

# World Journal of *Gastrointestinal Surgery*

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The primary aim of *World Journal of Gastrointestinal Surgery* (WJGS, *World J Gastrointest Surg*) is to provide scholars and readers from various fields of gastrointestinal surgery with a platform to publish high-quality basic and clinical research articles and communicate their research findings online.

WJGS mainly publishes articles reporting research results and findings obtained in the field of gastrointestinal surgery and covering a wide range of topics including biliary tract surgical procedures, biliopancreatic diversion, colectomy, esophagectomy, esophagostomy, pancreas transplantation, and pancreatectomy, *etc.*

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Observational Study

# Relationship between postoperative rehabilitation style, gastrointestinal function, and inflammatory factor levels in children with intussusception

Xue-Yan Wei, Hong-Chang Huo, Xin Li, Su-Li Sun, Jun Zhang

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## Abstract

### BACKGROUND

Intussusception occurs in children and progresses rapidly. If not treated in time, it may lead to secondary complications such as intestinal perforation, which affect the quality of life and health of children. Surgery is the most common clinical treatment and has a good effect. However, the postoperative prognosis of children with intussusception has a correlation with the postoperative rehabilitation method. Therefore, in this study, we explored the relationship between postoperative rehabilitation, gastrointestinal function, and the expression of inflammatory factors in children with intussusception.

### AIM

To explore the relationship between postoperative rehabilitation, gastrointestinal function, and inflammatory factor levels in children with intussusception.

### METHODS

The medical records of 18 children who were admitted to our hospital for intussusception surgery between October 2022 and May 2024 were retrospectively reviewed. The patients were divided into the routine nursing group ( $n = 6$ ) and rehabilitation training group ( $n = 12$ ) according to the postoperative rehabilitation method. The general data, gastrointestinal function, and inflammatory factor levels of the two groups were statistically analyzed. Pearson correlation analysis of gastrointestinal function, inflammatory factors, and postoperative rehabil-

itation was performed.

## RESULTS

We found no significant intergroup differences in sex, age, or disease course ( $P > 0.05$ ). The times to first defecation, bowel sound recovery, and anal exhaust were shorter and inflammatory factor levels were lower in the rehabilitation training group than in the routine nursing group ( $P < 0.05$ ). Pearson correlation analysis showed that gastrin and motilin levels were positively correlated with postoperative rehabilitation ( $P < 0.05$ ). Interleukin (IL)-2, IL-4, IL-6, IL-10, high-sensitivity C-reactive protein, and tumor necrosis factor- $\alpha$  levels were negatively correlated with postoperative rehabilitation ( $P < 0.05$ ). Gastrointestinal function was positively correlated ( $P < 0.05$ ), and levels of inflammatory factors were negatively correlated with postoperative recovery time ( $P < 0.05$ ).

## CONCLUSION

We found a positive correlation between gastrointestinal function and postoperative rehabilitation training, and a negative correlation between inflammatory factor levels and rehabilitation training in children with intussusception.

**Key Words:** Children with intussusception; Postoperative rehabilitation mode; Gastrointestinal function; Inflammatory factors

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**Core Tip:** In this study, we found that postoperative rehabilitation training in children with intussusception could accelerate the recovery of gastrointestinal function, elevate the levels of gastrin and migratory complex wave, and at the same time, significantly reduce the inflammatory factors, such as interleukin (IL)-2, IL-4, IL-6, IL-10, high-sensitivity C-reactive protein, and tumor necrosis factor- $\alpha$ . This study confirms that the rehabilitation training has a significant effect on the improvement of gastrointestinal function and the alleviation of inflammation, which is an important revelation in the clinical treatment.

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## INTRODUCTION

Pediatric surgical diseases with purulent blood paroxysms develop rapidly and can induce complications, such as intestinal perforation, intestinal necrosis, and endotoxemia, if not treated in time. This can seriously affect the life and health of children[1]. Currently, the primary clinical operation is to treat children, which is better than[2]. Studies have shown that postoperative prognosis is not only related to the surgical procedure but also to the mode of postoperative rehabilitation to a certain extent[3]. Surgical trauma and the application of anesthetic drugs can cause gastrointestinal dysfunction and inflammatory reactions, such as indigestion, diarrhea, and constipation after surgery, which can delay recovery in children[4]. Therefore, understanding postoperative gastrointestinal function and inflammatory factor levels in children with intussusception is helpful in developing reasonable and effective rehabilitation methods and improving the recovery rate and quality of life of children. In this study, we aimed to explore the effects of different rehabilitation methods on gastrointestinal function and inflammatory factor levels in children, provide a scientific basis for clinicians to formulate individualized rehabilitation programs, improve the rehabilitation effect and quality of life of children with intussusception, reduce the incidence of complications, and provide new ideas and methods for the treatment of acute abdomen in children.

## MATERIALS AND METHODS

### Participants

The medical records of 18 children with intussusception who were treated at our hospital between October 2022 and May 2024 were retrospectively analyzed. Patients were divided into a routine nursing group ( $n = 6$ ) and a rehabilitation training group ( $n = 12$ ) according to the postoperative rehabilitation method. The study was approved by the local ethics committee.

The inclusion criteria were as follows: (1) Met the diagnostic criteria of intussusception in pediatrics (8<sup>th</sup> edition)[5]; (2) Successful laparoscopic surgery; (3) Age 1–10 years; (4) Onset time < 3 days prior; (5) Availability of complete clinical data; (6) No malignant tumor or cardiovascular disease; and (7) No symptoms of acute or chronic infection before hospit-



alization.

The exclusion criteria were as follows: (1) Functional intestinal disease; (2) Congenital intestinal malformation; (3) Coagulation dysfunction; (4) Cognitive or speech disorder; (5) Severe intestinal strangulation or necrosis; and (6) Kidney or liver disease.

### Nursing methods

**Routine nursing group:** Postoperatively, the children in this group received routine nursing care, including limb massage before opening their eyes to promote blood circulation and relax their muscles. At the same time, according to the physician's advice and specific conditions, ibuprofen (Anhui Huachen Pharmaceutical Co., Ltd., National Medicine Zhunzi; H34020169) was used to relieve pain. At 4 hours postoperatively, the children were encouraged to eat and drink a little water; for those without vomiting, nausea, or abdominal pain, enteral nutrition was administered within 1 day postoperatively to accelerate intestinal peristalsis and promote the recovery of gastrointestinal function, before being gradually transitioned to a conventional diet.

**Rehabilitation training group:** The children in this group received rehabilitation nursing care. In younger patients, the quadriceps femoris and ankle joints were rotated, flexed, and massaged regularly. Older children were instructed to exercise their fists, elbows, and shoulders three times a day for 15 minutes. The rehabilitation training plan was customized according to each patient's specific situation, and the children were guided and assisted to complete the plan. Children were protected when they were active. Each child's family members were trained in the program's implementation, taught its importance, and prevented from quitting the practice for fear of pain. During the rehabilitation process, we actively communicated with the children or their parents to provide encouragement, improve compliance and cooperation rates, and promote patient recovery. Both groups underwent a 5-day intervention.

### Observation indicators

**General data:** The medical records of the two groups of children were analyzed, and general data, such as sex, age, intussusception course, onset season, clinical symptoms, fasting time, ferrule position, and daily rehabilitation training time, were collected.

**Recovery of gastrointestinal function:** The gastrointestinal function indices of children after surgery, including the first defecation time, recovery time of bowel sounds, and anal exhaust time, were evaluated.

**Gastrointestinal function:** After 5 days of rehabilitation, 5 mL of fasting venous blood was collected from the children in the morning and centrifuged for 10 minutes (radius, 11 cm; rotation speed, 3000 rpm). The levels of gastrin (GAS) and motilin (MTL) were measured using radioimmunoassay.

**Inflammatory factors:** After 5 days of rehabilitation, 8-10 mL of venous blood was taken from each child after fasting, and serum interleukin (IL)-2, IL-4, and tumor necrosis factor- $\alpha$  (TNF- $\alpha$ ) were detected by enzyme-linked immunosorbent assay according to the manufacturer's instructions (Wuhan Jilide Bio).

### Statistical analysis

SPSS 26.0 statistical software was used for data processing and analysis. Normally distributed measurement data were expressed as mean  $\pm$  SD, and intergroup comparisons were made using the *t*-test. Counting data were expressed as examples (*n*) or rates (%), and data were compared using the  $\chi^2$  test. The Pearson correlation coefficient was used to analyze the relationships among gastrointestinal function, inflammatory factor levels, rehabilitation mode, and rehabilitation time. The significance level was  $\alpha = 0.05$ .

## RESULTS

### Children's general data

We found no statistically significant intergroup differences in general data, including sex, age, disease course, and onset season ( $P > 0.05$ ; [Supplementary Table 1](#) and [Figure 1](#)).

### Comparison of the recovery time of gastrointestinal function among children

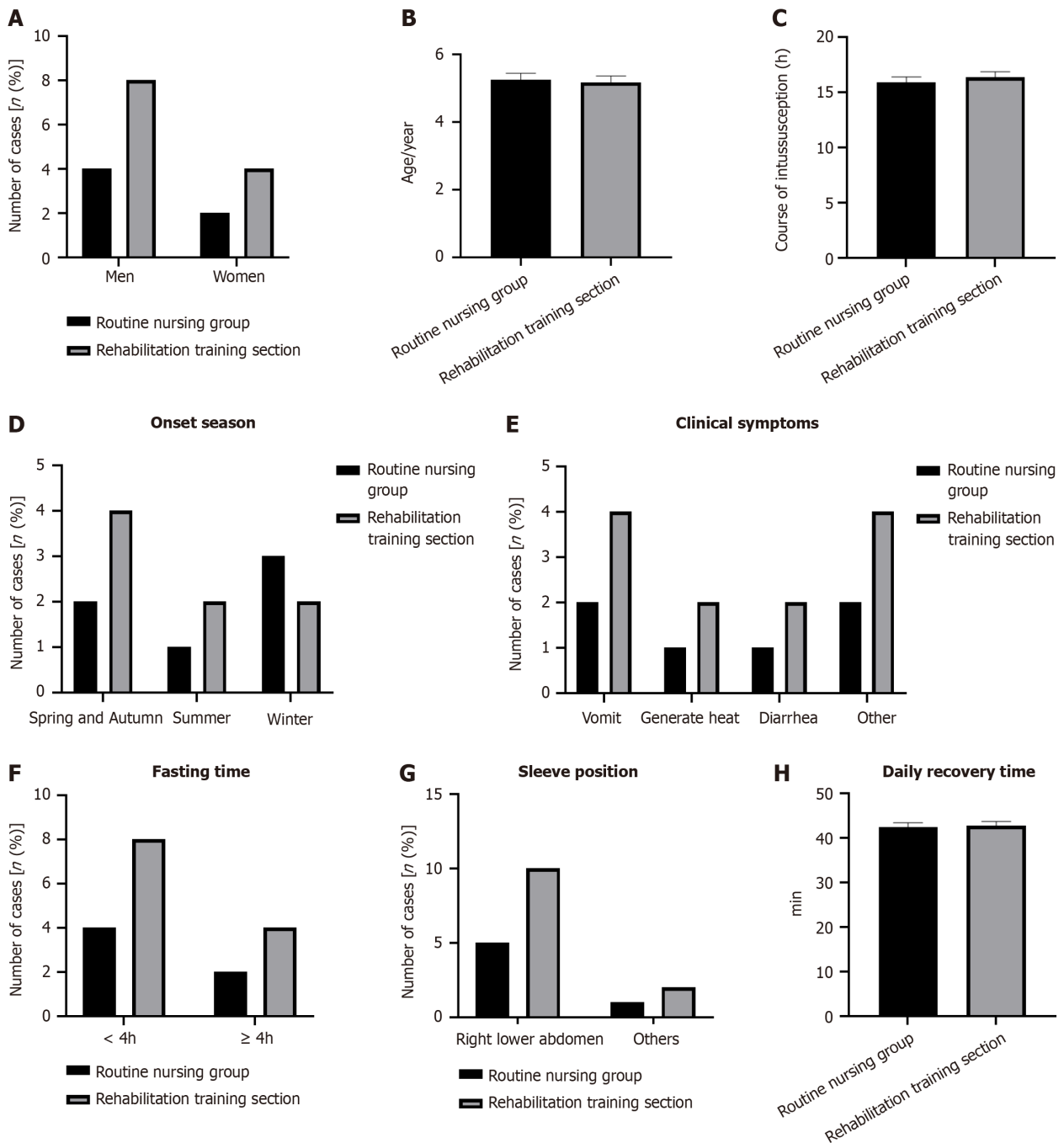
The times to first defecation, bowel sound recovery, and anal exhaust in the rehabilitation training group were shorter than those in the routine nursing group ( $P < 0.05$ ; [Supplementary Table 2](#) and [Figure 2](#)).

### Comparison of gastrointestinal function among children

Gastrointestinal function was significantly higher in the rehabilitation training group than in the routine nursing group ( $P < 0.05$ ; [Supplementary Table 3](#) and [Figure 3](#)).

### Children's inflammatory factors

The levels of inflammatory factors were significantly lower in the rehabilitation training group than in the routine nursing group ( $P < 0.05$ ; [Supplementary Table 4](#) and [Figure 4](#)).



**Figure 1 Children's general data.** A: Sex; B: Age; C: Course of intussusception; D: Onset season; E: Clinical symptoms; F: Fasting time; G: Sleeve position; H: Daily recovery time.

### Correlation analysis

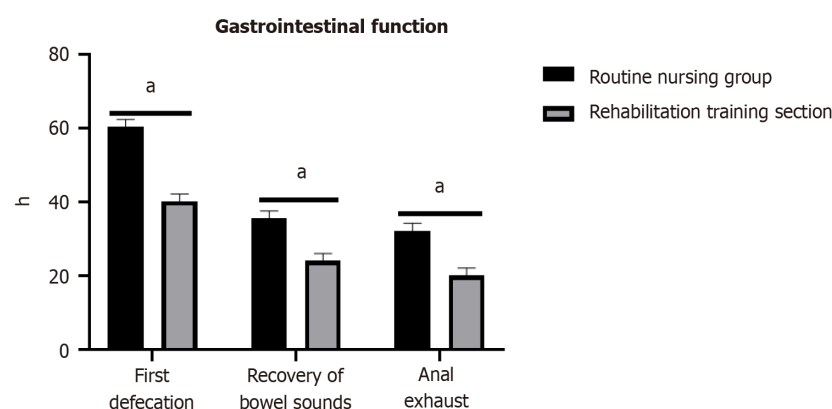
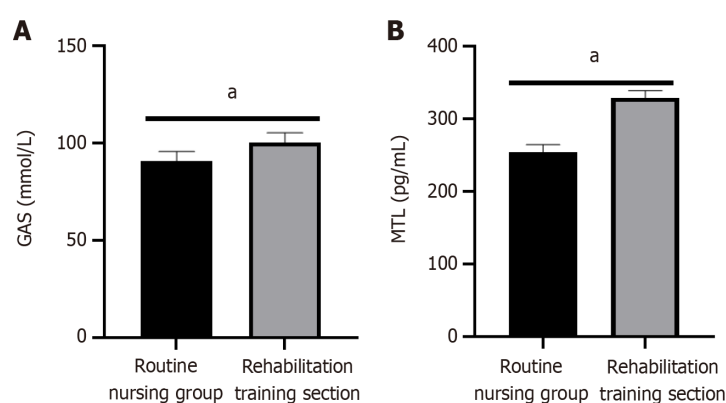
Pearson correlation analysis was used to analyze the relationships among gastrointestinal function, inflammatory factors, and postoperative rehabilitation in children with intussusception and it was found that GAS, MTL, and postoperative rehabilitation training were significantly positively correlated ( $P < 0.05$ ). IL-2, IL-4, IL-6, IL-10, high-sensitivity C-reactive protein (hs-CRP), and TNF- $\alpha$  were significantly negatively correlated with postoperative rehabilitation training ( $P < 0.05$ ; Table 1).

Pearson correlation analysis found that gastrointestinal function was positively correlated with postoperative rehabilitation time ( $P < 0.05$ ), whereas the inflammatory factors IL-2, IL-4, IL-10, and TNF- $\alpha$  were negatively correlated with postoperative rehabilitation time ( $P < 0.05$ ). No significant correlation was noted between IL-6 and hs-CRP levels and postoperative recovery time ( $P > 0.05$ ; Figures 5 and 6).

**Table 1** Correlation analysis

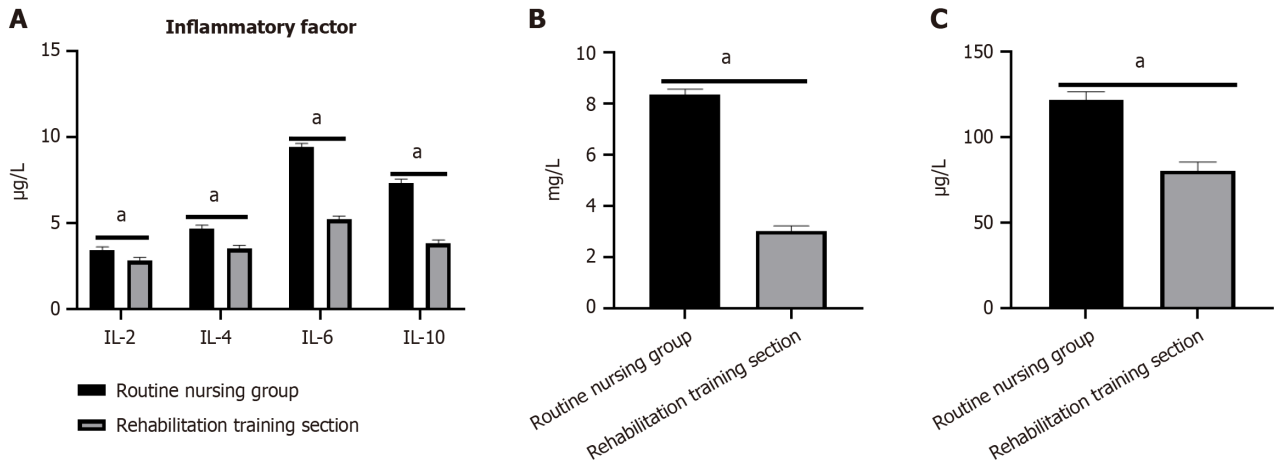
Index	Pearson correlation	P value (bilateral)	Deviation	Standard error	95%CI	
					Lower limit	Upper limit
GAS	0.490	0.039	-0.014	0.160	0.115	0.740
MTL	0.714	0.001	0.000	0.107	0.453	0.881
IL-2	-0.782	0.000	-0.006	0.105	-0.972	-0.564
IL-4	-0.871	0.000	-0.016	0.043	-0.964	-0.798
IL-6	-0.971	0.000	-0.003	0.015	-0.997	-0.943
IL-10	-0.979	0.000	-0.003	0.008	-0.995	-0.965
hs-CRP	-0.981	0.000	-0.002	0.007	-0.996	-0.970
TNF- $\alpha$	-0.921	0.000	-0.003	0.028	-0.974	-0.867

GAS: Gastrin; MTL: Motilin; IL: Interleukin; hs-CRP: High-sensitivity C-reactive protein; TNF- $\alpha$ : Tumor necrosis factor- $\alpha$ .

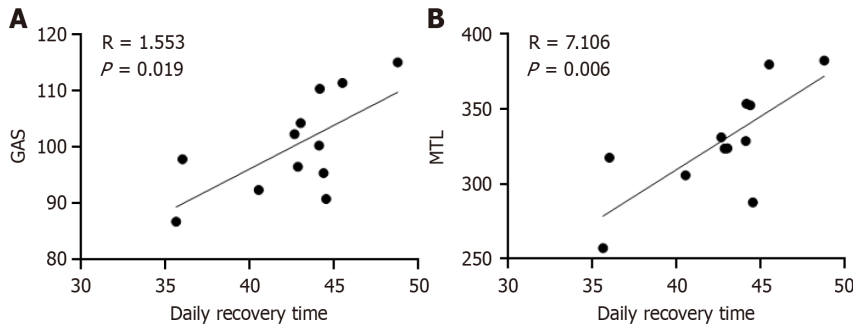
**Figure 2** Recovery time of gastrointestinal function compared to the routine nursing group. <sup>a</sup>*P* < 0.05.**Figure 3** Gastrointestinal function. A: Gastrin level; B: Motilin level. <sup>a</sup>*P* < 0.05 compared to the routine nursing group. GAS: Gastrin; MTL: Motilin.

## DISCUSSION

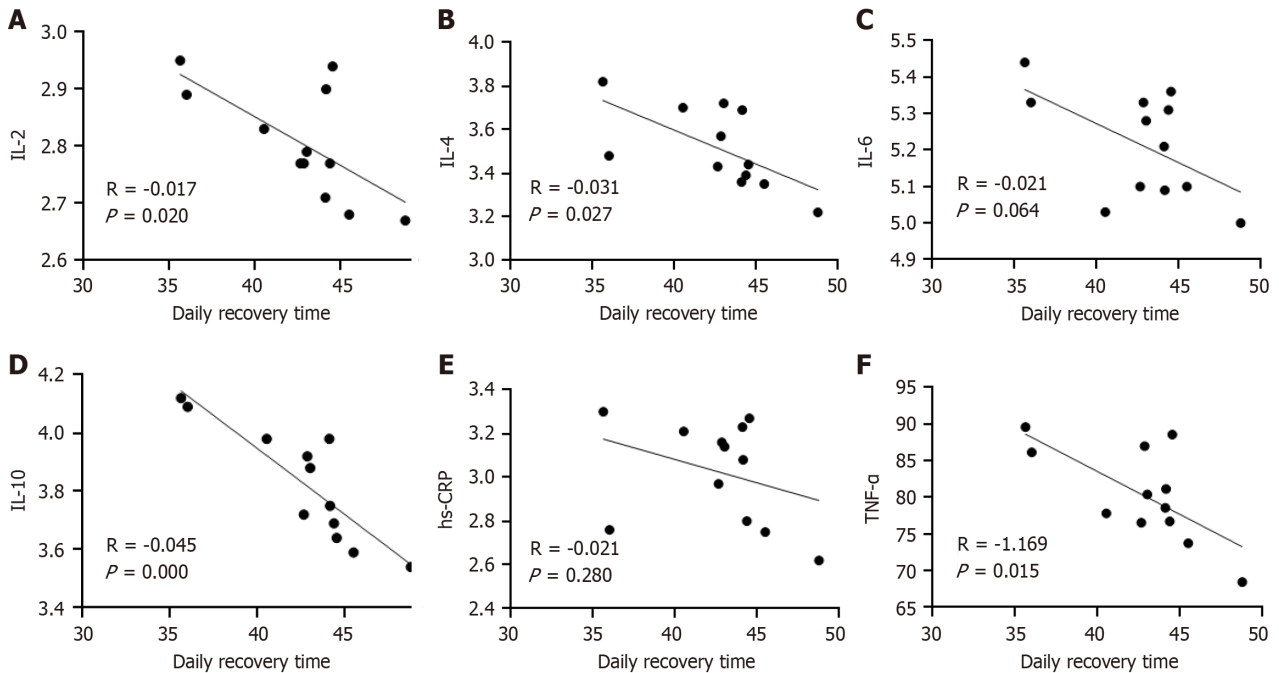
Intussusception is a surgical disease in children that can be caused by dietary changes, infection, and other factors[6]. In recent years, with continuous progress in medical technology, laparoscopy has become widely used for the treatment of intussusception. Laparoscopy provides a safe environment for reduction, significantly reduces fear and discomfort in children, and can achieve a greater reduction than traditional nonsurgical treatment[7]. However, as an invasive method, laparoscopic intussusception reduction can easily cause trauma, complications, and delayed disease recovery[8]. Therefore, postoperative rehabilitation is important for improving patient prognosis. Some studies have found obvious differences in the hospital stay and gastrointestinal function of postoperative patients among different rehabilitation



**Figure 4 Inflammatory factor levels.** A: Interleukin (IL)-2, IL-4, IL-6, and IL-10; B: High-sensitivity C-reactive protein; C: Tumor necrosis factor- $\alpha$ . <sup>a</sup> $P < 0.05$  compared to the routine nursing group. IL: Interleukin.



**Figure 5 Correlation between gastrointestinal function and postoperative rehabilitation time.** A: Gastrin; B: Motilin. GAS: Gastrin; MTL: Motilin.



**Figure 6 Correlation between inflammatory factors and postoperative rehabilitation time.** A: Interleukin (IL)-2; B: IL-4; C: IL-6; D: IL-10; E: High-sensitivity C-reactive protein; F: Tumor necrosis factor- $\alpha$ . IL: Interleukin; hs-CRP: High-sensitivity C-reactive protein; TNF- $\alpha$ : Tumor necrosis factor- $\alpha$ .

methods[9]. Therefore, in this study, we aimed to analyze the effects of different postoperative rehabilitation methods on gastrointestinal function and inflammatory factors in children with intussusception to improve the postoperative rehabilitation effect.

Comparison of the general data, gastrointestinal recovery time, gastrointestinal function, and inflammatory factor levels between study groups revealed that the recovery time of the gastrointestinal tract was shorter in the rehabilitation training group than in the routine nursing group. Meanwhile, Pearson correlation analysis revealed that gastrointestinal function was positively correlated with postoperative recovery time, while levels of the inflammatory factors IL-2, IL-4, IL-10, and TNF- $\alpha$  were negatively correlated with postoperative recovery time ( $P < 0.05$ ).

As a gastrointestinal hormone, GAS is secreted by G cells in the gastric antrum and duodenum, promoting gastric acid secretion and gastric antrum contraction, and directly affecting gastrointestinal secretion and motor function[10,11]. Min *et al*[12] found that patients who underwent rehabilitation training after laparoscopic surgery showed high GAS and MTL levels and improved gastrointestinal peristalsis. At the same time, Hsieh *et al*[13] found that rehabilitation training after laparoscopic surgery improved patients' gastrointestinal function and the corresponding index level. These studies suggest that the postoperative rehabilitation style used in children with intussusception influences their gastrointestinal function. However, this study showed that the GAS and MTL levels in the rehabilitation training group were higher than those in the routine nursing group, and Pearson correlation analysis showed that GAS and MTL levels were positively correlated with postoperative rehabilitation training ( $P < 0.05$ ). Postoperative rehabilitation training can regulate the hypothalamus-pituitary-adrenal axis and the autonomic nervous system, inhibit sympathetic nerve excitability, improve parasympathetic nerve excitability, and stimulate the gastrointestinal tract contraction and reflexes, thus improving local blood circulation and enhancing gastrointestinal peristalsis, shortening the retention time of food in the stomach, reducing the burden on the stomach, and stimulating GAS and MTL secretion. Simultaneously, rehabilitation training can improve cardiopulmonary function, enhance endurance, reduce stress and anxiety, indirectly promote gastrointestinal function recovery, and improve GAS and MTL levels in children[14,15].

As a key mechanism leading to gastrointestinal dysfunction, inflammatory reactions can affect patients' postoperative rehabilitation[16]. Thyregod *et al*[17] showed that exercise rehabilitation has a controlling effect on the inflammatory response in patients. Simultaneously, Kaasgaard *et al*[18] found that early rehabilitation training can improve the inflammatory state and alleviate the clinical symptoms of patients with chronic obstructive pulmonary disease. These studies suggest that the postoperative rehabilitation style used in children with intussusception influences their gastrointestinal function. However, we also found that the levels of IL-2, IL-4, IL-6, IL-10, hs-CRP, and TNF- $\alpha$  were higher in the rehabilitation training group than in the routine nursing group. Moreover, the Pearson correlation analysis found that inflammatory factor levels were negatively correlated with postoperative rehabilitation training ( $P < 0.05$ ). This is because rehabilitation training accelerates the blood circulation and metabolism of the children, promotes the accumulation of white blood cells and other immune cells in the blood, helps discharge waste and toxins from the body, promotes the regression of inflammatory reactions, and reduces the secretion of inflammatory factors. Simultaneously, exercises of the elbow and shoulder joints improved the range of motion, enhanced endurance, and reduced the inflammatory reactions caused by joint stiffness or sports injuries. Moreover, rehabilitation training reduces the stress response in children and the secretion of stress hormones such as cortisol, thus reducing the levels of inflammatory factors[19,20]. However, this study was limited by its small sample size and the relatively homogeneous source of study participants; therefore, targeted research in later stages is needed to ensure the authenticity and objectivity of our results.

## CONCLUSION

In summary, gastrointestinal function was better and inflammatory factor levels were lower among children with intussusception who underwent postoperative rehabilitation training compared to routine nursing care. Gastrointestinal function and postoperative rehabilitation training were positively correlated, whereas inflammatory factor levels and postoperative rehabilitation training were negatively correlated.

## FOOTNOTES

**Author contributions:** Zhang J designed research; Wei XY performed research; Huo HC and Li X contributed new reagents or analytic tools; Sun SL analyzed data; Wei XY wrote the paper.

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