The American Journal of Surgery (2010) 200, 124–130

The American Journal of Surgery®

Scientific (EXP)/Research

A novel technique for hepaticojejunostomy for nondilated bile ducts: a purse-string anastomosis with an intra-anastomotic biodegradable biliary stent

Johanna Laukkarinen, M.D., Ph.D.[a,1,*], Juhani Sand, M.D., Ph.D.[a,1], Jenni Leppiniemi, M.S.[b], Minna Kellomäki, Ph.D.[b], Isto Nordback, M.D., Ph.D.[a]

[a]Department of Gastroenterology and Alimentary Tract Surgery, Tampere University Hospital, Teiskontie 35, Finnish 33521, Tampere, Finland; [b]Institute of Biomaterials, Tampere University of Technology, Tampere, Finland

KEYWORDS:
Biodegradable;
Bioabsorbable;
Stent;
Bile duct;
Biliary;
Hepaticojejunostomy;
Purse-string;
Anastomosis

Abstract. In non-dilated bile ducts, performing a well-functioning hepaticojejunal anastomosis (HJ) may be challenging. We investigated a novel technique for small-caliber HJ: a purse-string anastomosis with an intra-anastomotic biodegradable stent. HJ was performed randomly either conventionally with interrupted sutures without any stent (n = 5; conventional) or using the novel purse-string technique with a 4-mm caliber polylactide-barium sulfate biodegradable biliary stent (n = 4; pursestring + stent) in minipigs with bile ducts 3.5–4.0 mm in caliber. The anastomosis creation time was not different in the groups. In the conventional group 2 complications occurred: 1 early anastomotic leakage, and 1 late anastomotic stricture. The remaining animals (3/5 in conventional, and 4/4 in purse-string + stent group) had normal liver histology and function, and developed no signs of complications during the 6-month follow-up. All biodegradable stents disappeared by 3 months. At 6 months, the HJ caliber was smaller in the conventional (5 [1–9] mm) than in the purse-string + stent group (12 [4–15] mm; $P < .05$). We conclude that this novel HJ technique is easy and safe to perform, and ensures a well-functioning anastomosis in nondilated bile ducts.

Hepaticojejunostomy (HJ) is a common procedure used to establish continuity when bypassing an obstructed bile duct (BD), and after resections of BD for various diseases and injuries. When the ducts are dilated due to biliary obstruction, the anastomosis is in most cases fairly easy to constitute, which in turn minimizes the risk for postoperative complications. With nondilated ducts, however, the early and late complications, such as leak and stricture formation, remain a challenging problem.[1–5] Controversy persists regarding which operative technique best prevents the anastomotic problems in these small ducts. Selective use of a transanastomotic stent has been recommended by some authors.[6,7] However, stenting techniques with a direct external connection (percutaneous drainage) create discomfort for the patient and may increase the risk of complications (infections, hemorrhage and bile leakage).[8] In this regard, an internal biodegradable biliary stent has certain advantages, such as a missing pass through the liver parenchyma or external connection, and no need for later stent removal.

We have recently developed a braided, self-expanding polylactide-barium sulfate (PLA-$BaSO_4$) biodegradable radiopaque stent and showed that it can be safely and effectively used in the conventional type of HJ performed in

[1]These authors contributed equally to the study.

* Corresponding author. Tel.: +358 3 311 611; fax: +358-33116 4358.
E-mail address: johanna.laukkarinen@fimnet.fi

Manuscript received February 16, 2009; revised manuscript May 6, 2009

0002-9610/$ - see front matter © 2010 Elsevier Inc. All rights reserved.
doi:10.1016/j.amjsurg.2009.05.012

7-mm to 9-mm BDs in swine, where it improves biliary drainage during an 18-month follow-up.[9] This kind of a stent also ensures healing of cytic duct leakage better than a plastic stent.[10] In addition, we have reported the first patients where the pancreatico-jejunostomy (PJ) anastomosis was created using purse-string technique and a biodegradable stent after pancreatoduodenectomy.[11,12] HJ anastomosis is usually created with interrupted sutures. We hypothesized that, instead of interrupted sutures, also in nondilated BDs it might be easy and safe to create a purse-string anastomosis, and to use a biodegradable stent inside to ensure anastomosis patency.

The aim of the present study was to investigate the use of this novel technique of HJ, featuring a purse-string anastomosis and the braided, self-expanding, radiopaque, PLA-$BaSO_4$ biodegradable biliary stent, and to compare the outcome to a conventional HJ anastomosis technique with interrupted sutures and without any stent in the HJ anastomosis with fairly small caliber BDs in minipigs.

Methods

The braided, gamma-sterilized biodegradable biliary stents and the custom-made elastic applicators were manufactured in the Institute of Biomaterials, Tampere University of Technology, Tampere, Finland, as previously described in detail.[9–11] The stent wall thickness was .25 mm, length 30 mm, and the outer diameter 4 mm when fully expanded (Fig. 1).

For all of the experiments and operations, anesthesia was induced after a 1-day fast by propofol (Propofol Alpharma 10 mg/mL, Alpharma AS, Oslo, Norway) 5 mg/kg by intravenous (IV) bolus after atropine (Atropin 1 mg/mL, OY Leiras Finland AB, Turku, Finland) .05 mg/kg administered imtramuscularly (IM) plus azaperone (Stresnil 40 mg/mL, Janssen Animal Health BVBA, Beerse, Belgium) 4 mg/kg IM premedication. The anesthesia was maintained with propofol 15 mg/kg/h and analgesia with fentanyl citrate (Fentanyl, 50 μg/mL; Janssen Pharmaceutica, Beerse, Belgium) 5 μg/kg/h after intubation with a cuffed endotracheal tube. During the induction of the anesthesia before the operations, the animals received cefuroxim (Zinacef; GlaxoSmithKline, London, UK) 30 mg/kg IV.

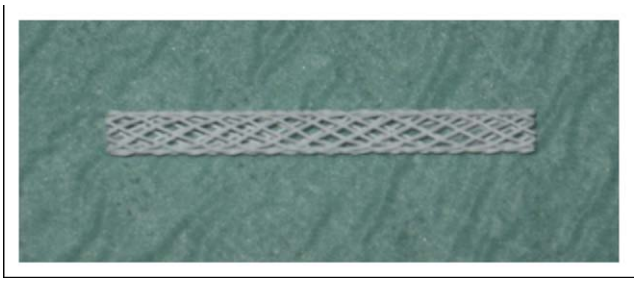

Figure 1 The braided, self-expanding, PLA-$BaSO_4$ biodegradable stent (length 20 mm, outer diameter 4 mm) used inside the novel purse-string HJ anastomosis.

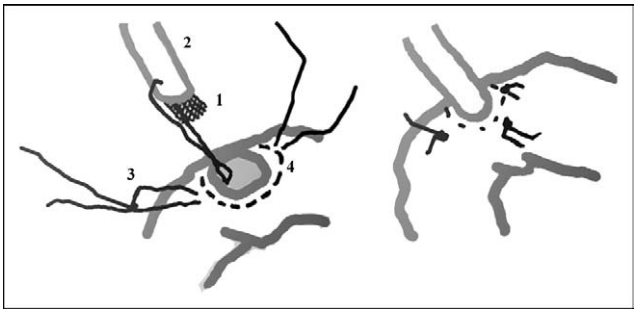

Figure 2 A schematic drawing of the novel HJ technique. A biodegradable biliary stent (1) is first introduced into the bile duct (2), after which, with the aid of 3 stay-sutures (one shown; 3), the bile duct with the stent is slide well inside the jejunal purse-string (4), which is then tightened.

Midline laparotomy was performed on 9 minipigs (weight median 23 kg [range 20–25 kg]). Cholecystectomy was performed and BD divided above the cystic duct confluence. The BD inner diameter was measured by probing. The jejunum was transected 15 cm distal to ligament Treitz. An end-to-side HJ was then performed, randomly either conventionally with interrupted 4-0 polytrimethylene carbonate sutures (Maxon; Syneture, Norwalk, CT) in 1 layer without any stent (n = 5) or by the novel purse-string technique (n = 4). The biodegradable biliary stent was first introduced into the BD, after which, with the aid of 3 pull-sutures (running through the bowel wall, the BD wall, and the stent), the BD with the stent was slid well inside the jejunum, which was tightened with the purse-string. The jejunal mucosa was inverted to create a serosa–serosa contact to BD and jejunum (Fig. 2). An end-to-side jejunojejunal anastomosis (Roux-en-Y) was made 50 cm distal to the HJ anastomosis in 2 layers with 4-0 polytrimethylene carbonate (Maxon) sutures (Figs. 2 and 3).

Prior to extubation, buprenorfine (Temgesic, .3 mg/mL, Reckitt & Colman Products, Ltd., Hull, UK) .009 mg/kg IM was given for postoperative pain medication; the dose was repeated after 8 hours and continued twice daily for the 3 following days or longer if needed. The animals received cefalexin (Kefexin, Orion, Espoo, Finland) 500 mg orally daily for 3 days to prevent intra-abdominal infections and omepratzole (Losec mups, AstraZeneca, Södertälje, Sweden) 20 mg orally daily for the entire follow-up period to prevent gastroduodenal ulcers. The animals were followed by repeated x-rays and liver chemistry for 6 months. They were fed with standard pig chow and were allowed free access to water and free movement in their pens. The study protocol was reviewed and approved by the Provincial Government of Eastern Finland and the Animal Ethics Committee of the University of Kuopio, Finland.

At 1 months, 3 months, and 6 months postoperatively, repeated serum (alanine transferase, alkaline phosphatase, total bilirubin, lactate dehydrogenase, amylase) and plasma (thromboplastin time) tests, and abdominal radiographs to