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ESOPHAGEAL STENTING WITH A SELF-EXPANDABLE METALLIC DEVICE: A PRELIMINARY STUDY

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ABSTRACT

This study was designed to investigate the potential of the Gianturco-Rosch Z stent in the alimentary canal, using the rabbit esophagus as the animal model. Single stents were implanted in four animals, which were followed up for predetermined periods, lasting from 48 hours to 6 weeks. All the stents remained in place. A florid tissue reaction was noticed, initially manifesting primarily as submucosal cellular infiltration, and mucosal erosion. Over the ensuing six weeks, the acute changes gave way to mucosal regeneration, and the appearance of granulation tissue in the submucosa. The stented segments remained patent, and feeding difficulties were limited to the immediate post-procedure period. These preliminary results suggest that peristaltic activity is no contraindication to the use of Z stents, though measures to limit the tissue response need to be identified.

Key Words: Esophagus, Interventional procedure, Stent, Metallic.

INTRODUCTION

The last few years have witnessed an explosive growth in the number of indications for the percutaneous implantation of metallic stents. Curiously enough, the extension of this therapeutic modality to the gastrointestinal tract has met with limited enthusiasm. An anecdotal report apart[1)], the papers by Hayashi et al and Fujiwara's group represent the sum total of the literature in this area[2,3)].

Conceptually at least, peristaltic activity is a major impediment to the use of metallic stents in the alimentary canal. This study was designed to investigate the feasibility of using Gianturco-Rosch Z stents in the gastrointestinal tract.

MATERIALS & METHODS

The rabbit esophagus was selected as the experimental model, with four adult rabbits forming the study population.

Stent implantation was performed under general anesthesia. After a six hour fast, the animal was premedicated with 0.01 mg/kg atropine. Pentobarbital 25 mg/kg was administered IV; half this dose was repeated during the procedure, if the level of anesthesia proved insufficient. Under

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fluoroscopic guidance, a 5 Fr multipurpose catheter was introduced through the mouth into the esophagus, and maneuvered into the stomach. It was then exchanged for a 12F Teflon sheath, over a guidewire. After ensuring that the tip of the sheath was in the mid-thoracic esophagus, the guidewire and coaxial dilator were withdrawn. A 2 cm long Z stent, 1.1 cm in diameter, made from wire 0.016″ in calibre, was backloaded in the sheath. The specifications of the stent were dictated by our previous experience with the procedure: 1.5 cm long, 8mm diameter stents of 0.010″ wire had consistently migrated into the stomach. The stent was then deployed in the esophagus by the conventional technique (Fig.1). The sheath and pusher were replaced by a

Fig. 1 Stent in esophagus, immediately after deployment.

catheter, and a contrast study was performed (Fig.2).

The rabbit was kept under observation until the effect of anesthesia were off. Measurement of body weight at intervals provided the objective parameter of stent function. Daily oral intake was also monitored. Fluoroscopy was performed once a week to identify any change in stent position.

One animal each was killed two days, one week, four weeks, and six weeks after stent implantation. The thoracic esophagus was carefully dissected from the rest of the mediastinum, and removed en bloc for morphologic, and subsequent histologic examination.

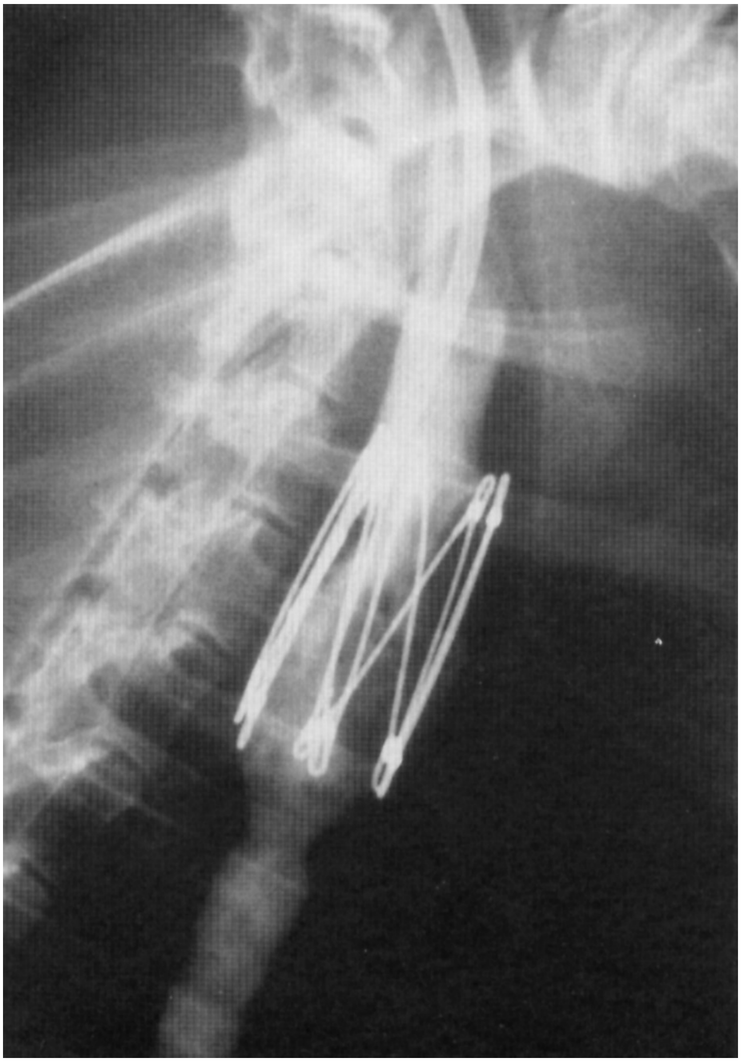

Fig. 2 Post-procedure esophagogram.

RESULTS

All the procedures were successfully completed at one session. A consistent observation was the negligible oral intake in the immediate post-implantation period, lasting twenty-four to forty-eight hours. Likewise, there was a drop in boby weight in the first week. None of the stents migrated distally before death. In every case, the final equilibrium diameter of the stent was a little more than the diameter at implantation.

Forty-eight hours after stent deployment, the esophagus exhibited an abrupt change in caliber around the prosthesis. The limbs were clearly visible through the stretched esophageal wall. The luminal aspect was hyperemic, and studded with mucosal elevations outlining the stent. Macroscopic ulcers were absent. Histologic examination revealed attenuation of the portions of the esophageal wall underlying the limbs, associated with mucosal loss, and disruption of the muscularis. Congested vessels and edema were present in the submucosa (Fig.3).

Within one week, thickening of the wall had rendered the stent invisible from the outside. The adventitia was otherwise unremarkable. On opening the esophagus, the stent was found partially hidden within the depths of the markedly thickened mucosa, though the struts remained intraluminal. Microscopy demonstrated foci of mucosal erosion even in areas that were not in physical contact with the stent. Prominent cellular infiltration in the submucosa and reactive fibrosis of the adventitia were present (Fig.4).

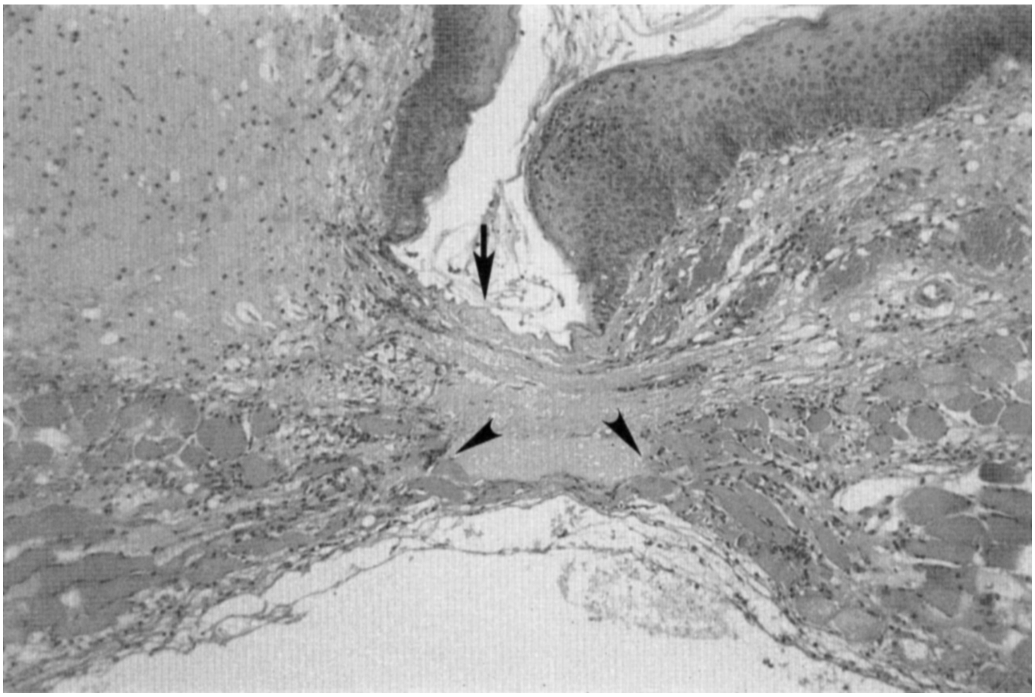

Fig. 3 Histology of esophagus, 48 hours after stenting (×40 magnification): thinning of tissue layers beneath stent, with mucosal loss (arrow), and disruption of muscular coat (arrowhead).

Fig. 4 Histology of esophagus, 1 week after stenting (×100 magnification): mucosal erosion, prominent cellular infiltration, and reactive adventitial fibrosis (arrow).

By six weeks, the alteration in caliber had progressed beyond the margins of the prosthesis. A focal protrusion was present on the anterior surface, which was adherent to the trachea. Adventitial perforation could not be identified. Filmy adhesions were noticed in the vicinity. The mucosal reaction had progressed to the formation of papillary excrescences enveloping the stent, and offsetting the increase in luminal diameter. The changes were particularly evident at the inferior margin of the prosthesis, resulting in a collar-like thickening covering the bends in the wire (Fig.5). The coexistence of granulation tissue with the cellular exudate, marked the major change in the histologic picture. Islands of regenerating epithelium were present in the mucosa (Fig.6).

The results of the examination of the four-week specimen did not dovetail into the pathologic continuum represented by the other three. The stented segment contained a large trichophytobezoar. The limbs of the stent were clearly separate from the underlying wall, except for one bend which had burrowed into an intramural location at a point corresponding to a localized bulge on the outer surface. Mucosal thickening was largely restricted to this area. Elsewhere, the luminal aspect was relatively featureless, lacking even the normal longitudinal folds. A few shallow, linear depressions were the only other morphologic stigma of stent placement. At microscopy, the extent and degree of cellular infiltration were limited, compared with thtat encountered in the other animals.

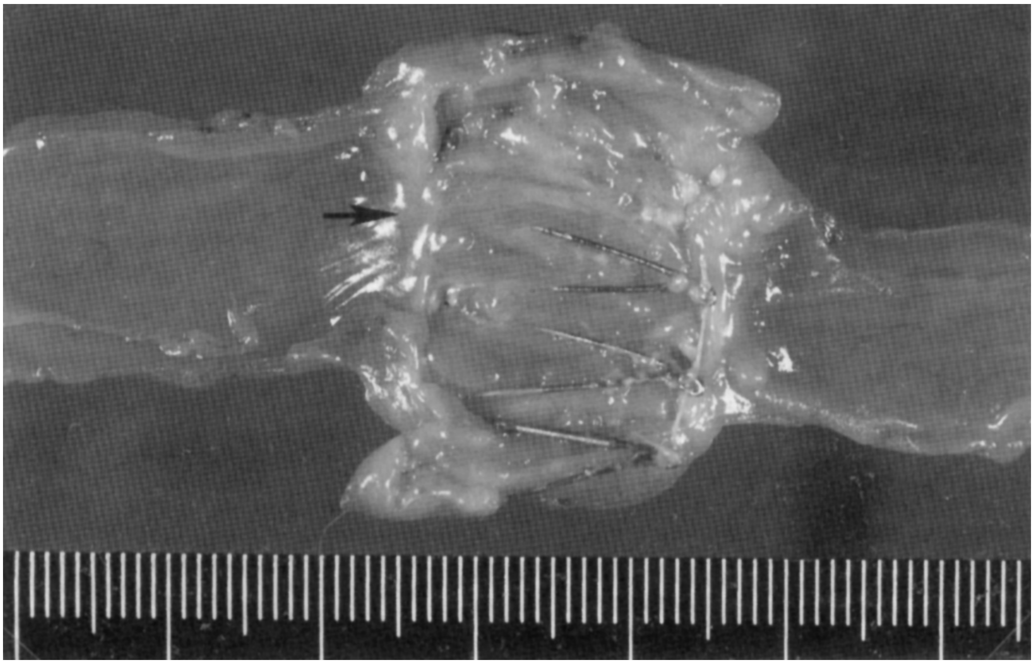

Fig. 5 Luminal surface of esophagus, 6 weeks after stenting: bends in wire covered by mucosa (arrow).

DISCUSSION

This laboratory experience does seem to support our hunch that its physical characteristics provide the Z stent with an intrinsic anchoring capability. The large difference in the luminal diameters of the esophagus and the stent probably ensures that the centrifugal force exerted by the limbs is sufficient to hold the device flush against the esophageal wall, thus discouraging migration. The fate of the 8mm diameter stents seems to lend credence to this hypothesis. Whether some other factor is also causally involved, remains open to question. The presence of a large phytobezoar in the stented segment in one rabbit, raises the suspicion of secondary motility disturbances also playing a role. Intriguingly, this animal never demonstrated any evidence of chronic feeding difficulties.

The histologic changes give food for thought. Fujimori et al noticed similar alterations in the dog esophagus following stenting[3]. This constellation of histologic findings can be explained by assuming that a metallic stent acts as a source of mucosal trauma, inducing an exaggerated reparative response[4]. The latter manifests as the papillary fronds visible macroscopically. Cyclic

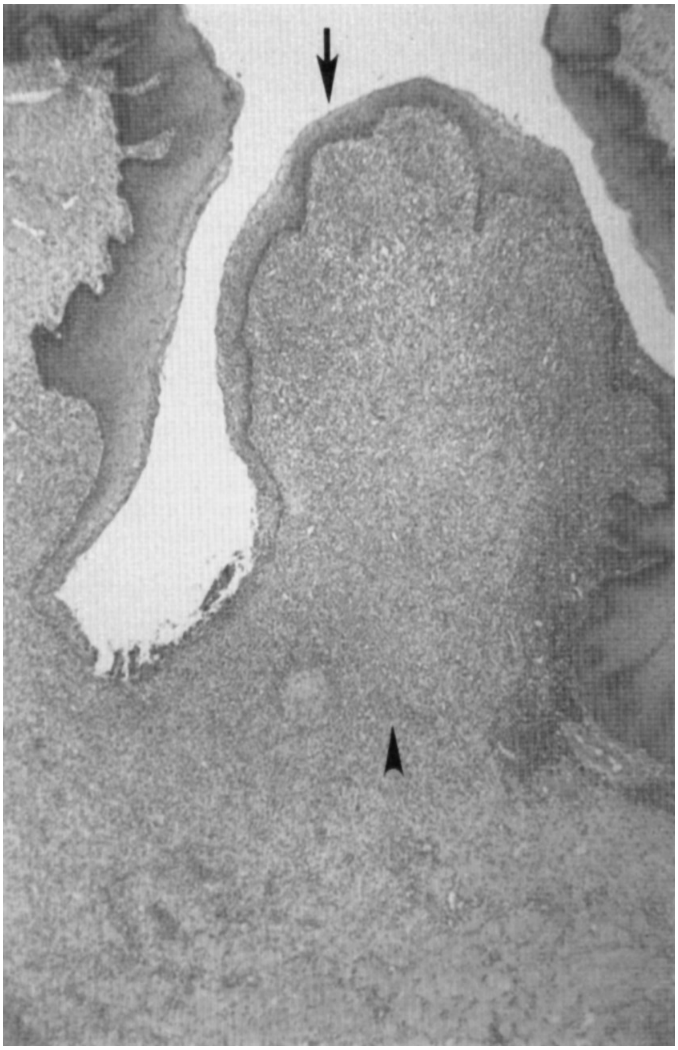

Fig. 6 Histology of esophagus, 6 weeks after stenting (×40 magnification): regenerating epithelium (arrow); granulation tissue in submucosal layers (arrowhead).

compression and expansion of the stent probably maintain the foci of mechanical irritation, with consequent persistence of the tissue changes beyond the acute phase. Pressure atrophy underlying the stent seems to be a common phenomenon as well[3,4]. Adventitial fibrosis presumably compensates for the anticipated weakening of the esophageal wall.

The significance of the tissue reaction may perhaps be limited, since in the clinical situation, deployed stents will largely be in contact with a fibrotic or neoplastic surface. Nevertheless, it should be remembered, the ends of a stent invariably overlap normal tissue, and prudence demands that this issue be addressed further. Perhaps a more compressible stent made from lower calibre wire would provoke a more muted tissue response.

In conclusion, a Z stent deployed in the esophagus remains in situ, without affecting food transit. The prosthesis induces structural changes in the esophagus, with probably neutral clinical implications. Further studies are warranted to determine the stent specifications most suitable for the gastrointestinal tract.

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