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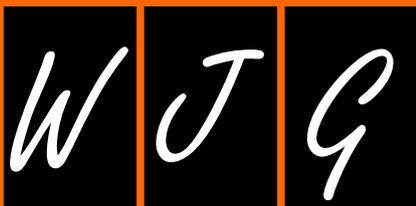
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EDITORIAL

- 5645 Direct-acting antiviral agents against hepatitis C virus and lipid metabolism

Kanda T, Moriyama M

REVIEW

- 5650 Liquid biopsy in patients with hepatocellular carcinoma: Circulating tumor cells and cell-free nucleic acids

Okajima W, Komatsu S, Ichikawa D, Miyamae M, Ohashi T, Imamura T, Kiuchi J, Nishibeppu K, Arita T, Konishi H, Shiozaki A, Moriumura R, Ikoma H, Okamoto K, Otsuji E

ORIGINAL ARTICLE

Basic Study

- 5669 Fluctuation of zonulin levels in blood vs stability of antibodies

Vojdani A, Vojdani E, Kharrazian D

- 5680 Effects of albumin/glutaraldehyde glue on healing of colonic anastomosis in rats

Despoudi K, Mantzoros I, Ioannidis O, Cheva A, Antoniou N, Konstantaras D, Symeonidis S, Pramateftakis MG, Kotidis E, Angelopoulos S, Tsalis K

- 5692 Cytoplasmic domain of tissue factor promotes liver fibrosis in mice

Knight V, Lourensz D, Tchongue J, Correia J, Tipping P, Sievert W

- 5700 *Schistosoma japonicum* attenuates dextran sodium sulfate-induced colitis in mice *via* reduction of endoplasmic reticulum stress

Liu Y, Ye Q, Liu YL, Kang J, Chen Y, Dong WG

- 5713 Metabolomic profiling for identification of metabolites and relevant pathways for taurine in hepatic stellate cells

Deng X, Liang XQ, Lu FG, Zhao XF, Fu L, Liang J

- 5722 Protective effects of *Foeniculum vulgare* root bark extract against carbon tetrachloride-induced hepatic fibrosis in mice

Zhang C, Tian X, Zhang K, Li GY, Wang HY, Wang JH

Retrospective Cohort Study

- 5732 Hypothesized summative anal physiology score correlates but poorly predicts incontinence severity

Young CJ, Zahid A, Koh CE, Young JM

- 5739 Minor endoscopic sphincterotomy followed by large balloon dilation for large choledocholith treatment

Xu XD, Chen B, Dai JJ, Qian JQ, Xu CF

- 5746 Diagnostic value of FIB-4, aspartate aminotransferase-to-platelet ratio index and liver stiffness measurement in hepatitis B virus-infected patients with persistently normal alanine aminotransferase

Tan YW, Zhou XB, Ye Y, He C, Ge GH

Retrospective Study

- 5755 Accuracy of endoscopic ultrasound-guided tissue acquisition in the evaluation of lymph node enlargement in the absence of an on-site pathologist

Chin YK, Iglesias-Garcia J, de la Iglesia D, Lariño-Noia J, Abdulkader-Nallib I, Lázare H, Rebolledo Olmedo S, Dominguez-Muñoz JE

- 5764 Doublecortin and CaM kinase-like-1 as an independent poor prognostic factor for resected pancreatic carcinoma

Nishio K, Kimura K, Amano R, Nakata B, Yamazoe S, Ohira G, Miura K, Kametani N, Tanaka H, Muguruma K, Hirakawa K, Ohira M

- 5773 Study to determine guidelines for pediatric colonoscopy

Yoshioka S, Takedatsu H, Fukunaga S, Kuwaki K, Yamasaki H, Yamauchi R, Mori A, Kawano H, Yanagi T, Mizuochi T, Ushijima K, Mitsuyama K, Tsuruta O, Torimura T

- 5780 Postoperative changes of manometry after restorative proctocolectomy in Korean ulcerative colitis patients

Oh SH, Yoon YS, Lee JL, Kim CW, Park IJ, Lim SB, Yu CS, Kim JC

- 5787 Threonine and tyrosine kinase may serve as a prognostic biomarker for gallbladder cancer

Xie Y, Lin JZ, Wang AQ, Xu WY, Long JY, Luo YF, Shi J, Liang ZY, Sang XT, Zhao HT

- 5798 Simple instruments facilitating achievement of transanal total mesorectal excision in male patients

Xu C, Song HY, Han SL, Ni SC, Zhang HX, Xing CG

- 5809 Donor-derived infections among Chinese donation after cardiac death liver recipients

Ye QF, Zhou W, Wan QQ

CASE REPORT

- 5817 Rarity among benign gastric tumors: Plexiform fibromyxoma - Report of two cases

Szurian K, Till H, Amerstorfer E, Hinteregger N, Mischinger HJ, Liegl-Atzwanger B, Brcic I

- 5823 Tegafur-uracil-induced rapid development of advanced hepatic fibrosis

Honda S, Sawada K, Hasebe T, Nakajima S, Fujiya M, Okumura T

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Retrospective Study

Postoperative changes of manometry after restorative proctocolectomy in Korean ulcerative colitis patients

Se Heon Oh, Yong Sik Yoon, Jong Lyul Lee, Chan Wook Kim, In Ja Park, Seok-Byung Lim, Chang Sik Yu, Jin Cheon Kim

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Abstract**AIM**

To investigate the changes of postoperative anal sphincter function and bowel frequency in Korean patients with ulcerative colitis (UC).

METHODS

A total of 127 patients with UC who underwent restorative proctocolectomy (RPC) during 20 years were retrospectively analyzed. The parameters of anal manometry and bowel frequency were compared according to the 6-mo intervals until 24 mo postoperatively. Manometry was used to measure the maximal squeezing pressure (MSP) and maximal resting pressure (MRP).

RESULTS

MSP decreased after surgery until 6 mo (157 to 142 mmHg); thereafter, it improved and was recovered to and maintained at the preoperative value at 12 mo postoperatively (142-170 mmHg, $P < 0.001$). Although the decreased MRP (65 to 56 mmHg) improved after 18 mo (62 mmHg), it did not completely recover to the preoperative value. The decreased rectal capacity after surgery (90 to 82 mL) gradually increased up to 150 mL at 24 mo. Although bowel frequency showed significant gradual decreases at each interval, it was stabilized after 12 mo postoperatively (6.5 times/d).

CONCLUSION

Postoperative changes of manometry and bowel frequency after restorative proctocolectomy in Korean patients with UC were not different from those in Western patients with UC.

Key words: Ulcerative colitis; Surgery; Treatment outcome; Manometry; Bowel frequency; Restorative proctocolectomy

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Core tip: Although there has been an increase in the prevalence of ulcerative colitis (UC) and the numbers of UC surgery in Asian countries, studies on the functional outcomes of restorative proctocolectomy (RPC) or the quality of life in Asians are still deficient. Most UC studies on functional outcomes were done in Westerners. The authors found that maximal squeezing pressure, rectal capacity, and bowel frequency were stabilized at 12 mo after RPC. Although the decreased MRP was improved after 18 mo, it did not completely recover to the preoperative value. These findings in Korean patients with UC were not different from those in Western patients with UC.

Oh SH, Yoon YS, Lee JL, Kim CW, Park IJ, Lim SB, Yu CS, Kim JC. Postoperative changes of manometry after restorative proctocolectomy in Korean ulcerative colitis patients. *World J Gastroenterol* 2017; 23(31): 5780-5786 Available from: URL: <http://www.wjgnet.com/1007-9327/full/v23/i31/5780.htm> DOI: <http://dx.doi.org/10.3748/wjg.v23.i31.5780>

INTRODUCTION

Ulcerative colitis (UC) is a chronic inflammatory bowel disorder that is characterized by a relapsing and remitting course. The common surgical indications for UC are complications (such as severe UC) that are unresponsive to treatment, dysplasia or malignancy, bleeding, perforation, and a toxic megacolon. Restorative proctocolectomy (RPC) with ileal pouch-anal anastomosis (IPAA) was first introduced in 1978 and is still used as the standard surgery^[1]. However, RPC causes decreased rectal reservoir, loss of anorectal sensation, and anal sphincter injury from surgical manipulation, resulting in functional derangement of bowel movement in patients postoperatively^[2-4]. The frequency of postoperative defecation ranges between 6 and 8 times/day, and more than one-third of patients experience anal incontinence^[5].

The incidence and prevalence of UC in South Korea are still lower than those in Western countries but have been rapidly increasing during the last decades^[6]. The mean annual incidence rate of UC in Koreans increased by 9-fold from 0.34 per 100000 in 1986-1990 to 3.08

per 100000 in 2001-2005^[7]. This recent change in the incidence and prevalence of UC is attributable to environmental factors, such as Westernized lifestyles featuring antibiotic use and improved hygiene^[7]. Moreover, differences between Asian and Western countries are also found in the family history and genetics of UC^[6]. A family history of UC among Asian cohorts was previously noted to be uncommon, with a frequency ranging from 0.0% to 3.4%^[8], considerably lower than the reported rates in Western series (range, 10%-25%)^[9]. The genetic susceptibilities of Asian patients with inflammatory bowel disease (IBD) differ from those of whites, as they are not associated with *NOD2/CARD15* mutations^[10].

Although there has been an increase in the prevalence of UC and the numbers of UC surgery in Asian countries, studies on the functional outcomes of RPC or the quality of life in Asians are still deficient. Most UC studies on functional outcomes were done in Westerners. The purpose of the present study was to investigate the changes of postoperative anal sphincter function and bowel frequency in Korean patients with UC. Furthermore, we attempted to find the difference in functional outcomes between Western and Korean patients.

MATERIALS AND METHODS

Patient selection

The clinical data of patients with UC who underwent laparotomy between October 1994 and June 2013 were collected retrospectively. During the study period, a total of 192 patients with clinically diagnosed UC underwent abdominal surgery. Of them, 41 patients who did not undergo RPC and 2 patients proven to have indeterminate colitis on pathology were excluded. One of the two patients with indeterminate colitis was included in the 41 patients who did not undergo RPC. Among 150 patients with RPC, 23 patients who did not undergo any preoperative or postoperative manometry were also excluded. Finally, 127 patients were analyzed. The clinical variables were sex, age at diagnosis, age at surgery, duration from diagnosis to surgery, indication for surgery, emergency operation, type of surgery, anastomotic configuration, presence of mucosectomy, and postoperative bowel frequency. Any complication that occurred within 90 d after RPC was defined as early complication. The mean follow-up duration was 71.5 mo (range, 3-192 mo). The study protocol was approved by the institutional review board of Asan Medical Center (registration No. 2017-0088).

Operation

Most of the RPCs were performed by experienced, IBD-specialized surgeons (Yu CS and Yoon YS) at our institution. The decision of performing surgery was made by gastroenterologists and IBD surgeons. The type of operation was decided by IBD surgeons,

considering the severity of disease, patient's condition, and presence of malignancy. IPAA included a 12-15-cm-long ileal J-pouch that was constructed by using linear staples and pouch-anal anastomosis through a double-stapling technique. If malignancy was suspected, cancer was present in the rectum, or removal of the remaining rectal mucosa was needed for any cause, mucosectomy was performed. Mucosectomy and hand-sewn anastomosis were performed from the perineal side of patients. Then, diverting ileostomy was constructed in most cases. Usually, at least 2 mo later, the diverting ileostomy was closed after checking the anastomosis and the integrity of pouch through radiological evaluation with a water-soluble, double-contrast dye. Most RPCs were performed as two-stage procedures by using a double-stapling method.

Manometry and bowel frequency

Anorectal manometry was performed through water perfusion by using an eight-channel flexible catheter with side holes connected to a perfusion pump and a stationary manometry system (Polygraf ID; Medtronic, Copenhagen, Denmark). Anal manometry was performed with the continuous pull-through method (1 mm/s), starting 6 cm from the anal verge, by using a thin polyethylene (diameter: 5.5 mm, length: 150 cm). The catheter was constantly perfused with saline at a rate of 0.5 mL·channel⁻¹·min⁻¹, and was connected to a water-filled pressure transducer linked to multichannel recorder. A latex balloon at the tip of the perfused catheter (eight channels) was positioned in the ileal pouch or rectum so that the distal end of the balloon was 6 cm above the anal verge. Manometry was initially performed preoperatively. Secondary manometry was checked just before ileostomy closure. Thereafter, manometry was irregularly followed at 6-12-mo intervals without a protocol. The parameters of manometry, known to be indicators of anatomical and physiological changes, included the maximal squeezing pressure (MSP), maximal resting pressure (MRP), rectoanal inhibitory reflex (RAIR), and rectal capacity. The normal range is 100-180 mmHg for MSP, 40-70 mmHg for MRP, and 100-300 mL for rectal capacity. The presence of RAIR is the normal condition. Bowel frequency was retrospectively reviewed by using electronic medical records. Most patients were followed at 6-mo intervals until the postoperative first year; thereafter, they were followed at 1-year intervals. No questionnaires were used, and the degree of continence, night soiling, and whether gas could be discriminated from stool were not checked regularly. Therefore, only bowel frequency per day was evaluated during the postoperative period.

Statistical analysis

Because of our irregular check-up of manometry and records of bowel frequency, we arbitrarily grouped the findings according to the 6-mo intervals until 24 mo

after surgery. A linear mixed model was constructed to evaluate the differences between manometric measurements at 0-6, 6-12, 12-18, and 18-24 mo after and before the operation. The significance level for multiple comparisons was adjusted with Bonferroni's method. The dependent variables at various times from before the operation to 24 mo after the operation were suspected to have a nonlinear relation with time. Thus, we fitted piecewise linear mixed models by assuming a series of linear segments and accompanying breakpoints. *P*-values of 0.05 were considered statistically significant. For piecewise linear mixed models, results are presented as β coefficients with SE. For linear mixed models, results are presented as least-square means with SE. SAS version 9.3 was used for statistical analyses.

RESULTS

Patients' characteristics and operation

Among 127 patients with RPC, 74 (58.3%) were men. The median ages at diagnosis and surgery of UC were 35.5 years (range, 14-65 years; SE, 12.4 years) and 39.6 years (range, 16-65 years; SE, 12.4 years), respectively. The mean interval from diagnosis to surgery was 50.3 mo (range, 0-279 mo; SE, 59.6 mo). Emergency operation was performed in four patients (3.1%). The most common indication for surgery was medical intractability, followed by malignancy (Table 1). A laparoscopic two-stage procedure of RPC with diverting ileostomy was performed in only one patient. The mean interval to ileostomy take down was 3.4 mo (range, 2.1-12 mo).

Two-stage procedures of RPC with diverting ileostomy were performed in 109 patients (85.8%). Single procedures of RPC without diversion were done in 11 patients (8.7%). Three-stage procedures of total colectomy with end ileostomy, followed by completion proctectomy with IPAA construction and closure of ileostomy were performed in seven patients (5.5%). Double-stapling anastomoses were performed in 100 patients (78.7%), and hand-sewn anastomoses were done in 27 patients (21.3%). Complications occurred in 49 patients (39.2%). Anastomotic leakage was the most common early complication, and pouchitis was the most common late complication (Table 2).

Manometry and bowel frequency

Preoperative manometries were possible in 94 of 127 patients, and follow-up manometries were performed in 74, 45, 12 and 9 patients at each 6-mo interval, consecutively. MSP immediately decreased after surgery until 6 mo but recovered at 12 mo postoperatively. A significant increase of MSP was found between 0-6 and 6-12 mo (142.4-169.7 mmHg, *P* = 0.0007; Figure 1). MRP significantly decreased after surgery from 64.6 to 56.4 mmHg (*P* = 0.0045). Despite a slight elevation (to 61.8 mmHg) after 12 mo,

Table 1 Indications for surgery

Indication	n (%)
Medical intractability	100 (78.7)
Malignancy	10 (7.9)
Bleeding	8 (6.3)
Perforation	4 (3.1)
Toxic megacolon	3 (2.4)
Fistula	2 (1.6)
Total	127 (100)

MRP was not recovered to the preoperative value. After 12 mo, MRP was maintained steadily (Figure 2). Rectal capacity slightly decreased at 6 mo (90.1 to 82.3 mL), but exceeded the initial volume up to 132.5 mL at 6-12 mo ($P < 0.0001$). Until 24 mo, rectal capacity gradually increased up to 150.3 mL (Figure 3). RAIR was identified in 20 patients (26.3%) and 5 patients (11.1%) at 0-6 and 6-12 mo, respectively.

Bowel frequency was studied in 80, 62, 37 and 11 patients at each 6-mo interval, consecutively. Although bowel frequency showed significant gradual decreases at each interval, it was stabilized after 6-12 mo postoperatively (Figure 4). The parameters of MSP, MRP, rectal capacity, and bowel frequency were compared between the double-stapling and hand-sewn anastomosis groups. However, there was no significant difference between the two groups.

DISCUSSION

RPC contributes to the enhancement of the quality of life of patients with UC by avoiding permanent ileostomy and maintaining intestinal continuity^[11]. However, defecatory dysfunction after surgery exists in many forms, such as anal sphincter injury and sensory loss of the anal transition zone (ATZ) from mucosectomy, and has a relatively long recovery of 6-12 mo^[12,13]. The external sphincter, which surrounds the internal sphincter and is innervated by somatic nerves, generates the voluntary anal squeeze and is also considered to be unaffected during mucosal proctectomy^[14]. This implies that the operation disturbs the function of the internal sphincter but does not affect that of the external sphincter^[15]. On the other hand, some studies insisted that weeks of non-use of the sphincter muscle might be the reason for the decrease in sphincter pressure. In fact, continuous mucous discharge from the pouch occurs during fecal diversion, implying that it is not in a totally resting state. After loop ileostomy closure, the external sphincter strength quickly improves owing to advanced exercise caused by loose stool. It thus compensates for the relatively low resting pressure values in these patients^[16]. A previous study reported that MSP decreased from 87.1 mmHg preoperatively to 68.1 mmHg at 8 wk postoperatively; however, at 1 year, it increased to 72.3 mmHg^[17]. Others showed no significant difference

Table 2 Postoperative complications

Variable	n (%)
Early complication	19 (15.2)
Leakage	5 (4.0)
Wound infection	5 (4.0)
Bleeding	2 (1.6)
Rectovaginal fistula	2 (1.6)
Thrombosis	2 (1.6)
Others	3 (2.4)
Late complication	30 (24.0)
Pouchitis	17 (13.6)
Ileus	5 (4.0)
Pouch failure	3 (2.4)
Others	5 (4.0)

between preoperative values and those obtained 1 year after surgery when the mean and maximal squeezing pressures were compared^[18]. In addition, another study reported that the MSP was 88.5 mmHg preoperatively and decreased by 12% to 68.0 mmHg before ileostomy closure. One year after ileostomy closure, the MSP was 96.5 mmHg, 8% higher than before surgery^[16]. In this study, MSP decreased at 6 mo and stabilized after 12 mo (8-9 mo after ileostomy closure). The result of our study was not different from those of previous Western studies.

Around 60%-80% of MRP originates from the internal anal sphincter. This muscle, which is responsible for the maintenance of resting anal tone, is innervated by the autonomic nervous system and is under involuntary control^[14]. It has also been observed that 84% of rectal mucosal tissue is composed of smooth muscle cell originating from internal sphincter muscle fiber, and the amount of smooth muscle has a significant relationship with the decrease of MRP that is associated with the bowel habit change of patients^[19]. Injury to the internal sphincter muscle can directly result from operative trauma, or secondarily result from denervation or ischemia. Injury to the autonomic nerve of the internal sphincter muscle during rectal dissection results in decreased MRP^[20]. Therefore, maintaining the integrity of the internal sphincter is responsible for preserving the MRP. The internal sphincter muscle is partially resected during mucosal proctectomy, and this loss of the muscle or the scar formation from the proctectomy contributes to the dysfunction of internal anal sphincter^[21]. In previous studies, early postoperative anal manometry revealed a significantly lower MRP (42 ± 4 mmHg) than the preoperative value (65 ± 4 mmHg). During the follow-up, MRP increased but remained within the lower limits late postoperatively (49 ± 5 mmHg)^[15]. Another study showed that preoperative MRP was 60.2 mmHg and the immediate postoperative MRP was 33.2 mmHg, a decrease of 45%. One year after ileostomy closure, the MRP was 46.2 mmHg, which was 23% lower than preoperatively^[16]. In this study, MRP decreased until 6 mo postoperatively and then

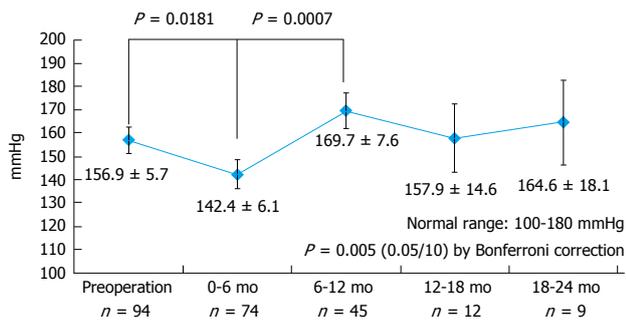


Figure 1 Maximal squeezing pressure. MSP immediately decreased after surgery until 6 mo; however, it was recovered after 12 mo postoperatively. MSP: Maximal squeezing pressure.

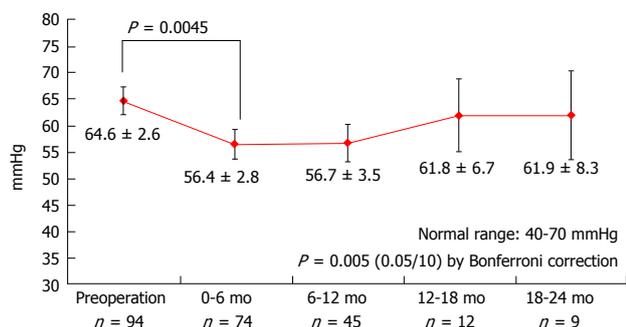


Figure 2 Maximal resting pressure. The decreased MRP after surgery increased slightly after 12 mo; however, it did not recover to the preoperative value. MRP: Maximal resting pressure.

gradually increased, but recovered to some extent at 2 years postoperatively. That the internal anal sphincter is sensitive to even minor degrees of dilatation is evident from the decrease in MRP. Although there were reports of slight improvements in MRP with time after RPC, other studies did not find any improvement after 1 year^[20]. In some studies, the postoperative change of MRP resulting from injury of the internal anal sphincter during IPAA may seem permanent^[20]. Although it is difficult, avoiding injury to the internal anal sphincter during RPC is the key to preserving structural integrity, improving continence, and preventing the decrease of MRP^[22].

Many studies reported that the use of stapler reduces the injury to internal sphincter and has a small effect of decreasing MRP, resulting in superior defecatory function^[1,20,23,24]. In contrast, surgeons who advocate mucosal proctectomy emphasize that the complete removal of all rectal mucosa not only confers the highest likelihood of complete surgical cure but, more importantly, removes all future risk of malignant transformation^[14]. However, a long-term follow-up study of dysplasia within the ATZ showed the incidence of dysplasia in the ATZ to be 4.5%, with significant correlation to prepouch risk factors, including colorectal cancer or dysplasia^[23]. Other contrasting studies argued that the sphincter complex could be easily damaged and functionally compromised^[25]. In addition, hand-sewn anastomosis was reported to entail prolonged operative

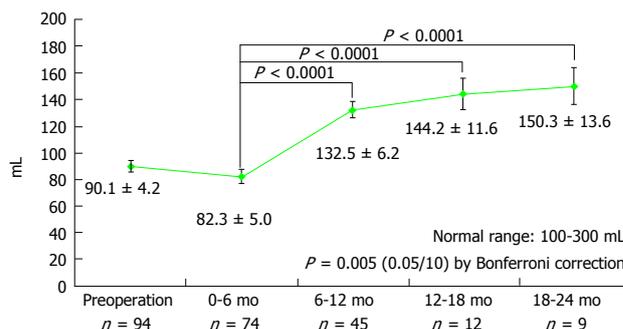


Figure 3 Rectal capacity. The decreased rectal capacity after surgery exceeded the initial volume up to 132.2 mL at 6-12 mo and increased up to 150 mL at 24 mo.

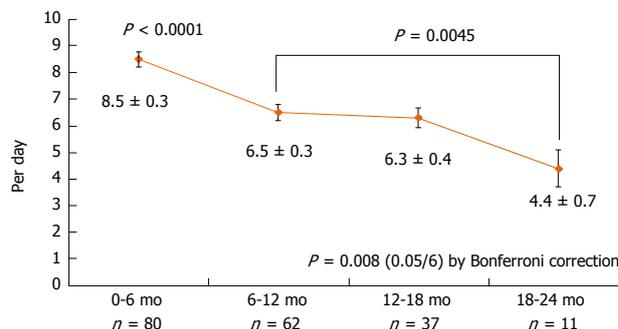


Figure 4 Bowel frequency. Bowel frequency gradually decreased at each interval and stabilized after 6-12 mo postoperatively.

time and frequent manipulation, resulting in decreased functional outcome and increased complications^[20,23]. On the other hand, some studies suggest that there is no significant difference in complications and bowel frequencies between double-stapling and hand-sewn anastomosis, which was consistent with our study^[14,23,26]. In this study, manometric findings and bowel frequencies were not different between the two anastomosis types.

RAIR is recognized as an important contributor to fecal continence through sampling and discrimination of contents. Preservation of the RAIR has been shown to correlate with a decreased incidence of nocturnal soiling after RPC^[27]. RAIR decreases up to 75%-100% in the immediate postoperative period, but is known to recover over time^[28]. A recent study claims that RAIR, which was identified in only 18% of patients after low anterior resection, was checked in 21% after 1 year and in 85% after 2 years, denoting that it has a significant meaning in the recovery of defecatory function^[29]. In our study, recovery was seen in 20 patients (26.3%) and 5 patients (11.1%) after 6 and 12 postoperative months; however, additional information was not obtained owing to follow-up loss and inaccurate data.

Rectal capacity is known to be an important factor in stool frequency and improves with time for 1-2 years after surgery^[12,13,30]. In addition, rectal capacity is a good index of the volume of the reservoir and can

play an important role in the storing of stool^[31]. This is increased compared with before surgery owing to the spontaneous adaptation of the ileal pouch and anal sphincter after ileostomy closure^[31]. In some studies, the rectal capacity was 140-142 mL before ileostomy closure, 235-279 mL at 3-6 mo, and 338-344 mL at 12 mo^[16]. In this study, rectal capacity also decreased in the immediate postoperative period, gradually increased after 6 mo, and showed marked improvement after 1 year, which seemed to contribute to the recovery of defecatory function.

The functional parameters of bowel frequency, which improved early after the operation, reached a plateau by 2 years and remained stable thereafter^[32]. Defecatory function recovers over time after ileostomy take down and stabilizes to 6 to 7 per day at 1 postoperative year^[32]. In a previous study, at 5 years after ileostomy closure, the average minimum and maximum 24-h frequency was 3.6 and 4.7, respectively^[33]. In another study, a bowel frequency of 6 times/d was identified 3 years later^[34]. In another report, the median bowel frequency per day was 6 at a mean follow-up of 40 mo^[2]. A study of 100 J-pouch procedures reported that the bowel frequency at 1, 3, 6, 12, and 24 mo was 7.5, 6.5, 6.2, 5.4 and 5.4, respectively^[35]. These results were similar to that of our study, which showed that the frequency decreased to 6.5 at 12 mo and 4.4 at 24 mo.

This study is limited by its retrospective design. Mainly, we did not use any questionnaire along with protocol. Major bias could result from the irregular check-up and follow-up of manometry. However, we attempted to minimize the bias of our study through specialized statistics. We expected to show the functional outcomes after RPC through our study. However, owing to the limited parameters, our study could show only a small part of the functional outcomes and quality of life after RPC.

In conclusion, the manometric findings of MSP and the rectal capacity and bowel frequency were stabilized at 12 mo after RPC. Although the decreased MRP was improved after 18 mo, it did not completely recover to the preoperative value. These findings in Korean patients with UC were not different from those of Western patients with UC.

COMMENTS

Background

Ulcerative colitis (UC) is a chronic inflammatory bowel disorder that is characterized by a relapsing and remitting course. The incidence and prevalence of UC in South Korea are still lower than those in Western countries but have been rapidly increasing during the last decades. Although there has been an increase in the prevalence of UC and the numbers of UC surgery in Asian countries, studies on the functional outcomes of restorative proctocolectomy (RPC) or the quality of life in Asians are still deficient. The purpose of the present study was to investigate the changes of postoperative anal sphincter function and bowel frequency in Korean patients with UC.

Research frontiers

The manometric findings of maximal squeezing pressure (MSP), rectal

capacity and bowel frequency were stabilized at 12 mo after RPC. Although the decreased maximal resting pressure (MRP) was improved after 18 mo, it did not completely recover to the preoperative value.

Innovations and breakthroughs

This study identified that the manometric findings and bowel frequency after RPC in Korean patients with UC were not different from those of Western patients with UC.

Applications

The presented research could be useful in studying the manometric functional outcomes and bowel frequency of UC patients in Asia and South Korea.

Terminology

RPC: most RPCs were performed as two-stage procedures by using a double-stapling method. Ileal pouch-anal anastomosis (IPAA): included a 12-15-cm-long ileal J-pouch that was constructed by using linear staples and pouch-anal anastomosis through a double-stapling technique.

Peer-review

The authors retrospectively reviewed the data of patients who underwent RPC in a single institute and attempted to find the difference in functional outcomes between Western and Korean patients. This study could show only a small part of the functional outcomes and quality of life after RPC but the results were very interesting.

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