Memory metal stents for palliation of malignant obstruction of the oesophagus and cardia

A May, M Selmaier, J Hochberger, L Gossner, S Mühlendorfer, E G Hahn, C Ell

Abstract

Thirty patients with incurable malignant obstruction of the oesophagus and cardia were treated with self expanding oesophageal memory metal stents (Ultraflex) in a prospective study. The endoprostheses were successfully placed in all patients. Within one week after implantation dysphagia had improved in 25 of 30 patients (83%). Stent expansion was incomplete within one week after implantation in 12 of 30 patients (40%). After an average of two dilatation sessions eight of 12 stents had expanded completely. Five patients complained of retrosternal pain and three of them suffered from heartburn over several days despite acid inhibition. Major problems in the follow up period occurred in 10 of 30 patients (30%) and included late perforation (one) and tumour ingrowth/overgrowth (nine). All of these complications were treated endoscopically. Improvement of the dysphagia of the patients with tumour ingrowth/overgrowth lasted for about eight weeks (median; range: 2-38 weeks). Until November 1994 six of 30 patients were still alive with a survival time of 309 days (median; range: 103-368 days). It is concluded that oesophageal memory metal stents are easy to implant, prove effective in the palliation of malignant oesophageal obstructions, and have a low risk of severe complications. The only disadvantages are that incomplete initial stent expansion as well as tumour ingrowth/overgrowth occurred in nearly one third of the patients. (Gut 1995; 37: 309-313)

Keywords: stents, malignant oesophageal stenoses.

In the past few years the search for an effective method of palliative treatment with a low rate of complications and suitable for the treatment of incurable malignant oesophageal stenoses had led to the development and clinical application of various types of self expanding metal endoprostheses.¹⁻¹³ Most reports concerned the Wallstent endoprosthesis version.^{2 3 6 8 12} But first clinical experiences with stents made of memory metal (nitinol) have also been reported.^{1 4 5 9 10} In most cases, only a small number of patients received treatment, however, or the reports are available only in the form of abstracts. Until now only one full paper from a radiological centre with memory metal stents (Ultraflex) in a larger number of patients (40) has been published.¹ Memory metal endoprostheses of the Ultraflex type,

which have recently been redesigned have been available in Germany in the improved version since August 1993. We report on our preliminary clinical experiences in implementing the new version of this stent in 30 consecutive patients.

Methods

Patients

From August 1993 to August 1994 a total of 30 patients with incurable tumours of the oesophagus and the cardia were treated with self expanding metal endoprostheses of the memory metal stent type (Ultraflex, Microvasive Boston Scientific, MA, USA) in a prospective study. Twenty five patients were men and five were women. Their age ranged from 43 to 90 years with a mean (SD) of 65 (12) years. Histologically, a squamous cell carcinoma was found in 15 of 30 patients (50%), an adenocarcinoma in eight (27%), and an anaplastic carcinoma in two (7%) patients. One patient had lung cancer and another patient a metastatic cancer of the thyroid gland, both leading to an oesophageal obstruction. A histological examination of the tumour was omitted in three patients, because the malignancy had been conclusively confirmed by imaging techniques or by assessment of the course of the disease. Most patients (19) showed the obstructive lesion in the distal part of the oesophagus and the gastro-oesophageal junction. In five patients, the tumour was located in the mid-section and in two patients in the proximal part of the oesophagus. Two other patients had a tumour recurrence at the anastomosis of an earlier gastrectomy and oesophageal resection, respectively. The length of the tumour stenosis ranged from 3 to 18 cm (mean (SEM) 7 (3) cm).

Seven of 30 patients suffered from dysphagia for solid foods alone (23%), 11 patients (37%) for semisolid foods, and 12 patients (40%) for liquids. Most of the patients (24 of 30) had received previous treatment in the form of bougienage (19), laser therapy (eight), dilatation (one), and percutaneous endoscopically controlled gastrotomy (PEG) (three).

Stent materials and implantation technique

The self expanding metal prostheses used were memory metal stents (Ultraflex), designed for use within the oesophagus. The stent mesh is knitted from a single elastic wire, consisting of a nickel-titanium alloy (nitinol), also referred to as memory metal. When fully expanded, the stent has a diameter of 18 mm. The upper end

Department of
Medicine I, University
of Erlangen-
Nuremberg, Germany

A May
M Selmaier
J Hochberger
L Gossner
S Mühlendorfer
E G Hahn
C Ell

Correspondence to:
Professor Dr med Christian
Ell, Medizinische Klinik I
mit Poliklinik, Universität
Erlangen-Nürnberg,
Krankenhausstr 12, 91054
Erlangen, Germany.

Accepted for publication
10 January 1995

is shaped like a tulip and measures 20 mm in diameter to improve the anchoring of the stent to the oesophageal wall. The prosthesis is available in three different lengths (7 cm, 10 cm, and 15 cm).

The prosthesis is mounted in a compressed state on the stent delivery system consisting of

a stabiliser and is encased in a soluble gelatin. The stabiliser is fairly flexible and enclosed in a transparent plastic protective sheath with an outer diameter of 8 mm. The tapered tip at the distal end of the stabiliser, which has a lumen for a 0.038 guidewire, favours the delivery system pass through tight strictures. Four radio-opaque markers are attached to the stabiliser. The two outer ones mark the ends of the stent in the compressed state and the inner ones mark the ends of the expanded and therefore shortened stent. To release the stent, the proximal end of the stabiliser is held steady while the outer plastic sheath is evenly retracted. Upon exposure to oesophageal fluids, the gelatin dissolves within three to five minutes, resulting in expansion of the stent. Finally the inner stabiliser is removed.

Before stent implantation, patients received a mild sedoanalgesia with 5–10 mg diazepam and 50 mg meperidine intravenously. If necessary, the stenosis was pretreated by laser coagulation or bougienage, or both, until a satisfactory dilatation was achieved. Generally, a diameter of 12 mm was considered to be large enough to permit an endoscope with a minimum diameter of 10 mm to pass the stricture easily. After placement of a guidewire the entire length of the tumour stenosis was precisely measured while retracting the endoscope to calculate the correct stent length. Ideally, the stent should extend beyond the margins of the tumour at both ends by at least 3 cm. In case of stenosis in the gastro-oesophageal junction the proximal extension of the stent ends beyond the tumour margins should be at least 5 cm. With patients in a supine position, metallic markers were attached to the patient's skin at the distal and proximal border of the stricture. Under fluoroscopic control the stents were inserted over the guidewire in the way described. Immediately after stent placement an endoscopy was performed to verify the position, expansion, and anchoring of the proximal part of the stent. A complete passage through the stent was not forced because of the increased risk of stent displacement. The stent opening was checked endoscopically and radiologically one or two days after implantation (Fig 1). If the endoprosthesis had not expanded sufficiently one day after implantation, the stent diameter was increased by means of balloon dilatation. The balloons were 15 and 18 mm in diameter and 8 cm in length (Rigiflex, Microvasive Boston Scientific, Watertown, MA, USA). Until the stent position was checked the patients were advised to take only liquids. Thereafter they had semi-solid or solid foods, as individually tolerated and were advised to avoid stringy meat, green salads, and cheese spread, even if they had no dysphagia after stent implantation. Antireflux measures (proton pump inhibitor and a prokinetic agent) were given to patients whose prosthesis extended beyond the gastro-oesophageal junction. In accordance with the study protocol an endoscopic follow up examination and a short medical history were carried out every four weeks. Only four patients refused to undergo further endoscopies and were

Figure 1: Tumour stenosis in the mid-section of the oesophagus before (A) and after stent implantation (B, C).

TABLE I Dysphagia before and after stent placement (≤ 7 days after implantation) (30 patients)

	Before implantation	After implantation
No dysphagia	0	11
Dysphagia for solid food alone	7	12*
Dysphagia for semisolid food	11	6
Dysphagia for liquid food	12	1†

*One patient was able to eat solid food with exception of meat and another patient with the exception of both meat and brown bread, whereas before stent implantation neither patient could ingest solid food.

†Psychogenic dysphagia, sufficient stent expansion.

questioned as to their symptomatic condition over the telephone at regular intervals.

Results

Stent placement was successful in all 30 patients. There were no technical problems during stent placement, except for one case of a premature user induced expansion of an endoprosthesis. The entire system was removed and a new stent was placed without problems. Every patient was treated with only one endoprosthesis. Twenty three of 30 patients were provided with a stent 15 cm in length. In five cases the stent had a length of 10 cm and in two cases 7 cm. One week after stent implantation 25 of 30 patients (83%) showed an improvement of dysphagia, five patients (17%) reported unchanged difficulties in swallowing (Table I). In four patients a dysphagia for solid food and in one patient a dysphagia for liquids remained. In two of these four patients this occurred despite a satisfactory stent passage after two dilatation sessions (one of two patients), which had served to improve an initially insufficient stent expansion. In the third patient it was not possible to achieve a complete expansion of the stent despite five dilatation sessions. Another patient could only eat semisolid foods because of recurrent chest pain and strong irritation of the throat. One patient suffered from a psychogenic dysphagia and could not eat any food, although the stent was fully expanded.

Severe early complications (≤ 7 days after implantation), for example, stent migration, bleeding or perforation did not occur. Minor problems, which were seen in 21 of 30 patients, included insufficient opening of the prosthesis up to 48 hours after implantation in 17 patients. A complete expansion of the stent without the need for further treatment within one week after placement was seen in five of

these 17 patients, whereas the remaining 12 patients (40%) required dilatation treatment (Table II). After an average of two dilatation sessions using a balloon catheter (range 1–5) eight of 12 stents had expanded completely, that is to say, to a point where a standard endoscope could have been moved through the stent without resistance. One of four patients with an insufficient expansion despite dilatation died three days after stent implantation and before completion of the dilatation treatment in consequence of a progressive Korsakow syndrome and a blood sugar disturbance. The exact cause of death could not be established because the relatives of the deceased patient did not consent to a necropsy. In the second patient a sufficient stent expansion could not be achieved, because the length of the tumour – which had reached an advanced stage – was 17 cm. In the third patient a pronounced compression of the tumour from outside was ascertained, which could be treated only partially by dilatation treatment. In another patient with a remaining stenosis in the region of the cardia despite five dilatation sessions after stent placement a Gianturco-Z-stent was successfully implanted, which showed a sufficient expansion with 48 hours (Fig 2). Eight patients complained of chest pain, three of them had acute pain sensations over a period of several days, and one of them also had a foreign body sensation. Three patients suffered from severe heartburn despite antireflux measures and acid inhibition over several days, which disappeared with increased oral intake of food. One patient reported intermittent moderate pyrosis (Table II). During the follow up period nine patients again developed increasing dysphagia eight weeks (median; range: 2–38 weeks) after stent placement. Tumour ingrowth/overgrowth was assumed and endoscopically diagnosed in six patients. The other three patients refused further endoscopies and were fed by the PEG only. Patients with tumour ingrowth/overgrowth were retreated by electrocoagulation of the tumour tissue. In one patient dilatation treatment was carried out. Two patients received a second stent, one memory metal endoprosthesis and one Gianturco-Z-stent. In one patient with an oesophageal carcinoma a perforation occurred about three weeks after placement of the endoprosthesis. The patient who complained of an increasing irritation of the throat was examined and an oesophagotracheal fistula was diagnosed. An elastic tracheal prosthesis was subsequently inserted and the fistula was sealed with a histoacrylic adhesive by approaching the fistula from the oesophagus (Table II). The final radiographic control images showed no further signs of contrast medium passing into the tracheal system. The patient survived for another 18 weeks after treatment. Table II lists the complications that occurred. In the remaining group of 20 patients no late complications have arisen to date. Until 14 November 1994, six of 30 patients were still alive with a survival time of 309 days (median; range: 103–368 days). Twenty three patients had died after a survival

TABLE II Acute and intermediate problems after implantation of the endoprosthesis (26 patients)

	Patients (n)	%
<i>Acute problems</i>		
Insufficient stent expansion requiring dilatation treatment	12	40
Retrosternal pain	8	27
Pyrosis despite antireflux measures and acid inhibition	3	11
<i>Intermediate problems</i>		
Recurrent dysphagia caused by tumour ingrowth/overgrowth*	9	30
Perforation	1	4

*Endoscopically verified in six patients, three patients refused re-endoscopy.

Figure 2: Tumour stenosis in the region of the gastro-oesophageal junction with an insufficient memory metal stent expansion despite dilatation after placement (A) and good passage after implantation of a Gianturco-Z-stent (B).

time of 70 days (median; range: 3–211 days). One patient returned to his native country (Croatia) and therefore was no longer available for further follow up.

Discussion

Gastroenterological experiences concerning the application of self expanding Ultraflex memory metal (nitinol) stents in the oesophagus have been reported to date only in the form of abstracts or short communications^{5 9 10} with the exception of one full paper published in a radiological journal.¹ Technical problems with the stent release that we and other users¹⁰ also had with the previous stent version, did not occur using the redesigned and improved stent, which has been commercially available in Germany since August 1993. Until now there have been no prospective randomised studies comparing the different stent types, but according to our experience the implantation procedure is easier to carry out with the memory metal stent (Ultraflex) than the oesophageal endoprostheses of Wallstent type in its original construction design.^{2 8} Oblique stent positions or stent migration as seen by our group when using the Wallstent prosthesis² did not occur with the Ultraflex stent versions. One reason for this could be attributed to the stent length of up to 15 cm, which permits a better coaxial positioning of the prosthesis in the oesophagus, particularly in stenosis of the

gastro-oesophageal junction. Whereas the maximum length of a fully expanded Wallstent prosthesis was only 11 cm. Furthermore, the material properties and design specifications of the Ultraflex stent give it a flexibility that can prove to be a particular advantage in managing kinking stenoses in the region of the gastro-oesophageal junction.

On the other hand, the Ultraflex memory metal stent seems to offer a lower force of expansion. Cwikiel *et al*¹ reported on the need for balloon dilatation after stent placement because of insufficient expansion in 38% of patients. The results of Rajman *et al*⁹ showed that even in 71% of patients dilatation treatment was performed, although some treatment was immediately after placement. To our experience about half of the patients provided with a memory metal stent initially showed an insufficient degree of spontaneous expansion, thus requiring 40% of the patients to have one or several dilatation treatments. With the exception of three patients maximum stent expansion could be achieved in all cases at the latest after five dilatation sessions. One of three patients with an incompletely expanded stent had a particularly long tumour stenosis of 17 cm and two had a strong external compression of the tumour. In contrast, retreatments entailing dilatation because of incomplete stent expansion, which became necessary after the implantation of Wallstents or Gianturco-Z-Stents have either not been reported or have remained exceptions.^{2 3 6 7 13}

In contrast with the Wallstent, the proximal end of the memory metal Ultraflex stent is shaped like a tulip enhancing firm anchoring of the stent of the oesophageal wall. This serves to avoid the formation of pouches that was seen in nearly every fifth patient when Wallstent prostheses were implanted.^{2 7} The risk of a bolus obstruction at the upper rim of the stent is thus distinctly reduced.

To date, we have seen tumour ingrowth or overgrowth in about a third of our patients. This is essentially in agreement with clinical experiences in implementing oesophageal Wallstents,^{2 8} but somewhat in disagreement with the findings reported by Knyrim⁶ who saw this problem in slightly less than 24% of his patients when vascular Wallstents were applied. Nevertheless, it can be assumed that tumour ingrowth/overgrowth closely correlates with the patient survival times and that such forms of tumour growth generally develop in association with all mesh type endoprostheses lacking a protective coating, especially in patients with long survival times. Retreatments based on thermocoagulation methods therefore remain unavoidable, as long as tumour ingrowth cannot be prevented. Coated stents can prevent this from happening, but bear the risk of stent migration.^{2 3 8 13}

In summary, it can be concluded that treatment of malignant tumour stenoses in the upper gastrointestinal tract by implementing self expanding wire mesh endoprostheses of the memory metal Ultraflex stent type is simple and effective. The implantation procedure imposes little strain on the patient and can be

performed on an outpatient basis. Dysphagia was distinctly improved in most patients. The rate of serious complications is low. The problem in the early period after implantation is the insufficient expansion of the stent particularly in strong tumour stenoses requiring further dilatation treatment. The main problem occurring in the intermediate treatment stage is that of tumour ingrowth and overgrowth.

In view of the degree of discomfort and the system inherent rate of complications associated with plastic tube implantations, the currently available generation of memory metal Ultraflex stents signifies, even today, a valuable improvement of palliative treatment concepts applied to malignant stenosis in the upper gastrointestinal tract.

We wish to thank Professor M Grade for translating and revising the manuscript.

Addendum

During the follow up period until February 1995 two more patients developed increasing dysphagia due to tumour ingrowth and were retreated with electrocoagulation and KTP lasercoagulation, respectively. Altogether the problem of tumour infiltration of the wire mesh occurred in 11 of 30 patients (36%) 18 weeks (median; range: 2–49) after stent placement.

Furthermore, two more patients died, so that until February 1995 four of 30 patients were still alive with a survival time of 416 days (median; range: 354–441) and 26 of 30 patients had died after a survival time of 108 days (median; range: 3–211).

- 1 Cwikiel W, Strindberg H, Tranberg K-G, Stael von Holstein C, Hambraeus G, Lillo-Gil R, *et al.* Malignant

- oesophageal strictures: treatment with a self-expanding memory metal stent. *Radiology* 1993; 187: 661–5.
- 2 Ell C, Hochberger J, May A, Fleig WE, Hahn EG. Coated and uncoated self-expanding metal stents for malignant stenosis in the upper GI-tract. *Am J Gastroenterol* 1994; 89: 1496–500.
- 3 Ell C, May A, Hahn EG. Gianturco-Z-stents in the palliative treatment of malignant esophageal obstruction and esophagotracheal fistulas. *Endoscopy* (in press).
- 4 Goldin E, Beyar M, Safra T, Globberman O, Craciun I, Wengrower D, *et al.* A new self-expandable, nickel-titanium coil stent for esophageal obstruction: a preliminary report. *Gastrointest Endosc* 1994; 40: 64–8.
- 5 Grund KE, Storek D, Naruhn M. Flexible metal stents in the esophagus [Abstract]. *Gastrointest Endosc* 1993; 39: 121.
- 6 Knyrim K, Wagner HJ, Bethge N, Keymling M, Vakil N. A controlled trial of expansible metal stent for palliation of esophageal obstruction due to inoperable cancer. *N Engl J Med* 1993; 18: 1302–7.
- 7 Kozarek RA, Ball TJ, Patterson DJ. Metallic self-expanding stent application in the upper gastrointestinal tract: caveats and concerns. *Gastrointest Endosc* 1992; 38: 1–6.
- 8 Neuhaus H, Hoffmann W, Dittler HJ, Niedermeyer HP, Classen M. Implantation of self-expanding esophageal metal stents for palliation of malignant dysphagia. *Endoscopy* 1992; 24: 405–10.
- 9 Rajjman I, Walden D, Kortan P, Haber GB, Fuchs E, Siemens M, *et al.* Expandable esophageal stents: initial experience with a new nitinol stent. *Gastrointest Endosc* 1994; 40: 614–21.
- 10 Saß NL, Hagenmüller F. Nitinolstent bei Ösophaguskarzinom [Letter]. *Dtsch Med Wochenschr* 1993; 118: 45.
- 11 Schaer J, Katon RM, Ivancev K, Uchida B, Rösch J, Binmoeller K. Treatment of malignant esophageal obstruction with silicone-coated metallic self-expanding stents. *Gastrointest Endosc* 1992; 38: 7–11.
- 12 Wagner HJ, Knyrim K, Bethge N, Starck E, Sommer N, Pausch J, *et al.* Palliativtherapie der malignen Ösophagusobstruktion mit selbstexpandierenden Metallendoprothesen. *Dtsch Med Wochenschr* 1992; 117: 248–55.
- 13 Wu WC, Katon RM, Uchida BT, Keller FS, Rösch J. Silicone-covered self-expanding metallic stents for the palliation of malignant esophageal obstruction and esophagorespiratory fistulas: experience in 32 patients and a review of the literature. *Gastrointest Endosc* 1994; 40: 22–33.