

Figure 4: Computed tomography revealed the dilated left intrahepatic bile duct.



Figure 5: Magnetic resonance cholangiopancreatography revealed the dilated left intrahepatic bile duct.

(Figure 6). Fixation of the greater omentum to the peritoneum was not necessary to prevent delayed gastric emptying [22,23] because the residual stomach did not come in contact with the cut surface of the liver, a potential cause of adhesion.

The postoperative course was uneventful, and the patient was discharged on postoperative day 10. After discharge, upper gastrointestinal endoscopy revealed no duodenogastric bile reflux.

## Discussion

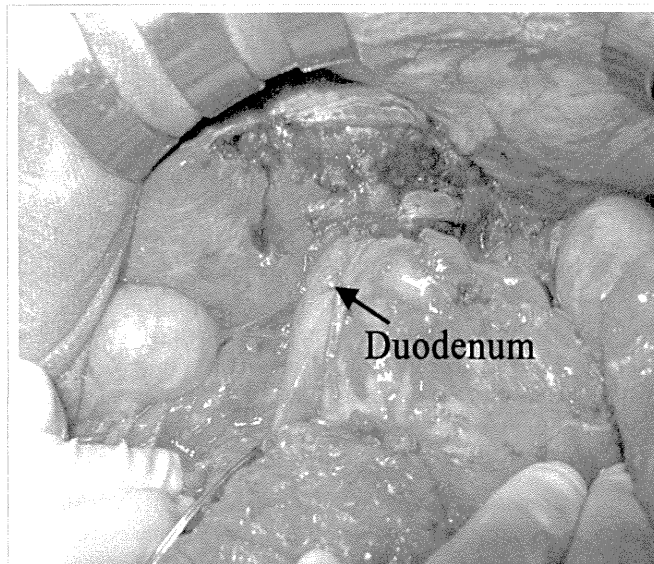
Biliary reconstruction using the duodenum has been successfully performed in liver transplantation and the treatment of biliary obstruction, common bile duct stones, biliary injury, choledochal cysts, and biliary atresia [2-14]. We decided to perform HD instead of HJ in the 2 patients described here, because it was technically difficult to perform HJ. No complication occurred after HD. One disadvantage

of HD is that, if an anastomotic leak does occur, the leakage volume can be much greater than with HJ because the leak would contain both gastric and pancreatic juices rather than bile alone in contrast to HJ. A second advantage of HD is that it is unnecessary to create a Roux-en-Y jejunal limb, associated with a higher incidence of adhesive bowel obstruction than HD. A third advantage of HD is that the biliary system can be easily accessed by endoscopy, which is not feasible with HJ.

One drawback of HD is anastomotic tension, which is higher than that of choledochoduodenostomy, especially in patients with perihilar cholangiocarcinoma. We performed wide Kocherization of the duodenum and confirmed that the anastomosis was tension-free by releasing the Kent retractor transiently. Wide Kocherization of the duodenum was an important factor in creating a tension-free anastomosis.

Shimotakahara [7] compared HD with HJ after excision of primary choledochal cysts in children. Complications after cyst excision occurred in 5 of the 12 patients in the HD group (42%). Four patients had bilious gastritis and 1 had temporary liver dysfunction. In the HJ group, 2 of the 28 patients (7.1%) had postoperative complications. Both patients had adhesive bowel obstruction, and 1 additionally had cholangitis. Liem [14] reported that cholangitis occurred at a rate of 5.3% and bilious gastritis at a rate of 14.3% after laparoscopic cyst excision and HD for choledochal cysts in children. Moraca [5] compare long-term biliary function between HD and HJ in patients who underwent treatment of major bile-duct injuries during cholecystectomy. On long-term follow-up, no patient had cholangitis, jaundice, or liver failure in either group. Bennet [8] reported that preliminary experience suggested that choledochoduodenostomy is a safe technique for cadaveric liver transplantation. Campsen [2] documented the outcomes of 7 patients who underwent living donor transplantation with HD as the primary type of biliary anastomosis. There were no deaths or re-transplants during the follow-up period. One patient had cholangitis that responded to intravenous antibiotics and endoscopic removal of the stent. Various complications have occurred after HD or HJ, including bilious gastritis, temporary liver dysfunction, bowel obstruction, and cholangitis. Bilious gastritis occurred after HD in some children with choledochal cysts, but has not been reported after HD in adults. The severest complication is bowel obstruction or cholangitis. One advantage of HD is that the creation of a Roux-en-Y jejunal limb and one anastomosis, associated with a higher incidence of adhesive bowel obstruction than HD, is unnecessary. After biliary reconstruction using the duodenum, cholangitis results from anastomotic stenosis and not reflux of the duodenal contents into the biliary tree [24]. The prevention of anastomotic stenosis is prerequisite to the prophylaxis of cholangitis.

In this study, we used a 10-Fr silicon drain with channels for internal biliary stenting of HD. We previously compared two types of stents in patients who underwent surgery for perihilar cholangiocarcinoma. In one group, a 10-Fr silicon drain with channels along the sides was used as a stent for HJ (channel stent group), while in the other a 5-Fr silicon drain with an internal lumen and side holes was used (intraluminal stent group). Leakage developed in 4 patients (36.4%) in the intraluminal stent group versus 2 (20.0%) in the channel stent group. Cholangitis developed in 3 patients with leakage (27.3%) in the intraluminal stent group versus no patient in the channel stent group.



**Figure 6:** Anastomosis of the right hepatic duct to the duodenal stump was established.

Our results suggested that the use of a 10-Fr stent helps to maintain a 10-Fr intraluminal diameter of the anastomosis, even in the presence of biliary leakage. A 10-Fr stent may thus prevent cholangitis due to anastomotic stenosis [21]. No complication occurred after operation in the present study.

Hakamada [25] reported that cholangiocarcinoma developed in 7.4% of patients a mean interval of 18 years after transduodenalsphincteroplasty. Maeda [26] documented the development of bile duct cancer 21 years after choledochoduodenostomy. Tocchi [27] estimated that the incidences of cholangiocarcinomas after sphincteroplasty, choledochoduodenostomy, and hepaticojejunostomy were 4.8, 7.6, and 1.9%, respectively, occurring at intervals of 11 to 18 years. Therefore, cholangiocarcinoma as a delayed complication of transduodenalsphincteroplasty and choledochoenteric anastomosis has become a serious issue.

In conclusion, we reviewed our experience with HD as an alternative to Roux-en-Y biliary anastomosis in patients undergoing hepatectomy for perihilarcholangiocarcinoma, reported our preliminary findings in 2 patients, and speculated on future applications. No complication occurred after operation in this study. We emphasize that wide Kocherization of the duodenum is necessary to provide a tension-free anastomosis, which should be confirmed after transiently releasing the Kent retractor. HD may be a reasonable alternative to Roux-en-Y biliary anastomosis in patients undergoing hepatectomy for perihilarcholangiocarcinoma. Additional studies and longer follow-up are needed, however, to confirm these findings and to accurately assess the rates and types of complications associated with HD. Further studies in larger numbers of patients are needed before HD can be designated a standard of care.

## References

1. Sano T, Shimada K, Sakamoto Y, Esaki M, Kosuge T. Changing trends in surgical outcomes after major hepatobiliary resection for hilar cholangiocarcinoma: a single-center experience over 25 years. *J Hepatobiliary Pancreat Surg.* 2007; 14: 455-462.
2. Campsen J, Zimmerman MA, Mandell MS, Wachs M, Bak T, Forman L, et al. Hepaticoduodenostomy is an alternative to Roux-en-Y hepaticojejunostomy for biliary reconstruction in live donor liver transplantation. *Transplantation.* 2009; 87: 1842-1845.
3. Cole FR, Pisillo CJ. Choledochoduodenostomy: an evaluation of its indications. *Int Surg.* 1966; 46: 108-112.
4. Todani T, Watanabe Y, Mizuguchi T, Fujii T, Toki A. Hepaticoduodenostomy at the hepatic hilum after excision of choledochal cyst. *Am J Surg.* 1981; 142: 584-587.
5. Moraca RJ, Lee FT, Ryan JA Jr, Traverso LW. Long-term biliary function after reconstruction of major bile duct injuries with hepaticoduodenostomy or hepaticojejunostomy. *Arch Surg.* 2002; 137: 889-893.
6. Srivengadesh G, Kate V, Ananthakrishnan N. Evaluation of long-term results of choledochoduodenostomy for benign biliary obstruction. *Trop Gastroenterol* 2003; 24: 205-207.
7. Shimotakahara A, Yamataka A, Yanai T, Kobayashi H, Okazaki T, Lane GJ, et al. Roux-en-Y hepaticojejunostomy or hepaticoduodenostomy for biliary reconstruction during the surgical treatment of choledochal cyst: which is better? *Pediatr Surg Int.* 2005; 21: 5-7.
8. Bennet W, Zimmerman MA, Campsen J, Mandell MS, Bak T, Wachs M, et al. Choledochoduodenostomy is a safe alternative to Roux-en-Y choledochojejunostomy for biliary reconstruction in liver transplantation. *World J Surg.* 2009; 33: 1022-1025.
9. Degenshein GA. Choledochoduodenostomy: an 18 year study of 175 consecutive cases. *Surgery.* 1974; 76: 319-324.
10. Bhandarkar DS, Shah RS. Laparoscopic choledochoduodenostomy for retained bile duct stone. *J Postgrad Med.* 2005; 51: 156-157.
11. de Aretxabala X, Bahamondes JC. Choledochoduodenostomy for common bile duct stones. *World J Surg.* 1998; 22: 1171-1174.
12. Onken JE, Pappas T, Baillie J. Long term results of choledochoduodenostomy in the treatment of choledocholithiasis. *Gastrointest Endosc.* 1992; 38: 403-405.
13. Ramirez P, Parrilla P, Bueno FS, Abad JM, Muelas MS, Candel MF, et al. Choledochoduodenostomy and sphincterotomy in the treatment of choledocholithiasis. *Br J Surg.* 1994; 81: 121-123.
14. Liem NT, Dung le A, Son TN. Laparoscopic complete cyst excision and hepaticoduodenostomy for choledochal cyst: early results in 74 cases. *J Laparoendosc Adv Surg Tech A.* 2009; 19: S87-90.
15. Bourgeois N, Deviere J, Yeaton P, Bourgeois F, Adler M, Van De Stadt J, et al. Diagnostic and therapeutic endoscopic retrograde cholangiography after liver transplantation. *Gastrointest Endosc.* 1995; 42: 527-534.
16. Sossenheimer M, Slivka A, Carr-Locke D. Management of extrahepatic biliary disease after orthotopic liver transplantation: review of the literature and results of a multicenter survey. *Endoscopy.* 1996; 28: 565-571.
17. Colonna JO 2nd, Shaked A, Gomes AS, Colquhoun SD, Jurim O, McDiarmid SV, et al. Biliary strictures complicating liver transplantation. Incidence, pathogenesis, management, and outcome. *Ann Surg.* 1992; 216: 344-350.
18. Greif F, Bronsther OL, Van Thiel DH, Casavilla A, Iwatsuki S, Tzakis A, et al. The incidence, timing, and management of biliary tract complications after orthotopic liver transplantation. *Ann Surg.* 1994; 219: 40-45.
19. Lerut J, Gordon RD, Iwatsuki S, Esquivel CO, Todo S, Tzakis A, et al. Biliary tract complications in human orthotopic liver transplantation. *Transplantation.* 1987; 43: 47-51.
20. Ryozaawa S, Iwamoto S, Iwano H, Ishigaki N, Taba K, Sakaida I. ERCP using double-balloon endoscopes in patients with Roux-en-Y anastomosis. *J Hepatobiliary Pancreat Surg.* 2009; 16: 613-617.
21. Yoshida H, Mamada Y, Taniai N, Mizuguchi Y, Kakinuma D, Ishikawa Y, et al. Silicon drain with channels along the sides for internal biliary stenting of hepaticojejunostomy in hepatic hilar malignancies. *J Gastroenterol Hepatol*

- 2009; 24: 752-756.
22. Yoshida H, Mamada Y, Taniai N, Mizuguchi Y, Shimizu T, Kakinuma D, et al. Fixation of the greater omentum for prevention of delayed gastric emptying after left hepatectomy with lymphadenectomy for cholangiocarcinoma. *J Hepatobiliary Pancreat Surg.* 2007; 14: 392-396.
23. Yoshida H, Mamada Y, Taniai N, Mizuguchi Y, Shimizu T, Takahashi T, et al. Fixation of the greater omentum for prevention of delayed gastric emptying after left-sided hepatectomy: a randomized controlled trial. *Hepatogastroenterology.* 2005; 52: 1334-1337.
24. Escudero-Fabre A, Escallon A Jr, Sack J, Halpern NB, Aldrete JS. Choledochoduodenostomy. Analysis of 71 cases followed for 5 to 15 years. *Ann Surg.* 1991; 213: 635-642.
25. Hakamada K, Sasaki M, Endoh M, Itoh T, Morita T, Konn M. Late development of bile duct cancer after sphincteroplasty: a ten- to twenty-two-year follow-up study. *Surgery.* 1997; 121: 488-492.
26. Maeda A, Yokoi S, Kunou T, Saeki S, Murata T, Niinomi N, et al. Bile duct cancer developing 21 years after choledochoduodenostomy. *Dig Surg.* 2003; 20: 331-334.
27. Tocchi A, Mazzoni G, Liotta G, Lepre L, Cassini D, Miccini M. Late development of bile duct cancer in patients who had biliary-enteric drainage for benign disease: a follow-up study of more than 1,000 patients. *Ann Surg.* 2001; 234: 210-214.

