Advances on the Clinical Application of Stent Placement for Colorectal Cancers (CRCs)

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Abstract: Colorectal stents have been reported as an effective alternative to surgery for the palliation or as a "bridge to surgery" for patients with obstructing colorectal cancers. This review describes the need for colorectal stent placement, distinction from colostomy and resection with primary anastomosis, the requirements for placement, and the many efforts over the past century to accomplish this goal experimentally and clinically. This work briefly presents both commercially available stents and relevant newly developed stents with experimental bio-functional materials, including elastic polymers (polyurethane), the biodegradable and bioresorbable materials, and the naturally occurring materials, focusing on their potential applications in the development of future colorectal substitutes. This paper also examines the critical issues and scientific challenges that require further research and cooperation of multidisciplinary teams.

Keywords: Colorectal stents, colorectal cancer, obstruction, palliation, biomaterials, multidisciplinary.

1. Introduction

Colorectal cancer (CRC) is one of the most common cancers in terms of both incidence and mortality in the world [1]. According to the World Health Organization, globally there are more than 800,000 newly diagnosed cases of colorectal cancer each year, with an overall annual mortality of more than 500,000 [2-4]. In particular, over 30,000 new cases are diagnosed in England and Wales each year, of which about half will have colorectal cancer registered as the underlying cause of death [5,6]; in the United States in 2009, 146,970 new cases of CRC were diagnosed with 49,920 dying of disease [7]; it comprises 10% of the over 500,000 annual cancer deaths, making it the third most common cancer in men and women; in the UK, it is about 25,000 new cases annually [3,8,9]. The same tendency is in China mainland and HK area and other countries and areas [10-12]. These data strongly suggest that more attention should be paid to the prevention and control of CRCs.

CRC is the principal cause of large bowel obstruction. Up to 75% of colorectal cancers occur in the left colon and a significant proportion (8-29%) of these will cause acute large bowel obstruction [12-14]. In 10-20% of all cases, partial colonic obstruction will develop, and complete obstruction occurs in an additional 5-20% [15, 16].

Although surgery is considered the standard treatment for neoplastic large bowel obstruction, complications after surgery for large bowel obstruction are relatively frequent, with reported mortality rates ranging from 8.8% to 27% [17-21]. In addition, many of these patients couldn't undergo curative surgical treatment because they were unfit for general anesthesia, in poor general health, nor had concomitant disseminated neoplastic disease [22]. However, in case of without surgery, these patients have a median survival of 7 months [23]. Death occurs within 5 years from diagnosis in 80-90% of cases [24]. Moreover, these patients have complications that considerably worsen their quality of life [25], including intractable pain, occlusion, bleeding, perforation and septic diseases [26]. Therefore, only palliative treatment is a possible relief for these symptoms.

Resection can provide rapid palliative treatment, but this treatment has a morbidity rate of 4%-60% and a mortality rate of 3%-11% [8]. Colostomy to resolve bowel decompression is an alternative treatment, but one with high morbidity and mortality rates in patients with large-bowel obstruction caused by neoplasm [22]. Thus, resection and colostomy are also avoided; space is created for other types of complementary therapeutic symptom relief.

2. Stent placement

Recent systematic reviews found colonic stenting, when used as a "bridge to surgery", can prevent acute colonic obstruction in patients who have impending

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obstruction detected either by colonoscopy or by diagnostic imaging (computed tomography canning, barium enema or water-soluble enema). This method is to be safe, with low mortality rates, and to have technical and clinical success in 92% and 88% of cases, respectively [27]. Earlier studies [28-30] have also demonstrated colonic stenting under combined endoscopic and fluoroscopic guidance in acute colonic obstruction is a minimally invasive, low-risk treatment for rapid relief of acute ileus. It allows relief of obstruction while avowing stoma formation in palliative cases, or it facilitates the completion of staging investigations, bowel decompression and preparation as a ‘‘bridge to surgery’’ for those with resectable disease [31]. It allows optimal preoperative planning and gives the opportunity for the administration of any neoadjuvant chemo/radiotherapy if required [32]. In addition, it can provide time for systematic support and obviate the need for faecal diversion or on table lavage. The method rapidly resolve bowel obstruction and/or bleeding without the risk involved in surgical treatment [33].

2.1 Basic principles

Stents are composed of a variety of metal alloys or compound materials with varying shapes and sizes depending on the individual manufacturer and organ of placement, which will allow bowel motions to pass through an area of the bowel which has been blocked, either by scarring or by tumor [34]. During patient’s colonoscopy, the blockage will be passed with the endoscope. This may require the blockage to be stretched (dilated), using a balloon passed through the endoscope. A thin wire will then be placed through the blockage and the endoscope removed. The stent will then be passed over the wire, through the blockage using X-ray control. At this point the stent is “released” which allows it to open up and hold open the blockage.

2.2 Materials

Since 1992, an increasing number of reports have described the use of stents for recanalization of malignant and benign bowel obstruction [35-40]. The common materials approved by FDA are listed in Tables 1, 2 as below [41-48]. As the development of molecular biology and biology engineering in recent years, some new bio-functional materials such as fibrin, collagen, PEG have been used for the treatment of colorectal diseases [25].

2.3 The types of stents

The first SEMS, the Z stent (Wilson Cook) was designed by Gianturco for use in vascular stenoses and described in use by Wright et al. [48] in 1985. They are available in a variety of diameters and lengths and are found in helical (eg, Esophacoil, Instent, Eden Prairie, MN), knitted (eg, Ultraflex, Boston Scientific, Oakland, NJ) and braided (Wallstent, Schneider, Zurich, Switzerland) varieties [31, 49]. Different types of colorectal stents are as shown in Figure 1.

2.3.1 Uncovered stent

Kim et al. [50] explored metal stents that lack a covering membrane (uncovered stents), with good flexibility and stability and therefore easier to deploy [51-60], which have been successfully used for both preoperative decompression of acute neoplastic large bowel obstruction and long-term palliation of patients who are not candidates for surgery [49, 50, 61-63]. However, stent occlusion due to tumor ingrowth has been reported in 10% to 30% of cases in which uncovered stents were used [62, 64].

Table 1 FDA-approved expandable metal esophageal stents

	Ultraflex	ZStent
Material	Nickel Titanium	Stainless Steel
Delivery system diameter (F)	16	28
Covering	Yes	
Degree of shortening	30-40%	0-10%
Radial force	+	++
Design	Mesh	zig-zag
Lumen diameter flanges	23, 28	21, 25
Lumen diameter shaft	18, 23	18