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## Original Article

# Bile duct injuries related to misplacement of “T tubes”

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## Abstract

**Introduction:** T tubes can be placed in the bile ducts either open or laparoscopically for several reasons such as: extraction of stones, biliary reconstruction after liver transplant and in end-to-end anastomosis in iatrogenic injuries. Inadequate placement of the T tube, long term stay and technical difficulties that can affect the outcome, can lead to an injury that usually requires a biliodigestive reconstruction. **Methods:** In a 15-year period (1990–2005) a total of 343 patients have been referred to our university hospital for biliary reconstruction. Files of those patients in which the injury was due to misplacement of a T tube or associated with a long-term stay were reviewed. We evaluated the type of injury, technique used for the reconstruction, long-term staying of the T tubes (1–6 months), hospital in stay, long term outcomes as well as associated comorbidities. **Results:** In 42 cases a biliary injury related to a T tube was identified (13%). All the injuries were classified as Strasberg E, with demonstration of a fistula (internal or external); 18 to the duodenum, 5 to the jejunum – ileum and 3 to the colon. A hepatojejunostomy was done to all patients; the duodenum and small gut fistulas were closed and in the 3 cases with colonic injury a right hemicolectomy was performed. The postoperative evolution was adequate without major complications but with a longer hospital stay. In 39 of the 42 patients (92%), good postoperative results were obtained. Only one case required a new surgery (22 months after the first one), due to recidivant cholangitis. **Conclusion:** Inadequate placement of the T tubes and long-term stay can produce complex biliary

injuries with associated comorbidities such as fistulas to the adjacent viscera. Placement of T tubes need a careful surgical technique and their indication must be carefully assessed.

**Key words:** T tube, bile duct injuries.

Placement of T tubes in the common bile duct has been a common practice and part of the therapeutic armamentarium for decades. Nowadays, its use has been restricted due to the introduction of new maneuvers such as ERCP, which gives the possibility of placing endoscopic stents and successful exploration of the bile duct without the placement of a T tube and a primary closure.<sup>1,2</sup>

There are several circumstances in which a T tube is placed in the biliary tree, the ones associated with bile duct injuries due to misplacement or long term stay of it are:

- A. Exploration of the bile ducts in order to extract stones. This applies up to 10% of the cases of almost all the series of cholecystectomy in which concomitant cholelithiasis is found in the intraoperative cholangiogram. (This can be done laparoscopically or by choledocotomy).<sup>3</sup>
- B. Conversion of a laparoscopic choledocotomy into an open approach, most of them placing a T tube others intending a primary closure of the bile duct.
- C. Biliary injuries themselves. It is a usual scenario for surgeons with less experience in bile duct repair to place a T tube inside the end-to-end anastomosis and leave it for along period of time (> 6 weeks) in order to assure a well developed scar at the injury's level (which usually occludes the duct after its removal).<sup>4</sup>

Technical misplacement of T tube, long term stay (1–6 months), and removal can cause associated comorbidities, that end in lost of continuity of the duct and/or a fistula that eventually requires a biliodigestive surgery with an approach similar to that done after an iatrogenic injury of the duct.

Herein, we report our experience with comorbidities related to the misplacement or long term stay of T tubes, which eventually require a biliary reconstruction because of their behavior as complex injuries.

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## Methods

### Description of the patients

From 1990 to 2005, a total of 343 patients were referred to our center for repair of bile duct injury. Thirty-three cases were referred minutes or hours after the injury (including injuries that occurred in our own hospital and neighbor hospitals). Others arrived days or weeks after the injury with or without an attempt of repair as well as some type of intervention (limited drainage, percutaneous drainage). The majority of cases are patients who have had an attempt of repair (end to end anastomosis, hepatoportoenterostomy and hepatojejunostomy) all of them in a stable condition, with clinical, laboratory and/or radiological data of obstruction, with jaundice and/or cholangitis.

### Management

After admission the general condition of the patients is evaluated; if there is any hydroelectrolytic disorder it is corrected and also further laboratory or radiological tests are performed (Ultrasonography, CAT scan and fistulography), in order to have a stable well studied patient.

Nowadays the most used image method in our hospital is cholangioresonance. This approach allows visualization of the complete biliary tree and status of the previous attempt of repair. Intraluminal defects (stones or debris) are also detected by this study.

In selected cases, percutaneous cholangiography with catheter placement is done. When feasible, dilatation of the bilioenteric anastomosis is performed, as well as drainage; especially in those cases who developed cholangitis.

The decision of scheduling a patient to surgery lies on his individual condition, if they are stable, without sepsis and hydroelectrolytic abnormalities, the procedure can be done.

On the other hand, if the patient is septic or with hydroelectrolyte imbalance the operation is delayed. If the origin of the sepsis is the biliary tree or an intraabdominal collection is found, a percutaneous drainage is done. If this fails, a limited open procedure can take place.

Some of these patients have arrived with abdominal wall defects secondary to abscesses or dehiscence. These cases represent a challenge, because in addition to the biliary duct reconstruction, abdominal wall reparation is needed as well.

After outlining the biliary anatomy the patients are evaluated by the radiologists and/or endoscopists. Endoscopic approach is only done when the bile duct has continuity and only small leakages (Type A Strasberg injuries). If there is a history of biliodigestive attempt, the patients are scheduled for a percutaneous dilatation of the anastomosis.

If the multidisciplinary evaluation of the patients results in failure if an endoscopic and radiological ap-

proach, the patients are scheduled for biliary reconstruction.

### Surgical technique

In all cases, a hepatojejunostomy (Roux en Y) is done. Briefly, after dissection of the porta hepatis, the common duct is identified and through the lumen, instrumental exploration is done with a thin Bakes dilator. The right posterior and anterior ducts are identified as well as the left hepatic duct. If segment IV and/or V hang over the ducts, partial resection of these segments is done after entering the hilar plate. In two thirds of the cases is not necessary to remove the liver and only the section of the hilar plate is necessary.<sup>5,6</sup>

An anastomosis is done with interrupted 5 – 0 absorbable monofilament sutures, from the defunctionalized jejunum to the anterior aspect of the ducts that are opened longitudinal in direction to the left duct (Hepp – Couinaud type).

We analyzed those cases in which the biliary injury was associated to the misplacement or long term stay of a T tube. These patients had loss of continuity of the bile ducts and/or dehiscence of the choledocotomy with an additional biliary fistula. All these cases subsequently needed a biliary reconstruction. The files of the patients were reviewed and possible etiologies of the final injury were also analyzed and classified.

## Results

Among the 343 patients operated for biliary reconstruction in a 15-year period, a total of 42 patients had history of T tube placement.

We presumed that in 22 cases, an end-to-end anastomosis was done, although it was not referred in all of them (*Figure 1*). An endoscopic cholangiography showed stenosis of the duct and/or fistulization to adjacent viscera. All these cases were electively repaired and arrived months after the attempt of repair (x 5 months, range 3 to 14). The remaining 20 cases had a history of bile duct exploration for stones extraction in an open procedure (apparently two of them started as laparoscopic but ended in a conversion to open surgery).

All injuries were classified as Strasberg E (E1 – E2 : 212 E3:18, E4:2, E5:1) (*Table I*).

Of the 42 patients, 12 had complete absence of bile drainage to the duodenum and a complete high volume external fistula; 4 cases had an external biliary fistula with partial drainage to anfractuous distal biliary ducts. The remaining fistulas were as follows: 18 to the duodenum, 5 cases to the jejunum – ileum and 3 to the colon.

The T tube was removed during surgery and the following operations were done: Roux en Y hepatojejunostomy alone in 16 cases, Roux en Y hepatojejunostomy with closure of the duodenal fistula in 18, Roux en Y



**Figure 1.** T tube misplaced with the two branches in the intrahepatic bile ducts. The patient had an end to end anastomosis of the bileduct which is completely obstructed. The main branch of the T tube has eroded to the duodenum creating an internal fistula (hepatoduodenal) that eventually malfunctioned and led to cholecystitis. A Roux en Y hepatojejunostomy was done with closure of the duodenal fistula. Uneventful recovery.



**Figure 2.** Dislocated T tube. The proximal branch of the tube is outside the lumen. The hepatic duct has no continuity, therefore the injury can be classified as Strasberg E2, meaning it will need an hepatojejunostomy.

**Table I.** Strasberg classification.

Class	Description
A	Bile leaks from minor ducts still in continuity with the common bile duct.
B	Occlusion of part of the biliary tree, almost always an aberrant right sectoral hepatic duct.
C	Section without ligation of a sectoral hepatic duct.
D	Lateral injury to an extrahepatic bile duct.
E1	Low common hepatic duct stricture – hepatic duct stump > 2 cm.
E2	Proximal common hepatic duct stricture – hepatic duct stump < 2 cm.
E3	Hilar stricture with no residual common hepatic duct – hepatic duct confluence intact.
E4	Destruction of hepatic duct confluence – right and left hepatic ducts separated.
E5	Involvement of aberrant right sectoral hepatic duct alone or with concomitant stricture of the common hepatic duct.

hepatojejunostomy with closure of jejunal defect in 1 case, Roux en Y hepatojejunostomy with limited small intestine resection and end to end anastomosis in 4 patients, and the last 3 cases with Roux en Y hepatojejunostomy and right hemicolectomy with primary anastomosis of the colon.

Postoperative evolution was uneventful. Four cases developed abdominal wall abscesses that were drained in the postoperative period. No postoperative problems were detected at the fistula site; there was no leakage to the duodenum, small gut and colon.

Postoperative stay was  $14 \pm 7$  days for the whole group.

In 39 (92%) of the 42 patients, long-term results (> 6 months) were good, obtaining resolution of the problem without postoperative cholangitis and jaundice. Three cases have had intermittent cholangitis with and without jaundice episodes. One of these cases required another surgery 22 months after the initial procedure. A new hepatojejunostomy was done with transhepatic transanastomotical stents.

One of the patients that had a hemicolectomy developed portal hypertension without cirrhosis and with partial recanalized portal vein thrombosis, demonstrated by means of angiography. No bleeding has been recorded at this time but he is receiving  $\beta$  blockers as prophylaxis.

## Discussion

Bile duct injuries occur with a constant frequency of 0.3 to 0.6% all over the world. They are usually the consequence of the section and devascularization of the bile duct at the time of cholecystectomy. The causes of injury have been analyzed extensively and have a multifactorial origin.<sup>7</sup>

T tubes have been used for decades in biliary surgery. In the eighties and nineties their use became restricted with the introduction of endoscopic exploration of the bile ducts.

It was a common practice to treat choledocolitasis by endoscopic approach, the majority were done in the pre-operative period, less frequently intraoperatively and in many instances postoperatively.

Nowadays, laparoscopic removal of stones during cholecystectomy is gaining more acceptance thanks to the fact that more surgeons are trained in this type of approach. Most of them perform the duct exploration through the cystic duct and others do it through choledocotomy.<sup>8</sup>

It is still controversial if a T tube should be placed after a choledocotomy. There is growing evidence that primary closure of the bile duct can be done and that no difference is found in the postoperative outcome, avoiding the complications related to the tube placement and stay. This is particularly true in patients that have had a sphincterotomy.<sup>1</sup>

Nowadays, many surgeons are not trained to place T tubes. Some of them do large and complete dissection of the common bile duct, devascularizing it in some instances. Others do a very large choledocotomy (3 to 4 cm) and others place inadequate caliber of the T tubes (very wide tubes for small ducts). In some cases even inadequate sutures are placed to close the choledocotomy.

For novice surgeons, it is a common and attractive practice to do an end-to-end anastomosis over the injury, placing a T tube to stent the anastomosis.<sup>4</sup> Many surgeons leave the T tube for a long period of time; in many of these cases a fistula adjacent to the viscus occurs (duodenum, jejunum-ileum and colon).<sup>9</sup> After removal, some of them form an internal fistula that gives inadequate drainage of the bile and as in the case of the colon, a dangerous source of cholangitis.

Moreover, after removal of the T tube, stenosis of the bile duct is observed because the anastomosis was done with tension between two devascularized stumps of the bile ducts.

In a minority of very well selected cases this type of reconstruction gives good results. The laparoscopic injury usually has two main components: ablation (loss of substance) of the duct and devascularization of it. These two features are related to the mechanism of injury. Usually the main duct is mistaken for the cystic duct and thus, the small vasculature located laterally in the duct is electro fulgurated. Moreover, usually the middle third of duct is resected together with the gallbladder.

Sometimes it is feasible to dilate the strictures using an endoscopic approach, with or without placement of a stent. These cases develop jaundice and/or cholangitis weeks or months after the removal of the T tube. We excluded these patients from our analysis; we only included the ones in which an external biliary fistula was found and demonstrated by cholangiography through the T tube. Furthermore, those in which the fistula was also attributed to misplacement of the T tube. Meaning that besides the presence of an ischemic high-tension anastomosis there was also inadequate placement of the T tube to stent the anastomosis, therefore favoring the injury.

The final result of the injury gives a devascularized stump that is anastomosed over the T tube, with tension due to inadequate length of them. This is not completely relieved with a Kocher maneuver. This is why an end-to-end anastomosis usually fails at the long term and specially after removal of the T tube. A minority of cases can be treated by dilatation and placement of several endoprothesis.<sup>10</sup>

This condition is the total opposite of the reconstruction done in liver transplant in which two well devascularized and preserved stumps are anastomosed tension free over a T tube (usually placed very carefully and in many cases without it). This type of anastomosis has a 90% successful rate.

Although there isn't a long-term publication that shows the results of an end-to-end anastomosis after iatrogenic injury, it is our belief, as well as others, that in no condition a 90% of success can be achieved.

When a surgeon decides to place a T tube he or she has to evaluate what is the final goal of this type of stent. T tubes are placed in order to diminish the intraductal pressure that appears as a consequence of inadequate instrumentation of the papilla that ended in traumatic edema with impaired drainage. This condition promotes leakage at the level of choledocotomy, which usually is the zone of less resistance to the bile pressure.

Formerly, T tubes were also placed in order to do post-operative extraction of stones undetected in the intraoperative period. It was shown that some of them could be successfully removed with a basket through the fistulous tract that the T tube left.

Nowadays, with the aid of endoscopy, sphincterotomy can be done warranting drainage of bile to the duodenum, giving the opportunity to close the choledocotomy without a T tube. Transcystic exploration of the duct also gives us the chance of doing the closure without a T tube.

If the laparoscopic surgeon decides to put a T tube, there are some principles that must be followed to assure its adequate placement: principles for adequate placement have to be followed:

- a) Limited dissection of the duct
- b) Anterior longitudinal choledocotomy as small as possible
- c) Placement of a T tube with an adequate caliber that can decompress the bile duct without producing damage (avoiding a wide tube in a small lumen).
- d) Placement of small stitches with non reactive material (5 – 0 absorbable monofilament)
- e) Removal of the T tube after its function is completed. If necessary, endoscopic sphincterotomy with clearance of the duct can be done before removal.

It is concluded that inadequate placement of T tube as well as an inadequate length of stay can produce significant morbidity.

In our series, 42 of 343 cases (13%) operated for bile duct repair were caused by inadequate placement and stay of T

tubes. In 26 of the 42 patients we found a fistula adjacent to a viscera, increasing the morbidity. Although no postoperative complications were detected, the patients remained hospitalized for a longer period of time ( $14 \pm 7$  days), associated to the fact that other types of surgery (including bowel resection) had to be done along with the biliary reconstruction. Placement of T tubes needs a careful surgical technique and their indication needs to be carefully assessed.

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