The role of biodegradable stents in the management of benign and malignant oesophageal strictures: A cohort study

Stephen McCain a,*, Scott McCain a, Barry Quinn b, Ronan Gray a,c, Joan Morton b, Paul Rice b

a Departments of General Surgery, Craigavon Area Hospital, Craigavon, Northern Ireland, UK
b Departments of Radiology, Craigavon Area Hospital, Craigavon, Northern Ireland, UK
c Cancer Epidemiology and Health Services Research Group, Centre for Public Health, Queen's University Belfast, Northern Ireland, UK

Article info
Article history:
Received 1 November 2014
Accepted 27 January 2015
Available online xxx

Keywords:
Oesophageal stricture
Benign stricture
Malignant stricture
Biodegradable stent

Abstract
Background: Oesophageal strictures can be caused by benign or malignant processes. Up to 10% of patients with a benign stricture are refractory to pneumatic dilatation and may benefit from biodegradable stent (BD) insertion. Biodegradable stents also have a role in malignant oesophageal strictures to facilitate enteral nutrition while staging or neo-adjuvant treatment is completed. The aim of this study was to review the safety and efficacy of BD stents in the management of benign or malignant oesophageal strictures.

Methods: A single centre retrospective cohort study was performed. Dysphagia was graded before and after stenting using a validated score. All patients were followed up for at least 30 days and all adverse events were recorded.

Results: Twenty eight stents were inserted in 20 patients; 11 for malignant and 17 for benign disease. One further attempted stenting was impossible due to a high benign stricture. There were no perforations and the 30-day mortality rate was zero. Mean dysphagia scores improved from 2.65 to 1.00 (p value <0.001) in benign disease and from 3.27 to 1.36 (p value <0.001) in patients with malignant disease. Surgical resection was not compromised following stent insertion in the malignant group.

Conclusions: Biodegradable stent insertion is a safe and efficacious adjunct in the treatment of benign and malignant oesophageal strictures. In malignant disease, BD stent insertion can maintain enteral nutrition while staging or neo-adjuvant therapy is completed without adversely impacting on surgical resection.

© 2015 Royal College of Surgeons of Edinburgh (Scottish charity number SC005317) and Royal College of Surgeons in Ireland. Published by Elsevier Ltd. All rights reserved.
Introduction

Oesophageal strictures commonly present with symptoms of progressive dysphagia, regurgitation and vomiting. As a result of the obstructive process there may be associated malnutrition and weight loss. Patients with these symptoms require prompt investigation with upper GI endoscopy or barium studies. Strictures can be caused by benign or malignant processes and have an overall incidence of 1.1 per 10 000 within the UK.1-3

Benign strictures are most commonly caused by long-standing oesophageal reflux. Other causes include external beam radiation, oesophageal sclerotherapy, caustic ingestions, surgical anastomosis, and rare dermatologic diseases. Routine management of benign strictures involves oesophageal dilatation, often in combination with acid suppression therapy.4 Up to 10% of all patients will not respond to this treatment and are deemed to have refractory disease.5 In these cases, self expanding metal stents (SEMS) and self expanding plastic stents (SEPS) have been used to alleviate symptoms. However, the limited symptomatic relief achieved and the high rate of adverse incidents encountered has led to the use of biodegradable (BD) stents, which have been in use since 2008.6

Biodegradable stents also have a role in the management of oesophageal malignancy. Palliative patients are managed successfully with SEMS for symptom control. However, many patients with oesophageal cancer present with severe dysphagia and malnutrition prior to the completion of staging investigations or experience worsening symptoms during neo-adjuvant treatment. For these patients, BD stent insertion as “a bridge to surgery” can improve symptoms and allow enteral nutrition while staging or neo-adjuvant treatment is completed.7,8

The aim of this study was to review the safety and efficacy of BD stents in the management of benign or malignant oesophageal strictures in our unit.

Methods

A retrospective review was performed between 30th March 2011 and 30th November 2013 in a single district general hospital (Craigavon Area Hospital) within the Northern Ireland Southern Health and Social Care Trust. All patients who underwent BD oesophageal stent insertion during the study period were included. Cases were identified using the radiology Picture Achieving and Communication System (PACS) database while relevant demographic and clinical information was obtained by retrospective chart review using a standardised data collection pro forma.

Patients were followed up until 31st December 2013 through review of outpatient clinic attendances or readmissions to hospital with all patients being reviewed for a minimum of 30 days. The clinical data collated included symptoms, indication for stent insertion, complications, validated pre- and post-stent insertion dysphagia scores, and method of nutrition pre- and post-stent insertion. Dysphagia was graded using the score described by O’Rourke et al. (0 = normal swallow, 1 = able to swallow some solids, 2 = able to swallow semi-solids, 3 = able to swallow liquids only, 4 = unable to swallow liquids).9 Pathological data and BD stent insertion details were also recorded.

Stent materials and insertion technique

A single experienced gastrointestinal interventional radiologist inserted all stents. Although use of BD stents in oesophageal malignancy does not fall within the current licence, patients were discussed at an upper gastrointestinal multi-disciplinary meeting and direct consultant-to-consultant referral was made.

The ELLA stent was inserted in all cases. This is a biodegradable stent made from polydioxanone absorbable surgical suture (Fig. 1). The stent degrades by random hydrolysis and this is accelerated by a low pH. Stent integrity and radial force of the stent is maintained for 6-8 weeks following implantation and stent disintegration occurs at 11-12 weeks from implantation. The stent is radio-transparent and has radiopaque markers at both the proximal and distal ends. The diameter of the stent is 25 mm and there are four available lengths ranging from 60 mm to 135 mm. The stent gradually expands upon release. Contraindications to stent insertion include inability to pass the 9.4 mm (28F) delivery system through the structure, the presence of a benign stricture at the upper part of the oesophagus in close proximity to the cricopharyngeus muscle and patients who have benign strictures due to previous laryngectomy.7

All BD stents were inserted in the Endoscopy Unit under conscious sedation using a titrated dose of intravenous midazolam and opioid analgesia. Direct visualization was performed using a paediatric gastroscope (Olympus GIF-XP260). Under fluoroscopic guidance proximal and distal boundaries of the oesophageal stricture were marked externally using metallic skin markers. The BD stents were then inserted over a guidewire, ensuring overlap of the radio-opaque markers within the stent delivery system and skin markers before deployment. Post procedure, patients were fasted for two hours and then allowed clear fluids. If tolerated, oral intake was then increased to allow solid foods as guided by a dietician.

Statistical analysis

Age has been expressed as a median and inter-quartile range. Time to re-intervention and lifespan post stenting have been

![Fig. 1 – ELLA-biodegradable stent made from polydioxanone absorbable material.](image-url)
expressed as median and range. Pre- and post-stent dysphagia scores have been expressed as means ± standard deviation and the difference analysed using the paired samples t-test.

### Results

#### Patients

Stents were inserted 28 times in 20 patients. Patient's demographics and characteristics of the oesophageal strictures are demonstrated in Table 1. All patients were symptomatic and complained of a combination of dysphagia, regurgitation of food and vomiting. In all cases an ELA-biodegradable stent was used. 14 stents measured 8 cm, 8 stents measured 10 cm and 7 measured 13.5 cm.

18 were attempted for benign disease. All patients with benign disease had previous dilatations and 11 of these had previous stenting with either temporary metal stents or biodegradable stents. 2 had stenting post oesophagectomy for management of an anastomotic stricture.

11 stents were attempted for malignant disease. 8 of these patients were awaiting completion of staging investigations whilst 3 were undergoing neo-adjuvant chemotherapy.

Stent insertion was requested by a Gastrointestinal (GI) surgeon in 18 cases (60%), a GI physician in 8 (26.7%), a non GI surgeon in 2 (6.7%) cases, and a radiologist in 2 (6.7%).

#### Outcomes

Stent insertion was successful in 28 out of 29 attempts. The one unsuccessful deployment was in benign disease and was secondary to the stricture being in close proximity to the cri-opharyngeus muscle. Complications associated with stent deployment are listed in Table 2. All patients were able to be discharged home well. There was no 30 day mortality.

8 patients with malignant disease had died at long-term follow up, none of these deaths were related to stenting. Median lifespan post stenting was 310 days (103–619). One patient with benign disease had died at long term follow up. This was 560 days following BD stent.

#### Discussion

Since the 16th century oesophageal dilatation with a balloon or bougie has been used to treat benign oesophageal strictures.10 This method is safe and effective at improving most symptoms. Strictures commonly recur and repeated dilatations at short intervals may be required.11,12 Some patients with complex strictures, refractory to dilatation are

<table>
<thead>
<tr>
<th>Table 1 – Patient demographics and characteristics of oesophageal strictures.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Age (median (Q1,Q3))</td>
</tr>
<tr>
<td>Gender</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Location of stricture</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Patient location</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Previous stenting</td>
</tr>
</tbody>
</table>

A pre-stent and post-stent dysphagia score was available in all patients. The improvement in dysphagia score of both benign and malignant disease is demonstrated in Table 3.

Of the 11 patients with malignant disease, 3 progressed to oesophagectomy. In this small series there was no documented increase in surgical difficulty or peri-operative complications. There was no increase in intra-operative blood loss and there were no anastomotic leaks post-operatively. There was inflammation at the stent site noted in one case but this did not complicate surgery.

4 patients with benign disease required re-intervention with a BD stent. 1 patient had 5 BD stents inserted at different time points, 1 patient had 3 BD stents inserted and 2 patients had 2 stents inserted. Median re-intervention time was 260 days (range 91–525).

Five patients with malignant disease required re-intervention with a SEMS. One of these patients had progressive dysphagia and required SEMS to enable nutrition during neo-adjuvant treatment, this patient progressed to oesophagectomy with a good outcome. The other four were found to have inoperable disease due to either locally advanced disease or distant metastases and stents were placed for palliation of worsening dysphagia. Median time from BD stenting to re-intervention with SEMS was 49 days (range 16–84).

### Table 2 – Complications following stent insertion.

<table>
<thead>
<tr>
<th>Complications</th>
<th>Benign disease (n = 17)</th>
<th>Malignant disease (n = 11)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Failed deployment</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Post-procedural pain</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Perforation</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Reflux</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Aspiration</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Failure to expand</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Stent migration</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### Table 3 – Mean pre-stent and post-stent dysphagia scores for benign and malignant strictures.

<table>
<thead>
<tr>
<th></th>
<th>Pre-stent dysphagia score (mean ± SD)</th>
<th>Post-stent dysphagia score (mean ± SD)</th>
<th>p value (paired samples t-test)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benign Disease (n = 17)</td>
<td>2.65 ± 0.606</td>
<td>1.00 ± 0.926</td>
<td>p &lt; 0.001</td>
</tr>
<tr>
<td>Malignant disease (n = 11)</td>
<td>3.27 ± 0.467</td>
<td>1.36 ± 0.505</td>
<td>p &lt; 0.001</td>
</tr>
</tbody>
</table>
candidates for oesophageal stent insertion. The goal of stent placement is to hold the stricture open for prolonged periods of time, and allow for tissue remodelling and to reduce the risk of stricture recurrence.13

While SEMS and SEPS have been employed for both benign and malignant strictures, their safety and efficacy has been somewhat variable.6 SEMS have been successful in palliation of symptoms due to inoperable malignant strictures but have not had the same success in managing benign conditions.14 The use of SEMS for benign disease has been limited by an unacceptably high migration rate and significant complications rates with a long-term response of less than 50%. SEMS require endoscopic removal and due to significant recurrent stricture formation require repeated re-intervention.6 Although initial data on SEPS showed some promise in several small studies, larger studies have shown poor resolution of symptoms in only 20–40% of patients.15–17

Due to the limited success of SEMS and SEPS for benign disease the subsequent introduction of BD stents has provided an additional therapeutic option. The ELLA stent, fabricated using polydioxanone surgical suture is the only stent in widespread clinical use. As a relatively recent innovation there remains a limited evidence base.6 The largest case series showed BD stenting to be both safe and effective in the management of benign strictures, with 45% of patients dysphagia free at one year and the remainder requiring less frequent dilatation.2 Our experience is that BD stent insertion is a safe procedure with no serious associated complications and no mortality at 30 days. Of the 9 patients who underwent a total 18 attempts at BD stenting for benign strictures, 5 were symptom free at follow-up. 4 patients required re-intervention with a BD stent and for some patients this was on multiple occasions. The median re-intervention time for benign disease was 260 days. One patient with multifocal oesophageal strictures, one of which was in close proximity to the cricopharyngeus muscle had been stented 4 times, but disease progression prevented further stenting.

In malignant disease, SEMS have been used successfully for palliation in unresectable disease. They have also been inserted for symptom control to enable oral nutrition during neo-adjuvant chemo-radiation. Although improvement in symptoms was evident, stent migration rates and other stent related morbidity were high.5 A single study has suggested that SEMS use for patients who proceed to surgery is feasible, but this has not been validated by other studies.18 In the context of neo-adjuvant chemo-radiation, a single study has noted a higher incidence of serious complications in patients who have a SEMS in-situ during treatment and as a result have recommended that SEMS should not be used in patients undergoing neo-adjuvant treatment.19

Following the success of BD stents in benign strictures they have been utilised in malignant disease to control symptoms and enable oral nutrition whilst staging investigations are completed or during neo-adjuvant chemo-radiation. Other small studies have shown improved dysphagia scores and no interference with neo-adjuvant therapy.3 10 This was also the case in our study, with significantly improved dysphagia scores. Stenting did not complicate the provision of neo-adjuvant treatment. All patients were able to resume oral nutrition.

There is no available data in the literature on the outcome of oesophagectomy with BD stents in-situ. Of the 11 patients that underwent stent insertion for malignant disease in our cohort, 3 proceeded to oesophagectomy. All patients underwent successful surgery with no documented difficult dissection although an inflammatory response from the biodegradable stent was noted during one procedure. There was no increase in intra-operative blood loss although one patient did require one unit of packed red cells in the post-operative period. There were no anastomotic leaks post-operatively. The remaining 8 patients, whose disease was inoperable were able to complete staging before further stenting was required, allowing for confirmation of inoperability and more effective decision making at the time of potential re-intervention. 5 patients did not require any further stenting, but 4 proceeded to SEMS. It is unclear from the information we were able to access if these patients had symptoms or if they were stented prophylactically.

This study is necessarily subject to the limitations of all retrospective studies. It would however be difficult, if not impossible to receive ethical approval for a randomised controlled trial which compared BD stenting against a control group who received no stenting or a self-expanding stent, particularly within the context of malignant disease. The findings of this study add to the evidence supporting the use of BD stents as a safe and effective treatment option in refractory benign strictures and malignant strictures as “a bridge to surgery”.

Conclusions

This study has shown BD stenting to be a very efficacious method of symptomatic relief of oesophageal stricture induced dysphagia, resulting in a significant improvement in dysphagia score post-stenting. BD stenting has an excellent safety profile, with no major complications and no stent related mortality. It would appear to offer patients with benign disease greater than 50% possibility of long-term symptom resolution. For those who require re-intervention, the duration of absence of symptoms and re-intervention time is significantly longer than would be expected with either dilatation or SEMS or SEPS. For malignant disease, BD stenting offers the opportunity for completion of staging and improvement in nutrition without compromise of neo-adjuvant treatment or surgery.

Competing interests

None.

References


Please cite this article in press as: McCain S, et al., The role of biodegradable stents in the management of benign and malignant oesophageal strictures: A cohort study, *The Surgeon* (2015), http://dx.doi.org/10.1016/j.surge.2015.01.002