Journal of Experimental and Clinical Medicine
http://dergipark.ulakbim.gov.tr/omujecm

Clinical Research

J. Exp. Clin. Med., 2016; 33(1): 27-29
doi: 10.5835/jecm.omu.33.01.008

A new surgical technique and intraoperative flourescent molecular imaging for biliary reconstruction

Arzu Sencan[a*], Chad Gridley[b], Hiep T. Nguyen[b], Aydin Sencan[c]

[a] *Department of Pediatric Surgery, Behcet Uz Children's Hospital, Izmir, Turkey*
[b] *Harvard Medical School, Boston Children's Hospital Robotic Surgery and Training Center, Boston, MA, USA*
[c] *Department of Pediatric Surgery, Faculty of Medicine, Celal Bayar University, Manisa, Turkey*

ARTICLE INFO

Article History
Received 08 / 05 / 2015
Accepted 10 / 05 / 2015

*** Correspondence to:**
Arzu Sencan
Department of Pediatric Surgery,
Dr. Behcet Uz Children's Hospital,
İzmir, Turkey
e-mail: arzusencan71@yahoo.com.tr

Keywords:
Biliary conduit
Biliary atresia
Choledochal cyst
Fluorescent molecular imaging
Pig

ABSTRACT

Up to date, many surgical techniques have been described for biliary reconstruction. The aim of this study is to try a new surgical technique for biliary reconstruction and also to show whether intraoperative fluorescent molecular imaging (IFMI) is effective to evaluate the perfusion of the new biliary conduit. Two adult pigs were operated. Cholecystectomy and removal of the extrahepatic biliary tract were performed by robotic surgery. A duodenal conduit was created from the duodenum by open surgery. The distal end of the conduit was sutured to portohepatis by end-to-end anastomosis. The perfusion of the conduit was evaluated by photo-dynamic eye. Although the viability of both of the duodenal conduits were macroscopically evaluated as normal, it was screened by IFMI that the middle and distal parts of the conduit were not well-vascularized and that only the base portion of the conduit had sufficient blood supply. As a result, IFMI is a good intraoperative diagnostic tool for showing tissue viability. This new technique may not be used for biliary reconstruction as described here. However, the development of alternative techniques to increase the viability of the conduit may enable the use of this technique successfully.

1. Introduction

The aim of surgery in choledochal cyst or biliary atresia is to remove the choledochal cyst or atretic extra hepatic biliary tract totally and to create a biliary conduit for bile flow from liver into the intestine without the reflux of intestinal contents. Jejunal loop is the most frequently used segment as a biliary conduit (Roux en Y portoenterostomy). This surgical method is effective in many patients. However, the main problem in this technique is the postoperative cholangitis due to the reflux of intestinal contents towards biliary tractus (Ohi and Nio, 1998). The main disadvantage of jejunal conduit is the very wide loop that needs to be narrowed. The jejunal loop is very wide compared to normal diameter and length of the common bile duct. In addition, while common bile duct normally opens into the duodenum, the conduit created from the jejunal loop opens into the jejunum. Furthermore, the loss of a long portion of the jejunum (about 40 cm) is the other disadvantage of this technique. For these reasons, searches for new surgical techniques of biliary conduit have been going on. Appendix conduit has been used and reported in the literature in limited number of cases. The similarity of diameter and length between the appendix and the

common bile duct, hence the lack of biliary stasis, the fact that intestinal integrity is not compromised, prevention of reflux when the anastomosis to duodenum is performed after being passed through a tunnel and being a simpler method than the classical Roux en Y can be summed up as the advantages of appendix conduit method. However, the inadequate length or the localization of the appendix and whether or not the cecum is mobile may cause technical difficulties. After reconstruction, the deterioration of the vascularity of the appendix, the luminal obstruction caused by swollen lymphoid follicles, the kink of the conduit and the development of stenosis are other problems (Crombleholme et al., 1989; Gupta and Rohatgi, 1989; Guaderer and Boyle, 1997; Delarue et al., 2000; Shah and Shah, 2005) The other method for biliary conduit is the ureteral conduit. It was reported in one presented case that the ureteral conduit has been remained open for 11 years (Weinberg, 1976). However, this method is not routinely used and is not a method of choice.

2. Methods

This study was performed in John Enders Pediatric Research Laboratories (Boston, MA, USA). After obtaining approval from the Ethics Committee of Animal Care and Use, it was planned to use 7 adult pigs, 5 of which were survival. However, after evaluating the results of the first two surgeries, the study was terminated following the second operation.

Fig. 1. Creation of conduit from the duodenum. The vascularity of the conduit looks normal macroscopically.

Surgical procedures

In this study, two adult pigs were used. Under general anesthesia, 4 working ports, one of which was the camera port, were placed on the upper quadrants of the abdomen. The da Vinci robot (Intuitive Surgical Inc.) was connected to the ports on reverse Trendelenburg position. The dissection of the gallbladder and extrahepatic biliary tract was performed robotically. However, due to the technical difficulties in the retraction of the liver and surgeon inexperience, creation of the duodenal conduit and the anastomosis of the conduit to portohepatis was performed after converting to open surgery in both of the pigs. After the removal of the gallbladder and the extrahepatic biliary tract, a duodenal conduit, 7 cm in length and 6 mm in diameter was created from the antimesenteric side of the duodenum by Endo-GIATM stapler (Autosuture). The conduit lumen patency was checked by a catheter (Fig. 1). The distal end of the conduit was sutured to portohepatis by end-to-end anastomosis with 6/0 polyglactin and the biliary reconstruction was completed.

Molecular imaging

2 cc Indocyanine Green (ICG) (Sigma Aldrich) was given via intravenous route and the perfusion of the duodenal conduit was evaluated by photo-dynamic eye (Hamamatsu Photonics KK, Japan). The molecular images were then recorded.

3. Results

Biliary reconstruction was successfully performed by the creation of duodenal conduit with sufficient length in both of the subjects. Although the viability of both of the duodenal conduits were macroscopically evaluated as normal (Fig. 1), it was screened by photo-dynamic eye that the middle and distal parts of the conduit were not well-vascularized and only the base portion of the conduit had sufficient blood supply (Fig. 2).

4. Discussion

The purpose of surgical treatment of choledochal cyst or biliary atresia is total removal of the cysts or atretic extrahepatic biliary tract and creation of an adequate biliary conduit that allows bile flow. The most common biliary conduit that is being used is jejunal loop (Roux en Y) (Ohi and Nio, 1998). In addition, appendix and ureter were also used to create biliary conduit in

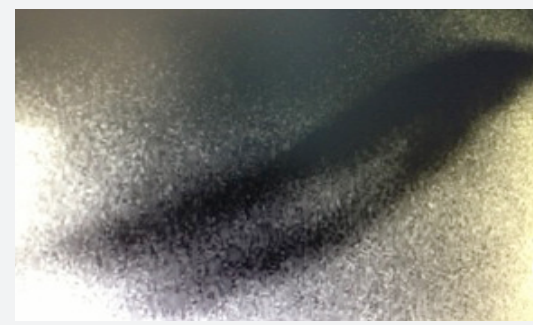

Fig. 2. Fluorescent molecular images obtained after Indocyanine Green injection. The middle and distal parts of the conduit are not well-vascularized.

a limited number of patients (Crombleholme et al., 1989; Gupta and Rohatgi, 1989; Guaderer and Boyle, 1997; Delarue et al., 2000; Shah and Shah 2005). Each method has its own advantages and disadvantages. In this article, a new surgical technique that has never been described in the literature before and intraoperative molecular imaging modality were used and the results were discussed.

Our described surgical technique has several advantages over the jejunal loop and appendix conduit; the created conduit is more physiologic because it is similar to common bile duct in diameter and length. It allows the direct flow of bile from gallbladder into the duodenum. This technique is much simpler and much shorter in duration than the classical Roux en Y technique. There is only one anastomosis to the portohepatis and the patency of the distal bowel remains intact. This technique, due to its simplicity and short duration compared to Roux en Y technique, seems to be a method of choice that can be more easily performed by laparoscopic and laparoscopy-assisted robotic surgery. The reason for not completing the biliary reconstruction by laparoscopy-assisted robotic surgery in this study was related with technical difficulties due to surgeon inexperience in robotic surgery. However, the main problem in the defined technique was the insufficient vascular supply of the created conduit evaluated by intraoperative fluorescent molecular imaging (IFMI). At the end of the surgical procedures, the insufficiency of the blood supply of the conduits was not obvious macroscopically and was evaluated as normal. Molecular images obtained after intravenous ICG infusion, however, showed that blood supply of the conduit adjacent to duodenum was good, but the middle and the distal part of the conduit were not well- vascularized. IFMI is important to show that molecular imaging can be used as a diagnostic tool for the evaluation of intraoperative blood supply of the organs. Literature about intraoperative photodynamic eye that is being successfully used for the evaluation of blood supply of organs and anastomotic sites has been increasing recently (Tobis et al., 2011; van der Poel et al., 2011; Mitsui et al., 2012). In our study, we evaluated the vascularity of the conduit intraoperatively by this technique. We observed that this molecular imaging was more effective in evaluating the vascularity compared to the evaluation with the naked eye. However, further studies for the development of alternative methods to provide better blood supply for the conduit (eg, omental wrapping of the conduit, creating shorter conduit, etc) and for the creation of antireflux barriers in the conduit should be planned.

There are some limitations in this study. First, the animals were not survival. Second, additional methods for neovascularization of the conduit were not tried in this study.

As a result, to create a duodenal conduit for biliary reconstruction is more physiologic and much simpler than the other biliary conduit techniques. The operation takes less time than the other surgical techniques. Nevertheless, this new technique may not be used for biliary reconstruction as described here, because the perfusion of the conduit was not sufficient. IFMI is a good intraoperative diagnostic tool for showing tissue viability. However, alternative techniques to increase the viability of the conduit should be developed to make this technique useable successfully.

REFERENCES

Crombleholme, T.M., Harrison, M.R., Langer, J.C., Longaker, M.T., 1989. Biliary appendico-duodenostomy: A nonrefluxing conduit for biliary reconstruction. J. Pediatr. Surg. 24, 665-667.

Delarue, A., Chappuis, J.P., Esposito, C., Valla, J.S., Bonnevalle, M., Allal, H., Robert, M., 2000. Is the appendix graft suitable for routine biliary surgery in children? J. Pediatr. Surg. 35, 1312-1326.

Guaderer, M.W.L., Boyle, J.T., 1997. Cholecystoappendicostomy in a child with Alagille syndrome. J. Pediatr. Surg. 32, 166-167.

Gupta, D.K., Rohatgi, M., 1989. Use of appendix in biliary atresia. Indian J. Pediatr. 56, 479-482.

Mitsui, Y., Shiina, H., Arichi, N., Hiraoka, T., Inoue, S., Sumura, M,, Honda S., Yasumoto, H., Igawa M., 2012. Indocyanine green (ICG)-based fluorescence navigation system for discrimination of kidney cancer from normal parenchyma: Application during partial nephrectomy. Int. Urol. Nephrol. 44, 753-759. doi: 10.1007/s11255-011-0120-x.

Ohi, R., Nio, M., 1998. The jaundiced infant: Biliary atresia and other obstruction. In Pediatric Surgery, Vol. 2, O'Neill JA., Rowe MI., Grosfeld JL., Fonkalsrud EW., Coran AG., eds. 5th ed, Mosby-Year Book, St Louis, pp. 1465-1481.

Shah, A.A., Shah, A.V., 2005. Appendix as a biliary conduit for choledochal cyst in children. Eur. J. Pediatr. Surg. 15, 128-131.

Tobis, S., Knopf, J., Silvers, C., Yao, J., Rashid, H., Wu, G., Golijanin, D., 2011. Near infrared fluorescence imaging with robotic assisted laparoscopic partial nephrectomy: Initial clinical experience for renal cortical tumors. J. Urol. 186, 47-52. doi: 10.1016/j.juro.2011.02.2701.

van der Poel, H.G., Buckle, T., Brouwer, O.R., Valdés Olmos, R.A., van Leeuwen, F.W., 2011. Intraoperative laparoscopic fluorescence guidance to the sentinel lymph node in prostate cancer patients: Clinical proof of concept of an integrated functional imaging approach using a multimodal tracer. Eur. Urol. 60, 826-33. doi: 10.1016/j.eururo.2011.03.024.

Weinberg, R.W., 1976. Appendix ureteroplasty. Br. J. Urol. 48, 234.