## ORIGINAL ARTICLE

# A NEW MODIFIED TECHNIQUE IN CLOSURE OF BILE DUCT STUMP IN LIVING DONOR HEPATECTOMIES

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## Abstract

**Introduction:** Donor safety is a critical issue in living donor liver transplantation (LDLT). Biliary complication in living donor hepatectomies (LDHs) is still common.

**Method:** A new modified technique in closure of bile duct stump in LDHs by "using interrupted non absorbable sutures and placing of surgical clip below suture line" aiming to decrease the high biliary leak (BL) rate.

**Results:** To evaluate the usefulness of the new technique; it was applied for consecutive 50 donor hepatectomies and the outcome as regard BL was compared with the 140 previously performed LDH in whom BL was reported in 26 donor (18.5%). These 140 patients were divided into 2 groups: 1- Group A (n=94) with sump closure using continuous sutures, BL rate was 19.1% (n=18). 2- Group B (n=46) with stump closure using interrupted sutures, BL rate was 12.4 (n=8). The 50 donor with the new technique considered as group C; minimal conservatively treated BL occur in only 4% (n=2). Management of BL in the 3 groups was studied and compared.

**Conclusion:** Significant marvelous reduction in BL rate was observed by using the new modified technique in closure of bile duct stump during LDH.

**Keywords:** Liver transplantation, biliary complication, bile duct stump.

## INTRODUCTION

LDLT is often the only means of saving patients with end-stage liver disease in countries where organ donation from deceased donors is scarce. Donor safety is a critical issue in LDLT, and biliary complication (BC) is one of the most important complications during donor surgery. (1)

Despite the fact that donors are relatively safe to undergo hepatectomy, many living donors still experience postoperative morbidity. Meticulous technical (I) and preoperative donor evaluation and treatment are sure to reduce the incidence of complications. (2)

Biliary complications affect the donors and their families psychologically and physically and economically. Therefore, the occurrence of BCs should be avoided. (1)

Shao et al., (2011)(3) reported that, the overall incidence of BCs in living liver donors ranges from 0.4% to 13%, and the rates of biliary leaks and strictures range from 0% to 12.6% and from 0% to 5.8%, respectively.

Technical refinements have reduced the occurrence of BCs from 6.4% during the early period to 1.8% during the later period. In addition, no BC was observed in the last 69 consecutive donors.[1]

The aim of this work is to evaluate the usefulness of a newly used technique in closure of donors bile duct stump in decreasing the relatively high biliary leak rate following LDHs.

## PATIENTS AND METHODS

A bile leak was defined by the presence of bile in the operative drain fluid, or by an intra-abdominal fluid collection containing bile (at percutaneous aspiration or drainage) regardless of the volume being drained.

**Patients:**

One hundred and forty LDLT were performed at National Liver Institute, Menoufiya University, Egypt from April 2003 to September 2011.

These donors were divided into 2 groups according to the used technique in closure of the remaining bile duct stump:

- Group A (n=94): Included donors with bile duct stump closure using continuous (running) sutures.
- Group B (n=46): Included donors with bile duct stump closure using interrupted sutures.

All the 140 donors were included as (group A+B) representing all LDHs performed before applying the new technique.

Subsequent 50 donors (donated liver graft from September 2011 to November 2012) with bile duct stump closure using the newly designed technique were considered as group C.

The clinical records of all donors were analyzed as regard operative details, post-operative BCs, its management and outcome

***Surgical procedures used in dealing with donors' bile duct during LDH:***

The anterior aspect of the hepatoduodenal ligament is separated; the hepatic and the portal vessels are isolated and the common bile duct can be identified avoiding excessive mobilization of the bile ducts to prevent ischemic damage.

After the right or left hepatic duct is identified, a small haemostatic clamp is applied to the predetermined cut line on the bile duct.

intraoperative cholangiography is performed with a silicone tube (size 4 French) inserted from the cystic duct in cases with right hepatectomy or through a 24 G puncture needle with a trocar is inserted into the common bile duct in cases with left hepatectomy

After identifying anatomical variations of the biliary tree, the hepatic duct is separated with scissors 2-3 mm away from the tributary of the right or left hepatic duct to prevent stenosis of the bile duct

If the identification of the proximal of the right hepatic duct is difficult, its anterior wall is incised and its direction is confirmed by inserting the fine forceps into the lumen of right hepatic duct, left hepatic duct, and the distal bile duct, and the posterior wall of the right hepatic duct is cut.

The stump of the main duct is closed with a 5-0 or 6-0 Prolene suture.

In some cases, the orifice of hepatic ducts from segment I or 4 appears on the cutting site close to left hepatic duct. In the left-lateral segment graft, segment 4 bile duct reconstruction is not necessary and it can be simply closed with a suture after confirming its direction. The duct is cut sharply with scissors and the stump of the left hepatic duct on the donor side is closed with a running suture using a 5-0 or 6-0 prolene suture.

A dissector (CUSA [Cavitron Ultrasonic Aspirator], Valley Lab, Inc., Boulder, Colo.) and bipolar electrocautery were used to transect the liver.

**The new technique: (Figs. 1,2)**

Closure of bile duct stump in LDH by "using interrupted non absorbable sutures and placing of surgical clip below suture line":

1. Interrupted, 6/0 prolene (Ethicon) sutures; (nearby, one line, close to the orifice edges and starting by the two angles).
2. Application of surgical metallic clip; (Small or medium sized) just below the suture line.
3. Completion control cholangiogram using dynamic C-arm.

Statistical analysis was done using the chi-squared and the Fisher exact tests. Statistical significance was defined as a p value $<0.05$.

## RESULTS

A total of 190 donors underwent living donor hepatectomies during the period of this study, operative procedures performed in these patients are listed in Table 1.

**Table 1. Type of the donor hepatectomy.**

| Group | left lateral segmentectoy | Left hepatectomy | Right hepatectomy |
|---|---|---|---|
| A (n=94) | 16 | 3 | 75 |
| B (n=46) | 6 | 2 | 38 |
| A+B (n=140) | 22 | 5 | 113 |
| C (n=50) | 5 | 6 | 39 |

The most frequent procedure was right hepatectomy representing about 80% of the performed donor hepatectomies. The number of left hepatectomies performed in each group is too small to be compared with large number of right hepatectomies, and so, the frequency of BCs occurred (following each type of operation) could not be compared statistically as regards the type of operation.

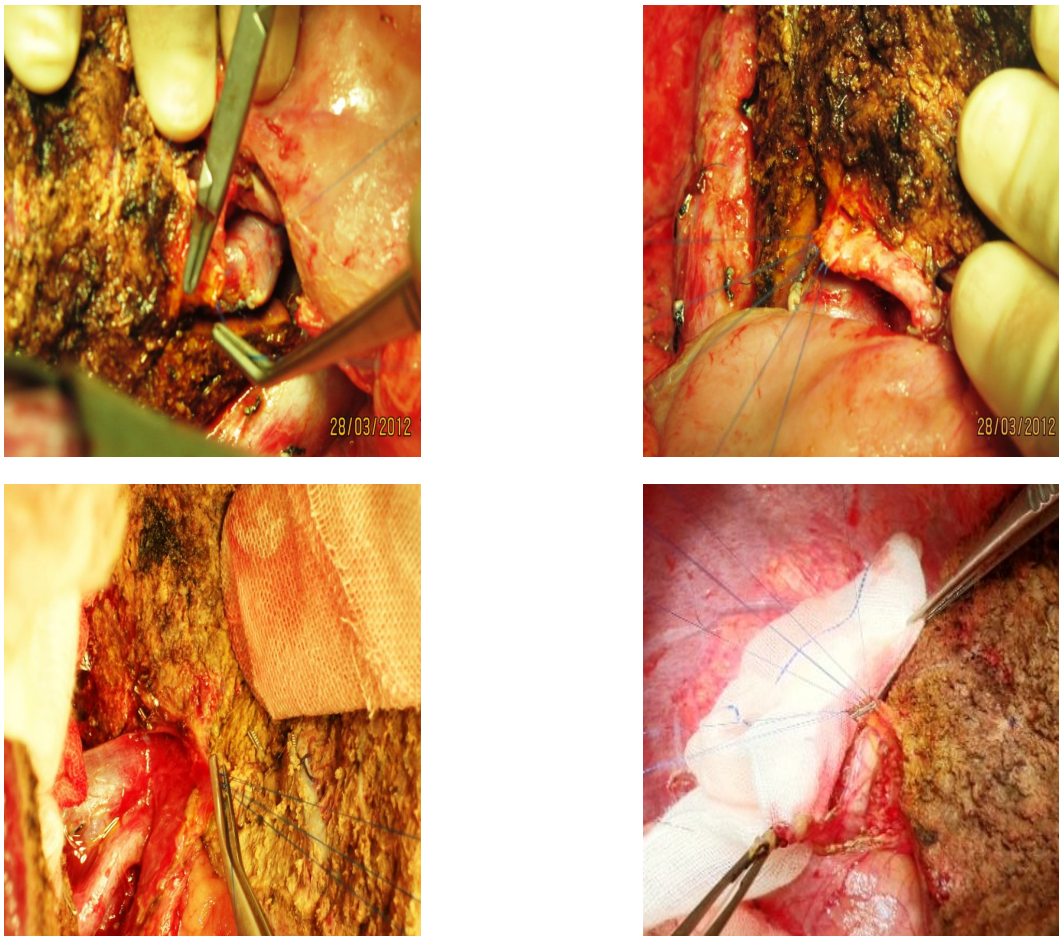


**Fig 1. Steps of closure of bile duct stump in LDH using the new modified technique.**

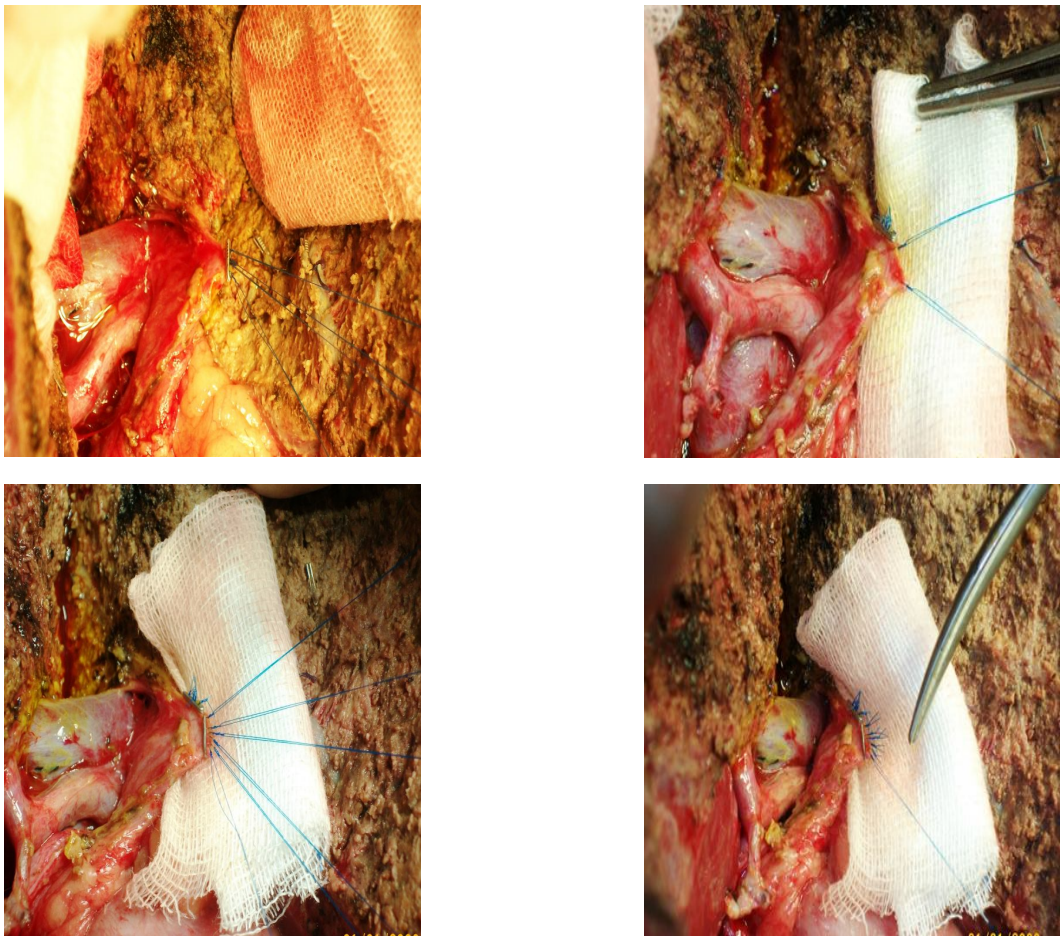

**Fig 2. Steps of closure of two bile duct stump in LDH using the new modified technique.**

The frequencies of each type of hepatectomy among the different groups were matched with no significant difference between the different groups as regard type of operation.

Number and percentage of bile duct orifices were estimated in each group and listed in Table 2.

**Table 2. Frequency of BL in each group according to number of bile duct stump.**

| Group | One duct | | Two ducts | | Three ducts | | More than one | |
|---|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | n | % |
| A (n=94) | 61 | 65 % | 30 | 32 % | 3 | 3 % | 33 | 35 % |
| B (n=46) | 26 | 56.5 % | 18 | 39 % | 2 | 4.5 % | 20 | 43.5 % |
| A+B (n=140) | 87 | 62.2 % | 48 | 34 % | 5 | 3.8 % | 53 | 37.5 % |
| C (n=50) | 34 | 68 % | 15 | 30 % | 1 | 2 % | 16 | 16 % |

The presence of one duct stump is the most common pattern in almost two thirds of cases in each group. There was no significant difference between donor groups as regards the number of bile orifices, and no significant difference between bile orifices number and the occurrence of BCs.

Biliary leak represented the most frequent biliary complication among donors of groups A and B; (18/94) 19.1% in group A and (8/46) 17.3% in group B. with no significant difference between the two groups.

Only one donor in each of groups A and B had biliary stricture.

BL markedly decrease to 4% (2/50) in group C with application of the new technique of bile duct stump closure.

There is statistical significant difference between group C and other groups as regards the frequency of BL.

**Table 3. Type and frequency of the donors BC in different donor groups. *= (p <0.05).**

| Group | Type of BC | N | % |
|---|---|---|---|
| A (n=94) | BL | 18 | 19.1 % |
| | BS | 1 | 1.06 % |
| | BC (total) | 19 | 20.2 % |
| B (n=46) | BL | 8 | 17.3 % |
| | BS | 1 | 2.1 % |
| | BC (total) | 9 | 19.5% |
| A+B (n=140) | BL | 26 | **18.5 %** |
| | BS | 2 | 1.4 % |
| | BC (total) | 28 | 20 % |
| C (n=50) | BL | 2 | **4% *** |
| | BS | 0 | 0 |
| | BC (total) | 2 | 2 % |

**Table 4. Management of the donors BC.**

| Group | BL | | | | | BS | |
|---|---|---|---|---|---|---|---|
| | No. | Type of definite management | | | | No. | Type of definite management |
| | | Conservative (operative drain) | Percutaneous drainage | ERCP | Surgical | | ERCP |
| A (n=94) | 18 | 5 | 4 | 8 | 1 | 1 | 1 |
| B (n=46) | 8 | 3 | 1 | 4 | 0 | 1 | 1 |
| A+B (n=140) | 26 | 8 | 5 | 12 | 1 | 2 | 2 |
| C (n=50) | 2 | 1 | 1 | 0 | 0 | 0 | 0 |

Postoperative management of these complications has focused on minimally invasive techniques.

Of the 19 donor with BCs in group (A), 18 donors had BL and one donnor had BS. Five donors had bile in the surgical drains (mean 80 ml/day; range 30 to 160 ml/day) and they were followed-up conservatively. They had no intraperitoneal collections or any signs of sepsis. Leak decreased gradually and resolved spontaneously within mean7 days (rang 3 to 15 day).

Three donors in group (B) had similar situation.

In group (C) [new technique group] one donor had minimal operative drain leak resolved after 6 days without any other intervention. This donor, although not

proved, considered to have minimal peripheral leaks (most likely cut surface).

Four donors in group (A) presented with a postoperative collection detected on ultrasound. In two donors of them no bile was present in the drain fluid and the drains had been removed. Three were treated with ultrasound-guided percutaneous drain placement, and the leak resolved spontaneously (based on cessation of drainage from the drain placed percutaneously). The other one treated by ultrasound-guided complete aspiration which needed to be repeated once, without the need of drain placement. Mean drain output was 130 (range 60 to 190). One donor in group (B) had similar situation.

In group (C), another one donor had subphrenic collection drained by percutaneous drain placed ultrasound guided for two weeks and spontaneously resolved.

The remaining 9 donors with BL in group (A) underwent endoscopic retrograde cholangiopancreatography (ERCP) with indwelling biliary stent insertion. Five donors had large amount of leak >250 ml / day and ERCP was done early within 72 hour of diagnosis, but in the other 4 donors ERCP performed after failure of conservative management one week. The site of leak had been revealed during ERCP in 6 cases as from the closed remaining duct stump, but in the other 3 cases no definite source had been detected. ERCP succeeded to control BL in 8 donors. The remaining donor had major leak from bile duct stump and was subjected to surgery in the form of bilioenteric anastmosis.

Also 4 donors in group B had large amount leak, they underwent ERCP which revealed the source in 3 cases of them, and stent was inserted, with cessation of leak in all cases

There were 2 cases of ERCP-related mild pancreatitis which resolved with treatment.

With regard to biliary stricture, only one case in group (A) and one case in group (B), both treated with ERCP and with insertion of stents. There was no BS detected in group (C).

## DISCUSSION

Donor safety is paramount in LDLT. The balance between the benefit to the recipient and the risk to the donor plays a central role in the justification of LDLT. In worldwide reports of living liver donor operations, donor morbidity ranged between 0% and 67 %.[4]

It is well known that liver donation puts the donor at risk of medical and surgical complications and death. No surgical intervention is completely safe, and death may complicate any intervention.[5,6]

Graft procurement must be done meticulously and safely to prevent such complications in a healthy donor. It is responsibility of the donor surgeon to minimize or eradicate complications.[1]

The absence of a clear definition of clinically significant bile leakage makes it difficult to compare the frequency of this complication in different studies.[7] We had defined BL regardless the cause of origin, onset, duration, or the volume of drained bile. This extension in the definition could explain our relative high frequency of BL, as we even considered any minimal surgical drain leak for a short period of time that resolved spontaneously as a bile leak

Differences in the reported frequency of biliary leakage are probably because of several factors.[7] In our opinion, these differences might be related to the difference in the used technique, team experience or the differences in definition of bile leak.

The reported frequency of bile leak after hepatic resection ranges from 6% to 14% [8, 9]. It was reported that the overall complication rate is 34%, including BCs in 5.3%.[10] Among 100 LDLT in Chicago,[11] minor complications developed in 20% of donors, while 14% of patients encountered major complications, including five bile duct injuries and two cut edge bile leaks. Our results showed BCs in 20% of the donors following the first 140 LDHs, and this percentage was reduced to 4% with adoption of the new technique in the subsequent 50 LDHs.

In Japan,[12] biliary complications occurred in 10% of patients after right hemiliver resections, compared to only 3.6% with the left hemiliver, and 1.9% with a bisegment II–III, ten donors required re-operation for biliary complications. These data are going with our results in that BL was much more evident in donors' right hepatectomies, and are contradictory different to some authors[7] that found bile leakage was more common in patients undergoing left hepatectomy.

Leaks from peripheral ducts may represent parenchymal leaks overlooked at surgery or may result from sloughing of necrotic tissue from the cut surface.[7] In the present study, many leaks are small and typically resolve without intervention and considered as cut surface leak. Leaks from biliary branches of the caudate lobe are usually refractory, therefore, careful attention should be paid to the performance of continuous suturing and ligation of the bile radicles; this will help to reduce the incidence of bile leakage in both donors and recipients.[3]

Leaks from major bile ducts, although rare, occurred only in patients in whom the leak presented as an intra-abdominal collection rather than bile in a surgical drain and may be explained by ischemia of the hepatic duct stump, resulting in necrosis and secondary bile leakage.[7] Major leaks in our donors presented by high

output bilious fluid from operative drain in few donors, and by abdominal collection that needed drainage in most of the cases. ERCP revealed leak from the closed bile duct stump, probably due to ischemic necrosis of the sutured edges.

Several mechanisms have been suggested including (**1**) spasm of the sphincter of Oddi following resection, producing increases in intrabiliary pressures, [13] (**2**) transected ducts at the cut surface unrecognized at surgery [14]; and (**3**) sloughing of necrotic tissue at the cut surface. Factors that may increase sphincter spasm and intrabiliary pressure include dissection with damage to parasympathetic and sympathetic innervations and the direct action of opioid analgesics administered in the postoperative period.[7]

However, there is no study that compares the effect of different surgical techniques on the frequency of bile leaks. [7] Although various methods have been tried to reduce the frequency of postoperative complications, including omentoplasty, [15] spraying the cut surface with fibrin glue, [16] or using an intraoperative bile leak test, [13, 17] none of these have been shown to provide any benefit in randomized controlled studies.[13,16]

Technical refinements and surgical procedures including the use of a real-time cholangiography by the C-arm, a minimized dissection of the hepatic vessels, the meticulous closure of the bile duct, and/or the use of Pringle maneuver during the parenchymal transection reduced the occurrence of BCs from 6.4% during the early period to 1.8% during the later period and no biliary complications in the last 69 consecutive donors were observed.[1]

In the current study, we had advocated our technical improvements to avoid the BC, including closure of donor biliary stump using interrupted non absorbable sutures and placing of surgical clip below suture line and the use of a real time control cholangiography by the C-arm as a routine, with great reduction of BL from 18.5% in previous donors in group A&B to 4% in group C in which the new technique had performed. In a report by Taketomi et al 2010, [1] the cutting orifice of the hepatic duct has been meticulously closed by 6-0 PDS (Ethicon) continuous suture since 2005 which led to reduction of BL rate.

It is important to preserve the blood supply for the biliary tract of both the graft and the remnant liver. Excessive dissection of the hepatic artery and portal vein from the surrounding tissues, results in an ischemic change in the biliary tract and the occurrence of BCs.[1] This is similar to our technique that considered preservation of vascular plexus around bile duct.

Post resection cholangiography is performed to exclude an inadvertent biliary injury during donation and provide a baseline study should future interventions be necessary.[1,18] Furthermore, from our experience cholangiography help to assess the competence of closure of biliary orifices, so we consistently applied it in later group C donors.

BC after a donor hepatectomy might be initially treated by a percutaneous or the endoscopic approach because the success rate of these nonsurgical treatments is relatively high. [1, 19] In the current study, 38% of our donors (8/26) in group (A+B) managed conservatively without any intervention, and operative management was needed in only one patient, moreover, all cases with BC in group C (2/50) had been managed conservatively with obvious success.

ERCP offered the advantage of being minimally invasive and provided a method of decompression of the biliary system to allow for closure of leaks, 20- 22, with success rate up to 90%. [23] 50% of our cases (13/26) in group (A+B) were managed by ERCP and stent insertion with success rate up to 93% (12/13), yet none of the donors in group C needed endoscopic management.

Stent was therefore used to maintain a low intrabiliary pressure. Endoscopic stent insertion is safe and effective for treatment of bile leaks after liver resection. A protocol for early endoscopic intervention has resulted in rapid closure of the bile leaks and a short hospital stay.[7]

In addition, it is well known that the team experience can lead to improved outcomes. This ongoing developed experience may be a contributing factor in our results improvement; furthermore some authors [1] explained better outcomes at the later period in donors might be related with better team experiences in addition to the reported technical refinements

In conclusion significant marvelous reduction in BL rate following LDH was observed by using the new modified technique in closure of bile duct stump in LDH. It is highly recommended to apply this new technique modification in all LDH for the maximum safety of donors.

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