



Understanding perioperative bowel preparation for colorectal surgery

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Abstract: Bowel preparation is an important perioperative measure in elective colorectal surgery. The goal is to empty the contents of the intestine and reduce the number of bacteria in the intestine, so as to reduce the risk of surgical-related infections, ensure the safety of the surgery and facilitate a smooth postoperative recovery. Compared with the upper abdominal surgery, colorectal surgery is usually associated with a higher risk of postoperative infection, including incision and abdominal infections, anastomotic leakage and infection-related intestinal obstruction, and of infections of distant organs, such as pneumonia and urinary tract infections. With the application of evidence-based medicine in clinical practice, especially the popularization of enhanced recovery after surgery (ERAS), the unfavorable factors of bowel preparation, such as physical discomfort, interference with normal physiology, and increased care burden, have received increasing attention. Relevant clinical trials and meta-analyses continue to emerge, and the clinical significance of bowel preparation in preventing postoperative infection has been questioned.

Keywords: Bowel preparation; enhanced recovery after surgery (ERAS); elective colorectal surgery

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The initial purpose and methods of bowel preparation

As the largest reservoir of bacteria of the human body, the number and species of gut microbiota are complex and huge, especially in the colorectal cavity. There are more than 4 million genes in human gut microbiota, 150 times the number of genes in human cells; these gut microbiotas are considered to provide a second human genome. The number and species of bacteria occur in a certain proportion to form a relatively stable intestinal microecosystem, which is involved in the body's metabolism, immune regulation and other physiological functions (1). However, gut microbiota is considered to be an important source of bacterial infection after colorectal surgery. Reducing the risk of postoperative infection by reducing the number of gut microbiota has always been an issue that surgeons

continue to explore.

In the early 20th century, surgeons tried to reduce the number of gut microbiota through preoperative diet control and oral laxatives to empty the contents of the intestine. In the 1970s, a relatively standardized regimen for bowel preparation was established: mechanical bowel preparation combined with oral antibiotics (2,3). The recommended methods were as follows. (I) On the 3rd and 2nd days before surgery, a low-residue diet is encouraged, and laxatives are also taken orally; on the day before surgery, the patient is given a clear liquid diet with oral laxatives and antibiotics. (II) Three days before surgery, a daily liquid diet is encouraged, and an enema is administered; oral antibiotics are added 1 day before surgery (4).

With the advent of new intestinal cleansing drugs, such as the isotonic laxative polyethylene glycol (PEG), the intestinal cleansing effect has become more ideal, the drug-

taking process has become more convenient, and bowel preparation has been further simplified. At present, most patients take oral laxatives and antibiotics one day before surgery; furthermore, preoperative dietary control is not as restricted, and usually, a low-fiber diet can achieve the goal. Hypertonic salt laxatives, which could cause an imbalance of water and electrolytes in the body, have been replaced by isotonic laxatives, and cleaning enema is no longer routinely used.

Differences in understanding bowel preparation

With the development of medicine, the unfavorable effects of perioperative mechanical bowel preparation, such as physical discomfort and dysregulation of the gut microbiota and the balance of the internal environment (water and electrolytes), have received increasing attention. Bowel preparation is contrary to enhanced recovery after surgery (ERAS). Studies focusing on the clinical application value of bowel preparation have emerged. Many clinical studies have found that mechanical bowel preparation has no preventive effect on postoperative infection-related complications and may even increase the risk of infection (5-8). Therefore, the guidelines for colorectal surgery issued by the European Society for ERAS clearly state that preoperative bowel preparation should not be routinely performed (9). However, it is also believed that bowel preparation still plays an active protective role in surgery (10). Therefore, the clinical significance of bowel preparation has not been completely denied. In the guidelines issued by the American Society for ERAS, routine preoperative bowel preparation is still recommended (mechanical bowel preparation combined with oral antibiotics) (11).

The clinical practice of bowel preparation in European countries, such as Spain, the United Kingdom and Denmark, has been studied, and the results have shown that colorectal surgeons do not follow the European guidelines and still use mechanical bowel preparation, especially for left hemi-colon surgery (12,13). Similar studies in the United States and South Korea have also shown that surgeons have not changed their attitude toward bowel preparation and that preoperative bowel preparation is still widely used (14,15). Currently, mechanical bowel preparation is still a routine perioperative measure for colorectal surgery in China (16).

In recent years, the superiority of oral antibiotic bowel preparation has been confirmed by an increasing number of studies (17-19). It is believed that preoperative oral

antibiotics can also prevent postoperative infection, with an efficacy that is comparable to or better than that of mechanical bowel preparation alone (20). Mechanical bowel preparation combined with oral antibiotics should have a better preventive effect (17,19). Therefore, some scholars have suggested that bowel preparation cannot be eliminated and that more attention should be paid to it. The relevant guidelines for ERAS should be updated to emphasize the necessity of perioperative bowel preparation (17). Moreover, mechanical bowel preparation combined with oral antibiotics should be recommended as the standard regimen.

Currently, there is no fixed selection of antibiotics for bowel preparation. However, on the day before surgery, broad-spectrum antibiotics are usually taken orally to eliminate Gram-positive, Gram-negative and anaerobic bacteria, and antibiotics can be intravenously injected within 24 hours after surgery (19). Nevertheless, the significance of preoperative oral antibiotics is still under debate (21-23).

Bowel preparation and gut microbiota

The purpose of mechanical bowel preparation is to significantly reduce the number of bacteria in the colorectal cavity. Clinical studies have confirmed that after oral laxative use, the number and species of gut microbiota are significantly reduced, but there are many differences between the expected and final effects of bowel preparation (24,25).

As early as the 1970s, studies suggested that mechanical bowel preparation cannot significantly reduce the bacterial concentration in the gyrus and colon cavity (4). Because nonpathogenic bacteria account for the majority of gut microbiota, the number of nonpathogenic bacteria decreases most significantly after bowel preparation, including beneficial bacteria, such as bifidobacterial and lactobacilli, while the number of pathogenic bacteria, such as *Escherichia coli*, *Staphylococcus*, and *Clostridium difficile*, increases (1). Studies have found that the bacteria that accumulate in the tissues around an intestinal anastomosis increase in patients with bowel preparation compared to those without mechanical bowel preparation (26). Emptying intestinal contents does not necessarily change the number of microbes attached to the surface of the intestinal mucosa, and the microbes on mucosal surface are effective for and directly affect anastomotic healing (27,28). In addition, after bowel preparation, the contents of the intestine become thinner and may easily leak through the anastomotic site, increasing the risk of anastomotic leakage and abdominal

infection.

Gut microbiota balance is a prerequisite for achieving the physiological function of gut microbiota and for resisting exogenous and endogenous infections. Currently, there are no highly selective antibiotics that target certain pathogens. Prophylactic oral antibiotics usually use nonselective broad-spectrum antibiotics. The intestinal tract contains the greatest number of harmless microbes; therefore, damage to them is significant, resulting in the increased risk of pathogenic bacteria. At present, a thorough understanding of gut microbiota is still at the initial stage, and knowledge regarding truly harmless or harmful bacteria and the number and species of gut microbiota is limited. Furthermore, knowledge of the relationship between gut microbiota and intestinal anastomotic healing mainly comes from animal experiments. Further understanding of the advantages and disadvantages of gut microbiota still requires extensive investigations (29,30).

How surgeons view the bowel preparation

Regarding the advantages and disadvantages of mechanical bowel preparation, surgeons are aware of the issues leading to the debate. Most of the clinical studies related to bowel preparation are retrospective, and there are many influencing factors.

There is no uniform method for bowel preparation, and specific implementation varies greatly from region to region. Although mechanical bowel preparation combined with oral antibiotics can effectively reduce the risk of postoperative complications of colorectal surgery, this measure has not been widely applied (16,21,31,32). In addition to mechanical bowel preparation, the causes of perioperative gut microbiota disorders include surgical trauma stress, bowel incision exposure to the air, and use of antibiotics. The application of prophylactic broad-spectrum antibiotics is untargeted, which increases the risk of gut microbiota disorders. Besides, the influencing factors of surgical complications are complex. In addition to perioperative management, systemic and local conditions of patients and surgeons' technical level can affect patient outcomes.

Practically, because intestinal emptiness is convenient for laparoscopic surgical operations and reduces the chance of intraoperative abdominal contamination, preoperative bowel preparation for laparoscopic surgery is routinely recommended (9). Anastomotic leakage is a serious complication of colorectal surgery, resulting in

abdominal infections that not only endanger the patient's life but also increase the risk of reoperation. In particular, this complication also puts great psychological pressure on surgeons (33). Significantly, preoperative intestinal emptiness can reduce the chance and degree of abdominal contamination in the case of anastomotic leakage, which can avoid reoperations for some patients. These patients can be cured by conservative treatment.

In summary, surgeons should view bowel preparation in terms of convenience of surgical operation, ERAS, and self-experience. Both positive and negative clinical trial results cause difficulty with regard to guiding specific clinical practices. Undoubtedly, mechanical bowel preparation allows surgeons to experience clinical benefits.

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Footnote

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