydrostatic, through-the-scope dilators. These dilators work well for over 90% of simple, benign, usually reflux-related distal esophageal strictures and rings [31].

Pneumatic balloon dilation remains one of the most effective first-line therapies for achalasia. Currently, the Rigiflex pneumatic dilator (Boston Scientific, Boston, MA) is the most widely used system for achalasia, but similar devices are available from other manufacturers (Cook Medical, Bloomington, IN; Hobbs Medical, Stafford Springs, CT). The polyethylene balloon comes in three sizes that inflate to fixed diameters of 30, 35, and 40 mm. This system offers a safety advantage over earlier compliant latex balloons, which delivered different diameters at different inflation pressures. Typically, a stepwise approach using the Rigiflex system starts with a 30 mm balloon for the first session. If there is no improvement noted at follow-up (by symptom assessment and X-ray evaluation for a persistent standing column on a timed barium study), the patient can be brought back for a repeat dilation session with a 35 mm and then, if needed, a 40 mm balloon. We do not recommend the use of a 40 mm balloon, however, and will refer the patient for per-oral endoscopic myotomy (POEM) or surgical myotomy. In our 30 years' experience, this graduated-dilation approach has been extremely safe, with no perforations to date. Additionally, it has yielded an overall 93% response rate to dilation over a mean follow-up period of 4 years and has become an accepted methodology of treatment [33].

A guidewire is used with the pneumatic balloon, which is passed with the endoscope in the stomach. The distal tip is positioned in the antrum. As the endoscope is removed over the wire, care must be taken to watch the distal end of the wire in order to insure that it does not push into the wall or develop an angulation kink along the greater curvature. The wire should form a gentle bend (Figure 100.2), which then needs to be carefully watched as the balloon dilator is passed over it. As the dilator is positioned, the key is to avoid a puncture-type perforation injury, which might result from the wire tip or any sharp angulation.

Before positioning the balloon, the endoscopist should be careful to fully decompress the stomach. When the balloon is inflated, if there is overdistension of the stomach and wretching against the tightly occluded esophagogastric junction, there may be significant risk of related esophageal barotrauma. The balloon is positioned in the stricture, ideally with its central portion corresponding to the central point of the stenosis. This is confirmed by endoscopy, fluoroscopy, or both. Prior to insufflation, the proximal margin of the balloon should be positioned at the tip of the endoscope and the shaft of the balloon dilator grasped firmly (at the biopsy port of the endoscopy) by the endoscopist's fingers, in order to brace against the downward pulling movement that typically occurs as the balloon is inflated. If it is not braced appropriately, the balloon may slip below the stricture and so not achieve the targeted dilation. This is especially common in achalasia dilation, which is typically carried out without reinsertion of the endoscope, so that the operator needs to firmly grasp and hold the shaft of the balloon at the entrance through the bite block. In such pneumatic dilations in particular, as the balloon is inflated, there is a tendency for it to move, usually pulling down antegrade, and the dilator may move through the hypertensive LES without application of the intended radial force. No standard has yet been established for the optimal duration of balloon dilation. Historically, a duration of 30–60 seconds was adequate, with 60 seconds more the standard for achalasia dilation. Recent studies indicate that a lower inflation time (as little as 10 seconds) may be as efficacious in the treatment of benign strictures [12]. We will routinely carry out two insufflations, paying particular attention to the obliteration of the "waist" effect on the dilator as the balloon is insufflated. This "waist" is the narrowing at the level of compression by the LES. The pressure applied in order to note the initial effect of the first dilation should be compared to when the "waist" is evident on the second dilation. Following all achalasia pneumatic dilations, once patients are awake in the recovery room, we have the radiologist perform a contrast-swallow exam, first with gastrograffin and then, if there is no evidence of perforation, with dilute barium.

For through-the-scope balloons, deflation of the balloon between sequential dilations is advised, so as to assess the level of mucosal trauma and better direct the rate of progression of sequential dilation. Care should be taken to limit further dilation once more than a minor mucosal disruption is evident, or once there is any evidence of disruption to the level of the muscularis.

Adjunctive and Novel Therapies

Intramural Steroid Injections

There is only limited evidence to suggest that the use of intramural steroid injections may be of benefit in refractory strictures, though the data are variable [34,35]. The pathophysiology remains unclear, but it has been suggested that it has to do wtih steroid-related inhibition of a variety of matrix protein genes, namely procollagen and fibrnoectin, in addition to other cytokines, which inhibit collagen formation, ultimately increasing stricture compliance [36]. As benign esophageal strictures are thought to result from fibrous tissue involved in keloid and scar formation, this technique may be helpful in strictures deemed refractory to standard dilation. Typically, following dilation, triamcinolone 40 mg is diluted with 5 cc of saline and injected in quadrant injections (0.5–1.0 cc aliquots), aiming in particular for the fibrous part of the structure – as suggested by the tear points noted following dilation. This fibrous area is also particularly evident from an increased resistance to injection via the sclerotherapy needle – this indicates the injection is in the correct place! The goal of this injection is to decrease the inflammatory response induced by the mucosal disruption of the stricture and reduce the reformation of fibrous healing. There is a lack of prospective data on the best sequence of dilation/injection, and this may be an area for future investigation. We perform the injection subsequent to balloon dilation, as this helpful in identifying the tear points for the fibrous stricture and, hopefully, avoiding the theoretic concern of creating lead points for mucosal tearing if the stricture is dilated following the repeated intramural injections.

Retrograde Dilation

In some cases, the anatomy of the stricture may preclude the gastroenterologist from standard endoscopic management, particularly when a guidewire cannot be positioned via an antegrade approach through the stricture. This may be especially evident in the proximal esophagus of patients who have received radiation for head and neck cancers. In such cases, an "endoscopic rendezvous" approach can be employed, typically in concert with the otolaryngologist [37–40]. A small-diameter endoscope is introduced through a mature percutaneous endoscopic gastrostomy (PEG) tract and advanced in a retrograde fashion into the esophagus until the stricture is identified. A flexible guidewire can be passed through the stricture and, using direct visualization (endoscopy or rigid laryngoscope), grabbed on the proximal side of the stricture by the assisting physician.

Endoscopic Stricturoplasty

In some cases, a thin membrane precludes passage of the guidewire. In such cases, a stiffer guidewire with/without assist using a needle-knife can be used to puncture the membrane in four quadrants, with subsequent Savary dilation. Data on the use of this technique are limited, but those available suggest that it may be a viable alternative in patients with refractory strictures, if performed by an extremely skilled endoscopist with a complete understanding of the anatomy (in order to avoid creating a false channel) [41,42].

"Pharyngoesophageal Punture"

Recently, Tang *et al.* [43] coined the term "pharyngoesophageal puncture" (PEP). They applied their expert endoscopic retrograde cholangiopancreatography (ERCP) technique and their skill in pancreaticobiliary obstruction to the management and treatment of refractory pharyngoesophageal stenosis (PES) and upper esophageal stricture [43]. They reported three successful cases of patients with severe or complete PES managed with PEP. In all cases, PEP utilized a combined antegrade and retrograde approach, performed under fluoroscopy. Under bidirectional endoscopy, the distal ends of both scopes were aligned along the same axis in order to obtain optimal trans-stenosis illumination and PEP. The stiff end of the ERCP guidewire was used to puncture the obstruction, with moderate pressure. Once the lesion was punctured, the hydrophilic tip of the guidewire was used to confirm the successful PEP. Use of the flexible tip minimizes the risk of creating a false tract.

Conclusion

The goal of esophageal dilation is to provide symptomatic relief. There are a number of options for the successful dilation of most strictures, but careful selection of a specific and individualized approach is necessary in order to minimize complications and maximize therapeutic benefit. It is important that the endoscopist have a thorough understanding of the underlying etiology and the anatomy of the stricture prior to developing a strategic approach. The novel and adjunctive therapies presented require extreme endoscopic skill and knowledge of the anatomy, and should only be performed by those at tertiary and quaternary centers with high-volume experience.

Take Home Points

- The best initial procedure after a thorough history and physical examination is a proper barium esophagram. Endoscopy alone is not always reliable as a substitute for a good barium contrast study in patients with strictures.
- After the history, physical, stricture etiology, and esophageal anatomy are determined, a thoughtful plan (including endoscopy and dilation) can be developed.
- Esophagoscopy should include an estimate of the lumen diameter, to assist in selecting an appropriate initial dilator size. This measurement is estimated using an open biopsy forceps in the narrowest lumen of the stricture.
- Complex strictures do not respond well to hydrostatic, through-the-scope dilators. These dilators work well for over 90% of simple, benign, usually reflux-related distal esophageal strictures and rings.
- No clear difference in effectiveness has been reported between the Savary-Gilliard and through-the-scope balloon dilators in the treatment of benign esophageal strictures
- For all wire-guided dilations, it is critical to use fluoroscopy to visualize the tip of the wire in the stomach as the dilator is passed. The wire should have a gentle curvature against the greater curvature of the stomach, to insure that the tip does not create a perforative force through the gastric wall. It is also key to avoid a sharp angulation in the wire, which might pose a similar perforation risk.
- The tactile sensation of stricture resistance during antegrade dilation is important in selecting successive dilator sizes and determining the pace of dilation
- Rarely are complex strictures safely responsive to a single dilation session, so the patient must understand that gradual progressive dilation during sequential follow-up will likely be necessary.
- The intervals between the initial dilation sessions are best kept to between 2 and 4 weeks. After the goal for presumed optimum diameter is reached, the intervals can be increased based on the patient's opinion of dysphagia relief.
- The etiology and complexity of the stricture should be established as a guide to therapy. The technique, equipment, and luminal restoration target (in mm) may need to be altered to suit the pathology of the stricture and the goals for the patient.
- The ultimate goal for dilation of esophageal strictures need not necessarily be a specific lumen size, but should be tailored to what is safe and acceptable to the patient.
- Long-term modification of dietary intake may be necessary even after dilation, depending on the nature of the stricture. This should be made clear to the patient as part of the initial assessment and plan.

References

1 Siersema PD. Treatment options for esophageal strictures. *Nat Clin Pract Gastroenterol Hepatol* 2008; **5**(3): 142–52.

2 Lew RJ, Kochman ML. A review of endoscopic methods of esophageal dilation. *J Clin Gastroenterol* 2002; **35**(2): 117–26.

3 Egan JV, Baron TH, Adler DG, *et al.* Esophageal dilation. *Gastrointest Endosc* 2006; **63**(6): 755–60.

4 Pereira-Lima JC, Ramires RP, Zamin I, *et al.* Endoscopic dilation of benign esophageal strictures: report on 1043 procedures. *Am J Gastroenterol* 1999; **94**(6): 1497–501.

5 Kochhar R, Poornachandra KS. Intralesional steroid injection therapy in the management of resistant gastrointestinal strictures. *World J Gastrointest Endosc* 2010; **2**(2): 61–8.

6 Siddiqui UD, Banerjee S, Barth B, *et al.* Tools for endoscopic stricture dilation. *Gastrointest Endosc* 2013; **78**(3): 391–404.

7 Ho SB, Cass O, Katsman RJ, *et al.* Fluoroscopy is not necessary for Maloney dilation of chronic esophageal strictures. *Gastrointest Endosc* 1995; **41**(1): 11–14.

8 Hernandez LV, Jacobson JW, Harris MS, Hernandez LJ. Comparison among the perforation rates of Maloney, balloon, and Savary dilation of esophageal strictures. *Gastrointest Endosc* 2000; **51**(4 Pt. 1): 460–2.

9 Riley SA, Attwood SE. Guidelines on the use of oesophageal dilatation in clinical practice. *Gut* 2004;**53**(Suppl. 1): i1–6.

10 Kabbaj N, Salihoun M, Chaoui Z, *et al.* Safety and outcome using endoscopic dilatation for benign esophageal stricture without fluoroscopy. *World J Gastrointest Pharmacol Ther* 2011; **2**(6): 46–9.

11 Raymondi R, Pereira-lima JC, Valves A, *et al.* Endoscopic dilation of benign esophageal strictures without fluoroscopy: experience of 2750 procedures. *Hepatogastroenterology* 2008; **55**(85): 1342–8.

12 Wallner O, Wallner B. Balloon dilation of benign esophageal rings or strictures: a randomized clinical trial comparing two different inflation times. *Dis Esophagus* 2014; **27**(2): 109–11.

13 Mönkemüller K, Kalauz M, Fry LC. Endoscopic dilation of benign and malignant esophageal strictures. *Int Ther Gastrointest Endosc* 2010; **27**(1): 91–105.

14 Piotet E, Escher A, Monnier P. Esophageal and pharyngeal strictures: report on 1862 endoscopic dilatations using the Savary-Gilliard technique. *Eur Arch Otorhinolaryngol* 2008; **265**(3): 357–64.

15 Jethwa P, Lala A, Powell J, *et al.* A regional audit of iatrogenic perforation of tumours of the oesophagus and cardia. *Aliment Pharmacol Ther* 2005; **21**(4): 479–84.

16 Harrison ME, Sanowski RA. Mercury bougie dilation of benign esophageal strictures. *Hepatogastroenterology* 1992; **39**(6): 497–501.

17 Zehetner J, Demeester SR, Ayazi S, Demeester TR. Home self-dilatation for esophageal strictures. *Dis Esophagus* 2014; **27**(1): 1–4.

18 Anderson SH, Meenan J, Williams KN, *et al.* Efficacy and safety of endoscopic dilation of esophageal strictures in epidermolysis bullosa. *Gastrointest Endosc* 2004; **59**(1): 28–32.

19 Lucendo AJ, De Rezende L. Endoscopic dilation in eosinophilic esophagitis: a treatment strategy associated with a high risk of perforation. *Endoscopy* 2007; **39**(4): 376.

20 Cohen MS, Kaufman AB, Palazzo JP, *et al.* An audit of endoscopic complications in adult eosinophilic esophagitis. *Clin Gastroenterol Hepatol* 2007; **5**(10): 1149–53.

21 Eisenbach C, Merle U, Schirmacher P, *et al.* Perforation of the esophagus after dilation treatment for dysphagia in a patient with eosinophilic esophagitis. *Endoscopy* 2006; **38**(Suppl. 2): E43–4.

22 Kaplan M, Mutlu EA, Jakate S, *et al.* Endoscopy in eosinophilic esophagitis: "feline" esophagus and perforation risk. *Clin Gastroenterol Hepatol* 2003; **1**(6): 433–7.

23 Jung KW, Gundersen N, Kopacova J, *et al.* Occurrence of and risk factors for complications after endoscopic dilation in eosinophilic esophagitis. *Gastrointest Endosc* 2011; **73**(1): 15–21.

24 Dellon ES, Gibbs WB, Rubinas TC, *et al.* Esophageal dilation in eosinophilic esophagitis: safety and predictors of clinical response and complications. *Gastrointest Endosc* 2010; **71**(4): 706–12.

25 Schoepfer AM, Gonsalves N, Bussmann C, *et al.* Esophageal dilation in eosinophilic esophagitis: effectiveness, safety, and impact on the underlying inflammation. *Am J Gastroenterol* 2010; **105**(5): 1062–70.

26 Bohm ME, Richter JE. Review article: oesophageal dilation in adults with eosinophilic oesophagitis. *Aliment Pharmacol Ther* 2011; **33**(7): 748–57.

27 Jacobs JW, Spechler SJ. A systematic review of the risk of perforation during esophageal dilation for patients with eosinophilic esophagitis. *Dig Dis Sci* 2010; **55**(6): 1512–15.

28 Schoepfer AM, Gschossmann J, Scheurer U, *et al.* Esophageal strictures in adult eosinophilic esophagitis: dilation is an effective and safe alternative after failure of topical corticosteroids. *Endoscopy* 2008; **40**(2): 161–4.

29 Moawad FJ, Cheatham JG, Dezee KJ. Meta-analysis: the safety and efficacy of dilation in eosinophilic oesophagitis. *Aliment Pharmacol Ther* 2013; **38**(7): 713–20.

30 Boyce HW Jr. Precepts of safe esophageal dilation. *Gastrointest Endosc* 1977; **23**: 215.

31 Boyce HW. Dilation of difficult benign esophageal strictures. *Am J Gastroenterol* 2005; **100**(4): 744–5.

32 Kochman ML. Minimization of risks of esophageal dilation. *Gastrointest Endosc Clin N Am* 2007; **17**(1): 47–58.

33 Walzer N, Hirano I. Achalasia. *Gastroenterol Clin North Am* 2008; **37**(4): 807–25.

34 Hirdes MM, van Hooft JE, Koornstra JJ, *et al.* Endoscopic corticosteroid injections do not reduce dysphagia after endoscopic dilation therapy in patients with benign esophagogastric anastomotic strictures. *Clin Gastroenterol Hep* 2013; **11**: 795–801.

35 Ramage JI, Rumalla A, Baron TH, *et al.* A prospective, randomized, double-blind, placebo-controlled trial of endoscopic steroid injection therapy for recalcitrant esophageal peptic strictures. *Am J Gastroenterol* 2005; **100**(11): 2419–25.

36 Pregun I, Hritz I, Tulassay Z, Herszényi L. Peptic esophageal stricture: medical treatment. *Dig Dis* 2009; **27**(1): 31–7.

37 Mcgrath K, Brazer S. Combined antegrade and retrograde dilation: a new endoscopic technique in the management of complex esophageal obstruction. *Gastrointest Endosc* 2002; **56**(1): 163–4.

38 Lew RJ, Shah JN, Chalian A, *et al.* Technique of endoscopic retrograde puncture and dilatation of total esophageal stenosis in patients with radiation-induced strictures. *Head Neck* 2004; **26**(2): 179–83.

39 Kos MP, David EF, Mahieu HF. Anterograde-retrograde rendezvous approach for radiation-induced complete upper oesophageal sphincter stenosis: case report and literature review. *J Laryngol Otol* 2011; **125**(7): 761–4.

40 Amateau SK, Khashab MA. Successful blunt recanalization of an obliterated long esophageal stricture by endoscopic rendezvous. *Endoscopy* 2013; **45**(Suppl. 2 UCTN): E49–50.

41 Raijman I, Siddique I, Rachal LT. Endoscopic stricturoplasty in the management of recurrent benign esophageal strictures. *Gastrointest Endosc* 1999; **49**: AB172.

42 Hagiwara A, Togawa T, Yamasaki J. Endoscopic incision and balloon dilatation for cicatricial anastomotic strictures. *Hepatogastroenterology* 1999; **46**(26): 997–9.

43 Tang SJ, Singh S, Truelson JM. Endotherapy for severe and complete pharyngo-esophageal post-radiation stenosis using wires, balloons and pharyngo-esophageal puncture (PEP) (with videos). *Surg Endosc* 2010; **24**(1): 210–14.