# Biliary complications in orthotopic liver transplantation: experience with a modified technique of duct-to-duct reconstruction

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Abstract. Biliary complications are described as frequent causes of morbidity during the postoperative course of orthotopic liver transplantation (OLTx), even in recent papers. The authors report here on their experience with duct-to-duct anastomosis as their method of choice for biliary reconstruction in a consecutive series of 100 OLTx in adult patients. The original technique, as described by Starzl, was modified by the authors by performing a wide, longitudinal plasty of both the donor and recipient bile ducts, joined together with two polidioxanone running sutures, producing the effect of a side-to-side anastomosis. This technique was used in all procedures, even when a significant discrepancy was evident between the ducts (n = 10). Follow-up was completed in 100% of the patients for a period of 2-40 months (mean 13.1 months). Four major complications (4%) occurred including hepatic abscesses due to ascending cholangitis, T-tube dislocation, partial occlusion by a branch of the T-tube at the anastomotic site, and disruption of the bile duct after T-tube removal. In four other patients, transient abdominal pain followed removal of the stent. Neither strictures nor fistulas were observed. Choledochocholedochostomy on a Ttube stent represents, in our experience, the technique of choice for biliary reconstruction in OLTx. The procedure, as described in the present study, proved to be safe in preventing strictures and leakages and appears to be feasible in nearly 100% of all adult patients undergoing OLTx.

**Key words:** Biliary reconstruction, in liver transplantation – Liver transplantation, biliary reconstruction

Complications of bile duct reconstruction are described as a common cause of graft failure in orthotopic liver transplantation (OLTx). Ascending cholangitis, anastomotic leakages, strictures, and "sludge" formation were so frequently present in the postoperative courses of the patients that Calne was prone to consider the bile duct anastomosis as the technical "Achilles' heel" of OLTx [2, 13, 14, 18]. Nowadays, increased experience with liver procurement and replacement, along with the development of the procedure worldwide, are causing a dramatic reduction in the number of surgical complications. Nonetheless, biliary problems still remain a frequent pitfall, with the result that several methods of reconstruction during OLTx have been advocated and tested [1, 8–10, 20].

The end-to-end choledochocholedochostomy seems to be the safest and the preferred method of biliary drainage [5, 6, 17], although in pediatric patients or when a discrepancy exists between the donor and recipient's common hepatic duct, choledochojejunostomy on a Roux-en-Y loop is reported, by many authors, to be the technique of choice [7, 17].

The present paper describes the authors' experience in biliary reconstruction, based on 100 consecutive OLTx. A personal modification of the original duct-to-duct anastomosis, as reported by Starzl et al. [14], has been constantly adopted with excellent results. Furthermore, we review recent literature in order to assess and compare the incidence of complications with different types of reconstruction and to identify the procedure of choice under different anatomopathological situations.

#### Materials and methods

One hundred OLTx, consecutively performed in our department from 1987 to 1990 on 91 patients with end-stage liver disease, are considered. Indications for grafting are listed in Table 1. All patients were adult. Lythiasis of the common bile duct and dilatation of the biliary tree were present in five patients. A discrepancy between donor and recipient ducts, unrelated to lythiasis, was evident in five other cases.

Biliary tract complications were defined as morbidity related to the biliary reconstruction necessitating medical or surgical treatment. An abdominal ultrasound scan was performed routinely during the first postoperative week, and then: before discharge from the hospital, before removal of the T-tube, every 6 months during the follow-up period, or whenever clinical and biochemical signs required it.

T-tube cholangiography was performed in the operating room at the end of the operation and then before removal of the T-tube, or whenever indicated, under antibiotic prophylaxis.

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Table 1. Indications for liver transplantation

Cirrhosis	55	
HCC in cirrhosis	16	
Primary biliary cirrhosis	3	
Budd-Chiari syndrome	1	
Cholangiocarcinoma	5	
Other hepatic tumors	6	
Fulminant hepatic failure	5	
Retransplantation	9	
Total	100	

Liver biopsies were not obtained routinely but only when complications were suspected.

Initially, immunosuppression was maintained with cyclosporin and steroids. Starting with the 30th OLTx, a triple drug therapy was adopted that included cyclosporin, azathioprine, and steroids. Rejection episodes were treated with steroid boluses and, if unresponsive, with OKT3 monoclonal antibodies for 10–14 days. ABO-identical or -compatible donors were always used.

Follow-up was completed in 100% of the patients for a period of 2–40 months (mean 13.1 months). The records of all patients were reviewed to identify complications related to the reconstruction of the biliary tract. All patients who died after OLTx underwent autopsy, and reports were reviewed for evidence of biliary tract problems.

# **Operative** technique

The surgical technique of the donor and recipient operations were similar to those described by Starzl et al. [14–16]. Belzer's UW solution for liver perfusion and cold storage was employed starting with the 30th OLTx.

The donor's common bile duct was transected close to the duodenum with only minimal dissection in order to preserve its vascular support [11]. The gallbladder and the biliary tree were irrigated with cold saline or UW solution before and after in situ perfusion. In the recipient, the bile duct was transected close to the hilum. In all but 12 patients, the gastroduodenal artery was tied off in order to allow the arterial anastomosis to be performed under optimal conditions.

In all cases a duct-to-duct biliary anastomosis was carried out. A widening plasty was performed on both donor and recipient bile ducts by a longitudinal incision, usually longer than the diameter of the transected bile duct. By adapting the length of the longitudinal incision on either the donor or the recipient side, this technique permitted the anastomosis to be performed regardless of the diameter of the bile ducts. The integrity of the vascularization of the ends of the ducts should be demonstrated by manifest brisk bleeding of their accompanying arteries. Further resection of the ducts may be required to obtain a well-vascularized anastomotic edge.

Two stitches are placed to join the upper ends of the longitudinal incisions to the opposite free edges of the bile duct and they are tied off (Fig. 1). The anastomosis is performed with two running sutures with 7/0 polidioxanone (PDS) using an everting technique.

A silicon transanastomotic T-tube (usually 9 Fr in diameter) is inserted through a small choledocotomy on the recipient's common duct and fixed with 6/0 PDS purse-string. The upper limb of the Ttube is usually long enough to almost reach the hepatic duct bifurcation; this prevents the migration of the limb into the cystic duct or even through the anastomosis, and it may prevent formation of strictures in the duct proximal to the anastomosis.

The T-tube is removed 3-4 months after OLTx; a T-tube cholangiography is always performed, before removal, under antibiotic prophylaxis. Bile cultures through the T-tube are obtained daily up until its clamping in the 3rd postoperative week and then before removal, together with the extremity of the tube, or whenever febrile episodes, changes in bile flow, or an increase in bilirubin values occur in the postoperative course.

## Statistical analysis

Actuarial survival was computed by Wilcoxon life-table analysis. Univariate analysis was achieved by means of Student's *t*-test. A probability value of less than 0.05 was considered significant.

# Results

Survival for the entire series and for the last 65 patients (since the introduction of UW solution for liver preservation) is shown in Fig. 2. In Fig. 3, a normal cholangiogram is depicted.

Five patients died during the immediate postoperative period and were, therefore, excluded from the present analysis. Eighty-three patients lived more than 1 month after OLTx and 76 had a follow-up period longer than 3 months (i.e., the time during which the T-tube was removed).



Fig. 1 A-C. Technique of choledochocholedochostomy. A A wide longitudinal plasty is performed on both donor (superior) and recipient (inferior) bile ducts. Two stitches are placed on the opposite free edges of the ducts. B Two running sutures are used to complete the anastomosis. The anterior and posterior anastomoses are performed suturing outside the choledochal lumen. The posterior is the first to be performed by switching the bile ducts. C A T-tube is inserted through the anastomosis while completing its anterior wall. Its exit is from the recipient bile duct. A little purse-string fixes the longitudinal branch of the T-tube



Fig.2. Actuarial survival of the entire series of patients (3-year survival rate 64%) is depicted on the *lower curve*, and that of the last 65 patients (since 1989, the time when UW solution for liver preservation was introduced into our protocols) on the *upper curve*. The 2-year survival rate is 86%. Improvement in the results are explained not only by the excellent quality of the graft obtained but also by refinements in surgical technique, in the management of patients, and in indications for grafting



**Fig.3.** T-tube cholangiogram 3 months after OLTx shows normal caliber of both intra- and extrahepatic biliary tree with excellent drainage of the dye into the duodenum. The duct-to-duct anastomosis was performed despite a significant discrepancy between the 11-year-old donor's bile duct and the dilated recipient's duct (a 45-year-old man with extra hepatic lythiasis). The *arrow* depicts the anastomotic line

Biliary tract complications occurred in four patients (4% of the entire number of procedures; Table 2). Of these, one patient suffered from recurrent episodes of ascending cholangitis with intrahepatic abscess. The patient was transplanted for hilar cholangiocarcinoma with biliary sepsis. After OLTx, bile cultures and culture of the T-

Table 2. Complications in 100 biliary reconstructions

Patient	Complication	Treatment	Outcome
1 2 2	Cholangitis + abscesses T-tube dislodgment	Drainage Replacement	Resolved Resolved
4	T-tube obstruction	Replacement	Resolved

tube removed during the 3rd month were always positive for *Pseudomonas aeruginosa*, despite specific antimicrobial therapy. During the 4th postoperative month, a hepatic abscess was percutaneously drained and a vigorous antibiotic treatment undertaken with resolution of the infection.

In the second patient, the T-tube was accidentally removed on the 7th postoperative day, causing onset of biliary peritonitis; it was immediately replaced surgically without further complications.

A third patient had biliary peritonitis after removal of the T-tube 3 months after OLTx; this resolved with medical treatment. The T-tube cholangiogram showed a normal drainage into the duodenum. The patient was operated on 1 month later because of an infrahepatic bile collection and a healing stricture that required a redo of the duct-to-duct anastomosis. The patient is alive and in excellent condition 9 months after reoperation with normal liver tests and without external drainage.

A fourth patient developed a partial biliary obstruction secondary to a migration of the upper limb of the T-tube against the bifurcation of the common hepatic duct. The patient was reoperated with correct repositioning of the stent 1 month after OLTx.

Four other patients had abdominal pain just after Ttube removal, which spontaneously resolved in 1–3 days; ultrasound scan and biochemical data are normal 39, 22, 10, and 6 months, respectively, after OLTx.

No significant statistical correlation was found in our patient population between biliary complications and, respectively, age and sex of patients, presence of lythiasis, or discrepancy between bile ducts, Child preoperative status, biliary sepsis, and arterial complications occurring during the postoperative period. However, the number of complications are too small to allow any conclusions to be drawn.

### Discussion

Overall results of OLTx have improved greatly in recent years, but complications of biliary tract reconstruction still represent an important cause of morbidity, ranging from 15% to 34%, as evidenced by international literature [3, 4, 6, 7, 9, 17, 19].

Duct-to-duct anastomosis and Roux-en-Y choledochojejunostomy are the most frequently encountered procedures. The former, when performed on a T-tube stent, represents the technique of choice in adult patients. The preservation of the sphincter mechanism (possibly decreasing the incidence of ascending cholangitis) and the simplified surgical procedure, together with the ability to monitor biliary function, are the main reasons why this technique is favored.

Alternatively, many authors advocate the use of the Roux-en-Y technique when there is a discrepancy in size between donor and recipient ducts or when the ducts are too small, as in small adults or in pediatric patients [3, 6, 7, 17]. Disadvantages of this technique include the longer operation time, concern about performing an enterotomy in an immunosuppressed patient, difficulty in assessing the biliary tract, and the theoretical reflux of septic material from enteric lumen to the biliary system [3, 17].

An alternative approach, the so-called side-to-side anastomosis, was developed by Neuhaus and colleagues in the laboratory and then introduced into the clinical liver transplant program in Hannover with excellent results (4.5% complication rate) [8–10, 12].

In our series, a modified choledochocholedochostomy on a T-tube stent was adopted in all the cases. The modification, compared with the technique described by Starzl et al. [4, 14, 16], consisted of a wide longitudinal plasty of the biliary ducts before anastomosing with two polidioxanone running sutures, thus obtaining a "side-to-sidelike" reconstruction. We were able to employ this technique even when a significant discrepancy existed between donor and recipient ducts (n = 10), in retransplantations (n = 9), and when cancer of the biliary tract was the indication for OLTx. Data from the literature differ with regard to preservation of the biliary tract in a cholangiocarcinoma on the basis of a possible spread of neoplastic cells in the recipient's duct. In no one of the five patients operated on, however, was recurrence found on the biliary ducts, and two patients are still alive and free of disease 42 and 39 months after operation. No patient in the present series was transplanted for sclerosing cholangitis, which represents, in our opinion, the main contraindication to the use of this technique.

The rate of complications observed was extremely low – only 4% of the total number of procedures – and similar results are reported with the side-to-side technique [12]. Biliary fistulas were never seen. In the patients in whom arterial thrombosis occurred, either reOLTx or death preceded the onset of this complication. However, in a patient in whom an arterial stenosis was documented soon after OLTx, no biliary problems developed even when a complete thrombosis of the hepatic artery became evident nearly 1 year after OLTx. The patient is alive and with normal liver tests at 39 months of follow-up.

Anastomotic strictures never occurred in our series. By performing a longitudinal plasty of the biliary ducts, a very wide anastomotic line is obtained and, in our opinion, cicatricial stenoses can be avoided. We advocate the use of a continuous running suture in order to make the anastomosis impermeable. This did not cause ischemic damage to the extremities of the ducts and was able to prevent the spread of even a small amount of bile around the suture line, which has been found to play an important role in the genesis of biliary stenosis. The only stricture encountered was not found at the anastomotic line, which was normal at reoperation, but at the exit of the T-tube, where the little purse-string, not yet reabsorbed, caused a disruption of the choledocal wall when the stent was removed.

The T-tube was always employed, even though three of the four biliary complications observed were directly related to its use. Controversy surrounds the use of a stent in duct-to-duct reconstruction because of the complications reported in different papers [3, 6, 9, 20] and because there is no evidence that it is of real benefit in healing or reducing the risk of stricture. Its employment, however, as an index of hepatic function by monitoring quantity and quality of bile produced is, in our experience, essential in the management of the transplanted patient. Complications, when present, were easily treated, medically or surgically, with complete resolution, even in long-term follow-up. Intrahepatic biliary problems (except chronic rejection, seen in two cases) were never encountered; the flush of the biliary tree during harvesting and UW solution, reducing ischemic damage, certainly played a role.

In conclusion, duct-to-duct anastomosis proved to be a safe method of biliary reconstruction in OLTx with a very low complication rate in both early and long-term followup. We recommend performing a longitudinal plasty of the ducts in all cases in order to obtain a wider anastomotic line. This allows duct-to-duct reconstruction, even when a significant discrepancy is evident, and seems to prevent the development of strictures during the healing process.

The technique described has the advantages of a sideto-side anastomosis [8–10, 12] but avoids the risks of the ductal blind ends. The surgical technique employed must be meticulous, both when performing the anastomosis and when dissecting the ducts during donor and recipient operations in order to prevent damage to their vascular and nervous supplies [11, 12]. In our opinion, this, together with an adequate hepatic arterial reconstruction, plays a major role in determining bile complications.

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#### References

- Calne RY (1976) A new technique for biliary drainage in orthotopic liver transplantation utilizing the gallbladder as a pedicle graft conduit between donor and recipient bile duct. Ann Surg 184:605-609
- Calne RY, McMaster P, Portman B, Wall WJ, Williams R (1977) Observation on preservation, bile drainage and rejection in 64 human orthotopic liver allografts. Ann Surg 186: 282-290
- Hiatt JR, Quinones-Baldrich WJ, Ramming KP, Brems J, Busuttil RW (1987) Operation upon the biliary tract during transplantation of the liver. Surg Gynecol Obstet 165: 89–93
- İwatsuki S, Shaw BW, Starzl TE (1983) Biliary tract complication in liver transplantation under cyclosporine-steroid therapy. Transplant Proc 15: 1288–1291
- Iwatsuki S, Starzl TE, Gordon RD, Esquivel CO, Todo S, Tzakis A, Makowka L, Marsh JW, Miller CM (1987) Late mortality and morbidity after liver transplantation. Transplant Proc 19: 2373-2377
- Krom RAF, Kingma LM, Haagsma EB, Wesenhagen H, Slooff MJH, Gips CH (1985) Choledochocholedochostomy, a relatively safe procedure in orthotopic liver transplantation. Surgery 97: 552-556

- Lerut J, Gordon RD, Iwatsuki S, Esquivel CO, Todo S, Tzakis A, Starzl TE (1987) Biliary tract complications in human orthotopic liver transplantation. Transplantation 43: 47–51
- Neuhaus P, Neuhaus R, Pichlmayr R, Vonnahme F (1982) An alternative technique of biliary reconstruction after liver transplantation. Res Exp Med 180: 239–245
- Neuhaus P, Brölsch CH, Ringer B, Lauchart W, Pichlmayr R (1984) Results of biliary reconstruction after liver transplantation. Transplant Proc 16: 1225–1227
- Neuhaus P. Blumhardt G, Bechstein WO, Steffen R, Keck H (1990) Side-to-side anastomosis of the common bile duct is the method of choice for biliary tract reconstruction after liver transplantation. Transplant Proc 22: 1571
- 11. Northover J, Terblanche J (1978) Bile duct blood supply: its importance in human liver transplant. Transplantation 26: 67-69
- Ringe B, Oldhafer K, Bunzendahl H, Bechstein WO, Kotzerke J, Pichlmayr R (1989) Analysis of biliary complications following orthotopic liver transplantation. Transplant Proc 21: 2472-2476
- Starzl TE, Porter KA, Putnam CW (1976) Orthotopic liver transplantation in 93 patients. Surg Gynecol Obstet 142: 487-505
- 14. Starzl TE, Iwatsuki S, Thiel DH van, Gartner JC, Zitelli BJ, Malatak JJ, Schade RR, Shaw BW, Hakala TR, Rosenthal TJ, Por-

ter KA (1982) Evolution of liver transplantation. Hepatology 2: 614-636

- 15. Starzl TE, Hakala TR, Shaw BW, Hardesty RL, Rosenthal TJ, Griffith BP, Iwatsuki S, Bahnson HT (1984) A flexible procedure for multiple cadaveric organ procurement. Surg Gynecol Obstet 158: 223-229
- 16. Starzl TE, Iwatsuki S, Esquivel CO, Todo S, Kam I, Lynch S, Gordon RD, Shaw BW (1985) Refinements in the surgical technique of liver transplantation. Semin Liver Dis 5: 349–356
- 17. Stratta RJ, Wood RP, Langnas AN, Hollins RR, Bruder KJ, Donovan JP, Burnett DA, Lieberman RP, Lund GB, Pillen TJ, Markin RS, Shaw BW (1989) Diagnosis and treatment of biliary tract complications after orthotopic liver transplantation. Surgery 106: 675-684
- Terblanche J, Koep LJ, Starzl TE (1979) Liver transplantation. Med Clin North Am 63: 507–521
- Vincente E, Perkins JD, Sterioff S (1987) Biliary tract complications following orthotopic liver transplantation. Clin Transplant 1:138–142
- Wall WJ, Grant DR, Duff JH (1988) Biliary tract reconstruction using external cholecystectomy without stenting in liver transplantation. Transplant Proc 20: 541–542