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ORIGINAL ARTICLE

Using of Ileucecal Interposition as a Neo-stomach in Dogs with Total Gastrectomy (Presentation of a Novel Technique)

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Abstract Total gastrectomy and R&Y reconstruction is the standard treatment of gastric cancer except distal form one. Malnutrition is a common adverse effect of this technique, and in this study, we preset a novel technique in order to help to reduce the rate of it. We use seven dogs as participants and after total gastrectomy; we used the 10 cm of the ileum and its concomitant cecum as a neo-stomach in them. For 3 months, the dogs were evaluated in nutrition status. Three of the dogs died—one due to endocarditis and two due to internal hernia. No anastomosis leakage or stricture was seen and there were no unusual neo-stomach dilation or food stasis. This technique can help the nutrition status of total gastrectomy patients but needs more comparative human studies.

Keywords Total gastrectomy · R&Y reconstruction · Jejunal J-pouch · Malnutrition

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Introduction

Gastric cancer is the second worldwide cause of death in cancer patients [1]. Total gastrectomy is still a mainstay of gastric cancer curative treatment except for tumors developing in the distal part of the stomach which require subtotal gastrectomy [2]. The method of choice for completion of surgery is Roux-en-Y reconstruction with or without jejunal J-pouch [3]. Although total gastrectomy is the treatment of choice, it may be associated with adverse effects such as digestive symptoms, loss of appetite, and malnutrition [1, 2, 4–8]. Though some limited studies indicated that malnutrition after total gastrectomy is relatively mild [9], one of the major problems in these patients is weight loss which makes the individuals weak and it may also prevent full recovery and returning to normal functions. Several factors such as perioperative weight loss due to catabolic metabolism, pancreatic insufficiency, reduced food intake after gastrectomy, lack of appetite, absence of hunger sensation, esophagitis, dysphagia, and loss of an appropriate food reserve like a normal stomach [2, 3, 8, 10, 11] can be suggested as the causes of this phenomenon, which are mostly inevitable. Moreover, following gastrectomy, gut peptides like cholecystokinin (CCK), which inhibit food intake, are released at remarkably high amounts in response to a meal [12, 13]. It is known that CCK can suppress food intake under physiologic conditions, and some studies revealed that CCK receptor blockade increases food intake and body weight after total gastrectomy [2, 14].

We believe that, if surgeons could create an appropriate food reserve and also a natural conduit through which food could pass, it may prevent severe weight loss and malnutrition in patients who underwent total

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gastrectomy. In this study, we present a novel technique (*Ehsan procedure*), in which a small part of the distal ileum and cecum were substituted with the stomach and changes in appetite and weight were examined.

Material and Methods

The study was conducted after obtaining animal ethics committee approval (Mashhad University of Medical Sciences, Iran) from April to November 2013. The participants included seven female dogs with the age ranged between 2 and 3 years and weight ranged between 25 and 29 kg which were prepared and operated on in the "Veterinarian Hospital of Ferdowsi University of Mashhad."

The digestive system, especially the colon, was mechanically and chemically prepared, using paraffin, water and soap, and metronidazole. Furthermore, in order to reduce postoperative complications, the dogs were evaluated for parasite infection and four cases were treated by anti-parasite agents (praziquantel and mebendazole). All participants underwent general anesthesia with the same anesthetic protocol (premedication: acepromazin and diazepam, induction and maintenance: propofol).

All dogs were operated through a large median incision, and a meticulous exploration was performed to detect any possible abdominal disorders. The next step in our approach was dissection of 10 cm of the distal ileum and cecum, while the vascular tree was carefully preserved (Fig. 1). Then, an end-to-end anastomosis was performed between the remained ileum and ascending colon, and the mesentery defect was repaired (Fig. 2).

After total gastrectomy, the open ileum was closed, and an end-to-side esophagoileostomy anastomosis was performed. The final step of the method comprised an end-to-end anastomosis between the cecum and duodenum (Fig. 3). All anastomoses were performed by hand-sewn technique. No drain was placed in this procedure.

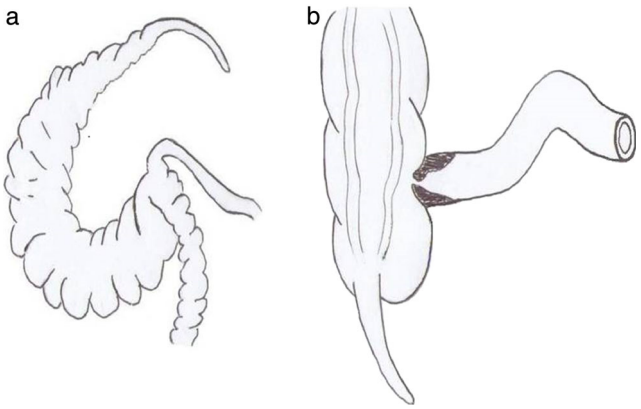

Fig. 1 Separation of the distal ileum and cecum with their mesentery (dog (**a**), human (**b**))

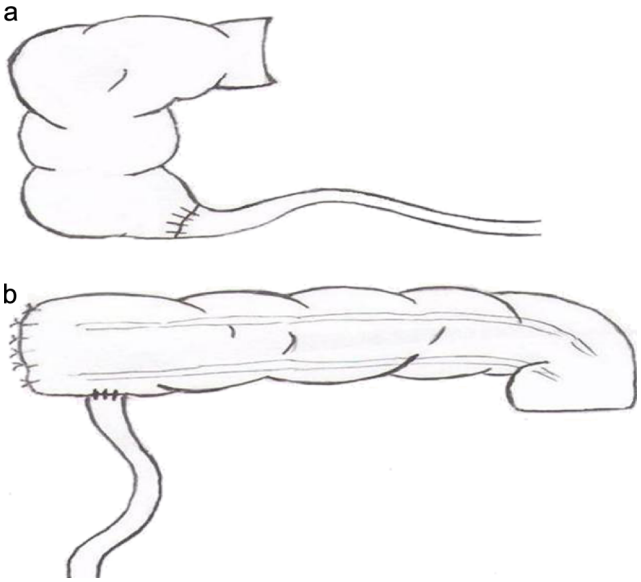

Fig. 2 Creation of a new ileocolic tube by anastomosis between the ileum and ascending colon in dogs (**a**) and ileum and transverse colon in humans (**b**)

Every participant was prescribed with broad spectrum intravenous antibiotics (ceftriaxone and metronidazole) before and 3 days after the operation. In follow-up, finding postoperative complications (e.g., anastomosis site leakage or abscess formation), the clinical signs and symptoms such as fever and leukocytosis were reconsidered. Intravenous flunixin meglumine was used as analgesic. For supportive management, intravenous B-complex vitamin was used. After 7 days, during which the dogs were under fasting condition and serum therapy, we started water and, then, liquid diet on the next day. For dogs which tolerated the liquid diet, we initiated the standard commercial solid food and fresh meat.

Laboratory evaluations included cell blood counts and serum Na, K, BUN, and Cr which were performed before surgery and also 3, 7, 30, and 90 days postoperatively. Two weeks after the operation, the dogs underwent a contrast swallow study to evaluate the anastomosis integrity and the new stomach size.

The food intake was measured daily and the weight gain was recorded every week. To evaluate the neo-stomach size and the stasis of barium in the stomach, after 3 months, the dogs underwent another contrast swallow study. Abdominal ultrasonography was performed in one case with suspected pregnancy.

For housing, the dogs were cared in a standard cage with the approved conditions for laboratory dogs (temperature 18–21 °C, air changes 8–12/h, lighting 12-h light/dark cycle, and humidity 35–70 %). At the end of the study, the dogs were taken to the animal care center of the city.

After data collection, statistical analysis was performed.

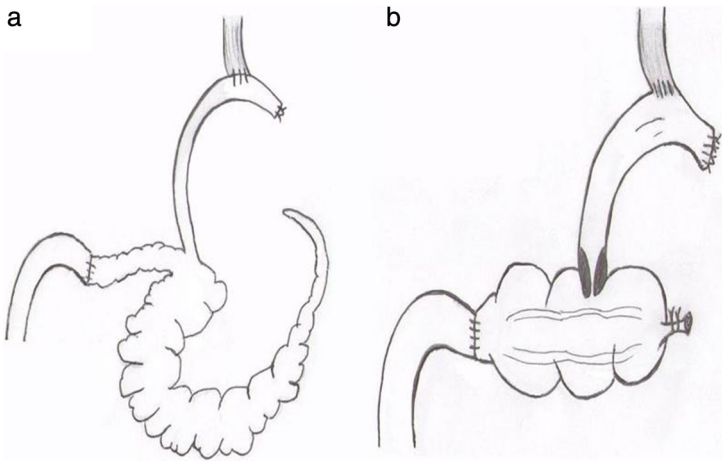

Fig. 3 Neo-stomach in a dog (**a**) and a human (**b**) after completion of the anastomosis

Results

The dogs' characteristics are shown in Table 1. The participants included seven dogs, three of which died and four of which are still alive. In one case, the dog died in the 2nd day after surgery, and the necropsy findings revealed bacterial endocarditis as the cause of death which was not related to the operation. The other two dogs died in 7 and 8 days after surgery. On necropsy, it was found that both had died from gastrointestinal obstruction due to internal herniation of the small bowel through mesentery defect of ileocolic anastomosis site.

At follow-up, 3 months later, no anastomosis leakage was detected. None of the participants experienced fascia dehiscence, abdominal or pelvic abscess, fistula, or significant anastomosis site stricture. In one dog, the final weight was greater than preoperative weight. The suspicion of pregnancy was excluded by ultrasonography in this case.

Discussion

Gastric cancer is one of the most common causes of cancer death in the world. Nowadays, the only approved treatment of this disease is surgery which, in some patients, is curative [3]. Although, in patients with distal gastric cancer, we can perform a distal gastrectomy, in others, the only chance for cure is achieved by total gastrectomy. Different types of reconstruction have been presented; however, Roux-en-Y esophagojejunostomy is the method of choice [3]. Indeed, the operation is associated with high risk of complications and severe morbidity. The most common complications are nutrition related, including postoperative weight loss (averaging 25 % of preoperative body weight), loss of appetite, malnutrition, osteoporosis, osteomalacia, impaired quality of life, anemia with ferropenia and vitamin B12 deficit, reduced levels of zinc and retinol transporting protein, and other metabolic and nutritional changes [1–8]. In fact, even when the patients are cured from their cancer disease, they are at obvious risk of complications caused by impaired food intake. This situation makes recovery more prolonged and incomplete. Having impaired quality of life, most of them refuse to participate in social activities [1].

Accordingly, several studies have been conducted to improve the nutritional status of these patients. For instance, several studies suggested using some type of pouch in the reconstruction to create a food reservation for the patients [3]. Today, the jejunal J-pouch is more commonly used [1, 3, 15]. Although because probably both the reservoir function of the pouch and changes in intestinal

Table 1 The characteristics of participated dogs

Dogs	Sex	Age (year)	Preoperation weight (kg)	1st month post operation weight	2nd month post operation weight	3rd month post operation weight	Destination
1	F	2	28	23.1	24.35	28.9	Alive
2	F	2	26.7	–	–	–	Died
3	F	3	32	–	–	–	Died
4	F	2	26	21.2	23.1	27.5	Alive
5	F	3	26.5	21.8	22.7	26.4	Alive
6	F	3	28.4	–	–	–	Died
7	F	3	30	23.2	25.8	28.6	Alive

transit time play an important role in improving nutritional recovery, the results from different studies are somewhat contradictory [3].

In addition, compared to patients who underwent a subtotal gastrectomy, those with total gastrectomy had poorer tolerance of normal diet and they need frequent eating with smaller meals [9, 16]. This can establish the important role of the stomach as a reserve in adequate nutrition and prevention of weight loss. Also, studies reveal that patients who underwent Billroth II reconstruction after a distal subtotal gastrectomy lost more weight than those with a Billroth I anastomosis [16]. This finding may confirm the superiority of normal gout conduit versus operations such as duodenal bypass, which can prevent an effective mixture of the meal, pancreatic and biliary secretions, and consequently food digestion.

We should take into account that, indeed, we perform a "bariatric surgery" in patients with gastric cancer. The stomach is extracted (reduction of the reserve) and the duodenum is bypassed, both of which are performed by bariatric surgeons in morbid obesity management. While total gastrectomy is considered an aggressive bariatric surgery, it itself can induce anorexia in a cancer patient, whose appetite decreases due to the prime disease.

In our proposed technique, we used a small part of the ileum and cecum as a new stomach, and the anastomosis were performed between the esophagus and ileum and also between the cecum and duodenum, which may have several potential benefits including:

1- Because of profuse vascularity of the ileum, the anastomosis between the esophagus and ileum is safer than between the esophagus and cecum.
2- The preservation of ileocecal valve can prevent the biliary secretion reflux to the esophagus.
3- Cecum can provide an appropriate volume in order to prevent reduced meal capacity.
4- The anastomosis between the cecum and duodenum creates a normal conduit and requires no duodenal bypass.

Although seemingly performing interposition of jejunum reconstruction (IJR) technique may have above advantages and requires no other technique, it has several problems. For instance, the jejunum provide limited space for food, the rate of bile reflux to the esophagus is high, and its superiority regarding quality of life and prevention of weight loss in contrast to Roux-en-Y reconstruction is under debate [17].

In spite of the benefits, there are some worries about our suggested technique:

1- Due to low vascularity of cecum, its anastomosis to the other organs may not be safe, so it is associated with higher risk of anastomosis leakage.
2- Because of the thin wall of the cecum, there is a concern about severe dilation and food stasis after a period of a time.
3- It is a complex and time-consuming procedure which can be harmful for old patients due to several co-morbidities.
4- Like Billroth I, the rate of bile reflux to the neo-stomach may become high. The long-term influence should also be considered.

Based on these concerns, we investigated the potential complications. One dog died due to endocarditis which it was not related to the operation. The other two deaths were due to internal hernia which can be justified. In fact, mesenteric defect closure was performed in all dogs, but because of the dog thin bowel mesentery, it ruptured in two. It seems that this complication less likely occurs in humans because of their appropriate mesentery. Although some studies have appreciated the importance of mesentery defect closure in Roux-en-Y standard operation, in the suggested technique, the risk of internal hernia formation is higher and requires high attention during surgery [18].

According to our findings, there was no anastomosis leakage which is considered as a major concern in this technique.

Regarding dilation in the neo-stomach, barium swallow study 3 months after surgery demonstrated no significant difference in comparison with that before operation (Fig. 4). Although these findings can support the technique, a longer follow-up is needed to exclude the negative potential of food stasis in the neo-stomach. Finally, like Billroth I reconstruction, in the suggested technique, reflux gastroesophagitis should be considered as a serious complication [19, 20].

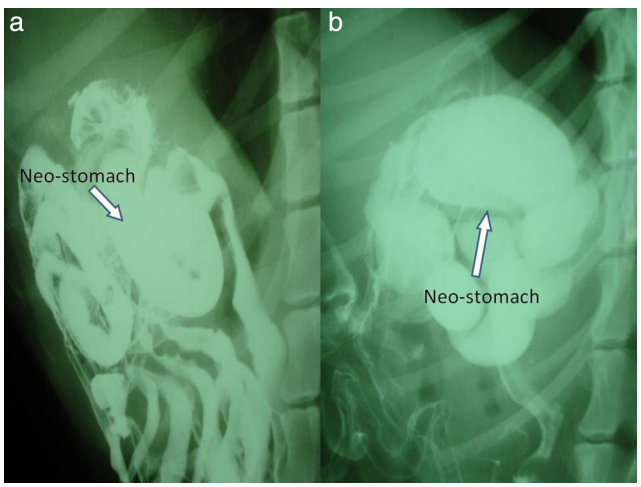

Fig. 4 Barium swallow study was performed before (**a**) and 3 months (**b**) after surgery

Because of complexity and prolongation of this procedure, an appropriate selection of patients is vital. It can be useful in younger patients who have not any major co-morbidity. Appropriate surgical equipments such as new electro-haemostatic devices and staplers are needed in order to save time. Also, surgical team must be trained in gastrointestinal cancer surgery. In addition, several major points should be considered in next human research:

1- In humans, it is better to perform the anastomosis between the ileum and transverse colon because the latter has more acceptable vasculature.
2- The suggested sequence of procedure is total gastrectomy, an end-to-end anastomosis between the cecum and duodenum and an end-to-side esophagoileostomy anastomosis. Finally, the open ileum is closed.
3- To save time, all of the anastomosis should be done by staplers.
4- It is necessary to perform an appendectomy before final anastomosis.

Conclusion

Although the ileucecal interposition (Ehsan procedure) may be a good option in the gastric cancer treatment because of its theorical benefits in patients' nutrition, however, it requires performing comprehensive human studies and comparing the findings with the standard technique results.

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Compliance with Ethical Standards Animal ethics committee approval (Mashhad University of Medical Sciences, Iran) was obtained for this study.

Conflicts of Interest The authors declare that they have no conflicts of interest.

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