

# Effect of polylactic film (Surgi-Wrap) on preventing postoperative ileus after major hepato-pancreato-biliary surgery

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**Backgrounds/Aims:** Major hepato-pancreato-biliary (HPB) surgery is usually performed via an open method rather than a laparoscopic method. Postoperative ileus (POI) is a classic complication after open surgery. The purpose of this study was to determine whether polylactic film is useful in the prevention of POI. **Methods:** A total of 179 patients who underwent major HPB surgery between 2005 and 2014, were retrospectively reviewed. A diagnosis of POI was made by a physical examination, laboratory, and radiological findings. Surgi-Wrap<sup>®</sup> polylactic film was preferentially used intraperitoneally by surgeons, just before wound closure. **Results:** Major HPB surgery included pancreato-duodenectomy (n=48), distal or subtotal pancreatectomy (n=24), hepatectomy (n=67), other bile duct or gallbladder operations (n=35), and others (n=5). Although patients with polylactic film showed a significantly lower incidence of POI (n=3, 4.1% vs. n=14, 13.3%,  $p=0.041$ ), they showed a significantly higher complication rate (n=20, 27.0% vs. n=19, 18.1%,  $p=0.004$ ), particularly intra-abdominal fluid collection (n=7, 9.4% vs. n=2, 1.9%), and wound infections (n=6, 8.1% vs. n=3, 2.9%), than those who did not receive the film, respectively. **Conclusions:** Although the polylactic film prevented POI, more complications other than POI were observed. Well-designed randomized controlled trials, using this anti-adhesive product, are needed to evaluate its effect on POI after major HPB surgery. (*Ann Hepatobiliary Pancreat Surg* 2016;20:191-196)

**Key Words:** Polylactic film; Postoperative ileus

## INTRODUCTION

Postoperative ileus (POI) is a common complication after abdominal surgery, and involves a temporary impairment in gastrointestinal (GI) motility following surgery.<sup>1-6</sup> POI is characterized by a lack of coordinated intestinal activity and a substantial overall reduction in peristalsis.

The clinical manifestations of POI vary, but include nausea, vomiting, abdominal distension, abdominal pain, inability to eat, or delayed passage of flatus and stool.<sup>5-7</sup> Patients may develop bloating and bilious emesis. The small bowel typically recovers movement within hours, and the colon recovers in 3-5 days following surgery, but POI is clinically distinct from this GI dysfunction.<sup>1</sup>

POI after GI surgery constitutes a major burden for healthcare globally, and may require repeated surgical

interventions.<sup>4</sup> Adhesions can result in serious clinical complications, such as intestinal obstructions, inadvertent enterotomy at reoperation, and secondary female infertility. Such complications require medical care as well as additional difficult surgical interventions, increasing the healthcare costs and leading to further complications.<sup>8-10</sup>

Intraperitoneal adhesions after abdominal surgery are the main cause of POI. Peritoneal adhesions form after healing of the peritoneal wound.<sup>2,3,10</sup> As a result, various interventions have been developed to separate the damaged peritoneum from the surrounding tissues.<sup>11</sup> Several clinical studies have reported the use of anti-adhesive film (AAF) significantly reduces the incidence of POI.<sup>4,8-10,12-19</sup>

However, few studies have evaluated the preventive effect of AAF for POI after major hepato-pancreato-biliary (HPB) surgery. Many studies about POI have focused on

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colorectal and obstetric surgery. Thus, the purpose of this study was to examine the safety and efficacy of poly(lactic acid) film (Surgi-Wrap<sup>®</sup>) as one of the anti-adhesion products after major HPB surgery.

## MATERIALS AND METHODS

### Study population

This retrospective cohort study was performed by reviewing the medical records of patients who had HPB surgery at Dongguk University Ilsan Hospital between October 2005 and November 2014. HPB surgery included pancreaticoduodenectomy, distal or subtotal pancreatectomy, hepatectomy, bile duct surgery, and extended cholecystectomy. All medical records were reviewed by a clinical research nurse and a general surgeon. All operations were performed by four surgeons who specialized in HPB surgery, using standard HPB surgical methods.

### Poly(lactic acid) film

Surgi-Wrap<sup>®</sup> (Surgi-Wrap MAST Bioresorbable Sheet, MAST Biosurgery Inc., San Diego, CA, USA) was used as the AAF material. Surgi-Wrap is a bioresorbable polymer sheet material fabricated essentially from the same lactic acid building blocks that occur naturally in the body.<sup>20</sup> The safety and effectiveness of Surgi-Wrap has been evaluated in preclinical animal studies.<sup>21,22</sup> Several clinical studies have demonstrated that poly(lactic acid) film significantly decreased the incidence and severity of adhesions, as it separates the tissue during wound healing.<sup>10,16,19,23</sup> Surgi-Wrap<sup>®</sup> was selectively used prefer-

entially by the surgeon, as an intraperitoneal spread just before wound closure after surgery.

### Postoperative ileus

POI is traditionally associated with a combination of upper and lower GI symptoms. A radiological investigation may be used in conjunction with the clinical diagnosis to confirm POI, but is usually reserved to exclude a bowel obstruction or a precipitating cause.<sup>1,7,9,17,24,25</sup> In this study, POI was classified into early and late types. Early type POI was defined as patients having unusual functional GI symptoms within the initial admission period. Patients with early POI were unable to start oral feeding at post-operative 5<sup>th</sup> day due to GI symptoms, which were observed as radiologic intestinal obstructions. The late POI type was defined as patients re-admitted due to POI.

### Statistical analysis

The data were analyzed with SPSS ver. 19.0 software (SPSS Inc., Chicago, IL, USA). The groups were compared using the independent *t*-test. A *p*-value  $\leq 0.05$  was considered significant. Continuous variables were reported as mean $\pm$ standard deviation (SD), and categorical data were presented as numbers and percentages.

## RESULTS

### Patient clinical characteristics

The study population consisted of 179 patients: 74 received Surgi-Wrap<sup>®</sup>, and 105 did not. No differences

**Table 1.** Clinical characteristics of patients

Variables	Patients without Surgi-Wrap <sup>®</sup> (n=105)	Patients with Surgi-Wrap <sup>®</sup> (n=74)	<i>p</i> -value
Age (years, mean $\pm$ SD)	60.6 $\pm$ 14.2	60.7 $\pm$ 14.0	0.949
Gender (male:female)	51:54	47:27	0.067
BMI (kg/m <sup>2</sup> , mean $\pm$ SD)	23.7 $\pm$ 3.8	22.9 $\pm$ 3.3	0.125
Co-morbidity (n, %)			
Cardiovascular ds	34 (32.4)	29 (39.2)	0.348
Diabetes mellitus	17 (16.2)	19 (25.7)	0.119
Pulmonary ds	5 (4.8)	4 (5.4)	1.000
Others	3 (2.9)	0	0.874
History of prior abdominal surgery (n, %)	32 (30.5)	20 (27.0)	0.617
Follow-up duration (months)	33.0 (2-115)	29.7 (3-104)	0.154

BMI, body mass index

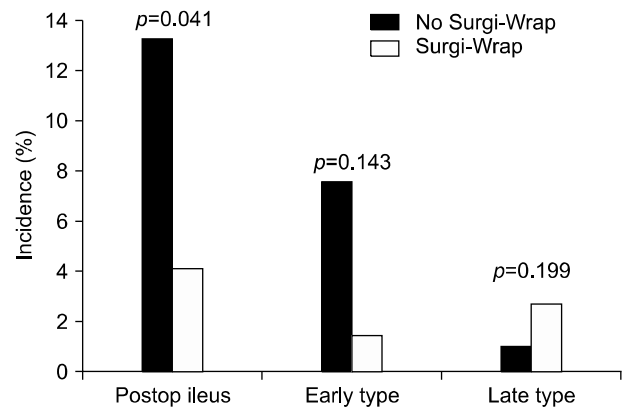
were observed in the patient characteristics, such as, age, sex, body mass index, co-morbidities, history of abdominal surgery, or follow-up duration between the groups (Table 1).

The proportion of patients with malignant disease was significantly higher in the group that received Surgi-Wrap<sup>®</sup> than in those who did not (60.9% vs. 83.7%, respectively;  $p=0.001$ ; Table 2).

**Clinical outcomes**

As shown in Fig. 1, patients without Surgi-Wrap<sup>®</sup> had a significantly higher POI rate than those with Surgi-Wrap<sup>®</sup> ( $n=14$ , 13.3% vs.  $n=3$ , 4.1%, respectively;  $p=0.041$ ). All 17 patients were treated with conservative management. Patients who did not receive Surgi-Wrap<sup>®</sup> had a significantly lower morbidity rate than patients with Surgi-Wrap<sup>®</sup>, such as postoperative hemorrhage, intra-abdomi-

nal fluid collection, and wound infections ( $n=19$ , 18.1% vs.  $n=20$ , 27%, respectively;  $p=0.004$ ; Table 3). On the



**Fig. 1.** Incidence rate of POI. The patients without Surgi-Wrap<sup>®</sup> had a significantly higher POI rate than those with Surgi-Wrap<sup>®</sup> ( $n=14$ , 13.3% vs.  $n=3$ , 4.1%;  $p=0.041$ ).

**Table 2.** Operative details and pathological data

Variables	Patients without Surgi-Wrap <sup>®</sup> (n=105)	Patients with Surgi-Wrap <sup>®</sup> (n=74)	p-value
Pathology (benign: malignant, %)	41:64 (60.9)	2:62 (83.7)	0.001
Diagnosis (n, %)			0.299
Periampullary diseases	24 (22.9)	26 (35.1)	
Liver diseases	32 (30.5)	19 (25.7)	
Other pancreatic diseases	14 (13.3)	12 (16.2)	
Other bile duct or gallbladder disease	31 (29.5)	14 (18.9)	
Others	4 (3.8)	3 (4.1)	
Operative methods			0.226
PD/PPPD	24 (22.9)	24 (32.4)	
Distal/subtotal pancreatectomy	12 (11.4)	12 (16.2)	
Hepatectomy	40 (38.7)	27 (36.5)	
Other bile duct or gallbladder operation	26 (24.8)	9 (12.2)	
Others	3 (2.9)	2 (2.7)	
Operating time (min, mean±SD)	318.9±172.2	305.5±125.4	0.554

PD, pancreaticoduodenectomy; PPPD, Pylorus-preserving pancreaticoduodenectomy

**Table 3.** Complications, other than postoperative ileus

Variables	Patients without Surgi-Wrap <sup>®</sup> (n=105)	Patients with Surgi-Wrap <sup>®</sup> (n=74)	p-value
Overall morbidity (n, %)	19 (18.1)	20 (27.0)	0.004
Hemorrhage (n, %)	2 (1.9)	3 (4.1)	
Intra-abdominal fluid collection or abscess (n, %)	2 (1.9)	7 (9.4)	
Wound infection (n, %)	3 (2.8)	6 (8.1)	
Pancreatic fistula (n, %)	12 (11.4)	4 (5.4)	
Postoperative hospital days (mean±SD)	17.9±8.5	26±17.4	0.833
Re-operation due to all causes (n, %)	2 (1.9)	5 (6.8)	0.127
30-days mortality (n, %)	0	0	1.000

other hand, rate of pancreatic fistulas was higher in patients without Surgi-Wrap<sup>®</sup> than in patients with Surgi-Wrap<sup>®</sup> (n=12, 11.4% vs. n=4 5.4%, respectively; Table 3). Re-operations were performed in 7 patients due to postoperative bleeding (n=3), wound dehiscence (n=2), and wound infection (n=2), all of which were unrelated to POI.

## DISCUSSION

Postoperative adhesions are a common cause of POI due to pathophysiology of peritoneal wound healing.<sup>1,7,10</sup> Postoperative adhesions account for 40% of POI cases, and 30-40% of these patients require reoperation to relieve POI.<sup>1-3</sup> Effective methods are being researched to prevent adhesions, and a diverse clinical techniques and agents have been advocated for preventing postoperative adhesions, including anti-inflammatory agents, antibiotics, fibrinolytic agents, solution barriers, and synthetic solid barriers.<sup>1,4-6,9,11,26</sup> Many studies have demonstrated the efficacy and safety of AAF for preventing POI, by separating the peritoneum from the damaged serosal area.<sup>9-13,15-19,23</sup> Fazio et al.<sup>15</sup> reported that AAF reduces POI after colorectal surgery, since their study observed a significant difference in the incidence of POI requiring reoperation, when compared with or without AAF. A prospective randomized trial in Korea showed that AAF significantly reduced POI after colorectal surgery.<sup>17</sup> Conversely, other studies have reported that although AAF significantly reduced the severity of postoperative adhesions, no difference in the incidence of POI was observed.<sup>9,18</sup> In the present study, the incidence of POI after major HPB surgery was significantly lower in the group of patients who received Surgi-Wrap<sup>®</sup> than those who did not (Fig. 1). Another study reported no benefit of Surgi-Wrap<sup>®</sup> in HPB surgery.<sup>27</sup> The gastric stasis rate were 2.3% and 3.2% in Surgi-Wrap<sup>®</sup> group and control group, respectively ( $p=0.77$ ). However, the incidence rate was too low in both groups, and further studies are necessary to prove the actual effect of Surgi-Wrap<sup>®</sup>.

In this study, the rate of other complications other than POI was higher in patients with Surgi-Wrap<sup>®</sup> than in those without Surgi-Wrap<sup>®</sup> (Table 3). Among these complications, intra-abdominal fluid collection or abscess occurred frequently in patients who received Surgi-Wrap<sup>®</sup> (Table 3). Several studies have reported the incidence

rates of postoperative intra-abdominal abscess or fluid collection.<sup>4,8,9,12,14,17,25</sup> Some reported that AAF significantly increased the incidence of anastomotic leakage or intra-abdominal abscesses after surgery, and suggested that AAF may interfere with the formation of "good" adhesions created by the inflammatory response.<sup>9,12</sup> Another possible reason is that Surgi-Wrap<sup>®</sup> could produce a foreign body reaction, and disturb absorption of the fluid and ascites remaining after surgery.

A wide range of natural and synthetic materials, including Surgi-Wrap<sup>®</sup>, are used as solid barriers and as absorbable or non-absorbable foil or membranes. Solid barriers must be directly applied to the damaged surface, which carries the risk of leaving uncovered wounded areas as a result of inappropriate application. The entire lesion must be covered and may need to be fixed with sutures, which can induce adhesions.<sup>10</sup> Using liquid, low viscosity barrier materials could prevent abscess formation without acting as a solid physical barrier. They are easy to apply as compared to solid barriers, and the barrier cannot be placed incorrectly since the entire peritoneal cavity is covered.<sup>10</sup> A prospective study has been planned in future, to confirm this hypothesis using a liquid barrier to prevent POI after major HPB surgery.

In this study, the incidence rate of wound infection was higher in patients with Surgi-Wrap<sup>®</sup> than without Surgi-Wrap<sup>®</sup> (Table 3). Theoretically, a surgical implant can affect the incidence of wound complications by a foreign body reaction.<sup>28</sup> However, no differences in the incidence of wound complications have been observed in many other studies evaluating polylactic films.<sup>16,20,21,23</sup> As a result, more observational or prospective studies are needed to confirm the safety of polylactic films for wound infections.

Some studies reported that patients receiving AAF experience a slightly greater frequency of pulmonary embolisms than those who do not.<sup>12,13</sup> However, other reports have suggested that AAF are safe with respect to pulmonary embolisms, when administered to patients undergoing abdominal surgery.<sup>25</sup> In our study, none of the AAF or control patients experienced a postoperative pulmonary embolism (Table 3). Because of the relatively rare incidence of pulmonary embolism and the small cohort of our study, we are unable to comment conclusively on the relationship between Surgi-Wrap<sup>®</sup> and pulmonary embolism.

Interestingly, pancreatic fistulas were more frequent in

patients who did not receive Surgi-Wrap<sup>®</sup> than in those who did (Table 3). Because pancreatic fistulas are a major complication after pancreatic surgery, numerous clinical studies have been conducted to prevent pancreatic fistulas.<sup>29-31</sup> However, no clear preventive methods to reduce pancreatic fistulas have been reported after pancreatic surgery. These results could be due to increased intraluminal pressure caused by postoperative adhesions that disturbs the flow of pancreatic juice into the anastomosed intestine or duodenum in patients without Surgi-Wrap<sup>®</sup>. We strongly expect that this will be a topic for future prospective trials to confirm this hypothesis.

This study had several limitations. As with all retrospective studies, the present study was limited in its ability to produce cause-effect relationships and to control all possible confounders. Because of the relatively small cohort of patients, it was impossible to perform subgroup or multivariate analyses, and contain heterogeneity of diseases or surgical procedures. Also, there were missing data values due to unavailable patient records and the retrospective nature of our analysis.

A limitation of Surgi-Wrap<sup>®</sup> as AAF lies in its handling characteristics, as it is brittle and difficult to apply. Moreover, since adhesions can form in all areas of the intra-abdominal cavity, it would be very expensive to apply this special covering to all areas. As mentioned above, liquid devices may be more useful in this setting. In the near future, we plan to perform a prospective study to test the preventive effect of a liquid AAF for POI after major HPB surgery.

In conclusion, use of Surgi-Wrap<sup>®</sup> during major HPB surgery decreased the incidence of POI. However, the frequencies of intra-abdominal fluid collection and abscess were higher in patients with Surgi-Wrap<sup>®</sup> than in those without Surgi-Wrap<sup>®</sup>. More evidence is needed regarding the efficacy and safety of Surgi-Wrap<sup>®</sup> to reduce POI, avoid repeated operative interventions, and for the improvement of quality of life. A further well-designed prospective randomized study to evaluate the effect of anti-adhesion products on POI after major HPB surgery is needed.

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## REFERENCES

1. Mattei P, Rombeau JL. Review of the pathophysiology and management of postoperative ileus. *World J Surg* 2006;30:1382-1391.
2. Weibel MA, Majno G. Peritoneal adhesions and their relation to abdominal surgery. A postmortem study. *Am J Surg* 1973; 126:345-353.
3. Menzies D, Ellis H. Intestinal obstruction from adhesions--how big is the problem? *Ann R Coll Surg Engl* 1990;72:60-63.
4. Robb WB, Mariette C. Strategies in the prevention of the formation of postoperative adhesions in digestive surgery: a systematic review of the literature. *Dis Colon Rectum* 2014;57: 1228-1240.
5. Lee AL, Kim CB. The effect of erythromycin on gastrointestinal motility in subtotal gastrectomized patients. *J Korean Surg Soc* 2012;82:149-155.
6. Ay AA, Kutun S, Ulucanlar H, Tarcan O, Demir A, Cetin A. Risk factors for postoperative ileus. *J Korean Surg Soc* 2011;81:242-249.
7. Vather R, Trivedi S, Bissett I. Defining postoperative ileus: results of a systematic review and global survey. *J Gastrointest Surg* 2013;17:962-972.
8. Beck DE, Cohen Z, Fleshman JW, Kaufman HS, van Goor H, Wolff BG. A prospective, randomized, multicenter, controlled study of the safety of Seprafilm adhesion barrier in abdominopelvic surgery of the intestine. *Dis Colon Rectum* 2003; 46:1310-1319.
9. Zeng Q, Yu Z, You J, Zhang Q. Efficacy and safety of Seprafilm for preventing postoperative abdominal adhesion: systematic review and meta-analysis. *World J Surg* 2007;31:2125-2131.
10. Brochhausen C, Schmitt VH, Planck CN, Rajab TK, Hollemann D, Tapprich C, et al. Current strategies and future perspectives for intraperitoneal adhesion prevention. *J Gastrointest Surg* 2012;16:1256-1274.
11. Kim JY, Cho WJ, Kim JH, Lim SH, Kim HJ, Lee YW, et al. Efficacy and safety of hyaluronate membrane in the rabbit cecum-abdominal wall adhesion model. *J Korean Surg Soc* 2013;85:51-57.
12. Becker JM, Dayton MT, Fazio VW, Beck DE, Stryker SJ, Wexner SD, et al. Prevention of postoperative abdominal adhesions by a sodium hyaluronate-based bioresorbable membrane: a prospective, randomized, double-blind multicenter study. *J Am Coll Surg* 1996;183:297-306.
13. Diamond MP. Reduction of adhesions after uterine myomectomy by Seprafilm membrane (HAL-F): a blinded, prospective, randomized, multicenter clinical study. *Seprafilm Adhesion Study Group. Fertil Steril* 1996;66:904-910.
14. Cohen Z, Senagore AJ, Dayton MT, Koruda MJ, Beck DE, Wolff BG, et al. Prevention of postoperative abdominal adhesions by a novel, glycerol/sodium hyaluronate/carboxymethylcellulose-based bioresorbable membrane: a prospective, randomized, evaluator-blinded multicenter study. *Dis Colon Rectum* 2005;48:1130-1139.
15. Fazio VW, Cohen Z, Fleshman JW, van Goor H, Bauer JJ, Wolff BG, et al. Reduction in adhesive small-bowel obstruction by Seprafilm adhesion barrier after intestinal resection. *Dis Colon Rectum* 2006;49:1-11.
16. Mabrut JY, Favre JP, Desrousseaux B, Chipponi J, Arnaud JP, Domergue J, et al. Safety and long-term outcome of a new concept for surgical adhesion-reduction strategies (Prevadh): a prospective, multicenter study. *Hepatogastroenterology* 2008;55: 517-521.
17. Park CM, Lee WY, Cho YB, Yun HR, Lee WS, Yun SH, et

- al. Sodium hyaluronate-based bioresorbable membrane (Seprafilm) reduced early postoperative intestinal obstruction after lower abdominal surgery for colorectal cancer: the preliminary report. *Int J Colorectal Dis* 2009;24:305-310.
18. van der Wal JB, Iordens GI, Vrijland WW, van Veen RN, Lange J, Jeekel J. Adhesion prevention during laparotomy: long-term follow-up of a randomized clinical trial. *Ann Surg* 2011;253:1118-1121.
  19. Canis MJ, Triopon G, Darai E, Madelenat P, LeVêque J, Panel P, et al. Adhesion prevention after myomectomy by laparotomy: a prospective multicenter comparative randomized single-blind study with second-look laparoscopy to assess the effectiveness of PREVADH™. *Eur J Obstet Gynecol Reprod Biol* 2014;178:42-47.
  20. Yamaoka T, Takahashi Y, Fujisato T, Lee CW, Tsuji T, Ohta T, et al. Novel adhesion prevention membrane based on a bioresorbable copoly(ester-ether) comprised of poly-L-lactide and Pluronic: in vitro and in vivo evaluations. *J Biomed Mater Res* 2001;54:470-479.
  21. Avital S, Bollinger TJ, Wilkinson JD, Marchetti F, Hellinger MD, Sands LR. Preventing intra-abdominal adhesions with polylactic acid film: an animal study. *Dis Colon Rectum* 2005;48:153-157.
  22. Gruber-Blum S, Petter-Puchner AH, Brand J, Fortelny RH, Walder N, Oehlinger W, et al. Comparison of three separate anti-adhesive barriers for intraperitoneal onlay mesh hernia repair in an experimental model. *Br J Surg* 2011;98:442-449.
  23. Schreiber C, Boening A, Kostolny M, Pines E, Cremer J, Lange R, et al. European clinical experience with REPEL-CV. *Expert Rev Med Devices* 2007;4:291-295.
  24. Artinyan A, Nunoo-Mensah JW, Balasubramaniam S, Gauderman J, Essani R, Gonzalez-Ruiz C, et al. Prolonged postoperative ileus-definition, risk factors, and predictors after surgery. *World J Surg* 2008;32:1495-1500.
  25. Hayashi S, Takayama T, Masuda H, Kochi M, Ishii Y, Matsuda M, et al. Bioresorbable membrane to reduce postoperative small bowel obstruction in patients with gastric cancer: a randomized clinical trial. *Ann Surg* 2008;247:766-770.
  26. Park JH, Jeong SH, Lee YJ, Choi SK, Hong SC, Jung EJ, et al. Current status of the use of antiadhesive agents for gastric cancer surgery: a questionnaire survey in South Korea. *J Korean Surg Soc* 2013;84:160-167.
  27. Park CS, Hwang S, Ahn CS, Kim KH, Moon DB, Ha TY, et al. A comparative study regarding the effect of an intraperitoneal anti-adhesive agent application in left-liver living donors. *Korean J Hepatobiliary Pancreat Surg* 2014;18:26-28.
  28. White TJ, Santos MC, Thompson JS. Factors affecting wound complications in repair of ventral hernias. *Am Surg* 1998;64:276-280.
  29. Park JS, Lee DH, Jang JY, Han Y, Yoon DS, Kim JK, et al. Use of TachoSil® patches to prevent pancreatic leaks after distal pancreatectomy: a prospective, multicenter, randomized controlled study. *J Hepatobiliary Pancreat Sci* 2016;23:110-117.
  30. Bai X, Zhang Q, Gao S, Lou J, Li G, Zhang Y, et al. Duct-to-Mucosa vs Invagination for Pancreaticojejunostomy after Pancreaticoduodenectomy: A Prospective, Randomized Controlled Trial from a Single Surgeon. *J Am Coll Surg* 2016;222:10-18.
  31. Probst P, Hüttner FJ, Klaiber U, Knebel P, Ulrich A, Büchler MW, et al. Stapler versus scalpel resection followed by hand-sewn closure of the pancreatic remnant for distal pancreatectomy. *Cochrane Database Syst Rev* 2015;(11):CD008688.