Repair of bile duct injuries using autologous peritoneal grafts

Ileana Lorenzana-Bautista,1 Aníbal Flores-Plascencia,1 Francisco Javier Barrios-Pineda,2 Georgia Alderete-Vázquez,3 Enrique Alejandro Sánchez-Valdivieso4

Abstract

Background: A significant number of individuals experience iatrogenic bile duct injury during laparoscopic cholecystectomy. Biliary-digestive bypass may be complicated by stenosis and biliary sepsis, affecting both quality of life and life expectancy. To avoid bypass, expensive synthetic grafts have been used. We assessed the use of an autologous peritoneal graft as an alternative.

Methods: Under general anesthesia, ten adult New Zealand rabbits were operated on. The common bile duct was approached and sectioned underneath the cystic duct followed by a liver biopsy. An autologous graft was constructed of peritoneum and graft-bile duct proximal and distal end-to-end anastomosis was done. Animals were followed with weekly bilirubin and transferases. Rabbits were scheduled to be euthanized and a liver biopsy was done for histological examination.

Results: Autologous graft was easy to create and all rabbits survived. Rabbits did not develop jaundice or alterations in their normal habits. At necropsy, autologous grafts were removed and no signs of occlusion were noticed. Moderate short-term liver damage was observed but long-term damage was negligible. Bileoma and pyogenic liver abscess were observed in two animals, respectively.

Discussion: Our results compare favorably with well-known procedures used for bile duct repair, especially in cases of severe injury (Bismuth-Strasberg E1-3). The procedure appears to be less complicated than biliary-digestive bypass, less expensive than synthetic grafts and much easier to construct than human amnion graft.

Conclusion: Interposition of autologous peritoneal graft is an easy-to-create surgical procedure and circumferential bile duct injuries were adequately repaired.

Key words: Common bile duct, injury, autologous graft, animal model.

Introduction

Bile duct injury occurs in 0.3-4.0% of all laparoscopic cholecystectomies.1,2 In the U.S. alone, more than one half million laparoscopic cholecystectomies are performed each year.3 From this number of patients, a significant number will experience an iatrogenic injury during the procedure. Bile duct injury is the most common cause for lawsuits.1 Repair of the injuries is frequent and is an important challenge for complex biliodigestive bypasses, which are a significant cause of morbidity and mortality. The principal complications are bypass stenosis, dehiscence of the anastomosis and repeat gallbladder abscesses, which can lead to death.4-6 The choice of type of repair depends on many factors, among which are extent and location of the injury, experience of the surgeon, and time of the repair.4-7 Until now, the most accepted option for treatment of bile duct injury is hepatojjunal anastomosis, which increases the operative time.6,8 One alternative is the use of grafts. Bile duct reconstruction has been attempted with biosynthetic grafts. Nau et al.9 used a bioabsorbable mesh in dogs composed of a polyglycolic acid polymer and trimethylene carbonate (PGA: TMC), commercially available as BIO-A® (WL Gore & Associates, Newark, DE), whereas Schanaider et al.10 used an expanded polytetrafluoroethylene patch (ePTFE, Gore-tex®) also in dogs. Gomez et al.11 suggested that the Gore-Tex vascular graft was a good option, and others12 have successfully used it.

More recently, Li et al.13 developed a model of bile duct injury in pigs and found that a functional biomaterial of

1 Departamento de Cirugía,
2 Enseñanza,
3 Patología, Hospital Regional de Alta Especialidad de Veracruz, Secretaría de Salud, Veracruz, Mexico
4 Departamento de Investigación, Escuela de Medicina, Universidad Cristóbal Colón, Veracruz, México

Correspondence:
Dr. Enrique Sánchez-Valdivieso
Carr. Veracruz-Medellin s/n
94270 Boca del Río
Veracruz, México.
Tel: 229 9230171, FAX 229 2021260
E-mail: easanchezv@gmail.com

Received: 2-13-2013
Accepted: 7-3-2013
collagen growth factor (composite biomaterial collagen/collagen-binding domain-bFGF) could significantly promote extrahepatic regeneration of the bile duct at the site of injury. Xu et al.14 used a biodegradable cannula of PLGA opaque to x-rays in a canine model. Li et al.15 developed a biliary-enteric anastomosis with a magnetic cannula in dogs. Some disadvantages of the synthetic grafts are that they are more thrombogenic, susceptible to infection and have a higher rejection rate compared with autologous grafts.16,17 Its high cost also prevents their use in a large part of the population; therefore, research aimed at developing more affordable alternatives and applying these to practice is justified.

Although some authors suggest that the medical scientific literature seems more interested in permanent biosynthetic materials, many studies have reported the successful use of autologous grafts. For example, Ismail et al.16 used human amnion graft together with peritoneomuscular vascularized flap for circumferential duct losses of a bile duct injury, a technique much more complex than our simple and always accessible graft.

This study describes a rapid and affordable technique in an animal model: an alternative for the repair of bile duct injury after laparoscopy or secondary stenosis as a complication of unsatisfactory repairs.

Materials and Methods

We carried out an experimental study using ten adult New Zealand rabbits that had a segment of the common bile duct resected. For end-to-end repair of the bile duct, a neo-conduit was constructed with parietal peritoneum as an autograft. The study was conducted in the Surgical Education Unit, School of Medicine, Universidad Cristóbal Colón, Veracruz, Mexico with prior approval of the bioethics and research committees. All procedures were performed in strict compliance with the Official Mexican Norms for technical specifications for laboratory animal experimentation.18,19 The Bismuth-Strasberg classification indicated in bile duct injuries during laparoscopy was used,20 modified from the Bismuth classification for biliary stenosis.21

Subjects

Ten 4-month-old male and female New Zealand (Oryctolagus cuniculus) rabbits weighing ~2 kg were used. Animals were housed in individual cages with commercial food and water ad libitum by a veterinarian.

Materials

The drugs given were ketamine (Anesket, Laboratory PiSA, injectable solution 100 mg/ml), xylazine (Tranquived, Laboratory VEDCo, injectable solution 2 mg/mL) and sodium pentobarbital (Penta-Hypnol, Laboratory Vetermex Animal Health, 2 mg/mL). We used 5 French silastic catheters and sutures: Prolene™ monofilament branch Ethicon caliber 5-0, atraumatic needle ½ circle; siliconized black braided silk brand Atramat caliber 4-0; polyglycolic acid (Vicryl™) caliber 2/0, atraumatic needle ½ circle; R26 brand Atramat caliber 1-0; nylon (Dermalon™) brand American caliber 3-0, atraumatic needle ½ circle.

Procedures

The animals remained in observation for 10 days prior to the surgical procedure. The day prior to the surgery the veterinarian confirmed the positive state of health of the animals. Peripheral blood was drawn for laboratory studies and preoperative liver function markers (liver function tests, transaminases and bilirubin). Prior to the abdomen being shaved, general anesthesia was administered i.m. with ketamine (35 mg/kg dose/body weight) combined with xylazine (5 mg/kg) in the same syringe and calculated at ratio of dose:weight in the posterior region of the femur with a 23Gx1 needle, with which anesthesia was achieved for 30–45 min per dose.

Using a Kocher-type incision, the abdominal cavity was approached, a ~10 mm × 7 mm sheet of tissue was obtained composed by the parietal peritoneum adhered to the posterior aponeurosis of the anterior rectus muscle of the abdomen. A similar graft was described for treatment of vascular lesions.16,22,23 With the sheet, a tubular structure was constructed over an appropriate fragment of a #5 French silastic catheter, using it as a template and leaving an internal splint for the graft. The peritoneum remained in the internal portion of the tube towards the catheter and the aponeurosis on the external face of the neo-conduit. The neo-conduit was completed with a continuous longitudinal suture with Prolene caliber 5-0, ½ atraumatic circular needle (Figure 1).

In an intentional manner a common bile duct segment of ~5 mm in length was removed which produced a circumferential lesion of the bile duct; an end-to-end anastomosis was done of the neo-conduit to the proximal and distal segments of the common bile duct with interrupted polypropylene suture (Prolene™) 5-0, needle ½ atraumatic circular, confirming that the continuous longitudinal suture of the neo-conduit was visible anteriorly (Figure 2). The silastic catheter was left within the neo-conduit as an internal ferula.
to prevent collapse of the graft due to compression and to prevent the physiological obstruction of the sphincter of Oddi. A catheter was used as a free biliary prosthesis, waiting until it spontaneously migrated and was released via the intestine. In order to guarantee an adequate blood supply and neovascularization, the graft was covered with omentum. All graft sutures and those of the bile duct were done by a third-year general surgery resident due to the ease of performing the technique without optical assistance: uncomplicated anastomosis using 5-0 suture material without the use of microsurgical techniques and without magnification lenses. The learning curve is evidently shorter. Finally, a biopsy of the liver parenchyma was taken, hemostasis was assured and the abdominal wall was closed. No drains remained.

The rabbits remained under continuous surveillance during the postoperative period. Oral feeding was begun immediately after recovery from anesthesia. Liver function tests in peripheral blood from each animal were analyzed weekly. At the same time, a photographic record was made of the sclera of the animals and their daily activity. Due to the lack of infrastructure it was not possible to carry out cholangiography.

We followed an experimental design similar to that developed by Rosen et al. In our study the animals were sacrificed at variable follow-up intervals. They were sacrificed with an i.p. lethal dose of sodium pentobarbital (40–60 mg/kg) in programmed fashion postsurgically: at 24 and 48 h, 7 days, months 1, 2, 4 and 5. Prior to being euthanized, blood was obtained for liver function test analysis. At autopsy, the common bile duct and liver were again examined. Resection of the segment with the biograft was done together with a new liver biopsy for histological examination of the neo-conduit and for evaluation of the histopathological changes of the liver, respectively.

Data Analysis

Results were recorded in an Excel® spreadsheet. Variables of clinical jaundice, wound healing, time of recovery and integration to normal activities, complications and results of the liver function tests, as well as the histopathological study results of the samples were taken into consideration. To analyze serial measurements of liver function tests looking for statistical differences, we used Student t test and one-way ANOVA.
Results

We used ten healthy adult New Zealand rabbits (4 months of age) weighing 1.9–3.0 kg (median 2 kg ± 0.5 kg) with normal activity. The procedure was carried out without any complications during the intervention. Total average surgical time was 60 min, with ~15 min for construction of the graft. There were no complications during the immediate postsurgical period. After recovering from anesthesia, animals returned to their normal activities (eating, drinking water, and adequate movements). Animals with the longest follow-up time showed weight gain; none of the animals showed any subconjunctival jaundice. Animals were sacrificed after the operation according to the following schedule: at 24 h (one animal), 48 h (one animal), 7 days (one animal), one month (two animals), 2 months (two animals), 4 months (one animal) and 5 months (two animals). On autopsy, the neo-conduits showed complete graft integration (Figure 3).

With regard to the permeability, no obstruction or stenosis of the anastomosis was observed. The silastic tube remained in place as a biliary prosthesis, even in animals that were sacrificed at 5 months. There was no migration and no maneuver for its extraction was carried out.

Complications

Only in one case (animal sacrificed at 7 days) was there dehiscence in a suture point of the graft that was sealed with the omentum with formation of a bilioma. Infectious complications were observed in only one animal on autopsy (animal sacrificed at 2 months). The animal had a small liver abscess away from the area of surgical manipulation. No other alterations in the remainder of the abdominal cavity were observed. In two additional cases (with <2 months of follow-up), the liver showed macroscopic data of macro-nodular cirrhosis.

Histopathological Changes

In the liver cuts, histopathological indicators such as fibrosis, proliferation of conduits, calcification, necrosis and bacteria were examined. In the initial liver biopsies and that of the common bile duct, no histopathological abnormalities were noted (data not shown). On histopathological study the neo-conduits showed mild fibrotic changes (Figures 4 and 5). In one case, graft calcification was observed. In general, the graft showed signs of incorporation with infiltration of native fibroblasts, blood vessels and biliary mucosa at 4 weeks and was replaced with native collagen covered with biliary epithelium at 4 months, similar to what was reported by Rosen et al.25

The liver fragment obtained by autopsy showed moderate to severe fibrotic changes, predominantly in the subjects at ~1 to 2 months of follow-up, along with mild dilatation of the intrahepatic biliary duct. The most severe changes occurred in animals sacrificed earlier than 1 month (Figure 6) and decreased in severity in cases with longer follow-up time, showing an evident recovery of the histopathological changes of the liver (Figure 7). The weekly results of the liver function tests remained within normal limits during the entire follow-up (Table 1).

We compared the determinations of liver function tests taken at different follow-up times with the baseline, which showed no statistically significant differences (Student t test: p = 0.69).

Discussion

The surgeon is often faced with complications that affect the bile ducts. With the large number of laparoscopic cho-
lecnecystectomies currently performed, the frequency of bile duct injury has increased\textsuperscript{1,26,27} Currently, bile duct injury occurs with a frequency of 0.3–4.0%, especially in procedures using only one port\textsuperscript{1,4,28,29} Multiple classifications have been developed to describe these injuries. Bismuth divided them according to five types:

\textit{Type I}. Injury of the common bile duct at >2 cm of the confluence

\textit{Type II}. Injury of the common bile duct at <2 cm of the confluence

\textit{Type III}. Absence of the common bile duct, preserved confluence

\textit{Type IV}. Absent confluence, separated conduits

\textit{Type V}. Absent confluence, separate conduits associated with an aberrant bile duct\textsuperscript{21} the design of the repair is very useful and has been included in the Bismuth-Strasberg classification (types E1-5) for bile duct injuries during laparoscopies\textsuperscript{20}

Although there are several techniques to repair Bismuth-Strasberg types E1, E2 and E3 bile duct injuries, recurrence and other problems limit their value and usefulness. One treatment alternative is biliary-digestive bypass (i.e., hepatojejunal-anastomosis), but this implies a high morbidity and mortality mainly due to postoperative complications\textsuperscript{12}
### Table 1. Concentration of the results of weekly liver function tests in animals (continued)

<table>
<thead>
<tr>
<th>ANIMAL</th>
<th>Basal values</th>
<th>Week 1</th>
<th>Week 2</th>
<th>Week 3</th>
<th>Week 4</th>
<th>Week 5</th>
<th>Sem 6</th>
<th>Sem 7</th>
<th>Sem 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LFT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Values:**

- **TB:** Transaminase levels (U/L)
- **ALT:** Alanine aminotransferase
- **AST:** Aspartate aminotransferase
- **GGT:** Gamma-glutamyl transferase
- **AP:** Alkaline phosphatase
- **FA:** Bilirubin
- **DB:** Direct bilirubin
- **BD:** Indirect bilirubin

**Concentrations:**

- **Normal range:** TB: 0.7-1.5, ALT: 10-40, AST: 10-40, GGT: 0-6, AP: 0-15, FA: 0-1, DB: 0, BD: 0
- **Weeks:** 1-8
- **Sem:** 1-8

**Autologous peritoneal grafts in bile duct injury repair**
Experimental repair of common bile duct injuries. We evaluated the applicability of a technique of constructing a conduit with autologous peritoneal grafts for cells, we evaluated the applicability of a technique of the regeneration activity and high plasticity of mesothelial cells, due to the limitations of synthetic grafts, the cost and knowledge of the replacement material has yet to be found. Due to the complications in bile duct reconstruction. Various materials have been used both clinically and experimentally to replace the damaged common bile duct. Various materials have been attempted; unfortunately, a satisfactory biliary replacement material has yet to be found. Due to the limitations of synthetic grafts, the cost and knowledge of the regeneration activity and high plasticity of mesothelial cells, we evaluated the applicability of a technique of constructing a conduit with autologous peritoneal grafts for experimental repair of common bile duct injuries. The liver tissue also had fibrosis and proliferation of ducts, which are expected changes in bile duct interventions. Gomez et al. report an interesting finding of an initial increase of serum bilirubin and alkaline phosphatase concentrations, which return to normal 2 weeks after graft placement. This agrees with our histopathological findings although we could not prove this with laboratory tests. In our study, animals with shorter postoperative follow-up time showed cirrhotic-type histopathological alterations in the hepatic parenchyma, although none had alterations in liver function test results due to a good reserve during the early postoperative period. These hepatic histological changes would perhaps have decreased or returned with additional time because the samples of animals with longer follow-up time did not show such marked alterations, possibly due to the adaptation response of the organism to the neo-conduit.

The potential advantage is that this treatment approach may have less morbidity because of the lower frequency of clinical complications and abnormalities in liver function tests over time that was observed in the animals. The subjects in this study had good survival without clinical or biochemical complications. This is very relevant considering that the patient with bile duct injury who has a biliary-enteric bypass procedure performed will have their quality of life significantly affected as well as their life expectancy. From 9–32.3% of “unfavorable” results after bypass have been reported, with stenosis, cholangitis or even death just 4 years after the bypass, depending directly on the Bismuth-Strasberg levels of the injuries.

| Table I. Concentration of the results of weekly liver function tests in animals (continued) |
| Sem | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| BT: 0.5 | (8/9)BT: 0.51 | (8/10)BT: 0.51 | (8/11)BT: 0.54 | (8/12)BT: 0.51 | (8/13)BT: 0.53 | (8/14)BT: 0.55 | (8/15)BT: 0.48 | (8/16)BT: 0.49 |
| BD: 0.28 | (8/9)BD: 0.3 | (8/10)BD: 0.32 | (8/11)BD: 0.36 | (8/12)BD: 0.29 | (8/13)BD: 0.27 | (8/14)BD: 0.26 | (8/15)BD: 0.3 | (8/16)BD: 0.3 |
| FA: 73 | (8/9)FA: 74 | (8/10)FA: 75 | (8/11)FA: 72.4 | (8/12)FA: 75 | (8/13)FA: 73.2 | (8/14)FA: 73.7 | (8/15)FA: 73.2 | (8/16)FA: 73.7 |
| AST: 44 | (8/9)AST: 42.5 | (8/10)AST: 43.7 | (8/11)AST: 44.3 | (8/12)AST: 42.2 | (8/13)AST: 42.1 | (8/14)AST: 42.1 | (8/15)AST: 42.1 | (8/16)AST: 42.1 |
| GGT: 5.1 | (8/9)GGT: 5.3 | (8/10)GGT: 4.9 | (8/11)GGT: 4.7 | (8/12)GGT: 4.2 | (8/13)GGT: 4.4 | (8/14)GGT: 4.4 | (8/15)GGT: 5 | (8/16)GGT: 5.1 |
| BT: 0.51 | (9/9)BT: 0.56 | (9/10)BT: 0.53 | (9/11)BT: 0.53 | (9/12)BT: 0.54 | (9/13)BT: 0.6 | (9/14)BT: 0.6 | (9/15)BT: 0.2 | (9/16)BT: 0.1 |
| BD: 0.4 | (9/9)BD: 0.5 | (9/10)BD: 0.5 | (9/11)BD: 0.5 | (9/12)BD: 0.6 | (9/13)BD: 0.5 | (9/14)BD: 0.4 | (9/15)BD: 0.5 | (9/16)BD: 0.08 |
| ALT: 35.4 | (9/9)ALT: 34.5 | (9/10)ALT: 34.5 | (9/11)ALT: 34.2 | (9/12)ALT: 34.5 | (9/13)ALT: 34.5 | (9/14)ALT: 34.5 | (9/15)ALT: 34.5 | (9/16)ALT: 34.5 |
| AST: 44.6 | (9/9)AST: 46.6 | (9/10)AST: 42.4 | (9/11)AST: 44.5 | (9/12)AST: 42.1 | (9/13)AST: 42.6 | (9/14)AST: 42.6 | (9/15)AST: 46.1 | (9/16)AST: 55 |
| GGT: 4.8 | (9/9)GGT: 5 | (9/10)GGT: 5.2 | (9/11)GGT: 5.1 | (9/12)GGT: 4.5 | (9/13)GGT: 4.8 | (9/14)GGT: 4.8 | (9/15)GGT: 5 | (9/16)GGT: 4.7 |
| BT: 0.8 | (10/9)BT: 0.8 | (10/10)BT: 0.8 | (10/11)BT: 0.68 | (10/12)BT: 0.77 | (10/13)BT: 0.8 | (10/14)BT: 0.8 | (10/15)BT: 0.79 | (10/16)BT: 0.8 |
| BD: 0.49 | (10/9)BD: 0.4 | (10/10)BD: 0.32 | (10/11)BD: 0.42 | (10/12)BD: 0.4 | (10/13)BD: 0.3 | (10/14)BD: 0.3 | (10/15)BD: 0.35 | (10/16)BD: 0.5 |
| FA: 73.5 | (10/9)FA: 77.1 | (10/10)FA: 76.9 | (10/11)FA: 77.9 | (10/12)FA: 77.9 | (10/13)FA: 74.8 | (10/14)FA: 73.9 | (10/15)FA: 76 | (10/16)FA: 78 |
| ALT: 35.1 | (10/9)ALT: 35.9 | (10/10)ALT: 35.6 | (10/11)ALT: 36.9 | (10/12)ALT: 36.9 | (10/13)ALT: 35.7 | (10/14)ALT: 35.7 | (10/15)ALT: 36.3 | (10/16)ALT: 36.1 |
| AST: 44.3 | (10/9)AST: 45 | (10/10)AST: 45.8 | (10/11)AST: 44 | (10/12)AST: 42.9 | (10/13)AST: 44 | (10/14)AST: 44 | (10/15)AST: 45 | (10/16)AST: 46 |
| AST: 4.4 | (10/9)AST: 4.2 | (10/10)GGT: 4.9 | (10/11)GGT: 5 | (10/12)GGT: 5 | (10/13)GGT: 5.2 | (10/14)GGT: 5.1 | (10/15)GGT: 4.9 | (10/16)GGT: 5 |
Experimental repairs of bile duct injuries have been done using human amnion as free grafts. Aikawa and group designed a technique for increasing the diameter of a segment of the bile duct in a pig model, with a bioabsorbable polymer patch (amnion), a substitute designed for its application in biliary stenosis. The same was shown with our technique, which also has another potential application in the substitution of a complete bile duct segment. The non-circumferential losses of the duct appear to be satisfactorily repaired with the amnion, similar to a plastic surgery repair. However, complete loss (circumferential) of the duct is not adequately repaired with the amnion graft.

Good results were obtained in experiments in which a small biograft of porcine intestinal mucosa was used in 15 dogs (SIS graft), nine with longitudinal injury of the gallbladder (elliptical patch) and six with resection of the anterior 2/3 of the bile duct (tubularized and interposing an SIS graft of 2-3 cm). A biliary fistula was observed in only 1/9 animals with the patch. This technique implies the need of a “donor operation” and another “recipient operation.” In the case of the technique proposed here, the donor site is adjacent and does not take >5 min to extract the graft due to the simplicity of the technique and without need of donor site closure. The fabrication of the neo-conduit is also very simple and easily reproducible, evidence that has previously been published. The potential for the use of this technique (similar to the SIS) as surgeries in stenosis or as an interposition graft in complex bile injuries is promising and encouraging. There are even reports of its use in humans for vascular repair as an emergent or elective procedure or due to a benign or malignant disease, with long-term follow-up without dilation or stenosis.

It is proposed with an experimental model of repair of injuries and stenosis of the bile duct that application of a posterior peritoneal and aponeurosis autograft of the anterior rectus, a rapid and simple procedure, can avoid performing complex biliodigestive bypasses representing prolonged surgical times and elevated morbidity, increasing the probability of complications.

We recognize that our study has some limitations: close follow-up that should be done in humans who have had bile duct repair with a biliodigestive bypass with frequent laboratory blood work studies, coagulation times, liver function tests, cholangiography, and lifetime prophylactic antibiotic therapy is impractical in experimental animals. This animal model suffered from treatment with an optimal antibiotic due to technical difficulties of its administration and due to lack of endoscopic studies and complementary imaging studies. However, the procedure that we propose apparently has low morbidity as an infectious complication was observed in only one animal (hepatic abscess). We did not attempt to evaluate long-term progress, but only the ease of performance, feasibility and application of the technique. Long-term follow-up appears promising, but further work with a larger number of individuals is necessary to evaluate the evolution and to determine the durability.

In conclusion, animals that have a peritoneal and posterior aponeurosis of the anterior rectus muscle of the abdomen autograft placed for repair of injuries due to a loss of a segment of bile duct show changes in the grafted segment and in the hepatic parenchyma that do not appear to have an impact on their normal activities or in liver function tests and appear to be recoverable. For this reason, this type of surgical intervention constitutes a treatment alternative that deserves to be studied with larger samples as a promising option in humans for bile duct injury repair due to loss of a segment or due to stenosis. This technique is proposed to undergo trials in humans with Bismuth-Strasberg E1-3 type injuries due to our results in this animal model.

References


