Endoscopic stent placement throughout the gastrointestinal tract

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CHAPTER 5

Duodenal stent placement for malignant gastric outlet obstruction: a literature review with pooled analysis of outcomes.

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J.E. van Hooft

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INTRODUCTION

Duodenal stent placement was first reported in the early 1990s ever since it has gained popularity especially for the treatment of symptomatic malignant gastric outlet obstruction (GOO).\(^1\) It has been suggested that stent placement for GOO is less invasive with a faster relief of symptoms compared to the conventional open or laparoscopic gastrojejunostomy.\(^2\)\(^-\)\(^4\) In this chapter we will mainly focus on the results including complications of duodenal stenting as a treatment for malignant GOO. After a brief elaboration on definitions, several outcome parameters and complications will be discussed point by point and if applicable influences of different indications and material will be taken into consideration. We will round up with some miscellaneous indications and a summary.

Defining results and complications

There is no clear definition of results regarding duodenal stenting. A composite of several outcome parameters is often described as results. Reviewing the literature the following outcome measures are stated in the majority of articles: technical success (adequate positioning and deployment of the stent), clinical success (relief of symptoms and/or improvement of oral intake predominantly defined by improvement of the GOO Scoring System (GOOSS) score, Table 1).

<table>
<thead>
<tr>
<th>Level of oral intake</th>
<th>GOOSS score</th>
</tr>
</thead>
<tbody>
<tr>
<td>No oral intake</td>
<td>0</td>
</tr>
<tr>
<td>Liquids only</td>
<td>1</td>
</tr>
<tr>
<td>Soft solids</td>
<td>2</td>
</tr>
<tr>
<td>Low-residue or full diet</td>
<td>3</td>
</tr>
</tbody>
</table>

A great number of publications also report on median survival and procedure-related hospitalization time, where only some articles elaborate on cost and quality of life as part of results.

Complications related to duodenal stenting are often divided into major and minor complications\(^6\)\(^-\)\(^10\) and/or into early and late complications\(^6\)\(^,\)\(^7\)\(^,\)\(^11\)\(^-\)\(^14\) in an attempt to render the severity and determine which complications might be procedure-related. Unfortunately the definitions used to classify complications differ between the main publications.\(^6\)\(^,\)\(^9\)\(^,\)\(^11\)\(^,\)\(^12\) In this chapter it was therefore decided to just mention the type of complication e.g. perforation or migration and refrain from judging the severity and the possible relation to the procedure.
RESULTS

To obtain an up-to-date insight in the results of duodenal stenting as a treatment for malignant GOO a critical review of the literature has been performed. All studies published between October 2003 and May 2011 that met the following criteria: information on technical and clinical success, publication in English and a study population of more than ten patients, were included and are summarized in Table 2.
<table>
<thead>
<tr>
<th>Publication</th>
<th>Study design</th>
<th>Procedure</th>
<th>Stent type</th>
<th>N</th>
<th>Technical success (%)</th>
<th>Clinical success (%)</th>
<th>Hospital stay (days)</th>
<th>Survival (days)</th>
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<tr>
<td>Van Hooft et al 2011</td>
<td>Prospective multicenter</td>
<td>EF</td>
<td>D-Weave Niti-S duodenal stent (Taewoon Medical, Seoul, Korea)</td>
<td>52</td>
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<td>Jeurnink et al 2010</td>
<td>Randomized prospective (GJJ vs stent) multicenter</td>
<td>EF</td>
<td>WallFlex (Boston Scientific, Matick, MA, USA)</td>
<td>21*</td>
<td>95</td>
<td>86</td>
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<td>84</td>
<td>ns</td>
<td>195*</td>
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<td>Randomized prospective (covered vs uncovered) single-center</td>
<td>EF</td>
<td>Covered (Niti-S Pyloric, Niti-S Comvi Pyloric(Taewoon Medical, Seoul, Korea))</td>
<td>80</td>
<td>100(c)</td>
<td>95(c)</td>
<td>ns</td>
<td>182(c)</td>
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<td></td>
<td></td>
<td></td>
<td>Uncovered (Wallsten, WallFlex)</td>
<td></td>
<td>100(u)</td>
<td>90(u)</td>
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<td>133(u)</td>
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<td>EF</td>
<td>Niti-S Pyloric (covered and uncovered)</td>
<td>154</td>
<td>100(c)</td>
<td>99(c)</td>
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<td>EF</td>
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<td>Phillips et al 2008</td>
<td>Prospective (n=43) &amp; retrospective (n=3) single-center</td>
<td>EF</td>
<td>Wallsten Alimaxx (Alveolus, Charlotte, NC, USA)</td>
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<td>91</td>
<td>ns</td>
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<td>Wallsten WallFlex Choostent (M.J. Tech, Ltd., Seoul, Korea)</td>
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<td>Niti-S pyloric</td>
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<td>EF</td>
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<td>91</td>
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<td>Clinical success (%)</td>
<td>Hospital stay (days)</td>
<td>Survival (days)</td>
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<td>96</td>
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<td>Ultraflex</td>
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<td>Mosler et al 2005&lt;sup&gt;36&lt;/sup&gt;</td>
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<td>EF</td>
<td>Gianturco Z-stent (Wilson-Cook Inc, Winston-Salem, NC, USA)</td>
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<td>ns</td>
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<td>72</td>
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<td>90</td>
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<td>Publication</td>
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<td>Procedure</td>
<td>Stent type</td>
<td>N</td>
<td>Technical success (%)</td>
<td>Clinical success (%)</td>
<td>Hospital stay (days)</td>
<td>Survival (days)</td>
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<td>Wallstent</td>
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<td>76</td>
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<td>Comparative retrospective (GJJ vs stent) single-center</td>
<td>EF</td>
<td>Ultraflex Z-stent</td>
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<td>Niti-S Pyloric (covered and uncovered type)</td>
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<td>80</td>
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<td>Song et al 2004</td>
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<td>F</td>
<td>Dual stent</td>
<td>102</td>
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<td>83</td>
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<td>73</td>
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<td>Dormann et al 2004</td>
<td>Systematic review</td>
<td>EF &amp; F</td>
<td>Wallstent</td>
<td>606</td>
<td>97</td>
<td>87</td>
<td>ns</td>
<td>85*</td>
</tr>
</tbody>
</table>

N=study population, ns=not specified, GJJ=gastrojejunostomy, EF=endofluoroscopy, F=fluoroscopic, c=covered, u=uncovered
¥ patients who received stent
* mean instead of median
¤ including all relevant studies published between January 1992 and September 2003
TECHNICAL SUCCESS

Overall technical success
In the vast majority of the patients with malignant GOO adequate positioning and deployment of the duodenal stent is achieved. The overall technical success ranges from 77% to 100% with a mean of 97% (2175/2243) in our pooled population (Table 2). The technical failures occurring in 3% of the patients are mainly caused by either the inability to cannulate the stricture with the guide wire or unsuccessful deployment of the duodenal stent. Adequate positioning of the guide wire might be hampered by the tightness of the stricture or looping in the distended stomach of either the endoscope or guide wire.6, 18, 35, 42, 43 Deployment failures are mostly related to a tortuous anatomy, causing too many or too sharp bends on the delivery device impeding the deployment force.23

Type of procedure and technical success
There are two types of procedures for duodenal stent placement: either endofluoroscopic (combination of endoscopic and fluoroscopic guidance performed by endoscopist) or sec fluoroscopic (performed by radiologist). There are however no studies published that do compare these techniques. Pooled analysis of the larger studies (n>50) in which either an endofluoroscopic8, 15, 18, 20, 27 or fluoroscopic technique23, 35, 44 was combined with one type of stent reveals technical success rates of respectively 97% (280/288) and 96% (372/387). Based on these data no conclusions can be drawn about the preferred type of procedure. To answer the question very large randomized controlled trials would be needed as the success rates appear to be rather similar. Regarding the current data one could also argue that both success rates are high and that the choice for either one should be determined by local expertise.

Tumor characteristics and technical success
As mentioned before, the tightness of the stenosis and the anatomic position may well influence the technical success rate of duodenal stent placement in patients with malignant GOO. Studies specifically assessing a relationship between tumor characteristics like type of malignancy or site of the lesion are however sparse.23, 45, 46 A study by Kim et al., in which stents were placed under fluoroscopic guidance by radiologists, showed a statistically significant difference for technical success rates depending on the site of the lesion: peripyloric region 98%, duodenum 93% and anastomosis (gastroduodenostomy and gastrojejunostomy) 82%.23 The authors state that severe loop formation of the catheter-guide wire system in the distended stomach and curved configuration of the duodenal C-loop are the main causes of the lower success rate in the latter two groups. Another study of Kim et al. found that the technical success rate was not statistically different, depending on the type of malignancy: primary gastric carcinoma 100% versus pancreatic carcinoma 100%.45 Although stent placement was technically successful in all patients, the radiologists found stent placement more challenging in the pancreatic carcinoma group for the same reasons as mentioned in their previous study.
Lindsay et al. performed a retrospective study in which stents were placed under endo-fluoroscopic guidance in groups of patients with GOO, caused by either pancreaticobiliary or gastric carcinoma, and found technical success rates of 100% in both groups.

In conclusion data suggest that sec fluoroscopic duodenal stent placement might be more challenging in distally located obstructions. Data with regard to endofluoroscopic stent placement are too sparse for any conclusion.

**Type of stent and technical success**

There are no data directly comparing the different kind of duodenal stents. Looking at table 18.2 only one study reveals a deviating finding with regard to technical success. In this study by Mehta et al. a technical success rate of 77% was found in a small study population (n=13) using the Wallstent duodenal stent (Boston Scientific, Natick, MA, USA). Other studies using the Wallstent duodenal stent report technical success rates ranging from 91 to 100%. Therefore it seems reasonable to assume that the Wallstent duodenal stent has similar outcomes regarding technical success compared to other stent types.

In contrast to the different types of stents, clusters of stents have been compared. A prospective randomized trial comparing endoscopic placement of covered stents (Niti-S Pyloric and Niti-S Comvi Pyloric (Taewoong Medical, Seoul, Korea)) (n=40) with uncovered stents (Wallstent and WallFlex (Boston Scientific, Natick, MA, USA)) (n=40) as a treatment for malignant pyloric obstruction in gastric cancer showed no difference concerning technical success rate (both 100%). This result is consistent with another prospective, non-randomized comparative study which compared endoscopic placement of covered (Niti-S Pyloric) (n=70) stents with uncovered stents (Niti-S Pyloric) (n=84) as a treatment for malignant GOO, technical also revealing success rates of 100% in both groups. In the guidelines for fluoroscopic placement of gastroduodenal stents by Sabharwal et al. is however stated that the delivery systems of covered stents are less flexible and larger and therefore more difficult to deploy at distant locations through tortuous anatomy. Notwithstanding there are no data in the current literature which can objectively support this statement.

The technical success rate of duodenal stent placement for GOO is really high. Neither the type of procedure nor the type of stent seem to make any distinctive difference.

On the contrary tumor characteristics might have their influence, especially when the obstruction is more distally located.
CLINICAL SUCCESS

Overall clinical success
Clinical success defined as relief of symptoms and/or improvement of oral intake is achieved on mean in 87% of the patients (1979/2271), ranging from 63% to 100% (Table 18.2). The difference might be caused by a variety in definitions of clinical success. The studies with lower clinical success rates (<80%) did define clinical success as an improvement of the GOOSS-score instead of ‘relief of symptoms and/or an improvement of the GOOSS-score’.15, 21, 28, 48 Furthermore, some patients do not improve even after successful stent placement because of unidentified sites of malignant obstruction, diffuse peritoneal carcinomatosis with bowel encasement23, 35, 44, functional gastric outlet obstruction from either neural (celiac axis) tumor involvement or as side effect from narcotic pain medication15, 20, 42.

Type of procedure and clinical success
There are no studies comparing the two types of duodenal stent placements with regard to clinical success. Pooled analysis of the larger studies (n>50) in which either an endofluoroscopic8, 15, 18, 20, 27 or fluoroscopic technique23, 35, 44 was combined with one type of stent reveals almost similar clinical success rates of respectively 84% (241/288) and 89% (346/387). Based on these results one could suggest that it is unlikely that the type of procedure does influence the clinical success rate.

Tumor characteristics and clinical success
At present there are two studies which specify clinical outcomes of duodenal stent placement in relationship to the type of malignancy.45, 46 The study of Kim et al., specifically set up to compare outcomes of duodenal stent placement in the palliative treatment of GOO either caused by gastric carcinoma or pancreatic carcinoma, did not show a significant difference with regard to the clinical success rates, respectively 97% and 93%.45

The study of Lindsay et al. found clinical success rates of both 80% in a group of patients with gastric carcinoma and a group with pancreaticobiliary cancer.46

Currently there are no data that show any influence of tumor characteristics on the clinical success.

Type of stent and clinical success
Though there is a rather large spreading of clinical success rates between studies there are no data, whether randomized or comparative, that support a relation with a specific type of duodenal stents. Clusters of stents e.g. covered and uncovered have been compared in prospective studies.9, 11 These studies did not reveal a significant difference, the clinical success rates were respectively 95% and 90% (covered vs. uncovered) in the study of Kim et al. and 98.6% and 96.4% in the study of Lee et al.9, 11 At the moment there is no scientific basis to prefer a specific type or cluster of duodenal stent with regard to clinical success.
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Though the overall clinical success rate is high there is a wide range in reported values, which could be explained by a difference in used definitions for clinical success. From the current data it is not possible to draw any firm conclusions regarding the influence on clinical success of the type of procedure, the tumor characteristics, or the type of stent.

**Procedure-related hospital stay, survival and stent patency**

Procedure-related hospital stay is an essential outcome parameter because the majority of patients with malignant GOO have a poor life expectancy and therefore a short hospital stay is desirable. Pooled analysis of all studies reporting on medians (Table 2) revealed an overall median hospital-stay after stent placement of 2 to 15 days with a mean of 6.3 days and a median survival after stent placement of 49 to 182 days with a mean of 86 days.

Another parameter to consider is stent patency, which is defined as the time period without need for re-intervention. An important goal of palliative stent placement is that stent patency exceeds patients survival. The current literature reports median stent patency to range from 190 to 385 days, with an adequate resolution of GOO symptoms until death in the majority of patients. Interestingly, Kim et al. showed that chemotherapy after duodenal stent placement was associated with a significant increase in maintenance of stent patency despite a significant increase in migration rate. This was attributed to the reducing effect of chemotherapy on the tumor burden, which likely decreased the chance of tumor overgrowth or stent collapse by tumor compression. Furthermore the authors noticed that chemotherapy may prevent or delay disease progression and subsequently may cause prolonged patient survival.

**Quality of life**

Although improvement of the quality of life (QoL) is considered an important goal in palliative cancer treatment, only a small number of studies did assess this outcome measure with regard to duodenal stent placement in patients with malignant GOO.

Older publications used the Karnofsky performance status (KPS), an indicator for patients’ general well being, to evaluate the QoL. A significant improvement of this measure was seen in two of these studies, while the other study showed a non-significant improvement. The KPS however only addresses physical functioning and might be to confined to adequately evaluate the QoL. More recent studies used more extensive QoL scoring questionnaires like the European Organisation for Research and Treatment of Cancer [EORTC] QLQ-C30 version 3 and QLQ-PAN26, the Short Form-36 Physical Health score and the 5 health dimensions of the EuroQol (EQ-5D) including the EuroQol visual analog scale [EQ-VAS]. These data revealed a significant improvement of the QoL in two out of four series while the other two revealed stable QoL scores until death. Though there are no data on the development of the QoL in case no duodenal stent would have been placed it seems credible that duodenal stenting has a positive influence on the QoL.
COMPLICATIONS

Stent obstruction
The most frequently observed complication, often requiring re-intervention, is stent-obstruction (Table 3). It is observed in the majority of studies with rates ranging from 3% to 44%.9, 11, 13, 15, 18, 20, 21, 23, 41, 44

Stent obstruction may be caused by tumor ingrowth (Figure 1), tumor overgrowth (Figure 2), tissue hyperplasia (Figure 3), food impaction or stent collapse (figure 4). In- and overgrowth, tissue hyperplasia and stent collapse can be successfully treated with coaxial stent placement15, 18, 20, 44, while impacted food can be removed endoscopically.23

Figure 1 | Endoscopic image of tumor ingrowth

Figure 2 | Endoscopic image of tumor overgrowth
Chapter 5

**Stent migration**
Stent migration is another frequently observed stent-related complication with rates ranging from 0 to 32% (Table 3).

Stents can migrate completely or partially and either proximally or distally. Insertion of an additional stent is often sufficient in case obstructive symptoms reoccur after (partial) stent migration. Proximally migrated stents can be retrieved endoscopically. Distally migrated stents may be completely asymptomatic and sometimes pass out through the rectum, but may also get stranded in the intestine and lead to obstruction, bleeding or perforation, requiring surgical intervention.

**Influence of stent design on obstruction and migration rates**
Different types of stents have been tried in order to reduce obstruction and migration rates, with the most important features being an uncovered or a covered design. Both designs have their advantages and disadvantages.
Table 3 | Summary of complication data from the systematic review of Dormann et al. and prospective studies with a patient population of $n\geq30$ and a follow-up until death, published between October 2003 until May 2011.

<table>
<thead>
<tr>
<th>Complication</th>
<th>Frequency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30-day mortality</td>
<td>22 - 23</td>
</tr>
<tr>
<td>Perforation</td>
<td>0 - 4</td>
</tr>
<tr>
<td>Bleeding</td>
<td>0 - 4</td>
</tr>
<tr>
<td>Obstruction</td>
<td>3 - 44</td>
</tr>
<tr>
<td>covered stents</td>
<td>3 - 7</td>
</tr>
<tr>
<td>uncovered stents</td>
<td>4 - 44</td>
</tr>
<tr>
<td>Migration</td>
<td>0 - 32</td>
</tr>
<tr>
<td>covered stents</td>
<td>17 - 32</td>
</tr>
<tr>
<td>uncovered stents</td>
<td>0 - 8</td>
</tr>
<tr>
<td>Biliary obstruction</td>
<td>0 - 2</td>
</tr>
<tr>
<td>Cholangitis</td>
<td>0 - 6</td>
</tr>
<tr>
<td>Abdominal pain</td>
<td>0 - 8</td>
</tr>
<tr>
<td>Other*</td>
<td>0 - 4</td>
</tr>
</tbody>
</table>

*consists out of stent fracture, cardiac failure, anemia, pneumonia, ascites, gastroenteritis, peritonitis carcinomatosa and bacteremia.

The mesh-like framework of uncovered stents prevents migration by providing an anchoring function, which is achieved by embedding (tumor) tissue within the meshes after expansion. The disadvantage of this design is logically a higher obstruction rate due to tumor ingrowth through the stent mesh (Table 3). Covered stents on the other hand prevent obstruction from tumor ingrowth with a covering membrane. Unfortunately this membrane causes a loss of the anchoring feature as described above and subsequently covered stents have a higher migration rate.9, 11 Furthermore covered stents do not prevent against re-obstruction by other causes than tumor ingrowth11 and sometimes tumor ingrowth still occurs due to traumatic damaging or chemical degradation of the covering membrane.51, 52

The randomized prospective trial of Kim et al. found statistical significant differences between uncovered and covered stents regarding obstruction and migration rates, with an obstruction rate of 44.4% and 3.2% and migration rates of 8.3% and 32.2% respectively.9 These results are consistent with the non-randomized prospective study of Lee et al. which revealed an obstruction rate of 19% and 7% respectively for uncovered and covered stents and migration rates of 0% and 17%.11 In both publications the negative features of the two types of stents compensated each other which resulted in similar stent patency times.

In order to overcome the shortcomings of the uncovered and covered stent designs, investigators are aiming to combine the best features of both in one design. For example a dual expandable nitinol stent, consisting of an inner uncovered and an outer partially covered part that was placed fluoroscopically in a large prospective series, showed promising results with a migration rate of 4% and an obstruction rate of 14%.23
Perforation
Perforation of the intestinal wall is rare with rates ranging from 0% to 4% (Table 3) and the majority of articles reporting no cases of perforation or a frequency of ≤1%, only one publication showing a percentage of 4%.21

Perforation can occur intra-procedural as well as post-procedural. Intra-procedural perforation can be caused by balloon dilatation or by manipulation of the intestinal wall by the guide wire, endoscope or stent.21 Pressure erosion of the bowel wall by the bare metal ends of the stent or stent migration can cause late onset perforation9,13 and sometimes fistula formation to surrounding structures.13

Bleeding
The occurrence of gastrointestinal bleeding during or after duodenal stent placement mainly has the same causes as perforation and has comparable rates (Table 3).9, 11, 13, 15, 18, 20, 21, 23, 41, 44 In most cases conservative treatment is adequate,18, 23 however some bleedings require endoscopic or radiologic intervention.20

Biliary problems
Biliary obstruction after duodenal stent placement develops in 0 to 2% of previously asymptomatic patients and cholangitis in 0 to 6% of cases.9, 11, 13, 15, 18, 20, 21, 23, 44 Dormann et al. lumped together biliary obstruction and cholangitis under the title 'biliary problems' in their systematic review and found a frequency of 1.3% after duodenal stent placement.41 It is hard to distinguish whether biliary complications are caused by stent placement across the papilla of Vater or by progression of the underlying disease.

Whether or not biliary drainage should be carried out prior to duodenal stenting remains a topic for debate. In the majority of patients biliary obstruction will occur either before or concomitant to GOO: in those cases there is a sound reason to drain the biliary tree. But the question remains if in patients with GOO but no signs of obstruction of the biliary tree, biliary stents should be placed prophylactically.42 An argument for the proactive approach has always been the expected difficulty to place a biliary (metal) stent through the meshes of an duodenal stent placed across the papilla.42, 53 More recent data from Mutignani et al. however revealed that biliary stents can successfully be placed through the meshes of the duodenal stents either endoscopically or percutaneously.54 After achieving biliary canulation they either widened the meshes of the duodenal stent with a pneumatic balloon or removed those covering the papilla with a rat-tooth foreign body forceps or organ plasma coagulation. Besides the technical feasibility one should take into consideration that most of the patients will not develop biliary problems after stent placement41 and might be unnecessary exposed to the risks linked with biliary stent insertion in case of a prophylactic approach. We therefore suggest to only treat patients with objective signs of biliary obstruction by inserting a metal biliary stent prior to duodenal stenting. The minority of patients who develop biliary obstruction after duodenal stenting can be treated with endoscopic or percutaneous transhepatic biliary decompression depending on the local expertise.42, 54
Abdominal pain
Abdominal pain is reported to occur in 0 to 4% of the patients after duodenal stent placement and normally lasts for 24 to 72 hours post-procedure.\textsuperscript{9, 11, 13, 15, 18, 20, 21, 23, 41, 44} In the majority of cases it resolves spontaneously without any need for treatment with analgesics.\textsuperscript{41}

30-day mortality
The 30-day mortality rate is an important outcome measure after surgical procedures. However there is only a small number of publications on duodenal stent placement which assess this parameter.

The 30-day mortality rates were 22% and 23% respectively in two prospective multicenter studies from Europe.\textsuperscript{15, 20} The vast majority of these patients, however, died from progressive malignant disease and only one patient died from unsuccessfully treated cholangitis. Therefore it is very difficult to interpret the 30-day mortality as an outcome parameter of duodenal stent placement. In addition there are no intra-procedural or directly procedure-related deaths reported in the literature.

Based on these data it seems that duodenal stent placement is not likely to cause the death of a patient.

Stent placement versus surgery
Before stent placement came into the picture, the traditional palliative treatment of malignant unresectable GOO was a surgical gastrojejunostomy. In this setting however, gastrojejunostomy is associated with relatively high morbidity rates ranging from 31.6% to 61%\textsuperscript{32, 50, 55-57} and 30-day mortality rates up to 30%\textsuperscript{32} due to a poor general condition of the patients. Moreover in many instances the patient is too ill to undergo surgery and supportive treatment would be the only option.\textsuperscript{32, 58} Stent placement therefore is considered an attractive alternative because of its less invasive character.

At present there are two systematic reviews, one meta-analysis and one recent randomized controlled trial (RCT), which compared the results of duodenal stent placement and gastrojejunostomy as a treatment for GOO.\textsuperscript{2-4, 7} Only the systematic review from Jeurnink et al. specifically compared the technical success rates of both treatment modalities.\textsuperscript{2} This article included all randomized and comparative studies published between January 1996 and December 2005 and calculated the Odds Ratio for technical success, which showed no statistical significant difference between duodenal stent placement (96%) and gastrojejunostomy (99%) (OR: 0.22, CI: 0.02 to 2.1, p=0.2). The clinical success rate however seemed higher after stent placement in this review (89% vs 72%, OR: 3.39, CI: 08 to 14.3, p=0.1).\textsuperscript{2} This result is in accordance to the other review and meta-analysis.\textsuperscript{3, 4} Moreover these publications and the RCT showed that oral intake was restored faster following stent placement\textsuperscript{3, 4, 7} though the RCT from Jeurnink et al. showed that food intake sustains longer after gastrojejunostomy.\textsuperscript{7}
Procedure-related hospital stay is significantly shorter after stent placement, while there is no difference in survival. Two prospective randomized studies assessed the QoL after both treatments. One study found that the QoL was significantly higher 1 month after stent placement in comparison to laparoscopic gastrojejunostomy, while the other revealed no difference in QoL after both treatments, although pain scores decreased more rapidly after stent placement.

Stent placement is associated with lower medical costs (Table 4). This is mostly caused by lower initial costs resulting from a shorter procedure time and a shorter hospital stay. One might expect that follow-up costs are higher after stent placement due to the higher re-intervention rate. However, Jeurnink et al. calculated all costs from randomization until death and found that follow-up costs were equal after both procedures. The authors attribute this balance to the fact that patients needed additional hospital days and/or medical procedures, for reasons other than (recurrent or persistent) obstructive problems, after gastrojejunostomy.

With regard to complications the majority of the literature report no differences in morbidity and 30-days mortality rates. However there are some interesting data to mention. It seems that patients who underwent gastrojejunostomy were more likely to develop ‘medical complications’ like respiratory tract infections, myocardial infarction and acute renal failure, while stent placement seems more associated with ‘stent-related’ complications like stent migration and obstruction. Moreover delayed gastric emptying develops more frequently after gastrojejunostomy. On the other hand some studies show a shorter time to re-intervention and a higher number of re-interventions in comparison to surgery.

In conclusion there is evidence that stent placement is superior over surgical bypass in terms of rapid improvement of food intake, a shorter hospital stay, less severe complications and lower medical costs. On the contrary, there is a higher recurrence rate of obstruction after stent placement, subsequently causing declines in food intake on the long-term and more re-interventions. Based on this information it seems reasonable to suggest stent placement in patients with a poor prognosis and gastrojejunostomy in patients with a longer life expectancy. Therefore accurate prognostication is of major importance for an advice on which treatment modality to choose in each individual patient. Data on accurate and easy to use tools for prognostication in patients with malignant GOO have recently be published.
Table 4 | Overview of articles comparing costs of duodenal stent placement and gastrojejunostomy (GJJ). All costs are noted in US $.

<table>
<thead>
<tr>
<th>Publication</th>
<th>Stent</th>
<th>GJJ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jeurnink et al.</td>
<td>8,819</td>
<td>12,433</td>
</tr>
<tr>
<td>Johnsson et al.</td>
<td>7,215</td>
<td>10,190</td>
</tr>
<tr>
<td>Mittal et al.</td>
<td>8,680</td>
<td>20,060</td>
</tr>
<tr>
<td>Yim et al.</td>
<td>9,921</td>
<td>28,173</td>
</tr>
</tbody>
</table>

**MISCELLANEOUS**

**Duodenal stenting for benign strictures**

Duodenal stenting has been tried in patients with GOO due to benign strictures who were not amenable to surgery and in whom the stenosis was refractory to balloon dilation.\(^{64-66}\)

However the literature on this topic is extremely sparse with only one publication reporting on a study population of more than two patients. In this study Kim et al. reported on seven patients who underwent duodenal stent placement for resistant benign anastomotic strictures after gastric surgery.\(^{66}\) Fully covered retrievable stents were placed in four patients for temporary purpose while partially covered dual stents were inserted in three patients for permanent use. A clinical success rate of 71% was achieved (temporary n=2, permanent n=3). Stent migration was the only reported complication after a mean follow-up of 12 months and occurred in three out of four patients who received a covered stent.

Though the results of this small study are promising, more data, especially long-term results, are needed to clarify whether duodenal stenting might be an attractive alternative to surgical revision for benign anastomotic strictures refractory to balloon dilatation. Furthermore there is a lack of data concerning results of duodenal stent placement for benign strictures due to other causes like post-ulcer scar tissue or corrosive injury.

**Magnetic gastroduodenal anastomosis**

Endoscopic creation of a gastroduodenal anastomosis by using magnetic compression in the palliative treatment of GOO has been invented with the purpose to combine the safety of duodenal stent placement with the long-term efficacy of a surgical bypass.

There are two studies describing this relatively new minimally invasive technique; in both studies a stent was inserted through the anastomosis to warrant its patency.\(^{67,68}\) The first study, a prospective single center study by Chopita et al., showed the procedure to be successful in 13 out of 15 patients (88.7%); in all technical successfully treated patients the oral intake of solids was maintained until their death.\(^{67}\) The mean survival was 5.2 months (range 1 to 10 months). Four complications (30.8%) occurred during the follow-up period: two instances of distal migration of the stent (the patients found them in their stools); one proximal migration; and one obstruction of the stent by solid food. The latter two complications were resolved endoscopically. Encouraged by these data an European
prospective multicenter study was conducted. This study, however, was terminated prematurely because of serious adverse events. In total 18 patients had been included, in 12 (66.7%) a gastroduodenal anastomosis with concomitant placement of an duodenal stent was achieved. The initially used specially designed fully covered “yo-yo”-shaped stent had a migration rate of 42.8%. Therefore the investigators switched to an uncovered conventional duodenal stent which did not migrate. However, this stent led to a fatal perforation of the jejunal wall in one patient. The authors concluded that: “Endoscopic creation of a gastroduodenal anastomosis by magnetic compression is feasible and safe; however, the necessity of a stent led to serious morbidity and even mortality in this study. The current system can therefore not be recommended for clinical use”.

In conclusion this new treatment option for GOO showed mixed results, with a fatal stent-related complication in one study and a relatively high stent migration rate in both studies. The creation of the gastroduodenal anastomosis, however, appears to be safe. Therefore further research on this interesting concept should focus on the creation of an anastomosis which does not need an duodenal stent to keep it patent.

SUMMARY

Duodenal stent placement as a palliative treatment in patients with nonresectable malignant GOO is technically feasible in the vast majority of cases. Moreover clinical success is achieved in a large number of patients. These two important outcome parameters seem not to be influenced by tumor characteristics, the type of procedure or the type of stent. Furthermore the small number of publications which assessed the QoL showed stable or improved results after duodenal stent placement.

Regarding complications duodenal stenting is generally safe with low rates of severe complications and no reported direct procedure- or stent-related mortality. However migration and obstruction of duodenal stents occur frequently with both of these complications strongly influencing stent patency. Uncovered stents are associated with a high obstruction rate, while covered stents tend to migrate more regularly. New stent designs have been developed with the aim to overcome these shortcomings and recent trials with these stents show promising results.

There is evidence that stent placement is superior over surgical bypass in terms of rapid improvement of food intake, a shorter hospital stay, less severe complications and lower medical costs. On the contrary, there is a higher recurrence rate of obstruction after stent placement, subsequently causing more re-interventions.

At this moment we in general recommend stent placement and only in fit patients with a life expectancy of more than two months the option of a surgical bypass has to be considered.
REFERENCE LIST


46. Lindsay JO, Andreyev HJ, Vlavianos P, Westaby D. Self-expanding metal stents for the palliation of malignant...


