

## Laparoscopic choledochojejunostomy via PTFE-covered stent successfully achieves internal drainage of common bile duct obstruction

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### Abstract

The purpose of this study was to develop a method of laparoscopic biliary bypass utilizing a PTFE-covered biliary stent. An animal model of common bile duct obstruction was developed. Three days before the planned choledochojejunostomy, the common duct in 10 female pigs was ligated using mini-laparoscopy instrumentation (2 mm) to create an obstruction model. A laparoscopic choledochojejunostomy was then performed using intracorporal suturing ( $n = 5$ ) or stented ( $n = 5$ ) techniques. In the sutured group, a side-to-side two-layer anastomosis was performed. In the stented group, a Seldinger technique was used to deliver the stent into the abdomen through the small bowel and into the anterior wall of the common bile duct for deployment across both the duct and bowel to create an anastomosis (under fluoroscopic guidance). After the surgery, the animals were followed for 7 days, and then sacrificed to examine the anastomosis grossly and histologically. Statistical analysis was used to compare the two groups. Although the difference was not statistically significant, the mean anastomosis time in minutes was shorter for the stented group (37.8; range 15–74 minutes) than in the sutured group (52.8; range 28–70 minutes). All animals survived for 7 days after the procedure with no detectable biliary leaks or biliary obstruction at autopsy. These gross findings were confirmed by pathologic examination of the anastomoses. Laparoscopic choledochojejunostomy using a PTFE-covered metallic biliary stent can be performed to relieve common bile duct obstruction. In addition, the stent method was as safe and effective as sutured laparoscopic choledochojejunostomy.

**Key Words:** *Laparoscopy, choledochojejunostomy, biliary bypass, biliary obstruction, stent*

### Introduction

Because of the current inability to screen for periampullary malignancies and the biologic aggressiveness associated with these cancers, more than 80% of patients with a malignant periampullary tumor present with jaundice and are not amenable to surgical resection [1,2]. Relief of jaundice in these patients controls the associated pruritus and significantly improves the overall quality of life of the patients [3]. Methods used to relieve jaundice are currently divided into operative and nonoperative procedures. Prospective randomized trials [4–8] for nonoperative methods, such as endoscopic stent placement across the malignant obstruction, are associated with a high initial success rate and low procedural morbidity and mortality. Late complications can occur, such as stent obstruction leading to recurrent jaundice and cholangitis. In contrast, the perioperative morbidity and mortality rates are higher

with open choledochojejunostomy, but it provides more durable relief of jaundice.

Minimally invasive biliary bypass has been proposed to achieve long-lasting palliation with low morbidity and mortality rates. However, there has been little use of laparoscopic choledochojejunostomy because it is a technically difficult procedure to perform. The purpose of this study was to design and test a novel method of laparoscopic choledochojejunostomy with the following characteristics: low associated morbidity and mortality, ease of performance, and potentially durable results.

### Materials and methods

#### *Animal model of distal biliary obstruction*

Ten female pigs, weighing 18–31 kg, were cared for according to institutional and published NIH guidelines

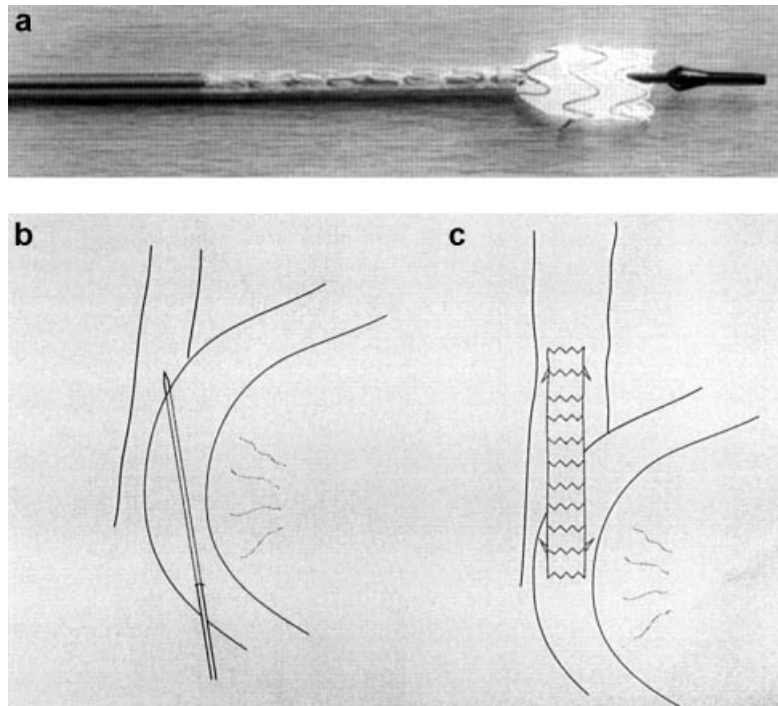


Figure 1. The PTFE-covered biliary stent is deployed via a sheath delivery system after delivery over a guidewire. Using the Seldinger technique, a needle and guidewire are placed through the small bowel and across the anterior wall of the common bile duct (CBD).

[9]. A survival surgical model of distal common bile duct (CBD) obstruction was developed as follows: after inducing general endotracheal anesthesia, intra-abdominal pneumoperitoneum was established. A 10-mm port was used for the scope and three 2-mm ports were used for the mini-laparoscopic instruments. The liver was retracted cephalad with gallbladder traction through the right lower port to expose the CBD, which was dissected free from surrounding structures and ligated distally with a 2.0 silk suture. The animals were followed clinically to determine their fitness and the presence of jaundice.

#### *PTFE-covered metallic biliary stent*

The biliary stent used (W. L. Gore & Associates, Flagstaff, AZ, USA) consists of an inner tubular lining of nonporous polytetrafluoroethylene (PTFE), impermeable to bile, surrounded by a supporting stent structure of helically wound nitinol wire (Figure 1a). The deployed stent is 8 mm in diameter and 6 cm long with drainage holes located at the proximal (hepatic) end. Radio-opaque markers at the proximal and distal ends allow visualization of the stent under fluoroscopy. The delivery system is a push rod within a 75-cm long, 10 Fr sheath with a 'Y' connector for flushing and wire manipulation.

#### *Laparoscopic sutured and stented choledochojejunostomy techniques*

At 3–5 days after CBD ligation, the animals were randomly assigned to receive one of two different

methods of laparoscopic choledochojejunostomy: sutured ( $n=5$ ) or stented ( $n=5$ ). In the sutured group, pneumoperitoneum (12 mmHg pressure) was established with a Veress needle, three 10-mm and three 5-mm ports were placed under direct visualization. The CBD was exposed in similar fashion to the CBD ligation surgery with gallbladder traction. A free jejunal loop was positioned adjacent to the common bile duct. In the sutured group, a side-to-side 1-cm choledochojejunostomy was performed with two layers of running synthetic absorbable 4-0 suture using intracorporeal suturing techniques.

In the stented group, abdominal insufflation, port placement, and retractor positioning were performed in a similar fashion. The jejunal loop was positioned adjacent to the CBD. The stent was delivered through the abdomen using the Seldinger technique. Briefly, a needle inside a 5 Fr Mixer Cholangiogram catheter (Cook Inc., Bloomington, IN, USA) was inserted through a 4-mm Berci introducer (Cook Inc.) via the right lower quadrant 5-mm port, punctured through a free small bowel loop exiting 10 cm proximally, and then inserted into the previously dilated anterior wall of the common bile duct (Figure 1b). The needle was then removed; the cholangiogram catheter was left in position and a 0.035-inch diameter Spencer modified biliary guide wire (Cook Inc.) was inserted under fluoroscopic guidance through the cholangiogram catheter and into the CBD and proximal biliary tree (Figure 1c). Under fluoroscopic guidance, the catheter was removed and the wire was then used to guide placement of the stent delivery system into the

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