

Original Research Article

Iatrogenic bile duct injury repair using isolated vascularized gastric tube: early experience in two tertiary centers

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ABSTRACT

Background: Bile duct injuries (BDI) constitute a disaster for both the patient and the surgeon without satisfactory results with the classic use of roux-en-Y hepaticojejunostomy (RYHJ). The purpose of this study was to evaluate our newly introduced technique utilizing isolated vascularized gastric tube (IVGT) as an alternative for RYHJ in reconstruction of the bile duct after iatrogenic BDI with lost segment.

Methods: This is a prospective study included 18 consecutive patients suffered from iatrogenic BDI with lost segment admitted to Assiut and Sohag University Hospitals, during the period from September 2013 to June 2016. Patients were subjected to operative treatment with the interposition of IVGT to bridge the lost bile duct segment. Patients were evaluated regarding demographic criteria, clinical picture, different investigations, efficacy of the use of IVGT and evaluation of post-operative complications after a mean follow-up of 2 years.

Results: Eighteen patients underwent repair of BDI utilizing IVGT during the study period. Three patients (17%) suffered immediate repairs, 10 patients (55%) experienced intermediate repairs and late repairs were performed for the last 5 patients (28%). Bile leak as a specific early morbidity was present in 3 patients (17%) with upper biliary tract injury without any operative mortality. Also, there was one patient with stent obstruction relieved by stent extraction. With long-term follow-up there was not any patient of biliary stricture.

Conclusions: IVGT proved to be feasible and safe for bile duct replacement and is a good alternative for biliary reconstruction being more anatomical and physiological than RYHJ.

Keywords: Biliary reconstruction, Bile duct, Bilioenteric anastomosis, Iatrogenic injury

INTRODUCTION

About 80% of BDI occur after cholecystectomy constituting a catastrophe for both the patient and the surgeon as they are associated with significant morbidity and mortality, reducing long-term survival and quality of life, and are associated with high rates of subsequent litigation.^{1,2} Laparoscopic cholecystectomy (LC) has largely replaced open cholecystectomy (OC) but its potential disadvantage is a 2-fold increase in BDI. Moreover, injuries after LC are more proximal, are

revealed earlier, are presented by leaks more than by strictures, are repaired more frequently by non-specialists, and more associated with lost segment and ischemia due to combined vascular injury.³ Most of BDI present as biliary stricture, external or internal fistula, and biliary peritonitis.⁴ If left untreated BDI may be complicated with biliary strictures, hepatic atrophy, cholangitis and intra-hepatic lithiasis. Later, fibrosis or even secondary biliary cirrhosis and portal hypertension can develop, enhanced by prolonged biliary obstruction associated with recurrent cholangitis.⁵ Also there is

increased risk of hepatocellular carcinoma and cholangiocarcinoma.⁶

The goal of surgical treatment of BDI is to restore bile flow to the alimentary tract. In order to achieve this goal, many techniques are used. RYHJ is the most commonly used approach, especially in cases of duct transection injury.⁷ Unlike duodenum, the use of jejunum allows a tension-free anastomosis.⁸ However, its long-term outcome is not devoid of complications as the high incidence of reflux cholangitis due to loss of the function of the Oddi's sphincter, choledocholithiasis, anastomotic stenosis, an increased risk of cholangiocarcinoma and the non-physiological re-establishment of bilioenteric continuity.⁹⁻¹¹ Complications such as bile leak, biliary fistula, biliary peritonitis have also been reported.¹² Add to this, peptic ulceration was reported in 7-13% of patients due to gastric hypersecretion and absence of neutralization of gastric juices following RYHJ.^{13,14} So, alternative methods for correction of biliary strictures especially those with lost segment, including creation of biliary conduits, are needed. Presented here is a new technique for reconstruction of the bile duct after iatrogenic BDI with lost segment utilizing IVGT as an alternative for RYHJ; checking its feasibility and evaluating its outcome.

METHODS

This was a prospective study of 18 patients with iatrogenic BDI, after OC and LC referred to the Department of General Surgery in Assiut and Sohag University Hospitals, during the period from September 2013 to June 2016 after exclusion of 24 patients who were treated by ERCP, conservatively, or operatively where there were no lost segments of bile duct.

Exclusion criteria included bile leaks from the gallbladder bed, Luschka's ducts and cystic ducts, strictures not related to a surgical injury, choledochal cyst, coagulopathies, those with associated co-morbidities (ASA>3), and patients with injuries treated primarily by ERCP.



Figure 1: Complete ligation of the distal CBD without filling of its proximal part.

The study was performed after approval by the Institutional Medical and Ethics Committee in the two centers. A written and verbal informed consent was obtained from all patients participated in the study for this newly introduced technique after a detailed explanation of the operative steps.

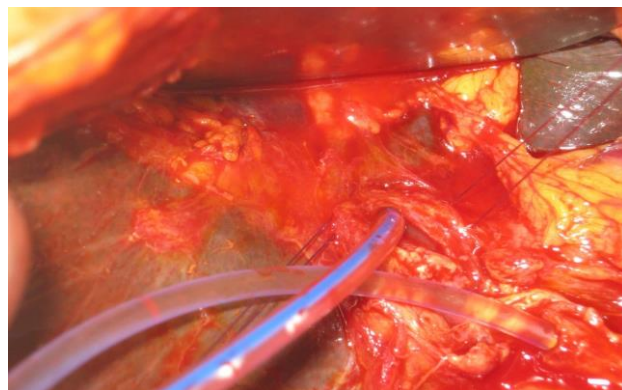


Figure 2: Identification of both the proximal and the distal cut ends of the bile duct.

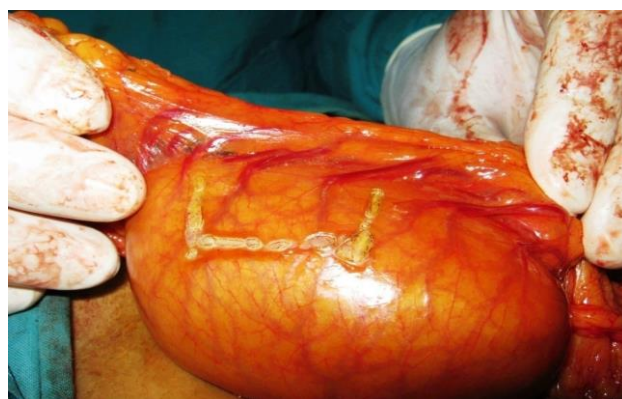


Figure 3: Selection of IVGT donation site from the middle 1/3 of the greater curvature of the stomach.

Patient's data included age, sex, careful history taking, presenting symptoms and signs of biliary obstruction or leak, and operative details. Laboratory investigations; liver function tests, abdominal ultrasonography, ERCP, and magnetic resonance cholangiography (MRC) were also performed to determine BDI types (Figure 1). Also hospital stay, mortality, and subsequent course of each patient regarding post-operative outcomes were evaluated. Injuries were classified according to their location on the basis of Bismuth's classification.¹⁵

Surgical management was done with the interposition of IVGT introduced by the author for reconstruction of the lost bile duct segment after conducting a similar study on animals; 16 an inverse J-shape incision (A right subcostal incision with upward midline extension) was done. The proximal end of the bile duct is identified first then the duodenum is koherized to find and loosen the distal end of the bile duct. If any fibrosis or scarred tissue is found,

it is excised until a healthy ductal mucosa is reached (Figure 2).

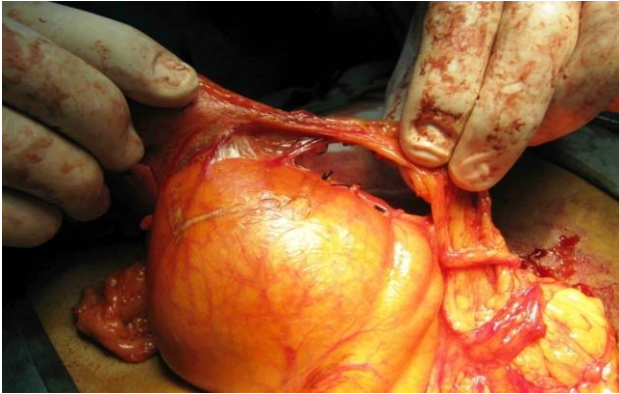


Figure 4: Freeing of the IVGT from the stomach with its intact blood supply.

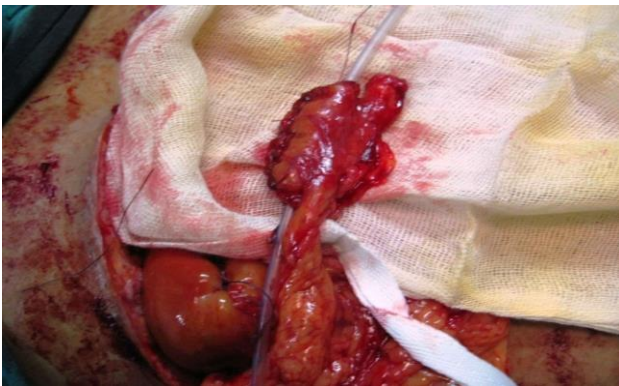


Figure 5: The IVGT is fashioned as a tube over a 10 Fr plastic catheter.

The lost segment between the proximal and distal end of the bile duct (or to lateral aspect of the middle of the second part of the duodenum if the distal end is not found or atrophied) is measured. A part of the middle 1/3 of the greater curvature of the stomach 10-15 cm from pylorus more than the length of the lost segment of the bile duct is obtained and completely separated from the stomach with its intact blood supply from the right gastroepiploic vessels which are mobilized by ligating and dividing its branches to the area of the stomach distal to that piece (Figure 3 and 4). This gastric flap is fashioned as a tube sewing its free edges together with 4/0 absorbable vicryl® (Ethicon inc., Johnson and Johnson company) in an interrupted pattern over a 10 Fr plastic catheter, which later acts as an anastomotic stent (Figure 5). Then the resulted defect in the stomach is closed in two layers (Figure 10).

The IVGT is anastomosed to both the proximal and distal cut ends of the bile duct in an end-to-end manner approximating the mucosa of IVGT to biliary mucosa using a 4/0 absorbable vicryl® suture starting by the posterior wall first from left to right with interrupted, everting, and water tight sutures in one-layer untied

sutures. This to be repeated in the anterior wall thus creating a wide trumpet-shaped opening, none of the sutures is tied but rather secured with a clamp until the entire row is completed. The stent is secured by a stitch of the same suture type to the IVGT to prevent slipping and its distal end is passed to the duodenum. The size of the anastomosis is kept within 10 mm.

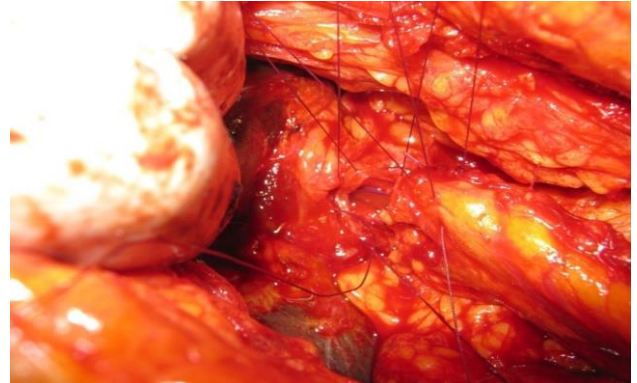


Figure 6: Sewing of the proximal cut end of the CBD mucosa to the IVGT.

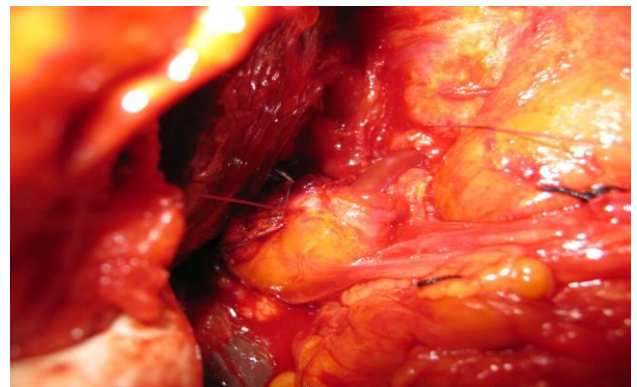


Figure 7: Anastomosis of the distal cut end of the CBD with the IVGT.

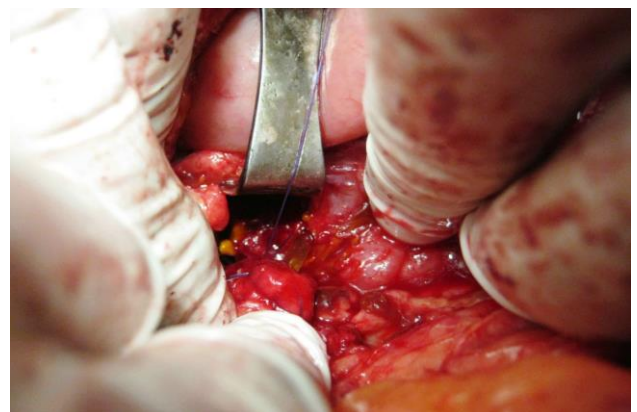


Figure 8: Completing the distal anastomosis.

If the distal end of the bile duct is not found or atrophied the distal anastomosis is conducted to lateral aspect of the middle of the second part of the duodenum (over an

internal stent with the aforementioned basis) keeping the size of stoma as small as <10 mm and the stoma is designed in a projecting fashion into the lumen to be amenable for ERCP examination. Extra Care is taken not to twist the IVGT, not being redundant, or under tension (Figure 6-10).



Figure 9: IVGT in place after completion of both the proximal and distal anastomoses.

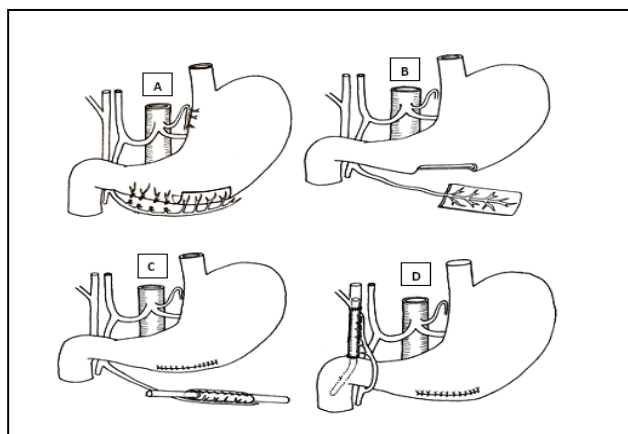


Figure 10: Schematic drawing of the operative steps; (A) Freeing of the right gastroepiploic vessels from the greater curvature of the stomach. till the IVGT donation site (B) The isolated vascularized gastric flap is set free from its donation site (C) The defect at the greater curvature of the stomach is closed and the isolated vascularized gastric flap is fashioned as a tube over a plastic catheter. (D) Anastomosis of the IVGT to both the proximal and distal cut ends of the CBD.

In case of BDI Bismuth's type IV, an end-to-end anastomosis of the proximal end of the IVGT to the left hepatic duct is done and then end-to-side anastomosis between the right hepatic duct and the IVGT away from the first suture line is achieved. Both left hepatic duct and right hepatic ducts are splinted with 10 Fr and 8 Fr plastic stents respectively where they are transfixed to the IVGT by absorbable sutures. After hemostasis is achieved, an external drain is placed, and the abdominal wall is closed. In the post-operative period, patients were evaluated for clinical evidence of bile leakage, jaundice, fever, routine

liver function tests, and abdominal ultrasonography before discharge from the hospital. The drain is kept usually for 7 days to observe for any leakage. If leakage is suspected the drain is kept for prolonged period. Patients were discharged from the hospital between 10-15 days after surgery with chologogues and choleretics.

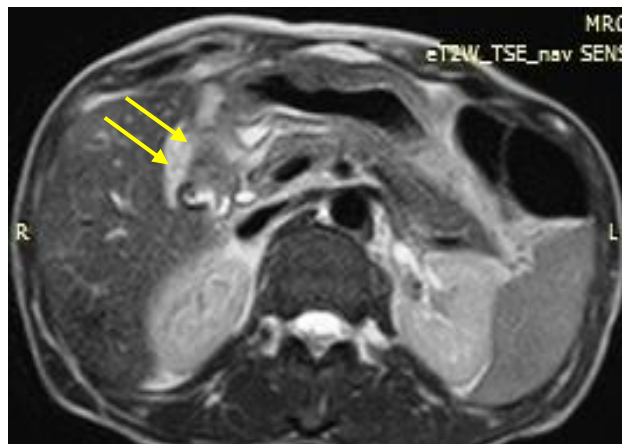


Figure 11: Post-operative axial T2W shows the vascularized graft (arrows) replacing the CBD. Neither intra-hepatic biliary channel dilatation nor bile leakage can be detected.

Patients were followed-up at 6th and 12th weeks after discharge from hospital for any biliary complications or the need for re-intervention. Stents were removed through ERCP 6 months post-operative or earlier if there is evidence of stent obstruction. MRC for all patients was done 1 year post-operative and annually thereafter (Figure 11 and 12).

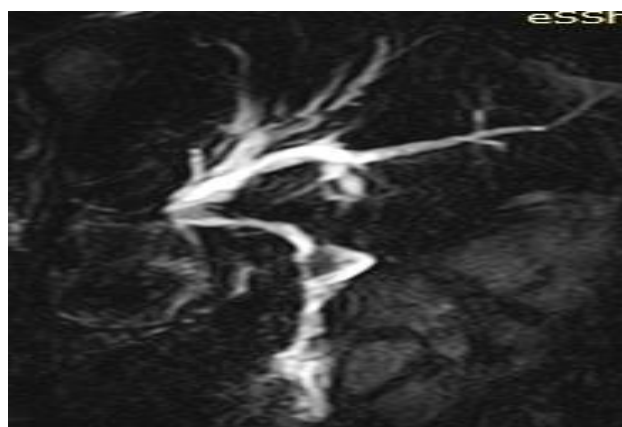


Figure 12: Post-operative SSh-HASTE MRCP shows normal intra-hepatic biliary channels with the graft replacing the CBD showing normal flow of bile.

Statistical analysis

Statistical analysis was done using SPSS (SPSS Inc., Chicago, Illinois, USA). Data on patient characteristics, and outcome were expressed as number of patients and percentages.

RESULTS

This study included 18 patients with iatrogenic BDI. Out of these 18 patients, 12 patients (67%) were females while 6 patients (33%) were males. The mean age was 36.3 (range: 25-53) years.

Regarding the etiology of BDI 7 injuries (39%) occurred after OC and 11 injuries (61%) were following LC.

Regarding the clinical presentation, 3 patients (17%) were discovered during cholecystectomy while most patients; 15 (83%) developed symptoms within 2 weeks after the primary surgery; most patients had a common presentation of obstructive jaundice and abdominal pain in 9 patients (60%) due to ligature and excision of a segment of the major bile ducts and 6 patients (40%) presented with bile leakage due to biliary fistula; those had earlier presentation than the obstructive group. Lastly eight patients (53%) had the classic triad of cholangitis. Out of the entire series beyond those discovered during cholecystectomy 11 patients (73%) had an elevated serum bilirubin level and 9 patients (60%) had an elevated serum alkaline phosphatase. Diagnosis was made by USG in 10 patients (67%), ERCP in all patients and MRC in 4 patients (27%). The data concerning the demographic criteria, clinical presentation and preoperative investigations are shown in Table 1.

Table 1: Demographic criteria, clinical presentation and preoperative investigations.

Parameter	Number and percentage
Age	
3rd decade	5 (28%)
4th decade	6 (33%)
5th decade	4 (22%)
6th decade	3 (17%)
Mean age	36.3
Gender	
Male	6 (33%)
Female	12 (67%)
Diagnosis time	0-2 weeks
Mean	3.4 days
Symptoms	
Obstructive jaundice and abdominal pain	9 (60%)
Bile leakage	6 (40%)
Charcot's triad	8 (53%)
Lab. investigations	
↑ serum bilirubin	11 (73%)
↑serum alkaline phosphatase	9 (60%)
Imaging	
USG positive in	10 (67%)
ERCP positive in	15 (83%)
MRCP positive in	4 (27%)

Based on Bismuth's classification BDI type was as following, 4 patients (22%) had type I injuries, 10 patients (56%) had type II injuries, 2 patients (11%) had type III injuries, and 2 patients (11%) had type IV injuries. The time lapse between the onset of BDI and reconstruction process varied between 0 and 90 days (mean: 18.8 days). There were 3 immediate repairs (17%) (0-72 hours) post cholecystectomy, 10 intermediate repairs (55%) (72 hours-6 weeks) and 5 late repairs (28%) (>6 weeks) (Table 2). Considering the operative time; it ranged from 2-3 hours with an average of 135 minutes. The data concerning the type of BDI, its etiology, the time between the onset of BDI and the biliary reconstruction, time of intervention, and the operative time are shown in Table 2.

Table 2: Etiology and operative information.

Variable	Number and percentage
Etiology of BDI	
Open cholecystectomy	7 (39%)
Laparoscopic cholecystectomy	11 (61%)
BDI stratification according to Bismuth's classification	
Type-I injuries	4 (22%)
Type-II injuries	10 (56%)
Type-III injuries	2 (11%)
Type-IV injuries	2 (11%)
The time lapse between the onset of BDI and reconstruction process	0-90 days Mean: 18.8 days
Time of intervention	
immediate repairs (0-72 hours post-cholecystectomy)	3 (17%)
intermediate repairs (72hours-6weeks)	10 (55%)
late repairs (> 6 weeks)	5 (28%)
Operative time	2-3 hours
Average	135 minutes

All the patients underwent surgery successfully and we got smooth recovery of our patients without any operative mortality or late postoperative morbidity but regarding early postoperative morbidity; there were two patients (11%) suffered of mild external biliary leak which stopped spontaneously 7 days later both of them with Bismuth's type IV injury (upper biliary tract injury), add to these one patient (5.5%) suffered from great bile leak and subjected to early exploration for whom RYHJ was offered, and also one further patient (5.5%) with obstructed stent which was early extracted through ERCP without any other sequences. Add to these there were 3 patients (17%) with postoperative pneumonia; responded well to medical treatment and superficial wound infection in 4 patients (22%) responded well to conservative measures (Figure 13).

The average hospitalization time for patients who underwent biliary reconstruction was 16 days (14-25).

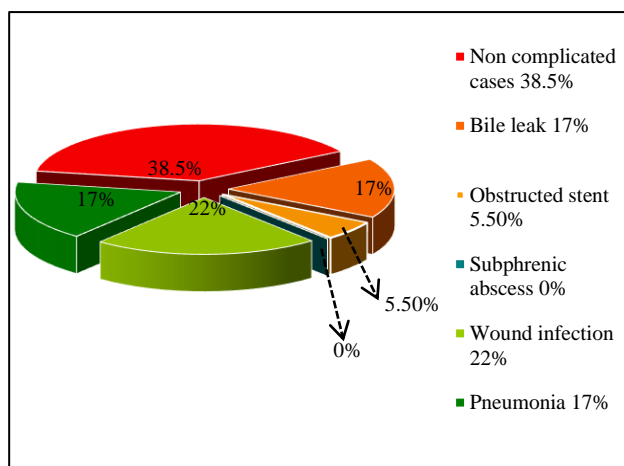


Figure 13: Postoperative patients' outcome.

The mean follow-up was 2 years with the longest follow up was 32 months and the shortest follow was 6 months in the last patient. No patient has suffered from any attack of cholangitis in the period of follow up and the level of serum total bilirubin and conjugated bilirubin remained within the normal range. ERCP results at 6 months of the reconstructive surgery revealed patent biliary tree without anastomotic strictures in all patients. These results were also confirmed at one year follow-up with MRC examination revealing the same results.

DISCUSSION

Post-cholecystectomy BDI is a disastrous complication of our everyday surgical practice. Its management costs 4.5 to 26 times the cost of a cholecystectomy.¹⁷

For a long time surgeons relied on RYHJ for BDI reconstruction although it has its drawbacks; the function of the Oddi's sphincter is lost leading to reflux cholangitis, adhesive intestinal obstruction, twisting of jejunal loop, duodenal ulcer, also 7 to 38% of patients develop anastomotic strictures requiring further treatment.^{9,18,19} Also as the bile flow path changes fat metabolism impairment happens resulting in loss of weight.²⁰ Another drawback of RYHJ is that it is not suitable for ERCP required for both diagnosis and treatment of biliary strictures that may develop in the post-operative period because of the limited length of instruments or the small therapeutic channel of the enteroscope.²¹ So, maintaining biliary continuity and integrity of function is fundamental in biliary reconstruction. Multiple experimental trials have been reported replacing the biliary defects with a variety of materials but failed to support the usefulness of these materials.²²⁻²⁷

Our new procedure utilizing IVGT interposition has the advantage of being physiologic keeping normal path of bile and keeping the sphincter of Oddi's function thus maintaining a normal anatomy without reflux. Even when performing anastomosis with the duodenum reflux is not

pronounced as the size of stoma is small (<10 mm) and the stoma is designed projecting into the lateral wall of the middle of the second part of duodenum to be amenable for ERCP examination if required. Also the IVGT has ample blood supply, thanks to the right gastro-epiploic vessels, thus stricture formation is very remote with satisfactory anastomotic circumferences.²⁸ We chose the greater curvature for flap donation rather than the lesser curvature although it is nearer to the extrahepatic region to keep the integrity of vagal innervation of the pylorus without disturbance. Also IVGT has the advantage of being denervated and taken from area not rich in G- cells.

Other potential advantages of IVGT are the light weight of the tube without traction on the anastomosis and also the irrelevance of the presence of short mesentery to the performance of this technique which was an obstacle in RYHJ. Furthermore, the length of the gastric tube could be adjusted to exactly bridge the biliary defect; a point offers the feasibility for diagnostic and therapeutic ERCP; a procedure proved to be extremely difficult after RYHJ.²⁹ Additionally it does not have the intestinal complications that may occur after RYHJ and with time there was no tube dilation which leads to bile stasis.¹⁸ Additionally, we were not confronted with cholangitis whether due to anastomotic stricture or due to reflux during the study period, although a longer follow up is needed.

The used internal stent function is to avoid the development of anastomotic fistula, decreases severity of leak if happens, and reduce the biliary stricture rate by effecting postoperative biliary decompression, and it is beneficial in prevention of anastomosis stenosis.³⁰ We removed the stent 6 months after surgery through ERCP although most of them were spontaneously slipped earlier due to fixing suture digestion.

The time lapse between the onset of BDI and reconstruction process varied between 0 and 90 days (mean: 18.8 days). When the patient was operated at the first 4 days after the insult, he/she passed smoothly without postoperative sequences. This is in accordance of the others due to the absence of local inflammation, but the main problem is the size of the bile ducts, which are often thin and narrow.³¹ While when we tried to reconstruct the BDI after 14 days we got two cases of bile leak, because of patient's bad general condition, presence of septicemia, and the tissue friability due to the inflammatory edema. This is in line with the others.³² So delayed repair in such cases is preferable, but in delayed repair we faced failure of identification of the distal end common bile duct or it was very narrow. So we resorted to anastomose the distal end of the IVGT with the lateral wall of the middle of the second part of duodenum. So, late intervention may be not favourable for the use of IVGT due to the inappropriate calibre of both the proximal and distal cut ends of the bile duct resorting to anastomosis with the duodenum which deprives the technique from one of its main advantages

Bile salt-induced toxicity is affected by extracellular pH, the alkalization of bile through HCO_3^- secretion is a protective mechanism against bile salt toxicity.³³ Also bile acids being conjugated within the biliary channels produces little injury than unconjugated bile acids.³⁴ So we are not in concern about the IVGT injury or cellular metaplasia. However, assessment of theoretical risk of metaplasia of IVGT mucosa due to chronic exposure to bile, although remote, needs prolonged follow up of large number of cases.

Present study showed that the procedure proved to be feasible, reproducible, and safe and for any reason in case of failure of this procedure we have the chance to resort to RYHJ. As the surgical revision of bilioenteric stricture is a troublesome because of the very short length of bile duct available for anastomosis repetition and also local fibrosis induced by previous repairs, also as the success rates for surgical repair decrease with each successive surgical intervention.^{35,36} We found our technique was a good first line repair of iatrogenic BDI with lost segment being more anatomical and physiological than others. Also, the indications of this procedure can be extended to include treatment of other causes of bile duct replacement. It uses readily available tissue which can be tailored to fit any bile duct defect, and does not involve enteric anastomoses. It has satisfactory results regarding biliary complications, liver functions and anastomotic circumference. However, larger sample studies with longer follow-up are needed before it can be standardized for BDI reconstruction.

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Conflict of interest: None declared

Ethical approval: The study was approved by the institutional ethics committee

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