Perforation during Esophageal Dilatation: A 10-Year Experience

Alexander F. Hagel1, Andreas Naegel1, Wolfgang Dauth2, Klaus Matzel3, Hermann P. Kessler3, Michael J. Farnbacher4, Werner M. Hohenberger3, Markus F. Neurath1, Martin Raithel1

INTRODUCTION

Stenoses in the esophagus can cause significant morbidity and mortality, presenting with dysphagia, chest pain, weight loss etc and may lead to aspiration pneumonia or death. Until the introduction of proton pump inhibitors (PPIs) at the end of the 80s, most stenoses were of peptic origin [1]. Nowadays, after establishment of PPI as standard therapy for gastric acid induced diseases, malignant, postradiotherapy and postsurgical esophageal strictures were more frequently detected in an older growing population [2, 3]. Newly recognized diseases such as eosinophilic esophagitis represent an upcoming novel further source for esophageal stenosis with a preference towards younger patients [4, 5].

One possible treatment is endoscopic dilatation in patients with esophageal stenoses. The main indication here represents the relief of symptoms and restoration of an appropriate wide esophageal lumen. In malignant conditions, dilatation procedures are used to facilitate further examination and treatment options (e.g. brachytherapy, endoscopic ultrasonography) or for palliative purposes (e.g. insertion of a percutaneous endoscopic gastrostomy or the placement of esophageal plastic or metal stent) [3, 6].

Endoscopic esophageal dilatation can be achieved either by high-pressure balloon dilatation (Through-The-Scope balloons, TTS) or by wire-guided polyvinyl dilatators for bougination of the stenosis [2, 7, 8]. A clear advantage could not be demonstrated for either of the two treatment options [9-11]. The main difference is represented by the fact that the balloon systems normally are intended for single use, whereas polyvinyl dilatators can be reused.

Esophageal perforation represents one of the most serious complications during endoscopic dilatation. In literature, perforation rates of 2-3% and a mortality of up to 1% have been reported [12, 13].

Interventional endoscopic options in esophageal strictures consist mainly of balloon dilatation and bougination [2, 7, 8]. In bougination, rigid polyvinyl dilatators with a caliber of 5-20mm are used. They possess a central lumen which enables...
insertion of the bougie over an endoscopically placed guide wire [14-16], sometimes controlled by fluoroscopy. Initially, in the 1960s and 70s a more aggressive approach to rapidly increase the diameter of the esophageal stenosis was used partly with rather large bougies. But this has repeatedly been reported to result in a high rate of complications. Hence the “rule of three” was introduced by which only three dilators with increasing diameters were used within one endoscopic session [8, 14-16].

The aim of this study is to evaluate occurrence, risk factors, outcome and treatment strategies in patients with esophageal perforations following endoscopic dilatation over the last decade in a tertiary endoscopy center.

MATERIAL AND METHODS

High-pressure balloon dilatation consists of a balloon which can be inserted through the scope with or without guidance provided by a guide wire (TTS balloon dilatation). After being placed into the stricture, the balloon is gradually inflated using water or a contrast agent [14, 15] by the use and control of a high-pressure manometer.

In balloon dilatation constant radial forces are employed onto the stricture. During bougination those forces are complemented by longitudinal forces beginning at the proximal end of the stricture [14, 17]. However, no clear advantage regarding complications for either of these methods could be shown [18].

Between 01.01.2002 and 31.12.2011 all dilatations and bouginations of esophageal strictures were consecutively included in this study. Patient and examination details were prospectively entered in a database which was then retrospectively searched for perforations. All patients signed the appropriate forms of consent. This study was conducted according to the Declaration of Helsinki and was approved by the institutional review board. The following details were evaluated: age, gender, indication for dilatation, further gastrointestinal diseases, time until suspicion of perforation, further diagnostics, length of hospitalization, further complications.

All dilatations were conducted either using rigid bougies (Savary–Gilliard Bougies, 6–20mm diameter) or Through–The–Scope balloons (TTS 8–20mm). For upper endoscopy GIFXP, GIF160, GIFQ160, GIF180 or GIF1T140 (Olympus, Hamburg, Germany) were used. For bouginations, Savary–Gillard bougies (Cook Medical, Bloomington, IN, USA) and for balloon dilatations, TTS balloons (Controlled Radial Expansion, CRE, Boston Scientific Ltd, Cork, Ireland and Eclipse Wire Guided Balloon Dilators Cook Ireland Ltd, Limerick Ireland) were used.

Documentation of perforations was assessed clinically and radiologically either by water-soluble contrast swallow (Solutrast or Imeron, Bracco, Konstanz, Germany), chest and/or abdominal X-ray, or computed tomography (CT) scans from thorax and/or abdomen, respectively.

These data were entered in a database for further analysis using the statistical software Stata10 (StataCorp, College Station, TX, USA). In order to statistically assess whether these characteristics differed significantly between different groups of patients, we applied Student t test for mean differences. The significance of differences between groups was determined according to p values (p<0.05 was considered significant).

RESULTS

Between 01.01.2002 and 31.12.2011, 1497 dilatations in 368 patients were conducted (4.07 per patient). An overview including indications and perforation numbers is given in Table I.

The average age was 61.3 years (range 21–94 yrs). There was no difference in patients with balloon dilatations (61.8 ±12.1 yrs) and bouginations (63.4 ± 9.8 yrs); 269 patients were male (73.1%).

In eight patients, a perforation occurred due to esophageal stricture treatment. All perforations occurred during bougination, whilst no perforation was reported after balloon dilatation.

<table>
<thead>
<tr>
<th>Esophageal diagnosis</th>
<th>Balloon dilatation</th>
<th>Bougination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post-surgical stricture</td>
<td>17</td>
<td>35</td>
</tr>
<tr>
<td>Malignant stricture</td>
<td>18</td>
<td>44</td>
</tr>
<tr>
<td>Peptic stricture</td>
<td>15</td>
<td>51</td>
</tr>
<tr>
<td>Post-interventional stricture</td>
<td>5</td>
<td>14</td>
</tr>
<tr>
<td>Post-radiotherapy stricture</td>
<td>3</td>
<td>39</td>
</tr>
<tr>
<td>External compression</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Schatzki ring</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Chemical burn</td>
<td>1</td>
<td>13</td>
</tr>
<tr>
<td>Epidermolysis bullosa</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Eosinophilic esophagitis</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Pseudo diverticulosis</td>
<td>4</td>
<td>17</td>
</tr>
<tr>
<td>Total</td>
<td>68</td>
<td>211</td>
</tr>
</tbody>
</table>

Pat. = patients, Ses. = sessions, Perf. = perforations, Post-interventional strictures included strictures after endoscopic mucosal resection (EMR) or esophageal band ligation.
dilatation. This yields a perforation rate of 0.53 % per procedure and a perforation rate of 2.17 % per patient. A detailed overview of the conducted interventions and the perforation is given in Table I.

The underlying cause of the esophageal stenosis was malignancy (in 2.79% of patients and 0.87% of procedures), post-radiotherapy stricture (in 3.1% of patients and 0.4% of procedures) and chemical burns (in 12.5% of patients and 1.32% of procedures).

Four of the eight perforations (50%) were suspected during the procedure. The diagnosis was confirmed using a contrast swallow in three patients and a computed tomography (CT) in one patient. The remaining patients without initial suspicion of perforation developed post-interventional thoracic pain after 6-24 hours. In three of these patients a CT was conducted and in one a contrast swallow.

The stenoses in the 8 patients with perforations were located in the proximal esophagus in 1 patient (12.5%), in the mid esophagus in 4 patients (50%) and in the distal esophagus in 3 (37.5%).Six of the 8 perforations (75%) occurred at the distal end of the stenoses, one at the proximal end (12.5%), and the stenosis due to alkali burn perforated in the middle (12.5%).

All strictures qualified as complex strictures. Initial diameter was less than 10mm in all cases. Half of the perforations occurred during the first session with a dilatation diameter of less than 12mm. The other perforations occurred during a second session, two to three days after a first intervention with the diameters varying between 11 and 16mm. The stenosis length (mean) in patients with perforations (34mm, range 12-50mm) was almost similar to the entire study cohort (39.6mm, range 5-160mm). Endoscopically and/or radiologically, the perforation size was estimated to be less than 1cm in all cases.

After interdisciplinary consultation with the surgeons, all patients were treated conservatively due to the perforation size and concomitant diseases.

All patients (100%) with perforation showed an increase in inflammatory markers and body temperature; 4 patients (50%) developed signs of systemic inflammatory response or sepsis. All patients were initially treated by fasting, analgetics, nasogastric tube and high dose antibiotics covering gram-negative and gram-positive bacteria. Additionally, endoscopic treatment was further performed in two patients (25%). In one patient, wound edges were adapted using TTS clip application (14.2%) and one perforation was covered by using an esophageal metal stent (14.2%).

One patient died due to a septic multiorgan failure after perforation, at 41 days after bougination. This patient suffered from stenotic esophageal squamous cell carcinoma as well as from alcoholic liver cirrhosis and chronic obstructive pulmonary disease (COPD GOLD stage IV).

The hospitalization duration for these patients was 21.3 days (range 9-41 days), significantly longer compared to patients without perforations (6.8 days, range 2-13 days, p=0.002).

**DISCUSSION**

In the investigated time period, we performed 1,497 dilatations in 368 patients, resulting in 8 perforations with one lethal outcome. Overall, this results in a perforation rate of 0.53% for the whole patient population. This lies in the lower end of the range published in literature of 0.1-5% [8, 13]. In the 70s and 80s, higher perforation rates were reported and explained by the use of single-sized bougies of 18-20mm [7]. Later on, bougies with varying diameters were used. Beginning with a small caliber which encounters only little resistance, the diameter is increased in due course. However, to prevent too much pressure onto the esophageal wall and to further reduce the perforation risk, the “rule of three” was established. Hereby, only three consecutive bougies with an increase of 1mm between each are used within one session [9, 15]. The strict appliance of this rule has led to a decrease over time in perforation rates to about 2% [12, 13]. Our present results fit very well in this trend and our low perforation rate confirms this approach.

Subdividing the results obtained with respect to the etiology of the stenosis (malignant tumor, post-radiotherapy) vs. benign (post-interventional, eosinophilic esophagitis etc) showed an up to five fold increased perforation risk for a malignant stricture [7, 12, 13]. In our patient population we found a similar rate. In 0.9% (5 perforations / 575 procedures) of all interventions conducted due to a malignant cause of the stricture a 3-fold higher perforation occurred, compared to 0.3% (3 perforations / 922 procedures) of benign strictures.

Another negative predictive factor is represented by the properties of the stricture. Strictures which cannot be passed by a standard endoscope, which are longer than 2cm, have a diameter of less than 12mm or are tortuous are defined as complex [14]. Commonly, the vast majority of perforations occur in complex stenoses, whereas in simple strictures perforations occur only rarely [13]. In our cohort, all perforations were found in complex strictures. Most of them fulfilled even more than one of the mentioned criteria.

In the past, several studies prospectively compared the dilatation of esophageal stenoses by balloons or bougies. In these studies no advantage of any type could be shown if the decision for the deployed system was made before endoscopic evaluation of the stenosis [20, 21]. In our study, we did not encounter any perforation during the dilatation using a high-pressure balloon instead of a bougie. A similar observation was reported earlier [13]. This might be due to the fact that usually less expensive bougies are used, which can be sterilized and re-used, and more expensive single-use balloons are only deployed when there is an endoscopic sign or indication of an esophageal inflammation or a high risk stricture [8, 9, 11, 22]. Further advantages for the excellent safety of the balloon dilatation are the possibility for the endoscopist to observe the dilatation effect endoscopically in the TTS method and to reduce the pressure immediately, when significant tissue damage may be observed. However, balloon dilatation induces only radial forces. In contrast, in bouginations X-ray is infrequently used in a minority of procedures to control the intervention, but this cannot illustrate early signs of mucosal lesions. Furthermore, bougination works with radial and longitudinal forces to combine and maximize the dilatation effect. However, the latter or the combination effect may make bougination more prone to induce mucosal or submucosal tears or even transmural perforation.

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In the literature, a sharp increase in perforation rates is reported, when the examiner has performed less than 500 previous upper endoscopic examinations [12]. One criterion in our endoscopy unit, before performing a dilatation is that the endoscopist has conducted at least 300 examinations. Furthermore, the first 20 dilatations should be conducted under the supervision of a senior endoscopist.

After bougination or dilatation, a final endoscopic assessment is warranted as it can find early signs of mucosal lesions, bleeding or perforation. Here, 4 of 8 perforations (50%) were detected early, followed by rapid confirmation using contrast swallows in three and a CT in one patient. Early detection of perforation may have a significant impact on the patient's outcome, because complication management of the perforation can be initiated immediately by endoscopic treatment (TTS or Over-The-Scope clips, self-expandable metal stents), nasogastric tube, antibiotics, surgical intervention etc [22, 23]. Decision of further treatment options (conservative, endoscopic closure, surgical) should be made interdisciplinary depending on the site and size of the perforation [22, 23]. Interestingly, since all perforations in our study were smaller than 1cm in size, all patients were subjected to conservative treatment after interdisciplinary assessment. However, conservative treatment of confirmed esophageal perforations was successful in 7 of 8 patients (87.5%). It remains to be speculated whether an early surgical approach would have avoided the lethal outcome in the eight patient, as he suffered from multiple co-morbidities and progressing malignancy. Concomitant diseases might further complicate a surgical approach and hamper postsurgical recovery.

Finally, we want to put the focus on another matter of interest. In all previous publications, the per-session perforation rate has been stated, but no per-patient data were given. However, since usually one patient is forced to undergo several dilatation sessions, not least due to the rule of three, the per-patient perforation rate might be an interesting variable for future decisions on how to handle esophageal strictures as it better illustrates the individual risk. Our study analyzing a patient cohort over one decade allowed us to calculate for the first time the per-patient complication rate over 10 years. This is an important new outcome parameter, since stricture disease of the esophagus may worsen over years, may recur, may be modified by new treatment strategies and regimens (chemo-radiotherapy, esophageal stenting etc) and finally, all these parameters may influence the individual complication and perforation risks. Especially, quality reports of hospitals and education of patients regarding esophageal diseases and stricture treatment should also contain these realistic data on a per-patient basis, because many patients require repeated examinations and they should receive an accurate long-term view about the actual treatment risks. Our data clearly demonstrate that balloon dilatation of esophageal strictures is much safer for the patient than bougination, which exerts biaxial forces. Thus, it might be expected that adequately informed mature patients may choose or give consent more likely to balloon dilatation than bougination in the future, an important issue which should be taken into economic considerations by hospitals and health assurances.

The limitations of our study consist of its retrospective setting, no randomization of patients to either dilatation method by balloon or bougie, the relatively low number of balloon dilatations in malignant stenoses, subjective decision of the endoscopist to either treatment modality and/or selection of the corresponding dilatation diameter within one session. However, the strength of this study is based on the high number of interventions performed within a 10 year interval in a high-volume endoscopy center, on results from an unselected population which reflects the real clinical situation of esophageal stricture treatment and its analysis of possible risk factors not only for the single dilatation session, but also for the individual complication rate per patient during a whole treatment course.

CONCLUSIONS

Dilatation in esophageal strictures is a widely-used and relatively safe technique. In our large cohort of patients from a 10 year period, bougination was found to cause a perforation rate of 0.53% with one lethal fatality (0.08%), while TTS-controlled radial extension balloon dilatation did not induce any perforations. The per-patient perforation rate was calculated as an outcome parameter in the long-term as disease severity may change, recur or predispose to complications. Perforation rate per patient was 2.17% during bougination, while it was zero when using TTS balloons.

The appropriate selection of the procedure (bougination, balloon dilatation), the diameter of the bougies or balloons used, examiner's experience and the use of the "rule of three" should be further carefully considered. In the future, patients' underlying disease, their preference to either treatment forms, and careful assessment of all co-morbidities will have an increasing impact to further reduce complications in esophageal stricture treatment. Furthermore, future studies and meta-analyses might include not only the per–intervention perforation rate, but also the individual long term per-patient perforation rate.

Conflicts of interest: No conflict to declare. No grants or funding were obtained for the carrying out of this study.

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