Int J Clin Exp Physiol. 2025;12(3):94-100.
https://www.ijcep.org

Original Article

Early Closure of End Ileostomy Following Visceral Slide Assessment Using Abdominal Ultrasound

Myong Chol Jang, Hye Song Ri, Hui Chol Kang*

Clinical Faculty No 2, Pyongyang University of Medical Sciences, DEMOCRATIC PEOPLE'S REPUBLIC of KOREA.

ABSTRACT

Background and Aim: The purpose of our study is to decide whether to perform or not early closure of end ileostomy based on the release of abdominal adhesion following visceral slide assessment using ultrasound after its creation. **Methods:** 59 patients with stoma closure from January 2022 to May 2024 were involved in the study. Of these, 9 patients were excluded from the analysis since stoma became permanent, 50 patients (20 female patients) were included. They were divided into 2 groups. In EC (early closure) group, we decided operation timing using ultrasound and performed closure within 180 days after ileostomy. In LC (Late Closure) group, we performed closure after 180 days based on doctor's judgment without former procedure. **Results:** There was no significant difference in the number of adhesions separated by operation between the 2 groups. Stoma-related complications and readmission rate in EC group were significantly lower than in LC group. No significant difference was noted in terms of operative time, length of postoperative hospital stay, operative intestine injury, morbidity and mortality between the 2 groups. **Conclusion:** Our findings suggest that stoma closure within six months performed in the certain period based on the ultrasound assessment can achieve a safety level equal to that of stoma closure after six months.

Keywords: Visceral slide assessment, Anastomosis, Peritonitis, Abdominal ultrasound.

***Correspondence:**
Hui Chol Kang
Clinical Faculty No 2, Pyongyang University of Medical Sciences, DEMOCRATIC PEOPLE'S REPUBLIC of KOREA.
Email: pmed17@ryongnamsan.edu.kp

Received: 05-08-2025;
Revised: 20-09-2025;
Accepted: 27-09-2025.

INTRODUCTION

Loop ileostomy is typically constructed to transform downstream anastomosis and may locally be obstructed, while end ileostomy is often constructed after enterectomy which seem to have anastomotic leak.[1] In general, the closure is performed 6 months after ileostomy considering intra-abdominal adhesion, fragility and inflammation. However, patients hope to have closure of ileostomy as soon as possible due to several stoma-related complications and the decrease in QOL.

Early closure of loop ileostomy in colorectal surgery is reported in number of literatures. Some studies suggested that early closure is not only safe[2-5] but also can reduce postoperative complications,[4,6] improve quality of life,[2] cut down expenses,[7,8] and still effectively protect distal anastomosis.[2,3,9] But there has been no enough studies about the closure of end ileostomy created for various reasons.

The period between ileostomy and closure would allow softening of peristomal adhesion, and resolution of fragility and inflammation, thus leads to reduce surgical difficulties related to the closure of ileostomy.[8] For the patients with end ileostomy, it requires longer time to close the stoma compared with those with loop ileostomy.[1] This is related to intra-abdominal inflammation, edema of intestine and invasion during the procedure of ileostomy. Also, serious intra-abdominal adhesion generated after end ileostomy could present a barrier to closure. But stoma-related complications increase with the delay of closure and temporary closure is the optimal choice to reduce complications and improve quality of life.[10]

The incidence of stoma-related complications is variable and some studies estimated it 14%-17%.[3] To reduce operative risk and relief pain, it is essential to decide optimal closure timing. In the abdomen of the patient with end ileostomy, serious adhesive changes are generated due to intra-abdominal inflammation and surgical procedures. Adhesions are pathological bonds between surfaces within body cavities.[11] Peritoneal Adhesions (PAs) are a pathological condition in which fibrous tissue bands are formed between the omentum, the small and large bowels, the abdominal wall, female pelvic organs, and other intra-abdominal organs.[12]

Postoperative adhesions are observed after major abdominal surgery at a rate of 63-97%.[13] Peritoneal injury due to surgery, infection or irritation results in fibrinous exudation and fibrin formation before adhesion is created.[14] Also wide incision potentially increases the risk of ileus, SBO, thus leading to broad

OPEN ACCESS

Manuscript TECHNOMEDIA

DOI: 10.5530/ijcep.2025.12.3.20

Publishing Partner : Manuscript Technomedia. [www.mstechnomedia.com]

intra-abdominal adhesion.[15] Midline incision is performed to close end ileostomy and intra-abdominal adhesion makes it difficult to enter abdominal cavity, thus increases iatrogenic injuries. Softening of such postoperative adhesion is needed, making it possible to enter abdominal cavity in end ileostomy re-revision, and to reduce operative intestinal injuries and complications. The development of adhesion and inflammation are closely related, vice versa; softening of adhesion is related to resolution of inflammation. Both surgery and infection can disturb the equilibrium between coagulation and fibrinolysis in the abdominal cavity, with a subsequent increase in the formation of peritoneal adhesions.[16]

Intra-abdominal inflammation is one of key factors in adhesion development and several cytokines generated by inflammation reaction play an important role in the formation of adhesion.[17-19] According to statistical analysis, the incidence rate of peritoneal adhesion is about 13%.[20] Adhesion formation is the result of both insufficient fibrinolytic capacity and increased fibrin formation in response to an enhanced inflammatory status of the peritoneum.[21] So it is obvious that softening of adhesion is only achieved by resolution of intra-abdominal inflammation, the main reason for intra-abdominal adhesion.

Softening of intra-abdominal adhesion would allow entering abdominal cavity through surgical scar in closure, also presents resolution of intra-abdominal inflammation, thus it can be an indication of re-revision after ileostomy. We could determine the adhesion extent of peritoneal wall and intestines by visceral sliding assessment using ultrasound. Vertical movement of intra-abdominal contents to abdominal wall during excessive inspiration/expiration of patient was referred to as visceral sliding between intestine and peritoneum.[22] Previous abdominal surgery or peritonitis may result in adhesions between the viscera and abdominal wall, and this can lead to reduction or loss of visceral slide.[23] Frank F. Tu[24] *et al.*, reported that sensitivity=86%, specificity-91%, positive predictive value=55%, negative predictive value=98% as for visceral slide threshold value<1cm to predict adhesion. But Ceana H. Nezhat[25] *et al.*, reported that sensitivity=83.3%, specificity=100%, positive predictive value=100%, negative predictive value=98.5%, accuracy=98.6% in this test.

In our study, this test was performed using ultrasound 20 days after end ileostomy due to severe peritonitis or ileus and it showed no visceral sliding or less than 1 cm around the surgical scar. This is due to adhesion between peritoneal wall and intestine, postoperative paralytic ileus and edema of intestine at this site.

Over time, intra-abdominal adhesion softens, and bowel paralysis and edema are resolved, resulting in improved visceral sliding in ultrasound findings. The aim of this study is to evaluate closure timing of end stoma using ultrasound and identify its safety and efficacy compared with closure after six months.

MATERIALS AND METHODS

25 patients were included in EC and LC group, respectively. They underwent end ileostomy created due to severe peritonitis, ileus or rectal cancer etc. from 2021 to 2024.

In EC group, there were 12 peritonitis, 8 ileus, 3 rectal cancer and 3 others, while there were 14 peritonitis, 7 ileus, 2 rectal cancer and 2 others in LC group. End ileostomy creation and its closure were performed by the same surgeon in all patients. The patients with stoma on the upper ileum were given priority to be included in EC group.

Written informed consent was obtained from all patients or their guardians. This study was approved by the Ethics Committee of teaching hospital, Pyongyang University of medical sciences.

The following data were collected on patient characteristics: age, sex, ASA grade, Body Mass Index (BMI), the waiting time interval for reversal, comorbidities and stoma-related complications.

Ultrasound Scan for Stoma Closure

In EC group, the real-time ultrasound was first performed on the site of surgical scar 20 days after operation. Visceral slide examination was performed using SonoSite ultrasound equipped with a 5.2 MHz celiac transducer and the area with the surgical scar as the center, to the left and right of 2.5 cm, was divided into three regions of upper, medium, and low from top to bottom and we measured bowel movement according to the excessive inspiration/expiration in each region. Medium region refers to umbilical region.

Visceral Slide Score

In real-time ultrasound, we evaluated no visceral sliding as 0, <0.5 cm as 1, 0.5~1 cm as 2, >1 cm as 3. After that, an ultrasound was performed every 30 days and when the scores of three regions were >7, we closed the stoma.

Surgical Techniques

One day before the ileostomy revision, proximal intestinal tract was washed with 500-1000 cm^3 saline water and enema is performed in distal intestinal tract. All patients in both EC and LC group were given ceftriaxone for prevention prior to surgery and the closure was performed under general anesthesia. Midline incision was used in order to enter abdominal cavity. Of 3 regions, we entered abdominal cavity first through the one with visceral sliding over 1cm. Then we carefully performed incision identifying whether there exists adhesion between peritoneal wall and intestine or not. After abdominal section we evaluated adhesion status in overall abdominal cavity. All adhesion was separated by gentle dissection. A peristomal oval skin incision was performed around the stoma, separating the stoma to anastomose with the proximal intestine. Parastomal intestine with edema was resected before anastomosis. The type of anastomosis

was hand-sewn (side to side). Closure of the abdominal wall was Performed with Absorbable Sutures (PDS), and the skin was closed with interrupted sutures.

Outcomes

The last surgery was performed in May 2024. Operation time, intestine status at the time of abdominal section (edema, hypertrophy), operative blood loss, the number of comorbidities developed during operation, the number of separated adhesions and length of hospital stay were noted. The separated adhesion was classified according to the grade Canbaz *et al.*,[26] suggested in 2005.

- Adhesion Grades (Canbaz *et al.*, 2005).
- Grade 0: No adhesions.
- Grade 1: Flimsy, filmy adhesions easily separated with a finger.
- Grade 2: Mild, continuous, avascular adhesions released by gentle blunt dissection.
- Grade 3: Moderate fibrous adhesions with some vascularity, requiring sharp dissection.
- Grade 4: Dense fibrotic tissue with obliteration of normal planes.

Postoperative complications occurring within 90 days-including anastomotic leak, wound infection, wound hematoma, ileus, intra-abdominal infection, or mortality-were analyzed. Complications were classified according to the Clavien-Dindo system[27] and grouped into Grades I-II and Grades III-IV.

Statistical Analysis of Data

All data were analyzed using the SPSS 16.0. Data were expressed as Mean±SD, median (range) or number of patients (%). *P*<0.05 was considered statistically significant.

RESULTS

59 patients with stoma closure from January 2022 to May 2024 were involved in the study. Of these, 9 patients were excluded from the analysis since stoma became permanent, 50 patients (20 female patients) were included. Both ileostomy and closure were performed by the same surgeon in the hospital. All surgical procedure was noted by assistant. In EC (early closure) group, we decided operation timing using ultrasound and performed closure within 180 days after ileostomy, while in LC (Late Closure) group, we performed closure after 180 days based on doctor's judgment.

Patient characteristics are shown in Table 1. The baseline characteristics of patients in the EC and LC groups were comparable (Table 1). The waiting time for ileostomy reversal was significantly shorter in the EC group (95.28±23.17 days) than in the LC group (225.68±37.08 days; p < 0.0001). In the EC group, no patient underwent closure within 0-60 days; 12 patients had closure between 60-90 days, 10 between 90-120 days, 2 between 120-150 days, and 1 between 150-180 days. The earliest and latest closures in the EC group occurred at 62 and 153 days, respectively, whereas in the LC group they occurred at 187 and 330 days. There were no statistically significant differences between the two groups in terms of age, sex, BMI, ASA classification, or overall comorbidities. The distribution of specific comorbid conditions—including hypertension, diabetes mellitus, coronary heart disease, arrhythmia, renal disease, chronic obstructive pulmonary disease, and arthrolithiasis - also showed no significant differences. Similarly, the underlying diagnoses leading to ileostomy creation (peritonitis, ileus, or other causes) were comparable between the groups.

Stoma-related complications in 2 groups are shown in Table 2. Stoma-related complications prior to reversal were significantly more frequent in the EC group compared with the LC group (p=0.013). In the EC group, higher occurrences of parastomal prolapse, stoma retraction, peristomal skin infection, dehydration/electrolyte imbalance, and cardiopulmonary complications were noted, although the differences for individual complications were not statistically significant. The need for total parenteral nutrition and the incidence of ileus or obstruction were similar between the two groups. According to the Clavien-Dindo classification, the proportion of Grade I-II and Grade III-IV complications did not differ significantly between groups. Readmission rates were higher in the LC group than in the EC group; however, this difference was not statistically significant.

Detailed findings in closure are shown in Table 3. The operative details of ileostomy closure were comparable between the EC and LC groups. The mean operative time did not differ significantly between the groups (98.12±11.66 min in EC vs. 93.68±10.74 min in LC; p=0.167). Intraoperative blood loss was also similar (79.60±13.83 mL vs. 75.80±9.72 mL; p=0.266). Although bowel injury occurred more frequently in the LC group (20%) than in the EC group (8%), the difference was not statistically significant (p=0.249). The number of adhesions lysed during surgery tended to be higher in the EC group (3.76±1.05) compared with the LC group (3.28±0.89), but this difference did not reach statistical significance (p=0.088). Findings of bowel hypertrophy or edema during laparotomy were rare and showed no significant differences between the two groups.

The separated adhesion during operation is shown in Table 4. A total of 94 adhesions were separated in the EC group compared with 82 in the LC group. Adhesions were classified according to the grading system proposed by Canbaz *et al.* No significant differences were observed between the EC and LC groups across all adhesion grades: Grade 1 (41 vs. 36; p=0.969), Grade 2 (35 vs. 31; p=0.937), Grade 3 (12 vs. 10; p=0.909), and Grade 4 (6 vs. 5;

Table 1: Baseline patient characteristics.

	EC group	LC group	P value
Waiting time interval for reversal (day)	95.28±23.17	225.68±37.08	<0.0001
Age	56.36±13.16	56.04±15.76	0.938
Gender (male/female)	14/11	16/9	0.589
ASA			0.066
1	3(12)	5(20)	
2	6(24)	8(32)	
≧3	16(64)	12(48)	
Body mass index (kg/m²)	23.75±2.99	24.72±4.29	0.362
Co-morbidities	16(64)	14(56)	0.589
Hypertension	6(24)	5(20)	0.749
Diabetes mellitus	3(12)	4(16)	0.703
Coronary heart disease	2 (8)	2 (8)	-
Arrythmia	-	1 (4)	-
Renal disease	1 (4)	-	-
Chronic obstructive pulmonary disease	2 (8)	1 (4)	0.577
Arthrolithiasis	2(8)	1(4)	0.577
Diagnosis	15(60)	13(52)	0.594
Peritonitis	9(36)	10(40)	0.785
Ileus	1(4)	2(8)	0.577
Other			

Values are Mean±SD, median (range) or number of patients (%). P<0.05 was considered statistically significant.

p=0.937). Overall, the distribution and severity of adhesions were comparable between the two groups.

Postoperative outcomes are shown in Table 5. Readmission rate due to complication was higher in LC group. There was no significant difference in postoperative complications in 2 groups. Postoperative wound infection occurred more often in EC group. No reoperation was performed in EC group, while two was performed due to ileus and anastomotic leak in LC group. No patient died in both groups.

DISCUSSION

The longer the period between ileostomy and closure, the more complications and psychological problems the patient may experience. Early closure of diverting loop ileostomy in colorectal surgery is reported in number of literatures. But there has been no studies about the closure of end ileostomy.

End ileostomy results in number of complications until closure due to abdominal inflammation, fragility of intestine, surgical invasion and postoperative adhesion. Also, patients would experience some psychological problems and inconvenience due to stoma apparatus. The only way to solve these problems is to close the end ileostomy as soon as possible. However, too early closure could lead to failure due to inflammation, edema, firm adhesion. In the surgery of ileus or severe peritonitis, serious inflammation and edema increase the risk of anastomotic leak, that's why the surgeon chooses end ileostomy. But severe peritoneal damage during operation results in adhesion. Also, abdominal infection by foreign bodies (talcum powder, suture, fecal substances) and bacteria cause inflammation reaction, resulting in abdominal adhesion.[28] Postoperative adhesion, paralytic ileus, edema restrict mobility of intestine which lead to decrease in visceral sliding in ultrasound 20 days after operation. Over time, softening of postoperative adhesion and resolution of paralytic ileus and edema occur, which lead to increase in visceral sliding in ultrasound. Furthermore, serious adhesion forms on the surgical scar region since many surgical procedures perform.

In our study 18 patient in EC group and 15 patients in LC group had severe adhesion (III, IV) on the surgical scar region and ultrasound showed visceral sliding less than 0.5 cm. Serious adhesion of peritoneal wall and intestine can be the reason for intestine injury in reoperation since it is performed on this region. Tu *et al.*,[29] evaluated 63 patients and found negative prediction value of 98% when visceral slide greater>1cm was used to indicate no adhesion. Postoperative adhesion delays secondary operation time[30,31] and increases risk of postoperative intestine injury.[32] In order to minimize postoperative intestine injury and achieve safe

closure of end stoma, the area with the surgical scar as the center was divided into three regions from top to bottom.

We measured bowel movement according to the excessive inspiration/expiration in each region and evaluated no visceral sliding as 0, <0.5 cm as 1, 0.5-1 cm as 2, >1 cm as 3. When the total score of three regions was greater than 7, we closed the stoma. Here there must be a region with the score greater than 3 which would allow entering abdominal cavity and safe surgery confirming adhesion extent in other regions. If firm adhesion exists, we avoided that region and performed an incision, then carefully separated adhesion.

During separation procedure, 2 patients in EC group had intestine injury, but it was not severe. 5 patients in LC group had severe intestine injury during reoperation. This resulted in more abdominal infection in control group after surgery. No difference was found in macroscopic findings of intestine during surgery in 2 groups. But 2 patients underwent reoperation due to postoperative ileus and anastomotic leak.

Table 2: Stoma-related complications before stoma reversal.

	EC group	LC group	P value
Stoma-related complications	8(32)	17(68)	0.013
Ileus	-	1 (4)	-
Obstruction	1 (4)	1 (4)	1
Prolapsus	-	1 (4)	-
Stoma herniation	2 (8)	2 (8)	1
Stoma retraction	1 (4)	2 (8)	0.577
Peristomal skin infection	2 (8)	4 (16)	0.414
Dehydration/ Electrolytic disorder	1 (4)	3 (12)	0.3277
TPN nutrition requirement	-	1 (4)	-
Cardiopulmonary disease	1 (4)	2 (8)	0.577
Clavien-Dindo classification			0.198
I-II	7 (28)	13 (52)	
III-IV	1 (4)	4 (16)	
Readmission	1 (4)	3 (12)	0.327

Values are number of patients (%). P<0.05 was considered statistically significant.

Table 3: Details of end ileostomy closure.

	EC group	LC group	P value
Operative time (min)	98.12±11.66	93.68±10.74	0.167
Blood loss in operation (mL)	79.60±13.83	75.80±9.72	0.266
Bowel damages during operation	2 (8)	5 (20)	0.249
Mean adhesions lysed during operation	3.76±1.05	3.28±0.89	0.088
Bowel statues in laparotomy			
Hypertrophy	-	-	-
Edema	1 (4)	1 (4)	1

Values are Mean±SD, median (range) or number of patients (%). P<0.05 was considered statistically significant.

Table 4: Adhesion grade.

	EC group	LC group	P value
Grade 1	41	36	0.969
Grade 2	35	31	0.937
Grade 3	12	10	0.909
Grade 4	6	5	0.937
Total adhesion	94	82	

P<0.05 was considered statistically significant.

Table 5: Outcomes after ileostomy closure.

	EC group	LC group	P value
Post-operative complications	8 (32)	10 (40)	0.581
Anastomotic leakage	-	1 (4)	-
Wound infection	4 (20)	2 (8)	0.249
Wound hematoma	1 (4)	2 (8)	0.577
Ileus	1 (4)	2 (8)	0.577
Obstruction	1 (4)	-	-
Intra-abdominal infection	1 (4)	3 (12)	0.327
Clavien-Dindo classification			0.396
I-II	7 (28)	8 (32)	-
III-IV	1 (4)	2 (8)	-
Reoperation	-	2 (8)	-
Cause of reoperation			-
Failed attempt of stoma closure	-	-	-
Anastomotic leakage	-	1 (4)	-
Ileus	-	1 (4)	-
Postoperative stay (days)	8.92±1.84	9.12±2.2	0.729
Mortality	-	-	-

Values are Mean±SD, median (range) or number of patients (%). $P<0.05$ was considered statistically significant.

CONCLUSION

Our findings suggest that stoma closure within six months performed in the certain period based on the ultrasound assessment can achieve a safety level equal to that of stoma closure after six months. Further studied are required to establish the optimal time of end stoma closure. However, our study could be the first step to determine the optical time of end stoma closure.

ACKNOWLEDGEMENT

None.

ABBREVIATIONS

EC: Early Closure; **LC:** Late Closure; **QOL:** Quality of Life; **BMI:** Body Mass Index; **ASA:** American Society of Anesthesiologists (Physical Status Classification); **TPN:** Total Parenteral Nutrition; **SBO:** Small Bowel Obstruction; **Pas:** Peritoneal Adhesions; **VS:** Visceral Slide.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

REFERENCES

1. Sier MF, van Gelder L, Ubbink DT, Bemelman WA, Oostenbroek RJ. Factors affecting timing of closure and non-reversal of temporary ileostomies. Int J Colorectal Dis. 2015;30:1185-92.
2. Zhou MW, Wang ZH, Chen ZY, Xiang JB, Gu XD. Advantages of early preventive ileostomy closure after total mesorectal excision surgery for rectal cancer: an institutional retrospective study of 123 consecutive patients. Dig Surg. 2016.
3. Aljorfi AA, Alkhamis AH. A systematic review of early versus late closure of loop ileostomy. Surg Res Pract. 2020.
4. Danielsen AK, Park J, Jansen JE, Bock D, *et al.* Early closure of a temporary ileostomy in patients with rectal cancer. Ann Surg. 2017;265:284-90.
5. Menahem B, Lubrano J, Vallois A, Alves A. Early closure of defunctioning loop ileostomy: is it beneficial for the patient? A meta-analysis. World J Surg. 2018.
6. Echazarreta-Gallego E, Elía-Guedea M, *et al.* Defunctioning ileostomy: is an early closure safe? Int J Colorectal Dis. 2016;31:771-3.
7. Elmasry M, Eardley N, Johnson M, Vimalachandran D, McFaul C. Early stoma closure following defunctioning for low anterior resection—a feasibility study. Int J Surg. 2012;S1-S52.
8. Robertson J, Linkhorn H, *et al.* Cost analysis of early versus delayed loop ileostomy closure: a case-matched study. Dig Surg. 2015;32:166-72.
9. Clausen FB, Dohrn N, *et al.* Safety of early ileostomy closure: a systematic review and meta-analysis of randomized controlled trials. Int J Colorectal Dis. 2020.
10. Yetişir F, Şarer AE, Acar HZ, Ciftciler E. Closure of stoma following open abdomen management. Indian J Surg. 2016;78(3):182-6.
11. Molinas CR, Binda MM, Koninckx PR. Angiogenic factors in peritoneal adhesion formation. Gynecol Surg. 2006;3:157-67.
12. Sandoval P, Jiménez-Heffernan JA, Guerra-Azcona G, Pérez-Lozano ML, *et al.* Mesothelial-to-mesenchymal transition in the pathogenesis of post-surgical peritoneal adhesions. J Pathol. 2016;239:48-59.
13. Bozdag Z, Gumus M, Arikanoglu Z, Ibiloglu I, Kaya S, Evliyaoglu O. Effect of intraperitoneal thymoquinone on postoperative peritoneal adhesions. Acta Chir Belg. 2015;115:364-8.
14. Liu X, Wei Y, Bai X, Li M, *et al.* Berberine prevents primary peritoneal adhesion reformation by directly inhibiting TIMP-1. Acta Pharm Sin B. 2020;10(5):812-24.
15. Yellinek S, Krizzuk D, Gilshtein H, Moreno Djadou T, *et al.* Early postoperative outcomes of diverting loop ileostomy closure surgery following laparoscopic versus open colorectal surgery. Surg Endosc. 2020.
16. Maleckas A, Daubaras V, Vaitkus V, Aniuliene A, *et al.* Increased postoperative peritoneal adhesion formation after the treatment of experimental peritonitis with chlorhexidine. Langenbecks Arch Surg. 2004;389:256-60.
17. Aysan E, Sahin F, Catal R, Javadov M, Cumbul A. Effects of glycerol and sodium pentaborate formulation on prevention of postoperative peritoneal adhesion formation. Obstet Gynecol Int. 2020.
18. Jin X, Ren S, Macarak E, Rosenbloom J. Pathobiological mechanisms of peritoneal adhesions: mesenchymal transition of rat peritoneal mesothelial cells induced by TGF-β1 and IL-6 requires activation of Erk1/2 and Smad2 linker region phosphorylation. Matrix Biol. 2016.
19. Almdahl SM, Burhol PG. Peritoneal adhesions: causes and prevention. Dig Dis. 1990;8:37-44.

20. Tang J, Xiang Z, Bernards MT, Chen S. Peritoneal adhesions: occurrence, prevention and experimental models. Acta Biomater. 2020.
21. Hellebrekers BWJ, Kooistra T. Pathogenesis of postoperative adhesion formation. Br J Surg. 2011;98(11):1503-16.
22. Larciprete G, Valli E, Meloni P, Malandrenis I, Romanini ME, *et al.* Ultrasound detection of the "sliding viscera" sign promotes safer laparoscopy. J Minim Invasive Gynecol. 2009;16:445-9.
23. Tan HL, Shankar KR, Ade-Ajayi N, Guelfand M, Kiely EM, Drake DP, *et al.* Reduction in visceral slide is a good sign of underlying postoperative viscero-parietal adhesions in children. J Pediatr Surg. 2003;38:714-6.
24. Tu FF, Lamvu GM, Hartmann KE, Steege JF. Preoperative ultrasound to predict infraumbilical adhesions: a study of diagnostic accuracy. Am J Obstet Gynecol. 2004;192:74-9.
25. Nezhat CH, Dun EC, Katz A, Wieser FA. Office visceral slide test compared with two perioperative tests for predicting periumbilical adhesions. Obstet Gynecol. 2014;123:1049-55.
26. Vaze MN, Joshi CG, Patil DB. Molecular basis of post-surgical peritoneal adhesions: an overview. Vet World. 2010;3:561-6.
27. Bolliger M, Kroehnert JA, Molineus F, Kandioler D, Schindl M, Riss P. Experiences with the standardized classification of surgical complications (Clavien-Dindo) in general surgery patients. Eur Surg. 2018;50:256-61.
28. Robertson D, Lefebvre G. Adhesion prevention in gynaecological surgery. J Obstet Gynaecol Can. 2010;32(6):598-602.
29. Nezhat C, Cho J, Morozov V, Yeung P Jr. Preoperative periumbilical ultrasound-guided saline infusion (PUGSI) as a tool for predicting obliterating subumbilical adhesions in laparoscopy. Fertil Steril. 2009;91:2714-9.
30. Beck DE, Ferguson MA, Opelka FG, Fleshman JW, Gervaz P, Wexner SD. Effect of previous surgery on abdominal opening time. Dis Colon Rectum. 2000;43:1749-53.
31. Coleman MG, McLain AD, Moran BJ. Impact of previous surgery on time taken for incision and division of adhesions during laparotomy. Dis Colon Rectum. 2000;43:1297-9.
32. Van der Krabben AA, Dijkstra FR, Nieuwenhuijzen M, Reijnen MM, Schaapveld M, van Goor H. Morbidity and mortality of inadvertent enterotomy during adhesiolysis. Br J Surg. 2000;87:467-71.

Cite this article: Jang MC, Ri HS, Kang HC. Early Closure of End Ileostomy Following Visceral Slide Assessment Using Abdominal Ultrasound. Int J Clin Exp Physiol. 2025;12(3):94-100.