

# Operable severe obstructive jaundice: How should we use pre-operative biliary drainage?

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Obstructive jaundice is a common surgical problem, and surgery in jaundiced patients is associated with a higher risk of postoperative complications than surgery in non-jaundiced patients. However, the efficacy of pre-operative biliary drainage (PBD) for patients with obstructive jaundice remains controversial. Many studies have been unable to confirm the benefit of PBD and have suggested that it should not be performed routinely. While we agree that routine PBD is not recommended for all jaundiced patients, we believe that it is useful for certain subgroups; however, there are no clear guidelines regarding its application in these subgroups. We suggest that further large and detailed randomised control studies should focus on formulating codes and standards of PBD for patients with operable conditions causing severe obstructive jaundice.

*S Afr J Surg* 2013;51(4):127-130. DOI:10.7196/SAJS.1597



Obstructive jaundice is a common surgical problem that occurs when there is blockage of the passage of conjugated bilirubin from liver to intestine. In most benign biliary diseases, jaundice is intermittent and incomplete. Only a few diseases (e.g. primary sclerosing cholangitis) result in persistent obstructive jaundice, or even in biliary cirrhosis and portal hypertension, and most cases are related to stone obstruction and/or cholangitis,<sup>[1,2]</sup> usually with a serum total bilirubin level  $<100 \mu\text{mol/l}$ ,<sup>[3]</sup> which does not cause significant problems during surgery. In contrast, malignant obstructive jaundice (caused by malignant diseases of the extrahepatic distal or proximal biliary tract) is usually chronic, and obstruction is more severe and often accompanied by older age, a weakened immune system, chronic organ dysfunction, and many other problems.

## Effects of obstructive jaundice

Jaundiced patients have marked systemic pathophysiological changes such as hyperbilirubinaemia, endotoxaemia, blood coagulation and liver function disorders, and renal, cardiac or pulmonary dysfunction.<sup>[4-9]</sup> Of these changes, hyperbilirubinaemia and endotoxaemia have been identified as being of most prognostic importance in surgical patients.<sup>[10-12]</sup> Prolonged and progressive obstructive jaundice results in hepatic dysfunction due to bile stasis and cholangitis, eventually leading to hepatic failure, which is a major cause of postoperative death.<sup>[13,14]</sup> Surgery is associated with a higher risk of postoperative complications in jaundiced patients than in non-jaundiced patients,<sup>[15-17]</sup> including sepsis, hypotension, gastrointestinal bleeding, anastomotic leakage, abdominal abscess and liver or renal failure. How to manage

patients with severe obstructive jaundice is therefore a complicated problem that surgeons have to face.

## Debate about pre-operative biliary drainage for obstructive jaundice

The increased risk of surgery in jaundiced patients was recognised as early as 1935 by Whipple *et al.*,<sup>[18]</sup> who proposed a two-stage procedure for surgery in severely jaundiced patients. The first stage consisted of a drainage procedure in the form of cholecystogastrostomy to decompress the biliary tract and improve liver function, followed 4 weeks later by radical resection of the tumour.<sup>[18]</sup> In the late 1970s, studies on pre-operative biliary drainage (PBD) reported that it reduced the postoperative death rate in jaundiced patients.<sup>[19-22]</sup> In the 1980s, the effect of PBD was questioned in many retrospective and prospective studies, and focus shifted towards the negative effects of PBD, such as an increase in the rate of infectious complications. From then on, numerous studies, both randomised and non-randomised and both retrospective and prospective, have compared outcomes of surgery with and without PBD.<sup>[23-27]</sup> Proponents advocate routine PBD in an attempt to reduce the incidence of hepatic dysfunction and peri-operative complications in patients with obstructive jaundice,<sup>[28-31]</sup> while opponents consider that it does not significantly reduce postoperative complications and mortality,<sup>[32-34]</sup> can even result in major complications that can delay surgery and increase hospital costs,<sup>[35-37]</sup> and therefore should not be performed routinely.<sup>[13,37-48]</sup>

We have noted that almost all the above studies on the effects of PBD have the following limitations and methodological flaws: (i) most patient data were collected retrospectively, so there is a risk of selection bias;<sup>[44,47,48]</sup> (ii) in some studies, no distinction

was made between different levels of biliary obstruction;<sup>[48-50]</sup> (iii) in many studies, no distinction was made between different types of operations;<sup>[36,44,48,51]</sup> (iv) often no distinction was made between different methods and durations of PBD;<sup>[45,47,49,52]</sup> and (v) most importantly, these studies did not take advances in surgical skills and techniques (e.g. improved methods of anastomosis and use of the electrocutter and ultrasonic scalpel), intra-operative management and postoperative care into account.<sup>[36,44,47-56]</sup> There is no doubt that these advances reduce postoperative complications.<sup>[57]</sup> Such methodological and reporting deficiencies would make it difficult to draw objective conclusions, and may be one of the reasons why controversy exists. In contrast, in animal experiments we can control differences between individual animals, severity of jaundice and types of operations. Experiments in which PBD was used before surgery in animal models showed it to have benefits such as improved liver function and nutritional status, a reduction in systemic endotoxaemia and cytokine release and an improved immune response, resulting in significantly reduced mortality.<sup>[58-65]</sup>

### Debate about method of PBD

The development of minimally invasive techniques has meant that conventional surgical PBD is rarely used today. The two methods most widely used for the relief of obstructive jaundice are percutaneous transhepatic biliary drainage (PTBD) and endoscopic biliary drainage (EBD), including endoscopic nasobiliary drainage (ENBD) and endoscopic biliary stenting (EBS). Although PTBD and ENBD can relieve biliary obstruction they do not restore bile flow to the duodenum, so the enterohepatic circulation is still disrupted, and impaired intestinal barrier integrity may continue.<sup>[59,66]</sup> EBS helps stabilise the internal environment, but can have complications such as migration of stents, pancreatitis, bacterial contamination from stents, and cholangitis due to clogging.<sup>[41,42]</sup> Biliary stenting also generates a severe inflammatory response in the wall of the bile duct, which probably increases the risk of bile leakage from the bilio-intestinal anastomosis.<sup>[33,43,67]</sup> Each of the above drainage procedures is known to have been associated with infection or other complications.<sup>[26,32,41,42,68-70]</sup> Although complication rates in major medical centres have been reduced to very low levels indeed, the therapeutic effect of PBD, either by means of PTBD or EBD, has been extensively debated in recent decades.<sup>[32,47,58,65,71,72]</sup> Experimental studies have proved that internal biliary drainage improves nutritional status,<sup>[73]</sup> reduces endotoxaemia<sup>[59,64]</sup> and has other benefits.<sup>[74-76]</sup> However, a retrospective review by Sohn *et al.*<sup>[43]</sup> analysed whether internal drainage was better than external drainage, and concluded that there was no difference in terms of death or complications.

PBD is widely used in Japan and the Netherlands, and the Japanese literature<sup>[66,71,72,77]</sup> is unanimous in emphasising its benefits. Mortality rates after major liver resection for hilar cholangiocarcinoma in Japan are currently low (0 - 9%), and many attribute this to PBD being regarded as an essential element in pre-operative management.<sup>[72,78,79]</sup>

We consider that the key question is not which method of PBD is better, because in each case the specific clinical situation, the

technical proficiency of the operator, the costs involved and the patient's personal requirements will differ. All these factors should be considered in choosing the most appropriate method and the one that will achieve the best outcome.

### Clinical and laboratory parameters

In series of studies from the 1980s, a bilirubin level of 170 - 200  $\mu\text{mol/l}$  was clearly shown to indicate a risk of postoperative complications.<sup>[11,21,22]</sup> More recent studies have shown that postoperative mortality in patients with a total bilirubin level  $>342 \mu\text{mol/l}$  was significantly higher than in those with a total bilirubin level of  $<342 \mu\text{mol/l}$ .<sup>[80-82]</sup> Many researchers therefore propose that PBD should be used when the bilirubin level is  $>342 \mu\text{mol/l}$ , but others consider  $>500 \mu\text{mol/l}$  a more reasonable level.<sup>[83]</sup> As an evaluation index of PBD the bilirubin level seems to be rising with advances in medical technology, but experience indicates that the role of liver function in jaundiced patients is also an important factor affecting prognosis. Prolonged pre-operative jaundice is associated with increased postoperative morbidity and mortality after hepatic resection as a result of severe cholestatic liver dysfunction.<sup>[84-87]</sup> Evaluation of probable postoperative residual liver function is therefore indicated for patients requiring major curative hepatic resection, as well as for those with operable malignant obstructive jaundice.<sup>[77,88]</sup>

In addition to the pre-operative bilirubin level and liver function, advanced patient age<sup>[89]</sup> is an important factor. Tian *et al.*<sup>[90]</sup> combined bilirubin level with age and calculated a formula,  $\text{age (years)} \times 3 + \text{total bilirubin } (\mu\text{mol/l}) > 450$ , which can be used after doing PBD for patients with malignant obstructive jaundice. According to the formula, the operation can proceed if the total bilirubin level declines steadily by more than 30% for 2 weeks after PBD – it is not necessary for it to go down to normal. When the initial level is less than  $450 \mu\text{mol/l}$  the operation can be done immediately, without PBD.<sup>[90]</sup> Of course, this formula needs to be supported by further clinical experience, and other laboratory parameters, such as prothrombin, creatinine, haemoglobin and haematocrit, should also be taken into account.<sup>[81]</sup>

### Conclusion

In certain specific subgroups of jaundiced patients, including those with acute suppurative cholangitis,<sup>[91]</sup> severe malnutrition, impending renal failure or hilar block requiring portal vein embolisation,<sup>[13,92,93]</sup> and those who need pre-operative neo-adjuvant therapy,<sup>[29]</sup> urgent PBD is indicated and can be life-saving. However, although several reports have been published, there are still no clear guidelines regarding use of PBD in those patients.<sup>[13,81]</sup> Whether or not to use PBD before surgery for severe obstructive jaundice currently depends mainly on local expertise. We believe that if the complications of the procedure itself can be reduced and the enterohepatic circulation can be restored (e.g. with PTBD plus bile replacement<sup>[66]</sup>), PBD is of benefit, but this needs to be validated by further research. We suggest that future large and detailed randomised control studies should focus on formulating codes and standards of PBD for operable severe obstructive jaundice, to guide clinicians in their management of these patients.

**Acknowledgment.** We are grateful for help provided by the Information Centre, Zhongnan Hospital of Wuhan University.

**Author contributions.** J Sun and G Liu collected data, J Sun, G Liu and Y Yuan analysed the data and wrote the paper; and Y He and Z Liu revised the manuscript.

## REFERENCES

1. Roche SP, Kobos R. Jaundice in the adult patient. *Am Fam Physician* 2004;69(2):299-304.
2. Bekele Z, Yifru A. Obstructive jaundice in adult Ethiopians in a referral hospital. *Ethiop Med J* 2000;38(4):267-275.
3. Garcea G, Ngu W, Neal CP, Dennison AR, Berry DP. Bilirubin levels predict malignancy in patients with obstructive jaundice. *HPB (Oxford)* 2011;13(6):426-430. [http://dx.doi.org/10.1111/j.1477-2574.2011.00312.x]
4. Mesner O, Miller MJ, Iben SC, et al. Hyperbilirubinemia diminishes respiratory drive in a rat pup model. *Pediatr Res* 2008;64(3):270-274. [http://dx.doi.org/10.1203/PDR.0b013e31817d9c0c]
5. Padillo J, Puente J, Gomez M, et al. Improved cardiac function in patients with obstructive jaundice after internal biliary drainage: Hemodynamic and hormonal assessment. *Ann Surg* 2001;234(5):652-656. [http://dx.doi.org/10.1097/0000658-200111000-00010]
6. Uslu A, Cayci M, Nart A, et al. Renal failure in obstructive jaundice. *Hepatogastroenterology* 2005;52(61):52-54.
7. Watanapa P. Recovery patterns of liver function after complete and partial surgical biliary decompression. *Am J Surg* 1996;171(2):230-234. [http://dx.doi.org/10.1016/S0002-9610(97)89554-2]
8. Papadopoulos V, Filippou D, Manolis E, Mimidis K. Haemostasis impairment in patients with obstructive jaundice. *J Gastrointest Liver Dis* 2007;16(2):177-186.
9. Cakir T, Cingi A, Yegen C. Coagulation dynamics and platelet functions in obstructive jaundiced patients. *J Gastroenterol Hepatol* 2009;24(5):748-751. [http://dx.doi.org/10.1111/j.1440-1746.2009.05801.x]
10. Blamey SL, Fearon KC, Gilmour WH, Osborne DH, Carter DC. Prediction of risk in biliary surgery. *Br J Surg* 1983;70(9):535-538. [http://dx.doi.org/10.1002/bjs.1800700910]
11. Dixon JM, Armstrong CP, Duffy SW, Davies GC. Factors affecting morbidity and mortality after surgery for obstructive jaundice: A review of 373 patients. *Gut* 1983;24(9):845-852. [http://dx.doi.org/10.1136/gut.24.9.845]
12. Greve JW, Gouma DJ, Buurman WA. Complications in obstructive jaundice: Role of endotoxins. *Scand J Gastroenterol Suppl* 1992;27(s194):8-12. [http://dx.doi.org/10.3109/00365529209096019]
13. El-Hanafy E. Pre-operative biliary drainage in hilar cholangiocarcinoma, benefits and risks, single center experience. *Hepatogastroenterology* 2010;57(99-100):414-419.
14. Van der Gaag NA, Kloek JJ, de Castro SM, Busch OR, van Gulik TM, Gouma DJ. Preoperative biliary drainage in patients with obstructive jaundice: history and current status. *J Gastrointest Surg* 2009;13(4):814-820. [http://dx.doi.org/10.1007/s11605-008-0618-4]
15. Armstrong CP, Dixon JM, Taylor TV, Davies GC. Surgical experience of deeply jaundiced patients with bile duct obstruction. *Br J Surg* 1984;71(3):234-238. [http://dx.doi.org/10.1002/bjs.1800710326]
16. Greig JD, Krukowski ZH, Matheson NA. Surgical morbidity and mortality in one hundred and twenty-nine patients with obstructive jaundice. *Br J Surg* 1988;75(3):216-219. [http://dx.doi.org/10.1002/bjs.1800750309]
17. Padillo FJ, Cruz A, Briceno J, Martin-Malo A, Pera-Madrado C, Sitges-Serra A. Multivariate analysis of factors associated with renal dysfunction in patients with obstructive jaundice. *Br J Surg* 2005;92(11):1388-1392. [http://dx.doi.org/10.1002/bjs.5091]
18. Whipple AO, Parsons WB, Mullins CR. Treatment of carcinoma of the ampulla of Vater. *Ann Surg* 1935;102(4):763-779. [http://dx.doi.org/10.1097/0000658-193510000-00023]
19. Takada T, Hanyu F, Kobayashi S, Uchida Y. Percutaneous transhepatic cholangial drainage: Direct approach under fluoroscopic control. *J Surg Oncol* 1976;8(1):83-97. [http://dx.doi.org/10.1002/jso.2930080113]
20. Nakayama T, Ikeda A, Okuda K. Percutaneous transhepatic drainage of the biliary tract: Technique and results in 104 cases. *Gastroenterology* 1978;74(3):554-559.
21. Denning DA, Ellison EC, Carey LC. Preoperative percutaneous transhepatic biliary decompression lowers operative morbidity in patients with obstructive jaundice. *Am J Surg* 1981;141(1):61-65. [http://dx.doi.org/10.1016/0002-9610(81)90013-1]
22. Pitt HA, Cameron JL, Postier RG, Gadacz TR. Factors affecting mortality in biliary tract surgery. *Am J Surg* 1981;141(1):66-72. [http://dx.doi.org/10.1016/0002-9610(81)90014-3]
23. McPherson GA, Benjamin IS, Habib NA, Bowley NB, Blumgart LH. Percutaneous transhepatic drainage in obstructive jaundice: Advantages and problems. *Br J Surg* 1982;69(5):261-264. [http://dx.doi.org/10.1002/bjs.1800690511]
24. Hatfield AR, Tobias R, Terblanche J, et al. Preoperative external biliary drainage in obstructive jaundice. A prospective controlled clinical trial. *Lancet* 1982;2(8304):896-899.
25. Sirinek KR, Levine BA. Percutaneous transhepatic cholangiography and biliary decompression: Invasive, diagnostic, and therapeutic procedures with too high a price? *Arch Surg* 1989;124(8):885-888. [http://dx.doi.org/10.1001/archsurg.1989.01410080015001]
26. Audisio RA, Bozzetti F, Severini A, et al. The occurrence of cholangitis after percutaneous biliary drainage: Evaluation of some risk factors. *Surgery* 1988;103(5):507-512.
27. Bakkevoeld KE, Kambestad B. Morbidity and mortality after radical and palliative pancreatic cancer surgery. Risk factors influencing the short-term results. *Ann Surg* 1993;217(4):356-368. [http://dx.doi.org/10.1097/0000658-199304000-00007]
28. Doglietto GB, Alfieri S, Pacelli F, et al. Extrahepatic bile duct carcinoma: A western experience with 118 consecutive patients. *Hepatogastroenterology* 2000;47(32):349-354.
29. Pisters PW, Hudec WA, Hess KR, et al. Effect of preoperative biliary decompression on pancreaticoduodenectomy-associated morbidity in 300 consecutive patients. *Ann Surg* 2001;234(1):47-55. [http://dx.doi.org/10.1097/0000658-200107000-00008]
30. Pisters PW, Lee JE, Vauthey JN, Evans DB. Comment and perspective on Sewnath and colleagues' recent meta-analysis of the efficacy of preoperative biliary drainage for tumors causing obstructive jaundice. *Ann Surg* 2003;237(4):594-595; author reply 595-596.
31. Chen D, Liang LJ, Peng BG, et al. [Effect of preoperative biliary drainage on liver function changes in patients with malignant obstructive jaundice in the low bile duct before and after pancreaticoduodenectomy]. *Ai Zheng* 2008;27(1):78-82.
32. Karsten TM, Allema JH, Reinders M, et al. Preoperative biliary drainage, colonisation of bile and postoperative complications in patients with tumours of the pancreatic head: A retrospective analysis of 241 consecutive patients. *Eur J Surg* 1996;162(11):881-888.
33. Karsten TM, Davids PH, van Gulik TM, et al. Effects of biliary endoprosthesis on the extrahepatic bile ducts in relation to subsequent operation of the biliary tract. *J Am Coll Surg* 1994;178(4):343-352.
34. Heslin MJ, Brooks AD, Hochwald SN, Harrison LE, Blumgart LH, Brennan MF. A preoperative biliary stent is associated with increased complications after pancreatoduodenectomy. *Arch Surg* 1998;133(2):149-154. [http://dx.doi.org/10.1001/archsurg.133.2.149]
35. Jagannath P, Dhir V, Shrikhande S, Shah RC, Mullerpatan P, Mohandas KM. Effect of preoperative biliary stenting on immediate outcome after pancreaticoduodenectomy. *Br J Surg* 2005;92(3):356-361. [http://dx.doi.org/10.1002/bjs.4864]
36. Wang Q, Gurusamy KS, Lin H, Xie X, Wang C. Preoperative biliary drainage for obstructive jaundice. *Cochrane Database Syst Rev* 2008(3):CD005444. [http://dx.doi.org/10.1002/14651858.CD005444.pub2]
37. Pitt HA, Gomes AS, Lois JF, Mann LL, Deutsch LS, Longmire WP Jr. Does preoperative percutaneous biliary drainage reduce operative risk or increase hospital cost? *Ann Surg* 1985;201(5):545-553. [http://dx.doi.org/10.1097/0000658-198505000-00002]
38. Akamatsu N, Sugawara Y, Hashimoto D. Surgical strategy for bile duct cancer: Advances and current limitations. *World J Clin Oncol* 2011;2(2):94-107. [http://dx.doi.org/10.5306/wjco.v2.i2.94]
39. Povoski SP, Karpeh MS, Jr, Conlon KC, Blumgart LH, Brennan MF. Association of preoperative biliary drainage with postoperative outcome following pancreaticoduodenectomy. *Ann Surg* 1999;230(2):131-142. [http://dx.doi.org/10.1097/0000658-199908000-00001]
40. Lai EC, Mok FP, Fan ST, et al. Preoperative endoscopic drainage for malignant obstructive jaundice. *Br J Surg* 1994;81(8):1195-1198. [http://dx.doi.org/10.1002/bjs.1800810839]
41. Cortes A, Sauvanet A, Bert F, et al. Effect of bile contamination on immediate outcomes after pancreaticoduodenectomy for tumor. *J Am Coll Surg* 2006;202(1):93-99. [http://dx.doi.org/10.1016/j.jamcollsurg.2005.09.006]
42. Sakata J, Shirai Y, Wakai T, Nomura T, Sakata E, Hatakeyama K. Catheter tract implantation metastases associated with percutaneous biliary drainage for extrahepatic cholangiocarcinoma. *World J Gastroenterol* 2005;11(44):7024-7027.
43. Sohn TA, Yeo CJ, Cameron JL, Pitt HA, Lillemoe KD. Do preoperative biliary stents increase postpancreaticoduodenectomy complications? *J Gastrointest Surg* 2000;4(3):258-267; discussion 267-258. [http://dx.doi.org/10.1016/S1091-255X(00)80074-8]
44. Sewnath ME, Birjmohun RS, Rauws EA, Huibregtse K, Obertop H, Gouma DJ. The effect of preoperative biliary drainage on postoperative complications after pancreaticoduodenectomy. *J Am Coll Surg* 2001;192(6):726-734. [http://dx.doi.org/10.1016/S1072-7515(01)00819-5]
45. Liu F, Li Y, Wei Y, Li B. Preoperative biliary drainage before resection for hilar cholangiocarcinoma: Whether or not? A systematic review. *Dig Dis Sci* 2011;56(3):663-672. [http://dx.doi.org/10.1007/s10620-010-1338-7]
46. Barauskas G, Gulbinas A, Pundzius J. [Influence of preoperative biliary drainage and obstructive jaundice on the early outcome of pancreaticoduodenectomy]. *Medicina (Kaunas)* 2003;39(4):359-364.
47. Mezhir JJ, Brennan MF, Baser RE, et al. A matched case-control study of preoperative biliary drainage in patients with pancreatic adenocarcinoma: Routine drainage is not justified. *J Gastrointest Surg* 2009;13(12):2163-2169. [http://dx.doi.org/10.1007/s11605-009-1046-9]
48. Sewnath ME, Karsten TM, Prins MH, Rauws EJ, Obertop H, Gouma DJ. A meta-analysis on the efficacy of preoperative biliary drainage for tumors causing obstructive jaundice. *Ann Surg* 2002;236(1):17-27. [http://dx.doi.org/10.1097/0000658-200207000-00005]
49. Abdullah SA, Gupta T, Jaafar KA, Chung YF, Ooi LL, Mesenas SJ. Ampullary carcinoma: Effect of preoperative biliary drainage on surgical outcome. *World J Gastroenterol* 2009;15(23):2908-2912. [http://dx.doi.org/10.3748/wjg.15.2908]

50. Saleh MM, Norregaard P, Jorgensen HL, Andersen PK, Matzen P. Preoperative endoscopic stent placement before pancreaticoduodenectomy: A meta-analysis of the effect on morbidity and mortality. *Gastrointest Endosc* 2002;56(4):529-534. [http://dx.doi.org/10.1016/S0016-5107(02)70438-0]
51. Mumtaz K, Hamid S, Jafri W. Endoscopic retrograde cholangiopancreatography with or without stenting in patients with pancreaticobiliary malignancy, prior to surgery. *Cochrane Database Syst Rev* 2007(3):CD006001. [http://dx.doi.org/10.1002/14651858.CD006001]
52. Qiu YD, Bai JL, Xu FG, Ding YT. Effect of preoperative biliary drainage on malignant obstructive jaundice: A meta-analysis. *World J Gastroenterol* 2011;17(3):391-396. [http://dx.doi.org/10.3748/wjg.v17.i3.391]
53. Figueras J, Llado L, Valls C, et al. Changing strategies in diagnosis and management of hilar cholangiocarcinoma. *Liver Transpl* 2000;6(6):786-794. [http://dx.doi.org/10.1053/jlts.2000.18507]
54. Hochwald SN, Burke EC, Jarnagin WR, Fong Y, Blumgart LH. Association of preoperative biliary stenting with increased postoperative infectious complications in proximal cholangiocarcinoma. *Arch Surg* 1999;134(3):261-266. [http://dx.doi.org/10.1001/archsurg.134.3.261]
55. Li SQ, Chen D, Liang LJ, Peng BG, Yin XY. [The impact of preoperative biliary drainage on surgical morbidity in hilar cholangiocarcinoma patients]. *Zhonghua Wai Ke Za Zhi* 2009;47(15):1134-1137.
56. Ercolani G, Zanella M, Grazi GL, et al. Changes in the surgical approach to hilar cholangiocarcinoma during an 18-year period in a Western single center. *J Hepatobiliary Pancreat Sci* 2010;17(3):329-337. [http://dx.doi.org/10.1007/s00534-009-0249-5]
57. Liu JF, Li A, Liu Q, Zhou JS, Sun JB, Li D. [Surgical treatment of 475 patients with periampullary carcinoma]. *Zhonghua Zhong Liu Za Zhi* 2005;27(4):251-253.
58. Saiki S, Chijiwa K, Komura M, Yamaguchi K, Kuroki S, Tanaka M. Preoperative internal biliary drainage is superior to external biliary drainage in liver regeneration and function after hepatectomy in obstructive jaundiced rats. *Ann Surg* 1999;230(5):655-662. [http://dx.doi.org/10.1097/0000658-199911000-00007]
59. Gouma DJ, Coelho JC, Fisher JD, Schlegel JF, Li YF, Moody FG. Endotoxemia after relief of biliary obstruction by internal and external drainage in rats. *Am J Surg* 1986;151(4):476-479. [http://dx.doi.org/10.1016/0002-9610(86)90107-8]
60. Gouma DJ, Coelho JC, Schlegel JF, Li YF, Moody FG. The effect of preoperative internal and external biliary drainage on mortality of jaundiced rats. *Arch Surg* 1987;122(6):731-734. [http://dx.doi.org/10.1001/archsurg.1987.01400180113022]
61. Greve JW, Maessen JG, Tiebosch T, Buurman WA, Gouma DJ. Prevention of postoperative complications in jaundiced rats: Internal biliary drainage versus oral lactulose. *Ann Surg* 1990;212(2):221-227. [http://dx.doi.org/10.1097/0000658-199008000-00018]
62. Thompson RL, Hoper M, Diamond T, Rowlands BJ. Development and reversibility of T lymphocyte dysfunction in experimental obstructive jaundice. *Br J Surg* 1990;77(11):1229-1232. [http://dx.doi.org/10.1002/bjs.1800771112]
63. Megison SM, Dunn CW, Horton JW, Chao H. Effects of relief of biliary obstruction on mononuclear phagocyte system function and cell mediated immunity. *Br J Surg* 1991;78(5):568-571. [http://dx.doi.org/10.1002/bjs.1800780516]
64. Saitoh N, Hiraoka T, Uchino R, Miyauchi Y. Endotoxemia and intestinal mucosal dysfunction after the relief of obstructive jaundice by internal and external drainage in rats. *Eur Surg Res* 1995;27(1):11-18. [http://dx.doi.org/10.1159/000129367]
65. Suzuki H, Iyomasa S, Nimura Y, Yoshida S. Internal biliary drainage, unlike external drainage, does not suppress the regeneration of cholestatic rat liver after partial hepatectomy. *Hepatology* 1994;20(5):1318-1322. [http://dx.doi.org/10.1016/0270-9139(94)90774-9]
66. Kamiya S, Nagino M, Kanazawa H, et al. The value of bile replacement during external biliary drainage: An analysis of intestinal permeability, integrity, and microflora. *Ann Surg* 2004;239(4):510-517. [http://dx.doi.org/10.1097/01.sla.0000118594.23874.89]
67. Karsten TM, Coene PP, van Gulik TM, et al. Morphologic changes of extrahepatic bile ducts during obstruction and subsequent decompression by endoprostheses. *Surgery* 1992;111(5):562-568.
68. Blenkarn JJ, Benjamin IS. Infection during percutaneous transhepatic biliary drainage. *Surgery* 1989;105(2):239.
69. Leung JW, Ling TK, Kung JL, Vallance-Owen J. The role of bacteria in the blockage of biliary stents. *Gastrointest Endosc* 1988;34(1):19-22. [http://dx.doi.org/10.1016/S0016-5107(88)71223-7]
70. Dowidar N, Kolmos HJ, Lyon H, Matzen P. Clogging of biliary endoprostheses: A morphologic and bacteriologic study. *Scand J Gastroenterol* 1991;26(11):1137-1144. [http://dx.doi.org/10.3109/00365529108998605]
71. Nimura Y. Preoperative biliary drainage before resection for cholangiocarcinoma (Pro). *HPB (Oxford)* 2008;10(2):130-133. [http://dx.doi.org/10.1080/13651820801992666]
72. Kawasaki S, Imamura H, Kobayashi A, Noike T, Miwa S, Miyagawa S. Results of surgical resection for patients with hilar bile duct cancer: Application of extended hepatectomy after biliary drainage and hemihepatic portal vein embolization. *Ann Surg* 2003;238(1):84-92. [http://dx.doi.org/10.1097/01.SLA.0000074984.83031.02]
73. Gouma DJ, Roughneen PT, Kumar S, Moody FG, Rowlands BJ. Changes in nutritional status associated with obstructive jaundice and biliary drainage in rats. *Am J Clin Nutr* 1986;44(3):362-369.
74. Parks RW, Clements WD, Smye MG, Pope C, Rowlands BJ, Diamond T. Intestinal barrier dysfunction in clinical and experimental obstructive jaundice and its reversal by internal biliary drainage. *Br J Surg* 1996;83(10):1345-1349. [http://dx.doi.org/10.1002/bjs.1800831007]
75. Clements WD, McCaigue M, Erwin P, Halliday I, Rowlands BJ. Biliary decompression promotes Kupffer cell recovery in obstructive jaundice. *Gut* 1996;38(6):925-931. [http://dx.doi.org/10.1136/gut.38.6.925]
76. Hirazawa K, Hazama S, Oka M. Depressed cytotoxic activity of hepatic nonparenchymal cells in rats with obstructive jaundice. *Surgery* 1999;126(5):900-907. [http://dx.doi.org/10.1016/S0039-6060(99)70031-0]
77. Nimura Y, Kamiya J, Kondo S, et al. Aggressive preoperative management and extended surgery for hilar cholangiocarcinoma: Nagoya experience. *J Hepatobiliary Pancreat Surg* 2000;7(2):155-162. [http://dx.doi.org/10.1007/s005340050170]
78. Seyama Y, Kubota K, Sano K, et al. Long-term outcome of extended hemihepatectomy for hilar bile duct cancer with no mortality and high survival rate. *Ann Surg* 2003;238(1):73-83. [http://dx.doi.org/10.1097/01.SLA.0000074960.55004.72]
79. Nagino M, Kamiya J, Nishio H, Ebata T, Arai T, Nimura Y. Two hundred forty consecutive portal vein embolizations before extended hepatectomy for biliary cancer: Surgical outcome and long-term follow-up. *Ann Surg* 2006;243(3):364-372. [http://dx.doi.org/10.1097/01.sla.0000201482.11876.14]
80. Moghimi M, Marashi SA, Salehian MT, Sheikhatvan M. Obstructive jaundice in Iran: Factors affecting early outcome. *Hepatobiliary Pancreat Dis Int* 2008;7(5):515-519.
81. Shirahatti RG, Alphonso N, Joshi RM, Prasad KV, Wagle PK. Palliative surgery in malignant obstructive jaundice: Prognostic indicators of early mortality. *J R Coll Surg Edinb* 1997;42(4):238-243.
82. Liu YB, Jian ZX, Liu ZX, Qu JR. Surgical treatment of hilar cholangiocarcinoma. *Journal of First Military Medical University* 2004;24(12):1401-1403.
83. Quan ZW, Wang ZY, He ZP, Miao Y. The pros and cons and reasonable choice of PBD in malignant obstructive jaundice. *Chinese Journal of Practical Surgery* 2007;27(10):776-783. [http://dx.doi.org/10.3969/j.issn.1009-9905.2010.01.001]
84. Kennedy TJ, Yopp A, Qin Y, et al. Role of preoperative biliary drainage of liver remnant prior to extended liver resection for hilar cholangiocarcinoma. *HPB (Oxford)* 2009;11(5):445-451. [http://dx.doi.org/10.1111/j.1477-2574.2009.00090.x]
85. Su CH, Tsay SH, Wu CC, et al. Factors influencing postoperative morbidity, mortality, and survival after resection for hilar cholangiocarcinoma. *Ann Surg* 1996;223(4):384-394. [http://dx.doi.org/10.1097/0000658-199604000-00007]
86. Gerhards ME, van Gulik TM, de Wit LT, Obertop H, Gouma DJ. Evaluation of morbidity and mortality after resection for hilar cholangiocarcinoma - a single center experience. *Surgery* 2000;127(4):395-404. [http://dx.doi.org/10.1067/msy.2000.104250]
87. Belghiti J, Hiramatsu K, Benoist S, Massault P, Sauvanet A, Farges O. Seven hundred forty-seven hepatectomies in the 1990s: An update to evaluate the actual risk of liver resection. *J Am Coll Surg* 2000;191(1):38-46.
88. Seyama Y, Makuuchi M. Current surgical treatment for bile duct cancer. *World J Gastroenterol* 2007;13(10):1505-1515.
89. Dixon JM, Armstrong CP, Duffy SW, Elton RA, Davies GC. Factors affecting mortality and morbidity after surgery for obstructive jaundice. *Gut* 1984;25(1):104. [http://dx.doi.org/10.1136/gut.25.1.104]
90. Tian FZ, Shi L, Tang LJ, et al. [Perspective of pre-operational jaundice-reducing indication in carcinoma of head of pancreas]. *Zhonghua Wai Ke Za Zhi* 2006;44(23):1614-1616.
91. Kumar R, Sharma BC, Singh J, Sarin SK. Endoscopic biliary drainage for severe acute cholangitis in biliary obstruction as a result of malignant and benign diseases. *J Gastroenterol Hepatol* 2004;19(9):994-997. [http://dx.doi.org/10.1111/j.1440-1746.2004.03415.x]
92. Van Gulik TM, van den Esschert JW, de Graaf W, et al. Controversies in the use of portal vein embolization. *Dig Surg* 2008;25(6):436-444. [http://dx.doi.org/10.1159/000184735]
93. Nagino M, Takada T, Miyazaki M, et al. Preoperative biliary drainage for biliary tract and ampullary carcinomas. *J Hepatobiliary Pancreat Surg* 2008;15(1):25-30. [http://dx.doi.org/10.1007/s00534-007-1277-7]