Biliary Reconstruction Without T Tubes or Stents in Liver Transplantation: Report of 502 Consecutive Cases

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Although T tubes and stents are widely used as part of the routine biliary reconstruction in liver transplantation, they have inherent complications and there is no proof that they are beneficial to healing. We do not use T tubes or anastomotic stents, and we reviewed our experience with 502 consecutive, whole-size liver grafts to determine the incidence and nature of biliary complications. Duct-to-duct (D-D) and Roux-en-Y loop-to-duct (RY-D) anastomoses were performed in 321 and 176 cases, respectively. In 62% of cases, the donor gallbladder was transplanted and an external catheter cholecystostomy was fashioned to provide for postoperative cholangiography. In the remaining cases the gallbladder was removed. Biliary complications of all types occurred after 13.5% of the transplants. Anastomotic complications (stricture, obstruction, or leak) occurred in 8.2% of the cases, and they were least frequent (4.0%) with RY-D reconstructions. Gallbladder-related complications accounted for one quarter of all biliary complications, and they outweighed the advantage of convenient access to the biliary tree for cholangiography. Four patients (0.9%) died of biliary complications. We conclude that routine reconstruction of the biliary tract without T tubes or stents is a safe technique in liver transplantation. Retaining the donor gallbladder as a method of providing cholangiography is not necessary.

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Biliary complications have been significant and persistent since the inception of liver transplantation, irrespective of the improvements that have occurred in patient and graft survival. In large recent series, their incidence is reported at 11% to 29%. Several methods of reconstruction have been used over the years in an effort to provide the best biliary drainage. They include cholecystoduodenostomy,4 Roux-en-Y loop to the donor gallbladder (RY-GB),5 the gallbladder conduit technique,6 duct-to-duct anastomosis (D-D),7 and Roux-en-Y loop to the duct (RY-D).8 Anastomoses using the donor gallbladder or the recipient duodenum have been discarded, and only D-D and RY-D reconstructions are commonly used today.9 It is standard practice in most programs to stent the biliary anastomosis. A recent survey of adult liver transplant centers in the United States showed that 80% routinely use T tubes in D-D reconstructions and 78% use some variety of anastomotic stent with RY-D reconstructions.10 Although T tubes allow postoperative cholangiography, they have inherent disadvantages, and problems related to their migration, obstruction, and leakage are common.11-13

We have never been convinced that stenting is advantageous or beneficial to the healing of biliary anastomoses. The routine method of biliary drainage in our center has been either a D-D or RY-D reconstruction without a T tube or stent. To give direct access to the biliary tree for postoperative cholangiography, it has been our practice to transplant the donor gallbladder with the liver when anatomically possible and to fashion an external cholecystostomy with a temporary indwelling catheter.14 The aim of this review was to determine the incidence and type of biliary complications in 502 consecutive whole-size liver transplants and to identify those factors associated with the development of biliary complications. Reduced-size grafts were excluded from this analysis because specific anatomical features relating to the cut surface of the graft and the point of division of the duct put them in a unique group for the development of biliary complications.

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1074-3022/97/0304-0003$3.00/0
Patients and Methods

A retrospective review of all patients who underwent orthotopic liver transplantation with whole-size grafts between June 1985 and June 1994 was carried out. There were 502 transplants performed in 462 patients (395 adults and 67 children). There were 40 retransplants (38 second and 2 third grafts). Adult ages ranged from 17 to 72 years (median, 49 years). Children's ages ranged from 6 months to 16 years (median, 5.5 years). The underlying diseases for which transplantation was performed are listed in Table 1.

The operations were performed according to previously published techniques, without the use of venous bypass in all but 6 patients. The liver was revascularized with portal flow before the arterial anastomosis was constructed. The biliary reconstruction was performed predominantly by D-D or RY-D as guided by the following principles. D-D reconstructions were used when there was adequate length of donor and recipient ducts to allow a tension-free anastomosis, when the recipient duct was not diseased, when there was no prior right upper quadrant surgery, and when the donor and recipient ducts admitted a 4-mm or larger Bake's dilator. When these criteria were not satisfied, and in all small children, an RY-D was performed. When RY-D reconstructions were used, the Roux loops measured 16 to 18 inches and were usually placed in retrocolic positions. RY-D reconstructions were used in 32 of 40 (80%) retransplants and in 56 of 77 (73%) pediatric transplants.

The biliary anastomoses were performed with interrupted 5-0 polydioxanone suture (PDS) in adults and 6-0 or 7-0 PDS in children. All knots were tied on the outside in D-D reconstructions, and back-wall knots were tied on the inside in RY-D reconstructions. An external cholecystostomy was made using a 10 F Foley catheter exiting from the fundus of the gallbladder (Fig. 1). Care was taken to gently but thoroughly wash out the gallbladder to remove any blood clot or debris from the lumen. The balloon was inflated with 5 mL of saline after it was positioned in the body of the gallbladder. The exit site in the fundus was closed snugly around the catheter with catgut sutures. The donor gallbladder was used in this way in 310 transplants (62%). When there was a low entrance of the cystic duct resulting in two separate lumens at the site of transection of the common bile duct in the donor, the gallbladder was removed. It was also removed if gallstones were present in the donor. Occasionally the donor had previously undergone cholecystectomy.

The catheter was left open to straight drainage in the immediate postoperative period. A cholangiogram was performed at the end of the first postoperative week to assess the biliary anastomosis. If drainage was satisfactory, the tube was clamped. The catheters were removed 6 to 8 weeks after transplantation, but some bile leaks occurred from the gallbladder fundus so the period was lengthened to approximately 3 months after transplantation. Before the catheter was removed, additional cholangiograms were obtained as indicated by the clinical course of the patients and the results of liver function tests.

D-D reconstruction was performed in 321 cases (with an external cholecystostomy in 211), and RY-D anastomoses were performed in 176 cases (external cholecystostomy in 99). In 5 patients, a RY-GB anastomosis was performed. The RY-GB anastomosis was used in the early experience only and was abandoned because of its unreliability.

All complications that were related in any way to the biliary drainage were reviewed, and the following data were retrieved for all patients—age, gender, underlying liver disease, previous surgery, type of biliary reconstruction, variant arterial reconstruction, organ preservation times, presence or absence of chronic rejection, hospital course, and outcome. The minimum follow-up was 1 year, and the maximum was 10 years.

Induction immunosuppression was usually with either OKT3 or antilymphocyte globulin. Maintenance immunosuppression was cyclosporine in combination with steroids and/or azathioprine in the majority of patients.

Patients with and without biliary complications were compared using Student's t test with respect to continuous variables, while $\chi^2$ test was used to compare categori-
cal variables. Stepwise logistic regression analysis was applied to examine multivariately the factors associated with biliary complications. Patient and graft survival were estimated using the Kaplan-Meier method. A P value of <.05 was considered significant.

Results
The type and incidence of biliary complications that occurred after D-D, RY-D, and RY-GB anastomoses are summarized in Table 2. Biliary complications occurred after 68 allografts for an overall incidence of 13.5%. Five patients experienced two complications each. The complication rate was lowest with RY-D reconstructions (8.0%) and highest in the small group of patients who had RY-GB anastomoses (20%). The incidence of complications was 16.5% in patients with D-D reconstructions, which was significantly higher than in patients with RY-D reconstructions (P = .0076).

Biliary complications were divided into 3 categories: anastomotic complications, gallbladder-related complications, and other complications.

Anastomotic Complications
Anastomotic stricture/obstruction or leak occurred after 41 of the 502 transplants (8.2%). Anastomotic complications developed in 33 of 321 (10.3%) D-D reconstructions and 7 of 176 (4.0%) RY-D reconstructions (see Table 2).

Anastomotic stricture or obstruction was the most common problem, occurring after 33 allografts at a median period of 3 months (range, 3 days to 58 months). Eighteen patients were treated nonoperatively with either percutaneous transhepatic drainage followed by balloon dilatation (12 patients) or endoscopic retrograde cholangiopancreatography (ERCP) and dilatation (6 patients). Strictures that were managed nonoperatively were diagnosed 7 days to 44 months after transplantation, but on average occurred 3 months posttransplant.

Fifteen strictures required operative revision, 8 after failed attempts at dilatation. In 12 cases the original biliary reconstruction had been a D-D and was revised to RY-D. The other 3 cases were more complicated. The first, a child with a RY-GB anastomosis, had evidence of biliary obstruction on day 3 postoperatively. At laparotomy the anastomosis was revised to an RY-D, but the hepatic artery was discovered to be thrombosed. The child subsequently received another transplant. The second patient, also a child, had a percutaneous transhepatic cholangiogram (PTC) showing an obstructed RY-D anastomosis 2 months postoperatively.
spite revision of the anastomosis, secondary biliary cirrhosis developed, leading to retransplantation 2.5 months later. The third patient underwent PTC and placement of a metallic stent across a strictured RY-D anastomosis 14 months after transplantation. Six months later the stent eroded into the hepatic artery, and the patient required retransplantation.

Anastomotic bile leaks were infrequent. They occurred after 8 grafts, and all were diagnosed within the first 6 weeks posttransplant. Six leaks occurred after D-D reconstructions and 2 after RY-D reconstructions (see Table 2). In patients with D-D anastomoses, anastomotic leaks were significantly more common when the gallbladder was not used as an external cholecystostomy (5/110 vs 1/211; \( P = .019 \)). Six leaks were managed operatively. Three patients had D-D anastomoses redone; 2 D-D anastomoses were revised to RY-D reconstructions; and 1 patient had a leaking RY-D anastomosis revised.

Two patients with bile leaks were treated nonoperatively. One patient with a D-D reconstruction developed a choledochoduodenal fistula that was seen on routine cholangiography via the gallbladder catheter 2 months postoperatively. At the same time, the patient had an endoscopically documented duodenal ulcer. The fistula closed with medical therapy for the ulcer. This case presumably represented perforation of a duodenal ulcer into the common duct. The second patient leaked from an RY-D anastomosis which was treated conservatively. He deteriorated 1 month postoperatively and died of liver infarction secondary to a thrombosed mycotic aneurysm of the hepatic artery. The biliary leak was believed to be the cause of the mycotic aneurysm.

### Gallbladder-Related Complications

There were 17 complications directly related to the donor gallbladder or the cholecystostomy catheter. Thus, the gallbladder accounted for 25% (17 of 68) of all biliary complications. Eight patients leaked bile from the fundus of the gallbladder at the exit site of the catheter. In 6 patients the leaks occurred when the catheter was intentionally removed 6 to 8 weeks after transplantation, and in 2, leakage resulted when the catheters accidentally migrated from the gallbladder in the early postoperative period. Each patient developed bile peritonitis and required laparotomy and reinsertion of the gallbladder catheter. Three patients died after the leak, and in 2 of these the bile peritonitis directly contributed to death.

Seven patients developed symptomatic gallstones that were diagnosed 5 to 36 months posttransplant. All were treated by cholecystectomy. In 1 patient, a gallbladder hematoma occurred 1 week after transplantation, and emergency cholecystectomy was required for bleeding from the cholecystostomy catheter. In the early postoperative period, one patient required antibiotic therapy and irrigation of the gallbladder catheter for biliary sludge and right upper quadrant pain with fever.

### Table 2. Type of 68 Biliary Complications in 502 Liver Transplants

<table>
<thead>
<tr>
<th>Type of Reconstruction</th>
<th>D-D with GB (n = 211)</th>
<th>D-D minus GB (n = 110)</th>
<th>RY-D with GB (n = 99)</th>
<th>RY-D minus GB (n = 77)</th>
<th>RY-GB (n = 5)</th>
<th>Total (n = 502)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anatomotic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stricture/obstruction</td>
<td>15</td>
<td>12</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>33 (6.6%)</td>
</tr>
<tr>
<td>Leak</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td></td>
<td>8 (1.6%)</td>
</tr>
<tr>
<td>Gallbladder-related</td>
<td>15</td>
<td></td>
<td>2</td>
<td></td>
<td></td>
<td>17 (3.4%)</td>
</tr>
<tr>
<td>Other</td>
<td>4</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td></td>
<td>10 (1.9%)</td>
</tr>
<tr>
<td>Total</td>
<td>35</td>
<td>18</td>
<td>9</td>
<td>5</td>
<td>1</td>
<td>68 (13.5%)</td>
</tr>
<tr>
<td>Gallbladder-related</td>
<td>(16.6%)</td>
<td>(16.4%)</td>
<td>(9.1%)</td>
<td>(6.5%)</td>
<td>(20%)</td>
<td>(13.5%)</td>
</tr>
</tbody>
</table>

* \( P = .0076 \)
Other Complications

Ten complications occurred in the category designated “other.” Three patients with RY-D reconstructions had clinical episodes of recurrent cholangitis with normal biliary anatomy and no obstruction on cholangiography. They were treated with antibiotic therapy. One patient who received an ABO blood group–incompatible liver developed diffuse necrosis of the intrahepatic biliary tree 5 months postoperatively. She was treated by retransplantation. One patient developed multiple intrahepatic strictures of the biliary tree that were believed to be the result of a preservation injury (the preservation period was 9.6 hours). There was one case of a mucocele of the cystic duct remnant that was managed by percutaneous aspiration and transhepatic dilatation. One patient developed a small bowel obstruction from an internal hernia at the entrance of the Roux limb through the transverse mesocolon.

The other three problems occurred after D-D reconstructions. Two patients with common duct stones were treated by ERCP and stone extraction at 5 and 19 months posttransplant, and 1 patient with papillary stenosis 2 months posttransplant was treated by endoscopic sphincterotomy.

The factors that were analyzed in patients with and without biliary complications are shown in Table 3. No association between age, gender, previous surgery, or type of arterial reconstruction and development of biliary complications was identified. The preservation periods were relatively short in both groups, averaging only 6 to 7 hours. When cold ischemia time was stratified for less than 8 hours, 8 to 12 hours, and more than 12 hours, there was still no difference in the number of allografts with or without biliary complications. However, only 48 grafts were preserved for more than 12 hours (maximum, 18.4 hours). Three factors were discovered to be associated with the presence of a biliary complication when examined univariately—presence of chronic rejection, non-RY-D anastomosis, and retransplantation. When examined multivariately by stepwise logistic regression analysis, chronic rejection and a non-RY-D reconstruction remained significant. The relative risk estimates and 95% confidence intervals were as follows: chronic rejection, 3.66 (1.67 to 8.05), \( P = .0012 \); non-RY-D reconstruction, 2.32 (1.24 to 4.33), \( P = .0084 \).

Biliary complications developed in 11 allografts in which chronic rejection also occurred (10 adults and 1 child). In only 1 of the cases was chronic rejection diagnosed before the onset of the biliary tract problem, whereas in the remainder it was diagnosed either when the biliary complication became evident or as long as 3 years later. In 9 patients, the biliary complication was a bile duct stricture, and in spite of surgical or nonsurgical correction of the stricture, retransplantation was subsequently required for chronic rejection of the allograft. The other 2 patients with chronic rejection are still being followed up with their first transplants.

Five patients who developed biliary complications died; in 4, death was directly caused by the complication. Thus the mortality attributable to

| Table 3. Relationship of Clinical Variables to Occurrence of Biliary Complications |
|---------------------------------|------------------|------------------------------|
|                                | No Complications | Complications                 |
|                                | \( n = 434 \)    | \( n = 68 \)                  |
| Age (yr)                       | 40.0 ± 19.7      | 42.4 ± 17.0                  | NS   |
| Gender                         |                  |                              |
| Female                         | 213 (49.1%)      | 41 (60.3%)                   | NS   |
| Male                           | 221 (50.9%)      | 27 (39.7%)                   |      |
| Previous surgery               | 170 (39.2%)      | 28 (41.2%)                   | NS   |
| Previous transplant            | 39 (9.0%)        | 1 (1.5%)                     | .0333|
| Variant arterial reconstruction | 42 (9.7%)        | 9 (13.2%)                    | NS   |
| Preservation (hr)              | 6.6 ± 3.7        | 6.2 ± 3.8                    | NS   |
| Presence of gallbladder        | 270 (62.2%)      | 46 (67.6%)                   | NS   |
| Chronic rejection              | 22 (5.1%)        | 11 (16.2%)                   | .0006|
| D-D reconstruction             | 268 (61.8%)      | 53 (77.9%)                   | .0076|
| RY-D reconstruction            | 162 (37.3%)      | 14 (20.6%)                   |      |
biliary complications was 0.9% (4 of 462 patients). Corrective surgery was required for definitive treatment of 40 of the 68 biliary complications (59%), and in 3 cases (4.4%) retransplantation was necessary.

One-year actuarial patient and graft survival rates were 83% and 80%, respectively, in patients without biliary complications and 93% and 91% in patients with biliary complications ($P = .005$ and .046, respectively).

**Discussion**

The tradition of using T tubes or stents in reconstructive surgery of the biliary tract was established decades before liver transplantation evolved. Prolonged stenting was a widely accepted, integral feature of the surgical treatment of bile duct strictures, although no proof existed that stents were advantageous to healing or improved results.18-20 When liver transplantation developed and D-D and RY-D reconstructions became the preferred methods of biliary drainage, anastomotic stents became part of the routine operative technique.7-9 Our habit of avoiding T tubes arose from the practical difficulties of inserting them, with the risk of damaging the ductal blood supply and potentially compromising the vascularity of the anastomosis.21 The problems of migration, obstruction, and leakage related to the tubes and stents, which occur in up to 10% of patients,3,11,12 were additional reasons to avoid them. Our experience has shown that T tubes are unnecessary, and routine biliary reconstruction without stenting is a safe technique with a complication rate that compares favorably to other series.1-3,22-24 Three transplant centers that once used T tubes routinely but no longer do recently reported their results with biliary complications. Rouch et al25 found significantly more complications when T tubes were used, attributable largely to the incidence of tube-related problems. Rolles et al26 found no benefit from T tubes, although early strictures occurred in 10% of patients with D-D anastomoses who did not have them. The latest report from Randall et al27 showed no significant difference in the incidence of biliary complications between patients who did and did not have T tubes. None of these series were randomized, there were small numbers in some groups, and some historical cases (with T tubes) were used for comparison in one study.25 Thus selection bias and modifications in operative technique could have contributed to the results. There was no bias in the selection of patients in our series in the sense that all of them were treated without stents or T tubes and they constituted a large, consecutive group of cases.

It should be emphasized, however, that the choice between D-D and RY-D reconstruction was an operative decision, determined mainly by the size of the ducts and local conditions. When the ducts were small, an RY-D drainage was the option chosen, the method that has had the lowest complication rate in our past21 and present experience. Similarly, we also favored RY-D anastomoses in patients with prior right upper quadrant surgery because that was previously shown to be a risk factor for biliary complications in patients with D-D reconstructions.23 We attribute the significantly lower biliary complication rate after retransplantation in this series to the fact that RY-D reconstructions were deliberately used in the majority (80%) of retransplants. D-D reconstructions were reserved for very early retransplants, when the recipient duct was easily dissected and appreciable scarring had not yet developed in the periportal tissues. RY-D reconstructions provided the most trouble-free drainage, and anastomotic leaks were rare. The lower anastomotic complication rate in RY-D reconstructions was mainly responsible for the overall reduction in biliary complications seen with RY-D reconstructions compared with D-D anastomoses. We have not encountered the Roux limb perforation syndrome in children that has been described by others.28

Aside from any putative benefit in preventing anastomotic leaks or strictures, T tubes have the practical role of providing cholangiography. Direct radiographic access to the biliary tract was particularly relevant during the early development of liver transplantation when biliary complications occurred in 30% to 50% of recipients and resulted in the deaths of nearly one third of patients.5,29 Our desire to maintain this direct access but avoid T tubes led us to use the donor gallbladder as an external cholecystostomy.14 This method gave good cholangiographic assessment of the biliary drainage, but the gallbladder or the catheter accounted for one quarter of all biliary complications. The argument could be made that this technique simply traded T tube- or stent-related complications for those related to the donor gallbladder. That is undoubtedly true, but the more important question is whether it is necessary today to have direct
access to the biliary tree after transplantation. The availability and diagnostic value of percutaneous liver biopsy, technetium-HIDA scanning, Doppler ultrasound, computed tomography, ERCP, and PTC have all made direct cholangiography less crucial. Those modalities were used as necessary in patients without external cholecystostomy to differentiate biliary complications from other causes of abnormal liver function in the postoperative period. Anastomotic strictures were the most common biliary complication, and half of them occurred more than 3 months after transplantation, after the gallbladder catheter had been removed. Thus other diagnostic approaches, such as ERCP or PTC, had to be taken to make the diagnosis in those patients. We have concluded that the sole advantage of cholangiography provided by the cholecystostomy was outweighed by gallbladder-related complications, and it is our current practice to routinely remove the donor gallbladder. Lack of convenient radiographic access was easiest to accept in patients with RY-D reconstructions because of the low incidence of anastomatic complications in that group and the minimal need for biliary tract radiography. In this analysis, there were fewer D-D anastomotic leaks in patients who had external cholecystostomies. It is tempting to postulate that the decompression of the biliary tree provided by the tube in the gallbladder reduced the chance of a leak. We are reluctant to accept that explanation because the amount of bile drainage from the gallbladder catheter was marginal, usually only drops per day, and too small to measure. In addition, all of the D-D leaks occurred before 1988, suggesting that technical factors were responsible for the leaks, and they were overcome by experience.

Although few patients have developed symptomatic stones in the donor gallbladder, more may develop them in the future. A previous study has shown that the transplanted gallbladder empties fairly normally, so stasis should not be a predisposing factor over its usual role in the pathogenesis of gallstones. Most donors are young, and that may delay the development of stones for a long time. Nevertheless, most recipients survive for many years, leaving ample time for gallstones to develop. The ultimate fate of the gallbladder is yet to be determined in those patients.

Neuhaus et al have recently reported a 1.0% incidence of anastomotic complications using the side-to-side modification of a D-D reconstruction with a T tube. In that series of 370 transplants, fewer than 10% had RY-D reconstruction, so it seems likely they often used D-D drainage in situations in which we would have used RY-D reconstruction. They also reported a low incidence of T tube–related complications, which they attributed to the use of a rubber tube that incites enough inflammatory reaction to minimize the risk of leaks from the exit site. We have not used the side-to-side technique, but when the occasion arises we would do so without a T tube. A widening plasty of both donor and recipient ducts has also been reported to have a low incidence of complications in D-D reconstructions. Regardless of the type of anastomosis, good blood supply and an ideal number of correctly spaced sutures are of overwhelming technical importance.

Despite stratifying preservation times, we did not find a relationship between prolonged cold ischemia and biliary tract problems. However, the average cold preservation time was approximately 6 hours, and fewer than 10% of the livers were preserved for more than 12 hours. Therefore, adverse effects of prolonged cold ischemia probably would have been minimal in this series of patients. Only one allograft developed diffuse intrahepatic biliary strictures consistent with a preservation injury. A recent report suggests that simultaneous portal vein and hepatic artery revascularization may prevent ischemic strictures, but that has not been part of our operative technique.

In this retrospective review, chronic rejection emerged as strongly associated with biliary complications. The association between chronic rejection and biliary strictures has previously been documented in children and adults. In the report on children, 35.2% of biliary strictures were associated with chronic rejection, whereas 1 of 3 children with biliary strictures in this series had chronic rejection. In the report on adults, chronic rejection was a risk factor for nonanastomotic or ischemic type strictures. However, nonanastomotic strictures were uncommon in our experience, occurring in only 1 adult who had chronic rejection. In the remainder, the strictures were anastomotic and typical of what we would interpret as purely technical in nature. It is possible that biliary strictures caused malabsorption of cyclosporine, which then resulted in rejection that became chronic, but we do not have documentation of that series of events. After apparently successful stricture repair in some patients, failure of liver func-
tion tests to return completely to normal was the first sign that chronic rejection was present. As suggested by others,\textsuperscript{39} the pathogenesis of biliary strictures is complex, and several factors may be operative in any given patient.

Biliary complications did not have an adverse impact on patient or graft survival; in fact, patients with complications had better survival rates. The logical explanation is that survival made it possible for complications to appear months after the operation, and early death obviously precluded their appearance. Prompt recognition and treatment of biliary complications have minimized the mortality from them.\textsuperscript{1,3} Nonoperative management is often successful,\textsuperscript{39-42} but complications are still a cause of serious morbidity, and half of the patients who developed anastomotic strictures in this series required surgical repair. Retransplantation was required to manage biliary complications in 4.4\% of the patients who developed complications.

Reconstruction of the biliary tract without T tubes or stents is a safe technique in liver transplantation, whether D-D or RY-D drainage is used. Hepatobiliary imaging modalities have made postoperative cholangiography via direct access to the biliary tree less important in patient treatment than it used to be. Omission of T tubes, stents, and the tube cholecystostomy described herein should not jeopardize patient outcome, and avoidance of them should reduce the incidence of biliary complications in liver transplantation.

Acknowledgment

The authors thank Margaret Gray for typing the manuscript, Kathryn Rycroft and Michael Bloch for gathering data, and Cindy Wong for providing statistical consultation.

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