Review Article

Biliary Stents: Selection and Technique for Insertion

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EXTRACT

Currently, there are many types of stent available in the market. Their uses and advantages are varies and the techniques for insertion are also different. This review will discuss the techniques, information regarding practical uses on stents that currently available in the market and will touch base on the development of stents. In addition, the new techniques for biliary stenting and related information will also be provided.

Key words : Biliary, Stent, Technique, Selection

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INTRODUCTION

Over the last two decades, endoscopic biliary stenting has become a procedure of choice for many biliary disorders. The benefit of this technique is not only involve in the treatment for patients with biliary stricture but also able to facilitate many difficult endoscopic conditions including Billroth II sphincterotomy, decompression bile duct in patient with bile leak and temporary stenting for patient with cholangitis from common bile duct stone.

Currently, there are many types of stent available in the market. Their uses and advantages are varies and the techniques for insertion are also different. This review will discuss the techniques, information regarding practical uses on stents that currently available in the market and will touch base on the development of stents. In addition, the new techniques for biliary stenting and related information will also be provided.

Types of biliary stents

Due to its convenience for use and cost effective, plastic biliary stent is the most popular for various biliary conditions. However, stent clogging can be expected within 3-4 months, thus a larger stent such as self expandable metallic stent (SEMS) has been more accepted as a better device for patient who required a longer patency[1]. In addition, stent removal and exchange is one of the limitation for plastic stent, hence a specially designed stent that can be self degraded is preferable. To date, this type of the stent is in the process of experimental evaluation and not yet available in the market[2,3].

Plastic stent

The first use of plastic stent was reported in 1980 for patient with malignant biliary obstruction of the distal common bile duct[4]. Plastic stents come with

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many sizes, shapes and lengths (3-15 cm and 5-11.5 Fr). Straight and pigtail types are the most popular in the market. These stents are made of either polyethelene or teflon. The main benefit of pigtail stent over the striaght system is the lower risk for migration. Therefore, pigtail stent is indicated in the situation with higher risk for stent migration such as large common bile duct, post biliary sphincterotomy, and gallbladder stentings.

The main problem with plastic stent is their tendency to occlude with time, leading to recurrent jaundice and cholangitis. Plastic stent occluding involves a complex mechanism starting with the development on the inner surface of the stent of a biofilm containing components of bacteria and bile(5,6). Stent function becomes impaired after weeks or months and requires stent exchange in up to 30 to 60% of patients(7). Special design of stent has been used to prolong the patency. Tannenbaum is a straight stent without side holes had a trend to improve patency over a standard plastic stent with side holes (Cotton-Leung and Cotton-Huibregtse) (Figure 1 and 2)(8,9). Unfortunately, further randomized controlled did not support these results(10-12). Many studies showed that the most effective method to prolong stent patency is to insert stents of large diameter (10 or 11.5 Fr) that remain unclogged for a significantly longer period when compared with smaller stents (7 or 8.5 Fr)(13,14) whereas no advantage has been found for 11.5 Fr stents compared with 10 Fr stents(15).

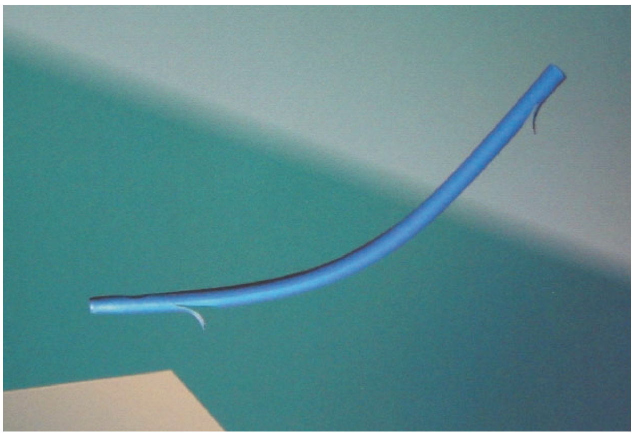

Figure 1 Cotton-Leung biliary stent set

Figure 2 Cotton-Huibregtse biliary stent set

Stent migration is one of the common problems after plastic biliary stenting. Distal migration is usually not difficult to manage if the stent is still inside the bile duct. By using a rat-tooth forceps or snare, the stent can be grasped and removed easily. Proximal migration of the stent is much more difficult to manage. Because no endoscopic view is available, therefore only fluoroscopic monitoring can be used. Balloon counter traction, snaring, holding by a rat-tooth forceps are different technique that many experts recommended (Figure 3)(16-18). Soehendra stent retriever is effective in the situation that the guide wire was able to cannulate into the stent (Figure 4, 5). The worse scenario for proximal stent migration is stent migration in patient with distal common bile duct stricture. With this condition, it is very difficult to negotiate stent removal devices trough the stricture. Rarely, surgical stent removal of the stent is required.

Self expandable metallic stent (SEMS)

To overcome the limitation of stent diameter inserting into the scope accessory channel, SEMS was introduced to clinical practice. SEMS is usually preloaded in a covered plastic sheath. The diameter of the delivery system is around 8-8.5 Fr. When fully expanded SEMS diameter can reach 30 Fr and has a significantly longer patency rate when compared with plastic stents(19-21). Most SEMS for endoscopic insertion are made of either stainless steel or Nitinol. Stainless steel SEMS has a characteristic of becoming shortening when it expands. This note must be taken to all endoscopists who deploying this stent. While, Nitinol is a superelastic alloy that blended from nikle and titanium. It has a special predetermined shape memory and depended on thermal effect of the body tissue. This allows SEMS to be expanded without shortening. Currently, there are many different types of SEMS available in the market. The Zilver Stent (laser cut

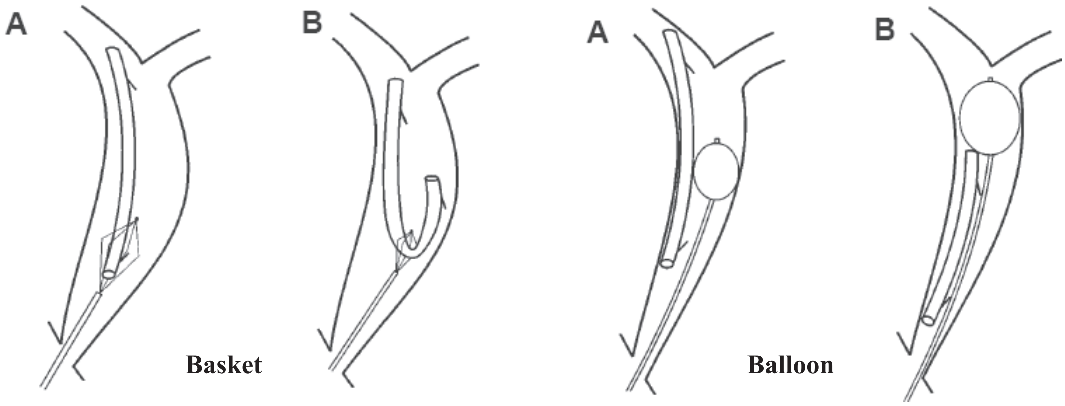

Figure 3 Different techniques to remove proximal plastic stent migration
(Modified from Chaurasia O, Rauws EA, Fockens P, Huibregtse K. Endoscopic techniques for retrieval of proximally migrated biliary stents: the Amsterdam experience. Gastrointest Endosc 1999;50:780-5)

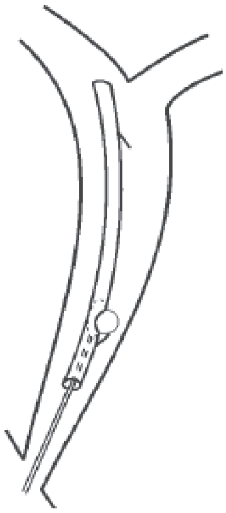

Figure 4 Demonstrating guidewire cannulation of the migrated biliary stent
(Modified from Chaurasia OP, Rauws EA, Fockens P, Huibregtse K. Endoscopic techniques for retrieval of proximally migrated biliary stents: the Amsterdam experience. Gastrointest Endosc 1999; 50: 780-5)

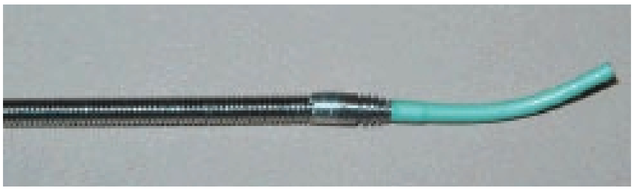

Figure 5 Soehendra stent retriever with a plastic curve

Nitinol) (Wilson Cook, Winston-Salem, NC), Wallstent (braided stainless steel) (Boston scientific, Natick, MA), the Diamond Ultraflex (braided Nitinol) (Boston Scientific, Natick, MA), and the Memotherm (braided Nitinol) (Bard Inc, Billerica, MA). Recently Asia produced SEMSs are available, mainly from South Korea and China, the characteristics of these stents are comparable to Western products.

There are two systems for loading over the guide wire; 1) the conventional technique (completely trough the stent) and 2) the monorail system. The advantage of the monorail system over the conventional technique is a shorter guidewire can be used. However, many endoscopists feel that the push forward effect may be less with this system. Therefore, optimal stricture dilation is required before placing this monorail SEMS. Another disadvantage of the monorail system is impossible for contrast injection after stent deployment. The main indication for SEMS insertion is for patient with malignant biliary stricture who will live longer than 6 months[22]. However, many studies demonstrated that stent occlusion is still possible from tumor ingrowth or hyperplastic tissue reaction[23-25]. Recently, the membrane coated SEMS has been introduced (Coverd Wallstent, Boston scientific, Natick, MA and Viabil, W.L. Gore and Associates Inc, Flagstaff, AZ). The concept of the covered membrane is to limit tissue ingrowth trough the metal latticework[26,27]. (Figure 6) Unfortunately, early clinical reports did not show a significant patency of the covered stent over non-coverd version[28,29]. In addition, stent dislocation and migration were found more frequently. There were also reported of cholecystitis and pancreatitis from stent that possible occluding cystic and pancreatic ducts respectively[28,29].

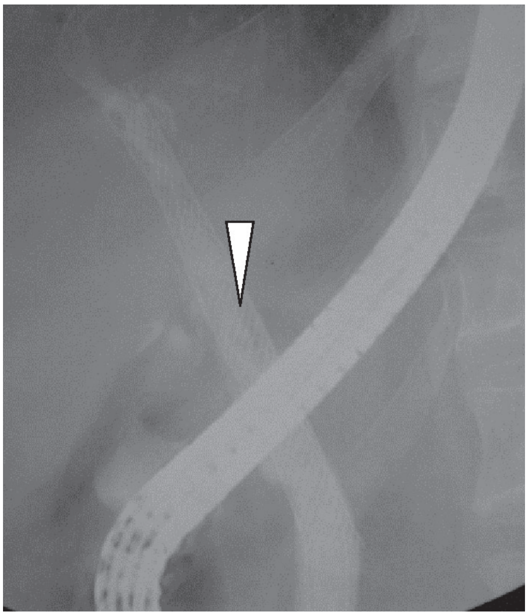

Figure 6 Demonstrating tumor ingrowth in a non-covered Wallstent

Because of the ability to removed covered SEMS[30,31], the option for using the covered SEMS for benign biliary stricture has been raised. Furthermore, there has been a report on the possibility of using a precise length of SEMS in patients with resectable pancreatic cancer without interfering operative field[32].

Biodegradable stents

To overcome several problems of conventional SEMS, there have been many attempts to manufacture stents made of biodegradable materials. Biodegradable stents have advantages for the treatment of benign and malignant biliary stricture, especially eliminating the need for stent removal. The advantages of these stents included large stent diameter, decreased biofilm accumulation and proliferative changes, elimination of the need for stent removal and imaging artifacts, and prospects for drug impregnation. However, suboptimal expansion has hampered prior iterations. In a prospective study, it remained patent up to 6 months[33]. However, filling defects from degraded material were detected at a followed up cholangiography. In addition, stent occlusion and migration may occur more often than standard stents. Currently, several studies of biodegradable self-expanding stent implantation is underway in many countries. The initial and 6-month results are favorable and suggest the feasibility, safety, and efficacy of the biodegradable stent in humans. However, long-term follow-up with larger numbers of patients will be required to validate the long-term efficacy of biodegradable stents.[34]

Technique for biliary stent insertion

Generally, a complete cholangiogram to evaluate stricture location and extent of biliary tree involvement is mandatory prior to stent insertion. However, over injection of contrast into undrainable biliary segment in patient with malignant hilar stricture is harmful since the possibility of post ERCP cholangitis is high especially in patient with advanced Bismuth lesions.[35] To avoid forceful injection of the contrast, preprocedured magnetic resonance cholangiopancreatography (MRCP) or thin slice computerized axial tomography (CT scan) of the biliary system is required. In addition, retrograde injection of the contrast after the catheter had advanced beyond the stricture is a safer technique to eliminate failed biliary drainage. Biliary sphincterotomy is usually recommended especially if placement of a large bore stent or more than 1 stent is expected, but is not mandatory if the papillary orifice is patent enough or if mechanical dilation of the papilla is preliminarily performed. A hydrophillic guidewire is preferred when negotiated with a tight stricture but for subsequent stenting, a stiffer wire can be replaced for a more stability of the system. Mechanical dilation with coaxial dilating catheters (Soehendra biliary dilator, Wilson Cook, Winston-Salem, NC) or pneumatic dilation with dilating balloons (Hurricane biliary dilator, Boston Scientific, Natick, MA or Quantum biliary balloon, Wilson Cook, Winston-Salem, NC) may be performed before stent placement according to the anticipated tightness of the stricture itself. When placing a large bore stent (10 Fr or larger) a plastic guiding catheter is helpful to prevent looping of the guide wire in the duodenum. The technique of advancing the stent in is demanding on the upward movement of both elevator and up-down wheel. Shorten the scope while pushing the stent is helpful especially when placing stent in a very tight stricture. One of the important information for plastic stent placement is no way to pull back the system. Once the stent has been pushed away from the scope, there is no chance to retrieve it back if forward movement is unsuccessful. Unlike plastic stent placement, SEMS deployment system allows the endoscopist to pull back the system at anytime because of the continuity of the system with SEMS. However, keep positioning of the delivery system is recommended since there is a tendency for forward movement of the SEMS while deploying the stent. One of the advantages of SEMS system is that some systems (Wallstent) can be resheathed as long as the deployment is not advanced far beyond the point of no return. As mention above, the endos-copist has to keep in mind that the Wallstent has a tendency to become shortening, thus prepare to leave at least 1-2 cm of the distal ends beyond the stricture is a safe protocol. In case of complex hilar obstruction, when bilateral stenting is planed, it is mandatory to get access into both intrahepatic systems prior to deployment of SEMS. In addition, it is preferable to place the first SEMS into the left hepatic duct and then repeat the procedure to drain the right branch/ branches.

In centers with adequate experience and case-volume, endoscopic stent placement has a technical success of nearly 90%[1].

Results of biliary stenting in benign biliary strictures

Many uncontrolled series reported benefit from endoscopic dilation followed by placement of plastic stent for variety of biliary strictures caused by post operative bile duct injuries[36,37], post liver transplantation[38-42], primary sclerosing cholangitis (PSC)[43-45] and benign stricture from chronic pancreatitis[46,47]. (Table 1)

These patients usually required stent upsizing by putting more number of plastic stents until achievement designed maximum number stent (at least 3 of 10Fr stent or equivalent). The period therapy is usually finished within 1 year and the 3-month duration is typically assigned. The outcome of post cholecytectomy and post transplant anastomotic strictures resolution from this protocol based on clinical, biological and morphological criteria was closed to 70-100%[48-50]. Unfortunately, the non-anastomotic stricture from liver transplant had a much poorer result, less than 60 % of patients achieved clinical resolution[50]. The speculation of this poorer outcome may be from a longer stricture resulting from ischemic process while transplant. To date, there has been no good randomized controlled study regarding the outcome of endoscopic stenting for biliary stricture from PSC. It has been advisable that the dominant extrahepatic stricture is the most amenable type for this mode of therapy. Unfortunately, endoscopic treatment for biliary stricture in chronic pancreatitis had the poorest outcome. The long-term result of clinical success rate was lower than 50 % in many series[51,52]. The more elasticity of this stricture may prevent the remodeling of the stricture area.

Table 1 Outcome of endoscopic stenting in various benign biliary stricture

Excellent	
	Post cholecystectomy
	Anastomotic stricture in post OLT
Fair	
	PSC
	Non-anastomotic stricture in post OLT
	Chronic pancreatitis esp without calcification
Poor	
	Chronic pancreatitis esp with calcification

Special indication for plastic biliary stenting

Apart from biliary strictures, plastic stent placement can be benefit for many situations. Acute cholangitis from common bile duct stones is one of the advantages of temporary biliary stenting. Biliary drainage by stent is generally adequate when the cholangitis is severe. In contrast, attempting stone removal may require a longer procedure time and this can be harmful in septic patient who is hemodynamically unstable. Moreover, over injection of the contrast may result to more bacteremia due to higher chance of biliovenous reflux[53,54]. Many studies showed the benefit of long-term stenting in patient with large stones and failed endoscopic removal[55-58]. Fragmentation of stones was found in at least 30% of the cases and patients did reasonably well without severe attack of cholangitis in another one third[55,56,58]. In patient with severe acute cholecystitis who gallbladder drainage is required but surgery or percutaneous cholecystostomy is impossible, endoscopic placement of a double pigtail stent is possible but the technique to achieve guidewire placement into the gallbladder is difficult and technical challenging. Performing bililary sphincterotomy in patient with post Billroth II anatomy is also difficult and required a special reversed side sphincterotome which is not available in every endoscopic center. Therefore placing a biliary stent first and perform sphincterotomy by a need knife over the stent is a preferable technique in this

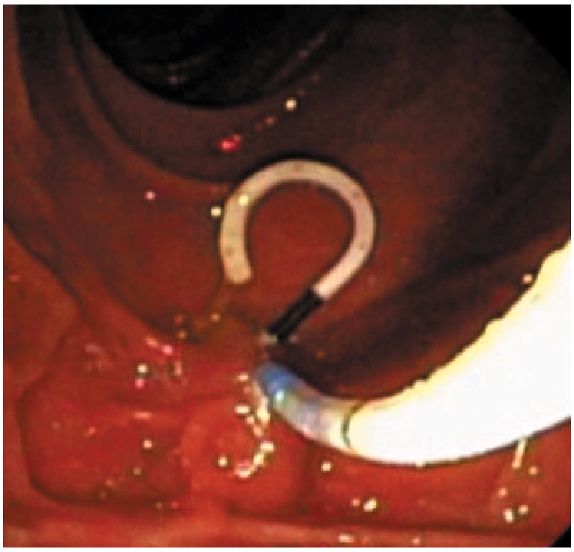

Figure 7 Demonstrating biliary sphincterotomy in Billroth II anatomy by a needle knife. White arrow is the direction for cutting

situation. In addition swing the needle knife upward in the billroth IIanatomy is much safer since it cutting toward the papilla (Figure 7).

CONCLUSION

Endoscopic biliary stenting is a standard technique to overcome many hepatobiliary disorders. Selecting appropriate stents for different situations is important for the satisfied outcome of the patients. Endoscopists must know the advantages and special techniques for each stent that they frequently used.

REFERENCES

1. Costamagna G, Pandolfi M. Endoscopic stenting for biliary and pancreatic malignancies. J Clin Gastroenterol 2004; 38: 59-67.
2. Meng B, Wang J, Zhu N, *et al*. Study of biodegradable and self-expandable PLLA helical biliary stent in vivo and in vitro. J Mater Sci Mater Med 2006; 17: 611-7.
3. Tsuji T, Tamai H, Igaki K, *et al*, et al. Biodegradable polymeric stents. Curr Interv Cardiol Rep 2001; 3: 10-7
4. Soehendra N, Reynders-Frederix V. Palliative bile duct drainage-a new endoscopic method of introducing a transpapillary drain. Endoscopy 1980; 12: 8-11.
5. Swidsinski A, Schlien P, Pernthaler A, *et al*. Bacterial biofilm within diseased pancreatic and biliary tracts. Gut 2005; 54: 388-95.
6. Sung JY, Leung JW, Shaffer EA, *et al*. Bacterial biofilm, brown pigment stone and blockage of biliary stents. J Gastroenterol Hepatol 1993; 8: 28-34.
7. Smith AC, Dowsett JF, Russell RC, *et al*. Randomized trial of endoscopic stenting versus surgical bypass in malignant low bile duct obstruction. Lancet 1994; 344: 1655-60.
8. Binmoeller KF, Seitz U, Seifert H, *et al*. The tannenbaum stent: a new plastic biliary stent without side holes. Am J Gastroenterol 1995; 90: 1764-8.
9. Seitz U, Vadeyar H, Soehendra N. Prolonged patency with a new designed teflon biliary prosthesis. Endoscopy 1994; 26: 478-82.
10. Van Berkel AM, Boland C, Redekop WK, *et al*. Aprospective randomized trial of Teflon versus polyethylene stents for distal malignant biliary obstruction. Endoscopy 1998; 30: 681-6.
11. England RE, Martin DF, Sheridan MB, *et al*. A prospective randomized multicentre trial comparing 10 Fr Teflon Tannenbaum stents with 10 Fr polyethylene Cotton-Leung stents in patients with malignant common duct strictures. Gut 2000; 46: 395-400.
12. Terruzzi V, Comin U, De Grazia F, *et al*. Prospective randomized trial comparing Tannenbaum Teflon and standard polyethylene stents in distal malignant biliary stenosis. Gastrointest Endosc 2000; 51: 23-7.
13. Speer AG, Cotton PB, MacRae KD. Endoscopic management of malignant biliary obstruction. Stents of 10 French gauge are preferable to stents of 8 French gauge. Gastrointest Endosc 1988; 34: 412-7.
14. Pedersen FM. Endoscopic management of malignant biliary obstruction. Is stent size of 10 French gauge better than 7 French gauge? Scand J Gastroenterol 1993; 28: 185-9.
15. Pereira-Lima J, Jakobs R, Maier M, *et al*. Endoscopic biliary stenting for the palliation of pancreatic cancer: results, survival predictive factors and comparison of 10 Fr with 11.5 Fr gauge stents. Am J Gastroenterol 1996; 91: 2179-84.
16. Chaurasia OP, Rauws EA, Fockens P, *et al*. Endoscopic techniques for retrieval of proximally migrated biliary stents: the Amsterdam experience. Gastrointest Endosc 1999; 50: 780-5.
17. Lahoti S, Catalano MF, Geenen JE, *et al*. Endoscopic retrieval of proximally migrated biliary and pancreatic stents: experience of a large referral center. Gastrointest Endosc 1998; 47: 486-91.
18. Tarnasky PR, Cotton PB, Baillie J, *et al*. Proximal migration of biliary stents: attempted endoscopic retrieval in forty-one patients. Gastrointest Endosc 1995; 42: 513-20.
19. Davids PHP, Groen AK, Rauws EA, *et al*. Randomized trial of selfexpanding metal stents versus polyethylene stents for distal malignant biliary obstruction. Lancet 1992; 340: 1488-92.
20. Knyrim K, Wagner HJ, Pausch J, *et al*. A prospective, randomised, controlled trial of metal stents for malignant obstruction of the common bile duct. Endoscopy 1993; 25: 207-12.
21. Prat F, Chapat O, Ducot B, *et al*. A randomized trial of endoscopic drainage methods for inoperable malignant strictures of the common bile duct. Gastrointest Endosc 1998; 47: 1-7.
22. Moss AC, Morris E, Mac Mathuna P. Palliative biliary stents for obstructing pancreatic carcinoma. Cochrane Database Syst

Rev 2006; 19: CD004200.
23. Lee BH, Choe DH, Lee JH, *et al*. Metallic stents in malignant biliary obstruction: prospective long-term clinical results. Am J Roentgenol 1997; 168:741-5.
24. O'Brien S, Hatfield AR, Craig PI, *et al*. A three year follow up of self expanding metal stents in the endoscopic palliation of longterm survivors with malignant biliary obstruction. Gut 1995; 36: 618-21.
25. Nakamura T, Hirai R, Kitagawa M, *et al*. Treatment of common bile duct obstruction by pancreatic cancer using various stents: single-center experience. Cardiovasc Intervent Radiol 2002; 25: 373-80.
26. Born P, Neuhaus H, Rösch T, *et al*. Initial experience with a new partially covered Wallstent for malignant biliary obstruction. Endoscopy 1996; 28: 699-702.
27. Shim CS, Lee YH, Cho Y, *et al*. Preliminary results of a new covered biliary metal stent for malignant biliary obstruction. Endoscopy 1998;30:345-50.
28. Yoon WJ, Lee JK, Lee KH, *et al*. A comparison of covered and uncovered Wallstents for the management of distal malignant biliary obstruction. Gastrointest Endosc 2006; 63: 996-1000.
29. Park do H, Kim MH, Choi JS, *et al*. Covered versus uncovered wallstent for malignant extrahepatic biliary obstruction: a cohort comparative analysis. Clin Gastroenterol Hepatol 2006; 4: 790-6.
30. Familiari P, Bulajic M, Mutignani M, *et al*. Endoscopic removal of malfunctioning biliary self-expandable metallic stents. Gastrointest Endosc 2005; 62: 903-10.
31. Matsushita M, Takakuwa H, Nishio A, *et al*. Open-biopsy-forceps technique for endoscopic removal of distally migrated and impacted biliary metallic stents. Gastrointest Endosc 2003; 58: 924-7.
32. Wasan SM, Ross WA, Staerkel GA, *et al.* Use of expandable metallic biliary stents in resectable pancreatic cancer. Am J Gastroenterol 2005; 100: 2056-61.
33. Ginsberg G, Cope C, Shah J, *et al*. In vivo evaluation of a new bioabsorbable self-expanding biliary stent. Gastrointest Endosc 2003; 58: 777-84.
34. Tsuji T, Tamai H, Igaki K, *et al*. Biodegradable Polymeric Stents. Curr Interv Cardiol Rep 2001; 3: 10-7.
35. Rerknimitr R, Kladcharoen N, Mahachai V, *et al*. Result of endoscopic biliary drainage in hilar cholangiocarcinoma. J Clin Gastroenterol 2004; 38: 518-23.
36. Bergman JJGHM, van den Brink GR, Rauws EAJ, *et al*. Treatment of bile duct lesions after laparoscopic cholecystectomy. Gut 1996; 38: 141-7.
37. Dumonceau J, Deviere J, Delhaye M, *et al*. Plastic and metal stents for postoperative benign bile duct strictures: the best and the worst. Gastrointest Endosc 1998; 47: 8-17.
38. Bourgeois N, Deviere J, Yeaton P, *et al*. Diagnostic and therapeutic endoscopic retrograde cholangiography after liver transplantation. Gastrointest Endosc 1995; 42: 527-34.
39. Rossi AF, Grosso C, Zanasi G, *et al*. Long-term efficacy of endoscopic stenting in patients with stricture of the biliary anastomosis after orthotopic liver transplantation. Endoscopy 1998; 30: 360-6.
40. Rizk RS, McVicar JP, Emond MJ, *et al*. Endoscopic management of biliary strictures in liver transplant recipients: effect on patient and graft survival. Gastrointest Endosc 1998; 47: 128-35.
41. Pfau PR, Kochman ML, Lewis JD, *et al*. Endoscopic management of postoperative biliary complications in orthotopic liver transplantation. Gastrointest Endosc 2000; 52: 55-63.
42. Park JS, Kim MH, Lee SK, *et al*. Efficacy of endoscopic and percutaneous treatments for biliary complications after cadaveric and living donor liver transplantation. Gastrointest Endosc 2003; 57: 78-85.
43. Marc van Milligen AW, van Bracht J, Rauws EAJ, *et al*. Endoscopic stent therapy for dominant extrahepatic bile duct strictures in primary sclerosing cholangitis. Gastrointest Endosc 1996; 44: 293-9.
44. Lee JG, Schutz SM, England RE, *et al*. Endoscopic therapy of sclerosing cholangitis. Hepatology 1995; 21: 661-7.
45. Marc van Milligen AW, Rauws EAJ, van Bracht J, *et al*. Lack of complications following short-term stent therapy for extrahepatic bile duct strictures in primary sclerosing cholangitis. Gastrointest Endosc 1997; 46: 344-7.
46. Barthet M, Bernard J, Duval JL, *et al*. Biliary stenting in benign biliary stenosis complicating chronic alcifying pancreatitis. Endoscopy 1994; 26: 569-72.
47. Smits ME, Rauws EAJ, Van Gulik TM, *et al*. Long-term results of endoscopic stenting and surgical drainage for biliary stricture due to chronic pancreatitis. Br J Surg 1996; 83: 764-8.
48. Kassab C, Prat F, Liguory C, *et al*. Endoscopic management of post-laparoscopic cholecystectomy biliary strictures. Long-term outcome in a multicenter study. Gastroenterol Clin Biol 2006; 30: 124-9.
49. Costamagna G, Pandolfi M, Mutignani M, *et al*. Long-term results of endoscopic management of postoperative bile duct strictures with increasing numbers of stents. Gastrointest Endosc 2001; 54: 162-8.
50. Rerknimitr R, Sherman S, Fogel EL, *et al*. Biliary tract complications after orthotopic liver transplantation with choledochocholedochostomy anastomosis: endoscopic findings and results of therapy. Gastrointest Endosc 2002; 55: 224-31.
51. Cahen DL, van Berkel AM, Oskam D, *et al*. Long-term results of endoscopic drainage of common bile duct strictures in chronic pancreatitis. Eur J Gastroenterol Hepatol 2005; 17: 103-8.
52. Eickhoff A, Jakobs R, Leonhardt A, *et al*. Endoscopic stenting for common bile duct stenoses in chronic pancreatitis: results and impact on long-term outcome. Eur J Gastroenterol Hepatol 2001; 13: 1161-7.
53. Chen MF, Jan YY. Bacteremia following postoperative choledochofiberscopy—a prospective study. Hepatogastroenterology 1996; 43: 586-9.
54. Rerknimitr R, Fogel EL, Kalayci C, *et al*. Microbiology of bile in patients with cholangitis or cholestasis with and without plastic biliary endoprosthesis. Gastrointest Endosc 2002; 56: 885-9.
55. Maxton DG, Tweedle DE, Martin DF. Retained common bile duct stones after endoscopic sphincterotomy: temporary and

longterm treatment with biliary stenting. Gut 1995; 36: 446-9.

56. Katsinelos P, Galanis I, Pilpilidis I, *et al*. The effect of indwelling endoprosthesis on stone size or fragmentation after long-term treatment with biliary stenting for large stones. Surg Endosc 2003; 17: 1552-5
57. Soomers AJ, Nagengast FM, Yap SH. Endoscopic placement of biliary endoprostheses in patients with endoscopically unextractable common bile duct stones. A long-term follow up study of 26 patients. Endoscopy 1990; 22: 24-6
58. Kubota Y, Takaoka M, Fujimura K, *et al*. Endoscopic endoprosthesis for large stones in the common bile duct. Intern Med 1994; 33: 597-601.