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Endoscopic Dilation of Benign and Malignant Esophageal Strictures

Klaus Mönkemüller[a,b] · Mirjana Kalauz[c] · Lucía C. Fry[a,b]

[a]Department of Internal Medicine, Gastroenterology and Infectious Diseases, Marienhospital, Bottrop and [b]Division of Gastroenterology, Hepatology and Infectious Diseases, Otto von Guericke University, Magdeburg, Germany, and [c]Divison of Gastroenterology, Department of Internal Medicine, University Hospital Rebro, Zagreb, Croatia

Abstract

The main indication for esophageal dilation is to relieve benign or malignant dysphagia. Endoscopic dilation of malignant strictures is also performed to facilitate the completion of endoscopic procedures, such as endoscopic ultrasonographic tumor staging and to permit the placement of esophageal stents or to place a percutaneous endoscopic gastrostomy for feeding purposes. Esophageal strictures are structurally categorized into two groups: complex and simple. Complex strictures are those that are asymmetric, irregular or angulated with diameter <12 mm. Simple strictures are symmetric or concentric with a diameter of ≥12 mm or those that easily allow passage of a diagnostic upper endoscope. Dilation can be accomplished through several steps using a variety of dilating devices and adjunctive techniques. The approach to management of esophageal strictures is reviewed with a focus on dilation technique.

Esophageal dilation is performed for the treatment of anatomic and sometimes functional narrowing of the esophageal lumen caused by a variety of benign and malignant conditions (table 1) [1–3]. Until the late 1980s, nearly 80% of esophageal strictures were due to gastroesophageal reflux, but at present the incidence of peptic strictures may be decreasing due to the widespread use of proton pump inhibitors (PPIs) [2] (fig. 1). Currently, malignant disorders, post-anastomotic or radiation-induced stenosis constitute common causes of esophageal strictures [1, 3–6] (fig. 2, 3).

Most patients with esophageal stenosis present with dysphagia. Dysphagia is a subjective sensation that suggests the presence of an organic abnormality in the passage of liquids or solids from the oral cavity to the stomach (fig. 4). Patient's complaints range from the inability to initiate a swallow (oropharyngeal dysphagia) to the sensation of solids or liquids being hindered during their passage through the esophagus into the stomach (esophageal dysphagia). Table 1 presents a list of differential diagnosis of dysphagia. The term 'odynophagia' refers to painful swallowing.

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Table 1. Differential diagnosis of dysphagia

Oropharyngeal	Esophageal
Neuromuscular disorders	Motility disorders
Cerebrovascular accident, dementia	*Primary*
Brainstem tumors	Achalasia
Head trauma	Diffuse esophageal spasm
Parkinson's disease	Hypertensive LES
Multiple sclerosis	Non-specific esophageal motility disorder
Amyotrophic lateral sclerosis	Nutcracker esophagus
Idiopathic UES dysfunction	*Secondary*
Manometric dysfunction of the UES or pharynx	Reflux-related dysmotility
Metabolic encephalopathies	Scleroderma and other connective tissue
Wilson's disease	Disorders
Guillain-Barré syndrome	Chagas' disease
Myopathic disorders	Structural disorders
Connective tissue disease	*Intrinsic*
Polymyositis	Benign stricture (peptic, radiation, post-surgery, PDT, corrosive)
Dermatomyositis	Schatzki ring
Myasthenia gravis	Benign tumors
Myotonic dystrophy	Malignancy
Oculopharyngeal dystrophy	Eosinophilic esophagitis
Metabolic myopathy	Pill esophagitis
Sarcoidosis	Esophageal diverticula
Paraneoplastic syndrome	Crohn's disease
	Extrinsic
Infectious diseases	Vascular compression (enlarged aorta, left
Mucositis (herpes, cytomegalovirus, *Candida*)	atrium or aberrant subclavian artery)
Lymes disease	Mediastinal mass (lymphadenopathy,
Diphtheria	abscess, lung cancer)
	Cervical osteophytes
Structural lesions	Iatrogenic causes
Tumors	Pill injury

Table 1. Continued

Oropharyngeal	Esophageal
Zenker diverticulum	Medication side effects (chemotherapy, neuroleptics, etc.)
Cricopharyngeal bar	Postsurgical muscular or neurogenic
Cervical webs	Radiation
Congenital abnormalities	
Miscellaneous	
Depression, Alzheimer's disease	Functional
Decreased saliva (Sy-Sjögren)	Functional dysphagia

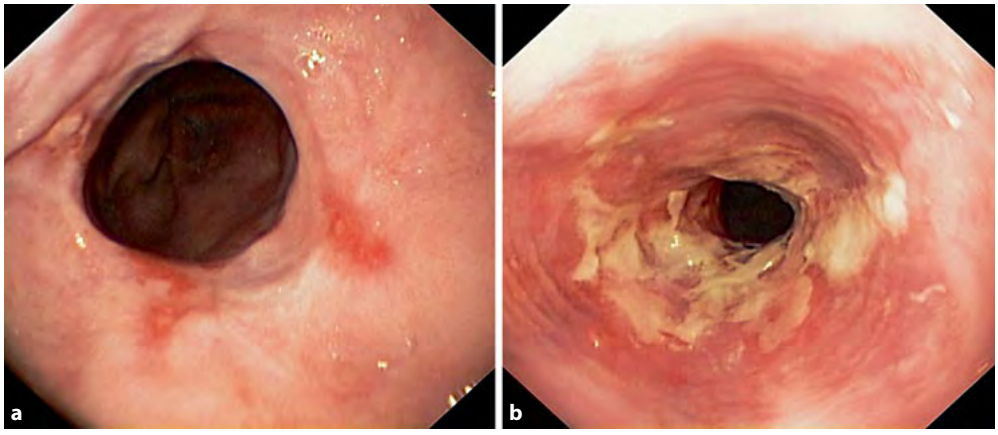


Fig. 1. Peptic strictures may be decreasing due to the widespread use of PPIs. **a** A Schatzki ring. **b** Severe esophagitis with stricture. Despite having a lesser degree of esophagitis, this patient also has a peptic stricture. This example shows that the Los Angeles classification is still an imperfect classification for gastroesophageal reflux disease.

placement of esophageal stents or to place a percutaneous endoscopic gastrostomy for feeding purposes [6–8]. Figure 4 provides a useful algorithm for the endoscopic approach of patients with esophageal stenosis. However, not all patients with dysphagia will require an endoscopic intervention. Note that most patients with dysphagia or odynophagia have conditions that can be managed medically, such as gastroesophageal reflux disease, infectious ulcers and eosinophilic esophagitis [9] (fig. 5).

Esophageal strictures can be structurally categorized into two groups: complex and simple. Complex strictures are those that are asymmetric, irregular or angulated with diameter <12 mm (malignant, anastomotic, post-radiation) (fig. 6). Simple strictures are symmetric or concentric with a diameter of ≥12 mm or those that easily allow passage of a diagnostic upper endoscope [1, 3, 10] (fig. 7). Esophageal strictures from a variety of benign and malignant causes require

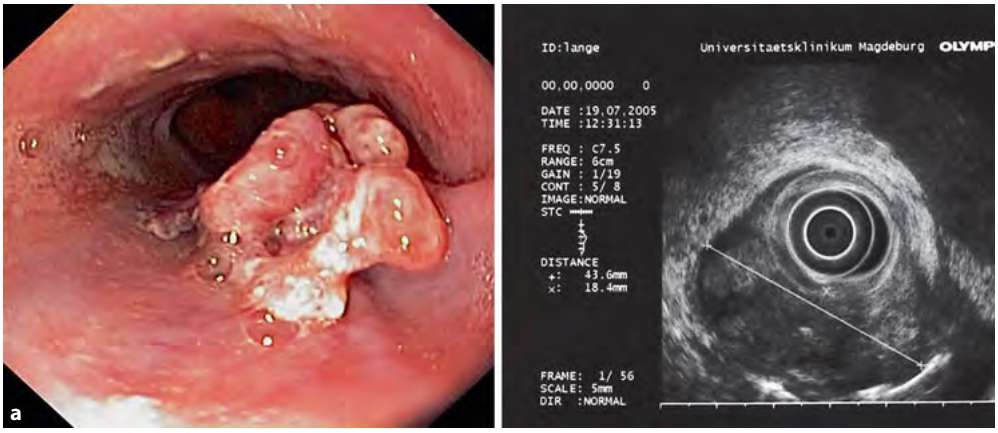


Fig. 2. **a** An adenocarcinoma of the distal esophagus presenting as a partially obstructing mass. **b** Endoscopic ultrasound. The tumor is very large and has spread into the mediastinum (T4).

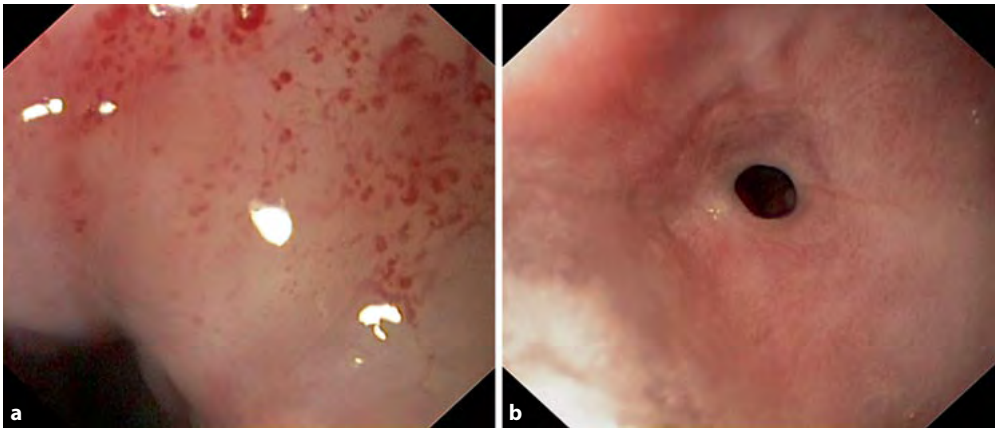


Fig. 3. **a** Radiation-induced stricture. **b** Using magnification endoscopy it is easy to see the proliferation of submucosal vessels that is characteristically seen in radiation esophagitis.

dilation therapy when patients develop symptoms of dysphagia. Dilation can be accomplished through several steps using a variety of dilating devices and adjunctive techniques (table 2). The approach to management of esophageal strictures is reviewed with a focus on dilation technique and special consideration for various stricture types and complications of the method.

Procedural Aspects

Patient Preparation

Patient preparation will depend upon the main cause of dysphagia. Patients with achalasia may require prolonged fasting and removal of food rests using a nasoesophageal tube (see also chapter on therapy of achalasia). Besides remaining NPO, laboratory tests may be warranted in patients

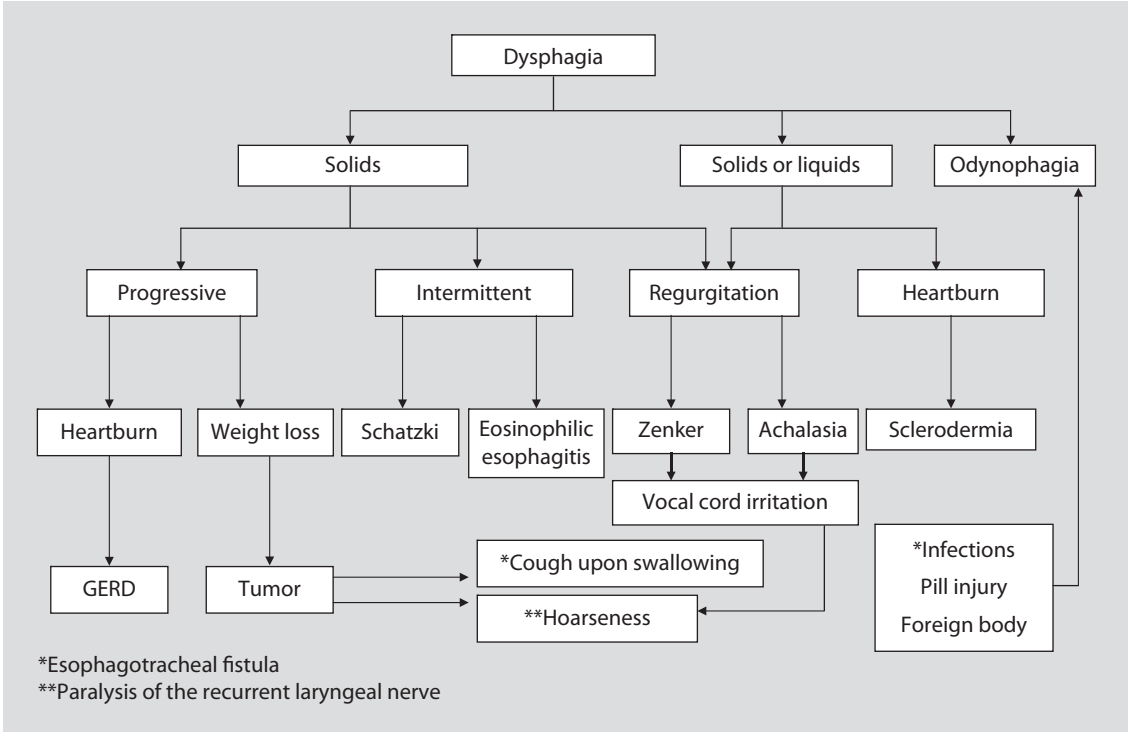


Fig. 4. Diagnostic algorithm for the assessment of a patient with dysphagia.

with blood dyscrasias or those taking anticoagulant therapy. Prior to endoscopy all patients have to provide written informed consent, also with written information about the risk of perforation (i.e. 1%) and the possible need for surgery. Endoscopies and dilations are carried out in the morning after an overnight fast and as an outpatient procedure, with the exception of patients with complex strictures, who should be observed for 24 h after the procedure. Radiographic contrast examination is not performed routinely before dilation, but it is performed after dilation of achalasia or complex strictures to exclude perforation.

As dilation is an invasive and uncomfortable procedure, conscious sedation is generally used. Esophageal dilations should always be performed or closely supervised by experienced endoscopists. Antibiotics are not used routinely before dilation; endocarditis prophylaxis guidelines should be followed [11]. Anticoagulants should be discontinued [12].

Accessories

Most esophageal dilations can be performed without the use of fluoroscopy [13]. However, some endoscopists working in open-access or fast-track endoscopy units prefer to have the patients placed in the fluoroscopy room (fig. 8). This is to avoid the unpleasant, and not infrequent situation in which a contrast imaging of the esophagus is needed either before or after the procedure and when a stent placement is planned or anticipated. The worst case scenario is to have a perforation and suddenly have to move with the patient to an appropriate room with x-ray capabilities in order to be able to place an emergent covered metal stent. In addition, currently, most esophageal strictures treated at some tertiary centers are complex, and their dilation may be facilitated

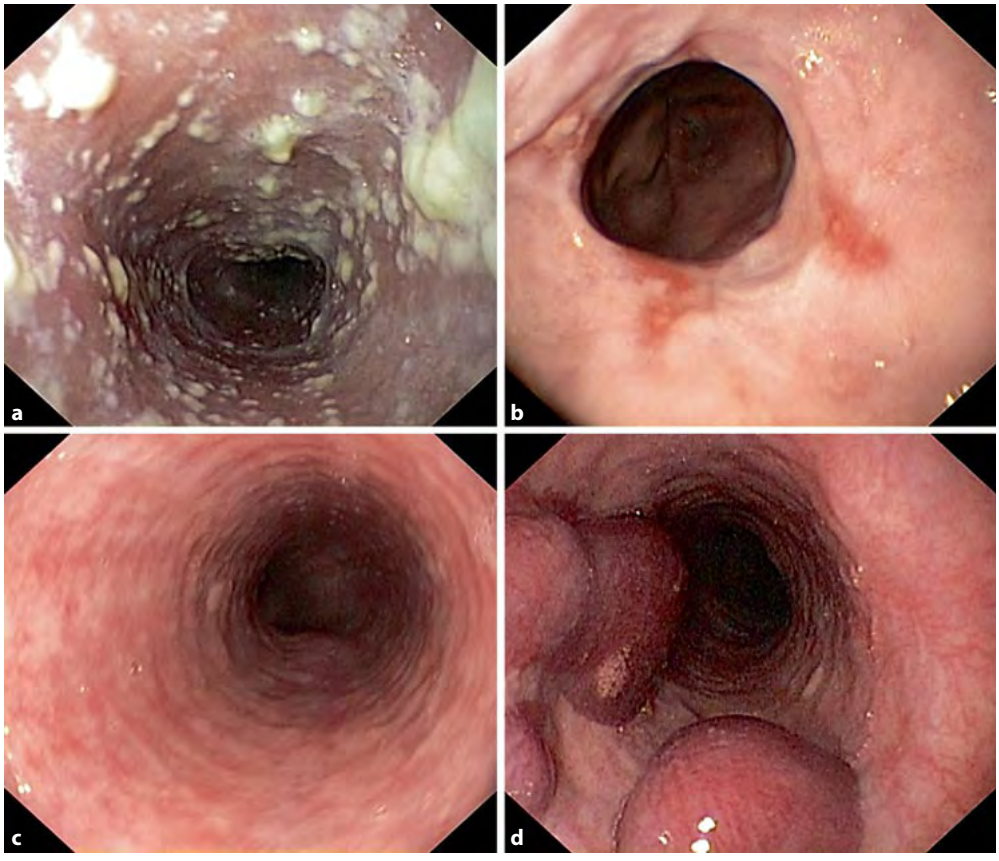


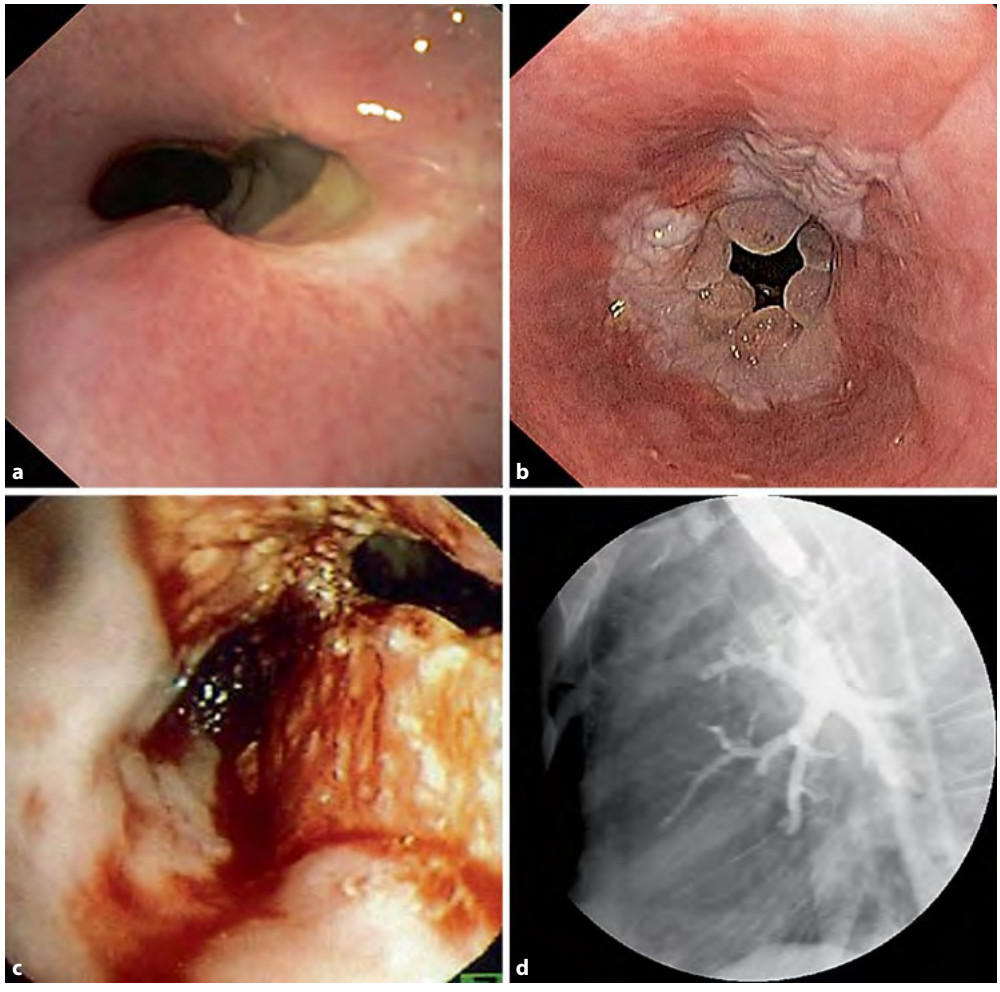
Fig. 5. Most patients with dysphagia or odynophagia have conditions that can be managed medically, *Candida* esophagitis (**a**), such as gastroesophageal reflux (**b**) disease, eosinophilic esophagitis (**c**) and pemphigoid (**d**).

by the use of fluoroscopy [14]. Furthermore, one study showed that fluoroscopy may lead to better functional results and fewer adverse events [15]. Regardless of the existing and controversial data, we believe that all patients with complex strictures should be dilated under radiographic control. Figure 9 is a practical algorithm for the management of esophageal strictures.

Technique

Esophageal dilation is currently performed using either bougies or balloons (table 3) (fig. 10–12) [1–4, 16, 17]. The word *bougie* comes from the French and means 'candle'. Formerly, esophageal dilation was performed using large candles. The words 'bougienage' and dilation mean the same, but we prefer to use the word 'dilation' and specify whether this was performed using a bougie or a balloon.

Historically, there are a large variety of bougies that have been used to perform esophageal dilation. However, currently two main types of bougies are used: mercury or tungsten-filled bougies (Maloney or Hurst) and over-the-wire (OTW) polyvinyl bougies (Savary-Gilliard® or American, Wilson-Cook Medical, Inc., Winston-Salem, N.C., USA) [4] (fig. 10). The Maloney type bougies have a tapered tip and are passed either blindly or under fluoroscopic control [18].



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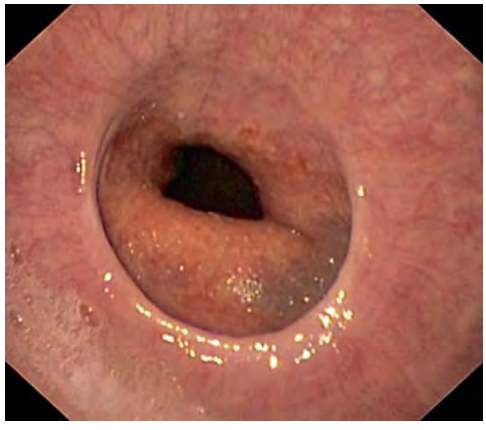

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Fig. 6. Complex esophageal strictures are those that are (**a**) asymmetric or ulcerated, (**b**) irregular or angulated or (**c**, **d**) associated with a fistula.

Fig. 7. Simple esophageal strictures are symmetric or concentric with a diameter of ≥12 mm or those that easily allow passage of a diagnostic upper endoscope.

This type of dilator is used for simple strictures with a diameter of 12–14 mm. The risk of esophageal perforation may be higher with blind passage of the Maloney dilators than with OTW Savary or TTS (through-the-scope) balloons, particularly in patients with a large hiatal hernia, a

Table 2. Steps in esophageal dilation

Patient preparation
Informed consent, fasting overnight, anticoagulants discontinued, sedation
Evaluate diameter and length of stenosis
Choose method
Bougie vs. balloon
If complex stricture or achalasia
Use fluoroscopy
When using balloon use wire (Jagwire) Observe for 24 h
Fluoroscopy: not needed for most stenosis

Table 3. Type of dilators

Mercury or tungsten-filled bougies
Maloney
Hurst
Wire-guided polyvinyl dilators (OTW)
Savary-Gilliard
American
Balloons
TTS dilation balloons
Without wire guidance
With wire guidance (Jagwire)

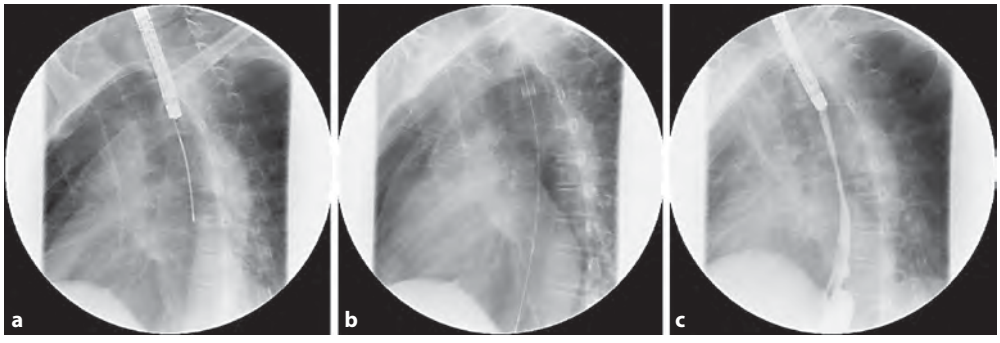

Fig. 8. Some endoscopists working in open-access or fast-track endoscopy units prefer to dilate esophageal strictures under fluoroscopy. This allows for a precise advancement and placement of a guidewire (**a**, **b**), especially when the stricture is very tight or irregular. In addition, contrast can be applied after the dilation, and thus rule out (**c**) or discover a perforation.

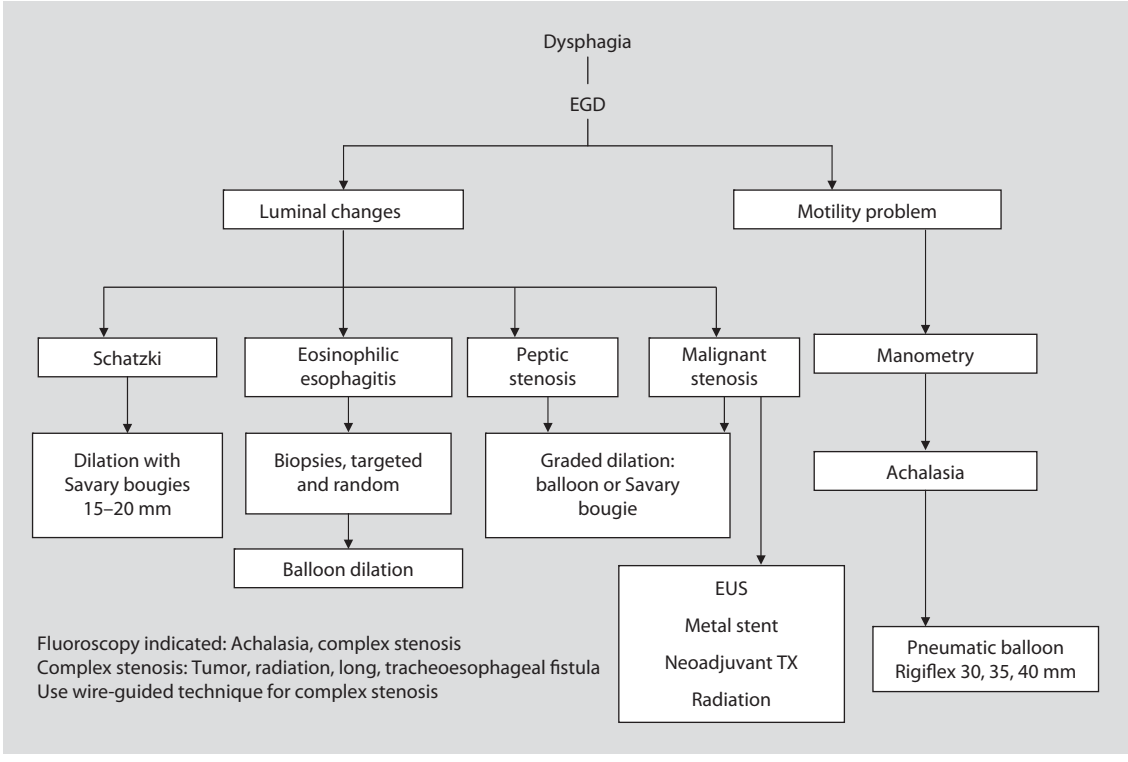

Fig. 9. Practical algorithm for the management of esophageal strictures.

Fig. 10. Classic Savary or American dilators. Dilators are also called bougies, which originates from the French word 'candle'. Formerly, esophageal dilations were performed with wax candles. American dilators are advanced OTW, usually the spring-tipped hard Savary wire. However, any soft wire, such as a 'Jagwire', can be sued to advance the Savary dilator.

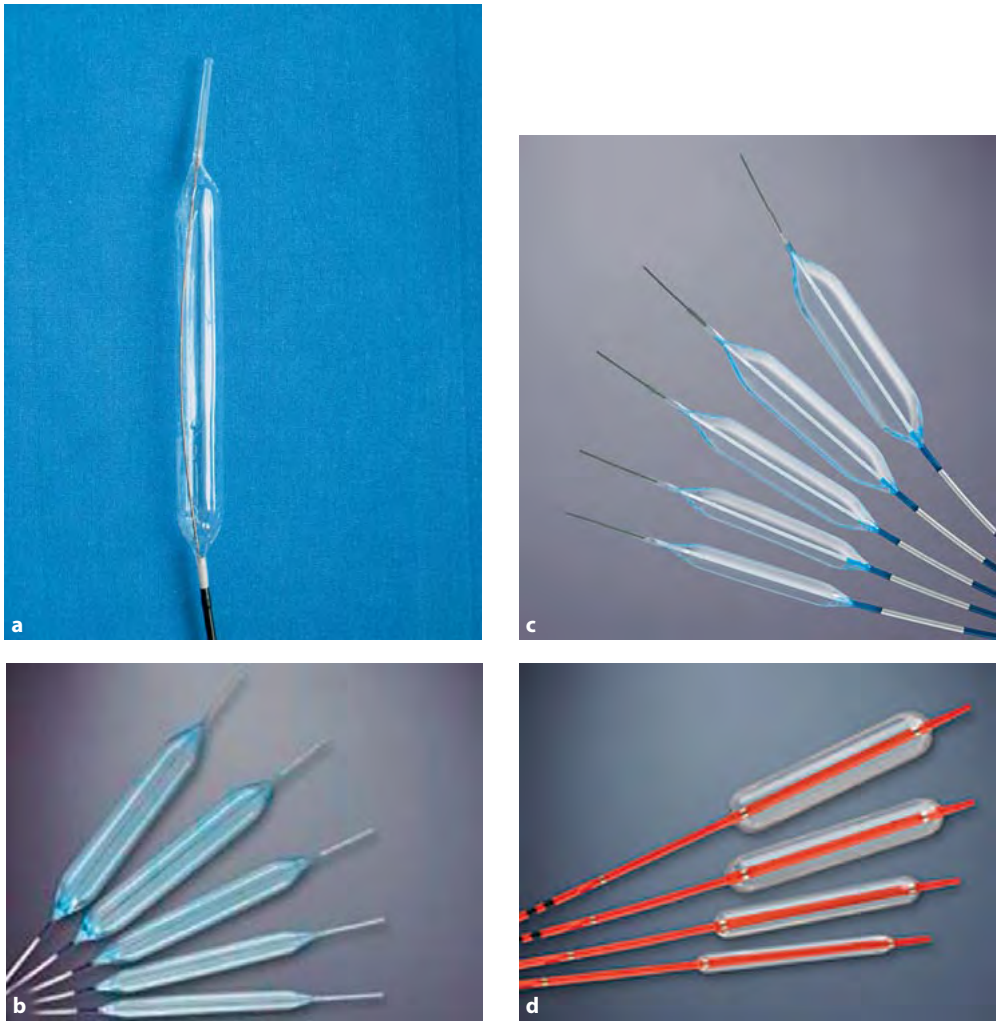

Fig. 11. Balloons used for esophageal dilation are advanced TTS and can be standard or OTW. If the stricture is tight, irregular or high risk it is always better to advance OTW. **a** Standard TTS balloon. **b** The Hercules® 3 Stage Balloon Dilator (Cook, USA) is available in various sizes, the smallest being 8 mm. The advantage of this balloon is its three-stage capability, which means that it can dilate a stricture in three different inflation diameters, thus following the classic 'rule-of-three'. The smallest balloon can dilate 8–9–10 mm (24–27–30 Fr), whereas the largest balloon goes from 18 to 20 (54–57–60 Fr). **c** If the stricture is irregular, tight or high risk, it is always better to perform the dilation with OTW balloons. **d** Titan® biliary balloon (Cook). Although this balloon is used to dilate biliary strictures, we have also found it very useful to dilate very tight esophageal stenosis (permission for image reproduction granted by Cook Medical Inc., Bloomington, Ind., USA).

tortuous esophagus, or those with complex strictures [1, 3, 4, 10] (fig. 11). Savary and American dilators are passed over a guidewire that has been positioned with a tip in the gastric antrum, with or without fluoroscopic guidance [19].

Various types of balloons are available to dilate the esophagus. We have accumulated a large experience using two main types of balloons: (CRE™, Controlled Radial Expansion, Boston Scientific Cork Ltd, Cork, Ireland, and Eclipse® Wire Guided Balloon Dilators Cook Ireland Ltd,

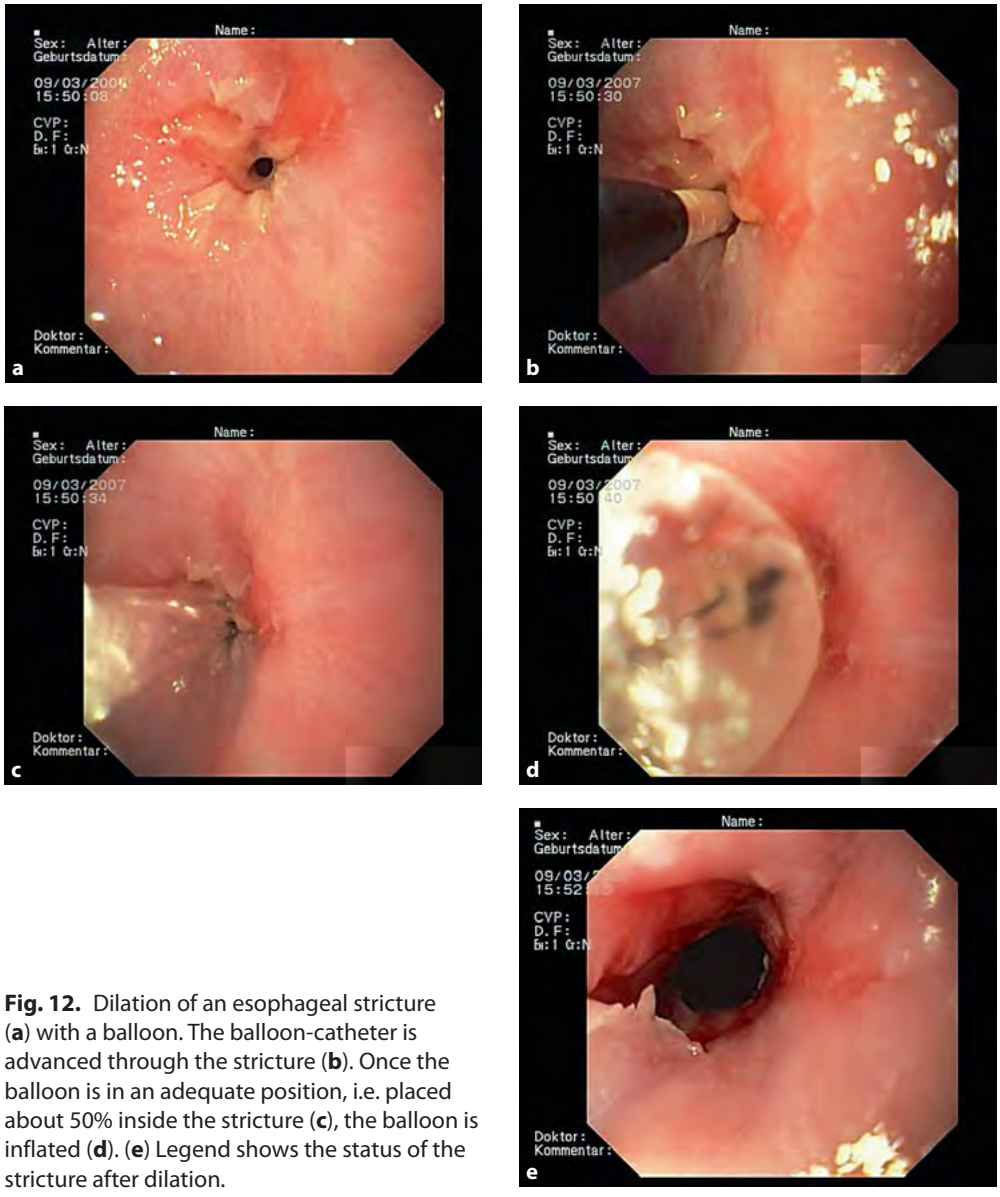

Fig. 12. Dilation of an esophageal stricture (**a**) with a balloon. The balloon-catheter is advanced through the stricture (**b**). Once the balloon is in an adequate position, i.e. placed about 50% inside the stricture (**c**), the balloon is inflated (**d**). (**e**) Legend shows the status of the stricture after dilation.

Limerick, Ireland). Balloons for esophageal stricture dilation come in various shapes and sizes. Because these balloons can be advanced through the accessory channel of the endoscope they are also referred to as 'through-the-scope' or TTS balloons [20] (fig. 11). One of the most important aspects to consider when choosing these balloons is the ability to further advance them OTW. These wires generally refer to any wire ≤0.035 inch (e.g. Jagwire, Microvasive, Boston Scientific). These TTS OTW balloons are particularly useful for complex, large, angulated, irregular, very tight strictures or if the luminal diameter of the stricture is <3 mm (fig. 12). In the presence of complex strictures the wire can be advanced under fluoroscopic guidance across the stricture and then, under direct endoscopic vision, the balloon can be advanced OTW (fig. 8). Advancing a 'plain'

TTS balloon without wire guidance in such strictures can lead to perforation, as the tip, even when it is floppy, can take a bend through the fibrosed or ulcerated stenosis and result in direct perforation or create a false passage, which after inflating the balloon, results in a large perforation.

It is important to clearly differentiate these balloons from the pneumatic balloons used to treat achalasia (Rigiflex® II Achalasia Balloon Dilators, Boston Scientific Corp., Natick, Mass., USA; Witzel Pneumatic Dilator, M-T-W-W Buderich, Germany, see achalasia chapter). The achalasia balloons can reach large diameters (30–40 mm).

Although the choice of dilatation device is left to the individual endoscopist, dilations in patients with tumors are mainly performed with Savary dilators following the conventional technique, using incremental diameters of the bougies, but no more than three per session ('rule-of-three'), and always under fluoroscopic monitoring. The 'rule of three' has been the standard for bougie dilation [21]. The initial dilator chosen should be based on the known or estimated stricture diameter. After moderate resistance is encountered with the bougie dilator, no greater than three consecutive dilations in increments of 1 mm should be performed in a single session [21, 22]. Although this rule does not apply to balloon dilators, a recent study suggested that inflation of a single large-diameter dilator (>15 mm) or incremental dilation of >3 mm may be safe in simple esophageal strictures [23]. Interestingly, most balloons allow a three-step inflation process, each of 1 mm, practically paralleling the 'rule-of-three'. Current AGA recommendations for management of peptic esophageal stricture include consideration that steroid injection into benign strictures immediately before or after dilation has been advocated to improve outcome by decreasing the need for repeat dilations [4]. A recent randomized trial of intralesional steroid injection with PPI therapy versus sham injection with PPI therapy in patients with recalcitrant peptic esophageal strictures showed that the need for repeat dilation was significantly diminished in the steroid group [24].

Limitations and Complications

Regardless of the specific method of dilation, early improvement in the ability to swallow is achieved in virtually all patients. Longer-term outcomes are influenced by the underlying pathology. For peptic strictures, smaller lumen diameter, presence of a hiatal hernia >5 cm, persistence of heartburn after dilation, and number of dilations needed for initial dysphagia relief were significant predictors of early symptomatic recurrence [25]. A multivariate analysis revealed that a non-peptic etiology of strictures was a significant predictor of early symptomatic recurrence within 1 year of initial dilation [26]. Patients with peptic strictures should be treated with PPI therapy. Compared with histamine receptor antagonist therapy, PPI use decreases stricture recurrence and the need for repeat stricture dilation [27, 28].

Esophageal perforation is the major complication associated with endoscopic dilation [4, 29–32]. The perforation rate for esophageal strictures after dilation has been reported to be 0.1–1% [11]. A United Kingdom regional audit reported an overall perforation rate of 2.6% with a mortality of 1% [32]. In that study, perforation was less common following dilatation of benign strictures (1.1%) than following dilatation of malignant strictures (6.4%) [31]. In older studies, perforation was most commonly associated with the blind passage of Maloney or non-wire-guided bougies into complex strictures [10, 31]. In another study from England the incidence of iatrogenic perforation for endoscopic treatment of tumors of the esophagus and cardia was 3.3% [32]. A common practice in England at that time was the use of single-sized bougies. Whilst data

were not available as to the caliber of dilators routinely used in that region, it was commonplace in the early 1990s to use large dilators (18–20 mm). Therefore, it appears that perforations are common when using a single bougie size dilator, irrespective of stricture diameter [32].

Perforation after esophageal dilation usually occurs at the site of the stricture, either intraabdominally or intrathoracically. Some experts recommend endoscopic reinspection immediately upon completion of the dilatation procedure as the appearances may raise the possibility of perforation and prompt early treatment. Perforation should be suspected if severe or persistent pain, dyspnea, tachycardia, or fever develops. Physical examination may reveal subcutaneous crepitus of the chest or cervical region. Although a chest radiograph may indicate a perforation, a normal study result does not exclude this diagnosis and a water-soluble contrast esophagram or contrast computed tomogram of the chest may be necessary to disclose a perforation [33].

When using bougies we prefer to use OTW Savary dilators. Bougie-type dilators exert not only radial forces as they are passed but also longitudinal forces as the result of a shearing effect [34]. Therefore, it is possible that the risk of perforation is less when using balloon dilators. In contrast, longitudinal forces are not transmitted with balloon dilators because the entire dilating force is delivered radially and simultaneously over the entire length of the stenosis rather than progressively from its proximal to distal extent [34]. However, this has not been shown yet by clinical studies and no clear advantage has been demonstrated between the two dilator types [29, 35, 36].

Data from the literature also confirm that the risk of perforation is higher in complex strictures and lower in simple strictures [10]. In a retrospective study performed at our endoscopy unit, we found that the perforation rate for malignant strictures was higher than for peptic strictures [14]. Some authors also suggest that perforation may be more common and severe with radiation-induced strictures [37]. Nevertheless, this was not observed in our study. Although we did not observe any overt perforations associated with radiation-induced strictures, we had two possible microperforations [14]. The perforation rate may also be influenced by the endoscopist's level of experience; one study indicated that the perforation rate was four times greater when the operator had performed fewer than 500 previous diagnostic upper endoscopic examinations [31]. Therefore, in small hospitals where thoracic surgeons are not routinely available, arrangements should be made in order to have available a surgeon capable of repairing an esophageal perforation.

The use of large-diameter covered metal stents and the use of expandable, removable plastic stents have been shown to be effective in the management of perforations after dilation of benign and malignant esophageal strictures [38, 39].

To summarize, endoscopic esophageal dilation is a safe procedure for the management of benign strictures, for the palliation of malignant strictures, and to expand malignant strictures previous to the placement of a self-expanding metal stent. A thorough clinical knowledge of dysphagia and its management is paramount for the interventional endoscopist, as only a minority of patients will require endoscopic therapy. The endoscopist should be well versed and trained with all the available accessories used for esophageal dilation, including wires, bougies and balloons. As perforation occurs in about 0.5–1.5% of esophageal dilations, identification of patients at higher risk and with complex strictures is crucial to prevent iatrogenic perforation. In addition, knowledge and skills on placement of self-expanding covered metal stents and close collaboration with the surgeon is mandatory. As with any other therapeutic endoscopic procedure, esophageal dilation should only be performed by endoscopists well trained in interventional endoscopy.

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Klaus Mönkemüller, MD, PhD, FASGE
Marienhospital, Bottrop, Josef-Albers-Strasse 70
DE–46236 Bottrop (Germany)
Tel. +49 2041 106 1000, Fax +49 2041 106 1009
E-Mail klaus.moenkemueller@mhb-bottrop.de