Intraoperative Dilatation and Air-Tight Testing of the Hepaticojejunoanastomosis: A New Technique

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ABSTRACT

Objective: To evaluate the effect of creating an air-tight anastomosis and intraoperative dilatation of the hepaticojejunoanastomosis (HJ) in reducing the early and long-term complications.

Study Design: Interventional study.

Place and Duration of Study: Department of Surgery, King Saud University, Riyadh, between March 2008 and January 2016.

Methodology: After completion of HJ, the anastomosis was tested for air-tightness, and dilated with Kelly clamp in all patients undergoing the procedure. The anastomosis was reinforced with extra suture in cases of air leak. Comparison was performed between the patients who underwent HJ by the same surgeon, after and before the new technique.

Results: Sixty-seven patients underwent HJ during the study period. Air leaks from HJ were observed in 3 patients before anastomotic dilatation. The anastomosis was reinforced in these patients. No air leak was observed after dilatation of the anastomosis. There was no postoperative bile leak in any patient. However, during the follow-up 3 patients presented with recurrent cholangitis and stricture formation at the HJ site required surgical revision. The new technique had significantly reduced the rate of bile leak (p=0.029) and stricture (p=0.037) at the site of HJ when compared with patients who underwent HJ without the new technique.

Conclusion: Creation of air-tight HJ anastomosis has completely eliminated the postoperative bile leak and reduced the rate of HJ stricture formation. The additional technique resulted in insignificant prolongation of operative time. There was no technique related complication.


INTRODUCTION

The first comprehensive evaluation on the feasibility and safety of Roux-en-Y hepaticojejunoanastomosis (HJ) in the management of benign biliary diseases was reported by Bismuth et al.1 At present, it is considered a definitive management for iatrogenic bile duct injuries.2,3 It is also performed after resection of benign and malignant pancreatobiliary lesions to establish the biliary-enteric continuity. The main complications of HJ are anastomotic bile leak in the early postoperative period and stricture formation with its sequelae in the long-term.4 Postoperative anastomotic bile leak is known to increase the morbidity.2,5,6 The new technique of HJ described here (Figure 1) was developed with two aims. The first was to reduce the rate of postoperative bile leak by creating an air-tight anastomosis. Observing gas bubbles during the injection of air through HJ anastomosis provides an opportunity to reinforce the anastomosis. Secondly, it releases any narrowing of the anastomosis created by the anastomotic sutures and disrupts any mucosal fold taken from the posterior row during the anterior row sutures of the anastomosis, which may predispose to narrowing or even obstruction. The objective of this study was to assess the efficacy of this new technique of air-tightening the HJ anastomosis in reducing later strictureting and bile leaks.

METHODOLOGY

This prospective study included all patients who underwent HJ for various indications at the Hepatobiliary Unit, King Saud Medical City, Riyadh, Kingdom of Saudi Arabia between March 2008 and January 2016. Ethical approval was obtained from the Hospital Research Committee before the commencement of this study. Informed consents were taken from all patients included in the study. All the patients underwent the same technique of HJ performed by a single surgeon (the author). The extrahepatic or hilar bile duct was prepared with a careful dissection, preserving its blood supply, and ensuring satisfactory bleeding from its cut end. Adjacent ducts were joined together with multiple interrupted polydioxanone (PDS) sutures to form one common channel for HJ anastomosis. In some patients, the left duct was opened along its length to achieve a sufficient duct caliber for the anastomosis. Roux jejunal limb was prepared by transecting the jejunum about 30 cm distal to ligament of Treitz by gastrointestinal...
anastomosis staplers and brought through the retrocolic, paraduodenal space to the right side of middle colic vessels. Stapled ends were reinforced with interrupted 3/0 PDS suture. Care was taken for the Roux jejunal loop not to be under any tension or any pressure from the mesenteric window. Side-to-side jejunojejunostomy anastomosis was performed manually with a single layer interrupted 3/0 PDS sutures, keeping the length of the Roux jejunal limb of approximately 60 cm. An enterotomy, slightly smaller than the diameter of the bile duct, was created on the anti-emesenteric side 2 cm distal to the stapled end of the Roux jejunal limb. End-to-side tension-free HJ anastomosis was created using single layer 4-0 PDS sutures. The anastomosis was performed by mucosa-to-mucosa, starting with two-stay sutures in the corners (3 and 9 O’clock positions) and a suture in the mid-posterior row. This was followed by multiple interrupted sutures (taking full thickness of the jejunum) in the posterior row approximately 2 mm apart. The anterior row was completed in a similar fashion. The knots of the posterior row sutures remained inside the anastomosis, while the knots of the anterior row were outside the anastomosis.

Descriptions of the new procedure (Figure 1) were as follows:

A small enterotomy (5 mm or less) was created on the antimesenteric side of the Roux jejunal loop, about 10 cm distal to the HJ. The subhepatic area was filled with saline-covering the HJ. Enterotomy site was kept above the level of saline. A soft intestinal clamp was applied on the loop of jejunum distal to the enterotomy to occlude its lumen. The nozzle of a 50cc syringe tightly fitted through the enterotomy was introduced and air was injected, causing the jejunal loop to distend, and observed for any gas bubbles coming from the HJ site. In case of clear gas bubbles coming from the HJ site, the anastomosis was reinforced by putting an extra suture at the leaking site.

A Kelly clamp was introduced through the enterotomy into the lumen of the HJ. Jaws of the Kelly clamp were opened gently until a slight resistance was felt and the anastomosis was dilated. Airtightness of the HJ was tested again as before (step 3) and the anastomosis was reinforced in case of any air leak. The enterotomy was closed in single layer with 3/0 PDS sutures.

A subhepatic J-VAC drain was placed near the HJ at the end of the procedure. Patients with percutaneous transhepatic cholangiography (PTC) catheter in place were submitted to cholangiogram on 5th postoperative day.

All patients were followed-up in outpatient clinic by clinical examination, LFTs, and imaging studies, if indicated. They were seen at shorter interval of 6-12 weeks for the initial 6 months and at 6-monthly interval subsequently. They were advised to report earlier in case of any problem.

The data included age, gender, indications for HJ, preoperative diameter of the bile duct on ultrasound measurement, operative procedure, evidence of gas bubbles during the procedure, revision of HJ, postoperative bile leak, postoperative liver function tests (LFTs), outpatient follow-up period, long-term complication, morbidity and mortality. The rate of postoperative bile leak and stricture formation in all patients who underwent HJ by the same author, before the use of the new procedure, were reviewed.

Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) version 21 software (SPSS Inc., Chicago, IL, USA, which was used for statistical analysis. Percentages and frequencies of complications of two different techniques were calculated. Chi-square test was employed to compare between two different techniques (new and old techniques) with respect to the complications of operation (bile leak and stricture). Statistically significant difference was assumed when p-value was less than 0.05.

RESULTS

A total of 67 patients were included in this study. Their mean age was 42 ±25.4 years (range 21 - 78 years) with male to female ratio of 1:2 [22 males (32.8%) and 45 females (67.2%)]. Table I shows the indications for HJ. The new technique in the HJ was performed by one hepatobiliary surgeon (author) in all patients. The preoperative duct diameter was > 6 mm in 36 patients and
jejunal loop, before dilatation of the HJ, revealed a gush of bile flowing into the biliary tract. Injection of the air in the Roux loop decompressing the biliary tract. Gas bubbles leak in 3 patients [one (1.5%) with dilated duct and 2 (3%) with non-dilated ducts]. The anastomosis was reinforced with extra suture in all 3 patients (4.5%) who underwent iatrogenic bile duct injury during the laparoscopic cholecystectomy as they did not respond to frequent percutaneous transhepatic cholangiogram, which did not show gas bubble leak in any patient after the Kelly clamp dilatation. Average time taken for this procedure was 10 minutes. No postoperative bile leak, intra-abdominal collection or biliary peritonitis was encountered in any patient. Nine patients (13.4%) with PTC catheter in situ underwent postoperative PTC cholangiogram, which did not show any evidence of bile leak. There was no hospital mortality.

All patients included in the study were followed prospectively till the present. LFTs returned to normal within 3 weeks in all patients. Three out of 67 patients (4.5%) developed stricture at the HJ site. They presented with rising LFTs and recurrent cholangitis during the follow-up at 8, 14, and 16 months after HJ surgery. All the 3 patients (4.5%) had sustained arterial injury during the laparoscopic cholecystectomy as evidenced by hypoperfused and atrophied right lobe of the liver in CT scan. All of them required surgical revision of HJ as they did not respond to frequent percutaneous balloon dilatation of the stricture. Seven patients (canceroma head of pancreas=5, cholangiocarcinoma=2) were lost to follow-up. The mean follow-up was 4.49 ±1.2 years, ranging from 0.667 to 8.33 years. A total of 58 (86.6%) patients underwent HJ for different indications by the same surgeons (author) before the use of the new technique. Four of them developed postoperative bile leak (6.9%) and 9 patients (15.5%) developed stricture at the site of HJ, during the long-term follow-up. The new technique has significantly reduced the rate of bile leak (p=0.029) and stricture formation (p=0.037) at the site of HJ when compared with the HJ, that was performed before adopting the new technique (Table II).

**DISCUSSION**

Surgeons involved in the treatment of different benign and malignant biliary disorders need to perform an optimal internal drainage of bile in order to prevent postoperative complications. Postoperative bile leaks, early narrowing due to mucosal entrapment, and delayed stricture formation with its sequelae are some of the problems faced by surgeons practicing in this area of surgery. Imperfectly performed biliary anastomosis leads to repeated interventions or re-operations, sometimes with devastating consequences.7,8 Bile leak after HJ, which may occur in up to 10%, has been identified as a significant factor for the long-term outcome.5,6 Hajjar et al. stated "biliary leak as the only significant independent predictor factor for the occurrence of late anastomotic stricture".2 Surgeons have tried to control bile leaks by placing trans-anastomotic stents. Biodegradable trans-anastomotic stent, resulting in low rate of bile leak and stricture formation, has been used in experimental models.9 In the present study, creating an airtight HJ was tried as a method to control the bile leak. This resulted in no postoperative bile leak, intra-abdominal collection or biliary peritonitis in the studied group.

Long-term stricture formation at the HJ site has been reported to vary from 4 to 38% in published studies.10,11 Several factors have been implicated in the occurrence of anastomotic leak and long-term stricture formation, including non-dilated proximal bile ducts, revision surgery, electrocautery damage, higher grade bile duct injury and presence of inflammation.12,13 Majority of postoperative bile duct strictures present within 2 years. However, it can be as delayed as 20 years in some patients.2,5,14 Among the present study group, only 3 patients (4.5%) developed stricture at the HJ site during a mean follow-up of 4.49 ±1.2 years. The low incidence of stricture formation in the present series may be attributed to no bile leak due to airtight anastomosis and intraoperative dilatation of the HJ anastomosis. The new technique significantly reduced the rate of bile leak and stricture formation at the HJ site, when compared with the HJ procedures that were performed by the same surgeon without the new technique.

The caliber of the duct was not a significant factor for the stricture formation in this study as only two out of 31

**Table I:** The indications for hepaticojejunostomy.

<table>
<thead>
<tr>
<th>The indication</th>
<th>Number of patients (%)</th>
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<tbody>
<tr>
<td>1. Iatrogenic bile duct injury</td>
<td>24 (35.8%)</td>
</tr>
<tr>
<td>2. Carcinoma of the head of pancreas</td>
<td>20 (29.8%)</td>
</tr>
<tr>
<td>3. Benign bile duct stricture</td>
<td>10 (15%)</td>
</tr>
<tr>
<td>4. Cholangiocarcinoma</td>
<td>6 (8.9%)</td>
</tr>
<tr>
<td>5. Biliary tract stones</td>
<td>4 (6%)</td>
</tr>
<tr>
<td>6. Mirizzi syndrome</td>
<td>3 (4.5%)</td>
</tr>
</tbody>
</table>

**Table II:** Comparison of patients who underwent hepaticojejunostomy with and without the new technique.

<table>
<thead>
<tr>
<th></th>
<th>With new technique (n = 67)</th>
<th>Without new technique (n = 58)</th>
<th>p-value</th>
<th>x²</th>
<th>Chi-square</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bile leak</td>
<td>0 (0%)</td>
<td>4 (6.9%)</td>
<td>0.029*</td>
<td>4.773</td>
<td></td>
</tr>
<tr>
<td>Stricture</td>
<td>3 (4.5%)</td>
<td>9 (15.5%)</td>
<td>0.037*</td>
<td>4.366</td>
<td></td>
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</table>

*By Chi-square test

≤ 6 mm in 31 patients. Patients with non-dilated duct (≤ 6 mm) were either having iatrogenic bile duct injury (n=6, 9%) detected and managed with HJ during the index surgery, or had biliary catheters in place [PTC = 9 (13.4%), endoscopic plastic stents = 16 (24%)] decompressing the biliary tract. Injection of the air in the Roux jejunal loop, before dilatation of the HJ, revealed gas bubbles leak in 3 patients [one (1.5%) with dilated duct and 2 (3%) with non-dilated ducts]. The anastomosis was reinforced with extra suture in all 3 (4.5%) patients during surgery. Dilatation of the HJ revealed gush of bile flowing into the Roux jejunal loop in all patients. No gas bubble leak was noticed in any patient after the Kelly clamp dilatation. Average time taken for this procedure was 10 minutes.

No postoperative bile leak, intra-abdominal collection or biliary peritonitis was encountered in any patient. Nine patients (13.4%) with PTC catheter in situ underwent postoperative PTC cholangiogram, which did not show any evidence of bile leak. There was no hospital mortality.

All patients included in the study were followed prospectively till the present. LFTs returned to normal within 3 weeks in all patients. Three out of 67 patients (4.5%) developed stricture at the HJ site. They presented with rising LFTs and recurrent cholangitis during the follow-up at 8, 14, and 16 months after HJ surgery. All the 3 patients (4.5%) had sustained arterial injury during the laparoscopic cholecystectomy as evidenced by hypoperfused and atrophied right lobe of the liver in CT scan. All of them required surgical revision of HJ as they did not respond to frequent percutaneous balloon dilatation of the stricture. Seven patients (canceroma head of pancreas=5, cholangiocarcinoma=2) were lost to follow-up. The mean follow-up was 4.49 ±1.2 years, ranging from 0.667 to 8.33 years. A total of 58 (86.6%) patients underwent HJ for different
patients with non-dilated bile duct developed strictures at HJ. However, vascular injury during cholecystectomy affecting the blood supply to extrahepatic hepatic bile duct may be a major contributory factor to the development of stenosis. All those who developed stricture (n=3) in this study had HJ for bile duct injury sustained during the cholecystectomy. All of them had shown hypoperfused and atrophied right lobe of the liver in postoperative CT scan, an evidence of vascular compromise. Presence of inflammation in subhepatic area can also adversely affect the long-term outcome of HJ. All patients with complete bile duct injuries, discovered postoperatively in this series, were initially managed by drainage of intra-abdominal collections and control of sepsis. They were operated after 8-12 weeks from the index gallbladder surgery, after complete resolution of the subhepatic inflammation. None from this group presented with stenosis of HJ during the study period.

Many approaches and techniques in creating HJ have been described with variable results. Maintaining patency with a wide caliber and prevention of long-term stricture formation are the main objectives of most of these procedures. Sewing the end of common hepatic duct to the side of the jejunum with extramucosal stitches has been performed with a low rate of bile leak (1.7%) and stricture formation (4.9%), and no mortality. Trans-anastomotic stent to reduce the incidence of bile leak and long-term stricture formation has been recommended by recent reports. The technique of HJ used in this study was an end-to-side with sutures taking full thickness of bile duct and the jejunum. No trans-anastomotic stent was used in any patient in this study. Creating an airtight anastomosis, completely eliminated postoperative bile leak and its associated morbidity in these patients. This along with the intraoperative HJ anastomosis dilatation was responsible for low stricture formation, comparable with other studies.

Recently, postoperative progressive balloon dilatation of HJ, to improve the outcome of stricture formation, has been described by Luo et al. after iatrogenic biliary injury. However, this technique requires frequent biliary manipulation with the risk of balloon rupture and air leak. Repeated balloon dilatation was unsuccessful in this series and all 3 patients with stricture needed surgical revision of the HJ.

The aims of the newly applied technique in this study were to reduce the bile leak and its consequences; and to reduce the incidence of stricture formation. These were successfully achieved as no patient developed postoperative bile leak and the stricture formation was quite low, comparable with other studies with low stricture rate. Gentle dilatation of the HJ anastomosis to release the tension, created by sutures and disrupt any mucosal fold taken between the anterior and posterior rows during creation of the HJ, has also contributed to low stricture formation rate. However, the technique of anastomosis dilatation by Kelly clamp may carry the risk of HJ anastomosis disruption, if not performed carefully and gently. Therefore, extra caution should be taken by the operating surgeon during the procedure.

**CONCLUSION**

The new procedure was able to control the postoperative bile leak and reduced the long-term stricture formation rate at the site of the HJ. It was not associated with any complication. However, it minimally prolongs the operating time and carries a small risk of disruption of the HJ, if a surgeon is not careful when performing this new procedure.

**REFERENCES**


