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Comparative study between Roux-en-Y gastric bypass and sleeve gastrectomy in dogs

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Abstract

Aims of study to compare between Roux-en-Y gastric bypass and gastric sleeve surgery to reduce excess weight in dogs with less complication. The study was conducted on 12 overweight male dogs. Their weights ranged between 33 and 39 kg, while their ages ranged from 20 months to 38 months. The dogs were randomly divided in two equal groups. The first group underwent gastric sleeve surgery, while the second group underwent gastric bypass surgery. The following criteria were used to evaluate the results: Animals weights were checked every two weeks for eight weeks. Laparoscopy was also performed two and eight weeks after surgery to evaluate any complications at the surgical operation site and ensure that stomach or intestinal contents were not leaking into the abdominal cavity. A blood sample was taken from each animal before surgery (zero time) and at the 2^{nd}, 4^{th}, 6^{th}, and 8^{th} weeks after surgery to measure iron and vitamin B_{12} levels. The weights of the animals in both groups decreased during 2^{nd}, 4^{th}, 6^{th}, and 8^{th} weeks, but the animals in the second group lost significant weight ($p \leq 0.05$) more than the animals in the first group. The results of the laparoscopic examination showed that there was no leakage of stomach and intestinal contents into the abdominal cavity; However, adhesions to the omentum, adjacent organs, or another part of the intestine are observed at the site of the operation. These adhesions were less in the first group than in the second group. According to the result of the iron test, the iron level in the second group decreased more than in the first groups. Vitamin B_{12} levels in the second group were lower than in the first group. In conclusion, the study showed that gastric bypass surgery effects on iron and vitamin B_{12} also severe adhesion and loss body weight more than gastric sleeve surgery.

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Introduction

Being overweight is an abnormal and excess of fat accumulation in different parts of the body (1). Obesity is now so prevalent in the world's population that it is overtaking malnutrition and infectious diseases as the leading cause of illness. Obesity, in particular, is linked to diabetes, coronary heart disease, some cancers, and sleep-breathing difficulties. Obesity is defined by a body mass index (weight divided by height squared). also refers to an illness in which extra body fat has accumulated to the point where health is threatened (2). Obesity is related to an increased incidence of type 2 diabetes mellitus, cardiovascular disease, dyslipidemia, and hypertension, as well as an increased risk of atherosclerotic disease and mortality. Bariatric surgery refers to operations that induce weight loss by reducing stomach capacity or creating nutrient malabsorption (3). For patients with clinically significant obesity, bariatric surgery is increasingly regarded as an accepted treatment (4). The current most effective treatment for morbid obesity is regarded to be bariatric surgery (5). resulting in long-term weight loss, noticeable improvements in comorbid conditions like diabetes, hypertension, and obstructive sleep apnea, and a decline in

mortality (6). The most popular and highly efficient method for treating severe obesity is gastric bypass surgery (5). Is a form of weight reduction surgery that causes weight loss by both food restriction and malabsorption, in these bypass surgeries, the duodenum and a piece of the small intestine are excluded from the digestive system, A tiny gastric pouch is made as part of the Roux-en-Y gastric bypass procedure. This pouch is joined to the area of the jejunum where food passes (7). Studies on humans have demonstrated that operations affecting the gastrointestinal tract, such as bariatric procedures and the complete or partial removal of the stomach, reduce the absorption of vitamin B_{12} (8). The most successful treatment for severe obesity is currently gastric bypass surgery, and it is now well known that it has positive benefits on co-morbidities associated with obesity, such as diabetes and hypertension (9). Gastric bypass surgery is especially related to iron insufficiency and iron deficiency anemia, which are more common with bypass than with simply restrictive operations (7). To limit how much food a person can eat; surgeons conduct sleeve gastrectomy (10). Sleeve gastrectomy (SG) is a bariatric procedure that has developed from both restrictive and malabsorptive or a combination of the two surgeries for the management of morbid obesity (11). One surgical operation used to treat morbid obesity is called a sleeve gastrectomy (SG), which involves removing the gastric fundus and narrowing the stomach (12). With a sleeve gastrectomy, the stomach is left without any fixations along the entire greater curvature, which increases the risk of volvulus (13). Iron concentrations in the body's tissues must be strictly controlled because excess iron causes tissue damage due to the generation of free radicals (14). The duodenum is the site of almost all iron absorption (15). Anemia is usually caused by iron deficiency, which is a typical side effect of bariatric surgery (16). Iron deficiency and anemia are common side effects of obesity. Iron loss and absorption are both increased by bariatric surgery (17). The Roux-en-Y gastric bypass of the principal site of absorption in the duodenum and proximal jejunum may lead to the development of iron deficiency and anemia after surgery (7). Surgical treatments that create restriction through forming a tiny gastric pouch, such as RYGB, can result in serious vitamin B_{12} deficiency due to decreased acid and pepsin digestion of protein-bound cobalamins in food, inadequate release of R binders, and decreased intrinsic factor production (18).

Therefore, the aim and the importance of this research are to compare between Roux-en-Y gastric bypass and gastric sleeve surgery to reduce excess weight in dogs with less complication

Materials and methods

Ethical approval

Ethical approval was granted through the local committee of animal care and use at the College of Veterinary Medicine within the University of Mosul number UM.VET.2023.098 dated 02/01/2023.

Animals

Twelve overweight local breed male dogs weighing 33 to 39 kg and 20-36 month of age were used in this study. The dogs were randomly divided into two equal groups. The first group underwent gastric sleeve surgery while the second group underwent gastric bypass surgery. A blood sample was taken from all dogs before surgery, as well as 2,4,6 and 8 weeks post operation to evaluate iron and vitamin B_{12} levels.

Surgical procedures

The surgery was done under general anesthesia using (19,20). The ventral abdominal wall was prepared for aseptic surgery and an incision of 10-15 cm was made, extending from the xyphoid cartilage to the umbilical region. Then two types of operation were done which sleeve gastrectomy and gastric bypass.

Sleeve gastrectomy

The stomach and spleen are completely extracted outside the abdominal cavity a double ligation by silk was done to cut the blood supply from the part that needs to be removed (greater curvature). Once the blood supply to the area that needs to be removed has been completely severed, a doyen's intestinal clamp is inserted along the stomach, make the remaining part tube shape to mark the surgical site and stop the stomach contents from flowing out. Once the site has been established, we use surgical blades or scissors to cut the area that needs to be removed. The stomach and spleen were cleaned with sterile normal saline solution at a concentration of 0.9%. Following the removal of the specified stomach portion, the edges of the stomach are sutured using a continuous connel suture technique by polyglycolic acid no: 0 or 1.

Gastric bypass

The first steps are similar to the sleeve gastrectomy. Doyen's intestinal clamps is inserted perpendicular to the stomach to create a small pouch from the side of cardiac orifice. Stomach cut from the specified part. The first part of the stomach is sutured using a continuous connel suture technique by polyglycolic acid no: 0 or 1 and leaving the lower part without suturing to connect it to the intestine. But the second part of the stomach near the duodenum are sutured completely with the same technique and materials after the intestine is extracted outside the abdominal cavity and to the point where the duodenum connects with the jejunum and cut between them in to connect the jejunum with the stomach by using the End-to-End anastomosis by simple interrupted suture technique. Finally, connect the duodenum with jejunum by using the End-to-Side anastomosis by simple interrupted suture technique to obtain a Y-Shape. After completing the gastric bypass, the

anastomosis area and the parts close to it are washed with sterile normal saline solution, and then the anastomosis site is examined to ensure that there is no leakage of stomach and intestinal contents from the anastomosis site by applying pressure on the anastomosis area with the finger. The abdominal cavity and skin are close by routine methods. Postoperative animals care following their recovery from anesthesia, the animals were moved into their assigned cages within the animal home. The dogs in both groups fed soft food for 3 days following the surgery. Then, continue normal food as they feed before the surgery to monitor the weight. As well as their normal physiology, such as defecation and urination throughout the trial period.

Blood samples

Blood samples were obtained from each animal before the surgery and 2,4,6, and 8 weeks after the surgery to evaluate iron, vitamin B_{12}. Blood samples were obtained in 5 ml volume under aseptic circumstances. The sample were transferred to laboratory to determine iron level using a chemical reaction by Spin 120 (British) and B_{12} level using fully automatic immune assay by LIASON (Diasorin) Germany. As described by Alkattan *et al* (21). was done at 2,8 weeks for examine the abdomen by use laparoscopic system which was imported from Karl Starz company, Germany.

Statistical analysis

The data of experiments were expressed as mean ±SE. The data were compared by one- and two-way repeated measures ANOVA (Analysis of Variance). Significant differences were determined by Duncan's Multiple Range Test. Data were analyzed using Sigma Stat (Jandel scientific software V3.1), and $P<0.05$ was considered as statistically significant.

Results

Animal weights

Table 1 shows the decrease in the weight of all animals in both groups, the weight of the dogs was reduced significantly ($P\leq0.001$), two weeks after surgery compared with the weight before surgery, and the weight of dogs continued to decrease after 4,6 and 8 weeks. The results of group 1 showed that the average weight loss was 1±0.0 kg two weeks after surgery, and the weight loss continued until the eighth week when the loss reached 2.6±0.3 kg (Table 1). As for the second group, the rate of decrease was more severe two weeks after the surgery, 2.6±0.2 kg, and the decrease continued until the eighth week. The weight loss recorded 3.5±0.3 kg (Table 2). It is clear from this that weight loss rate dogs in the first group in the second week was significantly lower ($P\leq0.05$) than it was in the following weeks. As for the dogs of the second group, they showed a clear and more severe decrease than the first group throughout the experimental period, which was eight weeks, and there were no significant differences in weight loss when compared between the weeks included in the study. And there was a significant difference in the average weight loss between the two groups, at a significant level ($P\leq0.05$) where weight loss was more severe and noticeable in the second group (Table 1).

Table 1: the mean of weight of the animals before and after the surgical operations in two groups

Groups	Body weight (kg) in different weeks post operation				
	Zero time	2nd weeks	4th weeks	6th weeks	8th weeks
Sleeve gastrectomy	33.5±1.5[a]	32.5±1.5[b]	30.1±1.4[c]	27.6±1.4[d]	25.0±1.4[e]
Gastric bypass	39.1±1.8[a]	36.5±1.7[b]	33.5±1.7[c]	30.5±1.8[d]	27.0±1.8[e]

[a-e] the different small letters refer to a significant variation between the columns at $P\leq0.001$.

Table 2: The mean of lost weight of the animals after the surgical operations

Groups	Body weight (kg) in different weeks post operation			
	2nd weeks	4th weeks	6th weeks	8th weeks
Sleeve gastrectomy	1±0.0 [A,a]	2.3±0.2 [A,b]	2.5±0.2 [A,b]	2.6±0.3 [A,b]
Gastric bypass	2.6±0.21 [B,a]	3.0±0.0 [B,a,b]	3.0±0.2 [A,a,b]	3.5±0.3 [B,b]

[a,b] The different small letters refer to a significant variations between the columns ($P\leq0.05$). [A,B] The different capital letters refer to a significant variations between the rows ($P\leq0.05$)

Laparoscopically

According to the results of the laparoscopic examination performed on the dogs of both groups, no leakage of stomach and intestinal contents into the abdominal cavity from the surgical site was observed in all dogs and in both groups. However, adhesions to the omentum, other organs, and to each other were seen at the surgical site in both groups (Figure 1). The adhesions were more severe in the second group than the first group, as the adhesions were simple in the first group, unlike the second group (Figure 2). A change

in the shape of the stomach was observed in both groups, and the shape of the stomach changed more clearly in the first group, as the shape of the stomach become tubular (Figure 3). The stomach's Y-shape was also noticeable following the bypass operation (Figure 4).

Iron

The results of the blood iron level analysis showed a significant decrease in the average blood iron level in both groups (Table 2) compared to its level before the operation. While the iron level was 134.3±5.3 and 113.5±3.8 before the operation, and in the two groups respectively, its level in the blood began to decrease from the first week, and this decrease continued throughout the study period, as the decrease was more severe in the eighth week compared to the second week in the first group same result was showed in the second group. When comparing the decrease in iron levels between the two groups, no significant differences were observed in the level of decrease.

Vitamin B_{12}

The results of the vitamin B_{12} test for the first group showed that there was a slight decrease in the level of the vitamin in the blood throughout the experiment period although this decrease was not significant, while the level of vitamin recorded a significant decrease throughout the observation period in the dogs of the second group. The results also showed that there were no significant differences. In the vitamin level when comparing the vitamin level between the group of dogs that underwent gastric sleeve surgery and the second group that underwent surgery (Table 3).

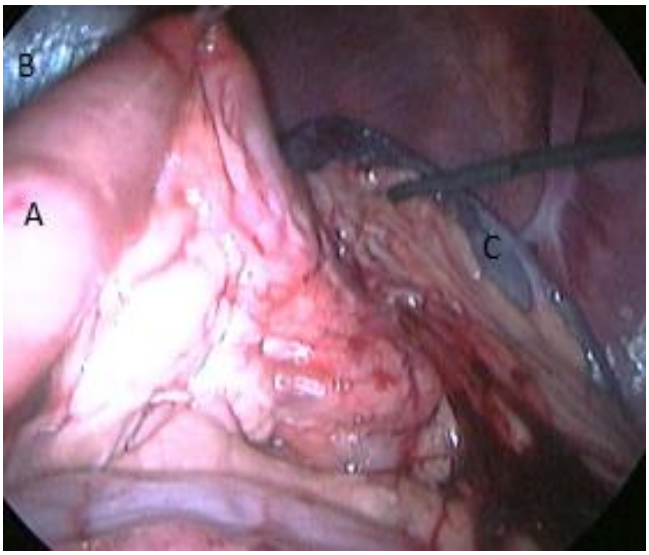

Figure 1: There are very slight adhesions to the omentum and no leaks from the surgical site. A (stomach), B (liver), C (spleen).

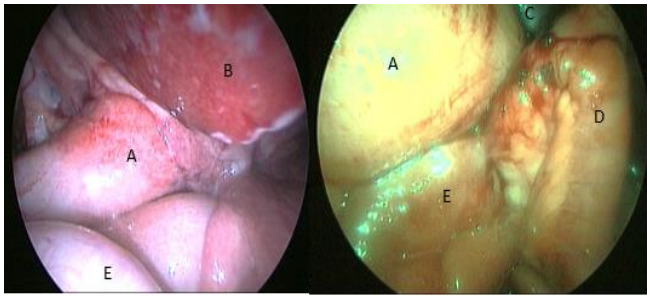

Figure 2: presence of sever adhesions with the omentum and between adjacent organs and the surgical site. A (stomach), B (liver), C (spleen), D (jejunum), E (duodenum)

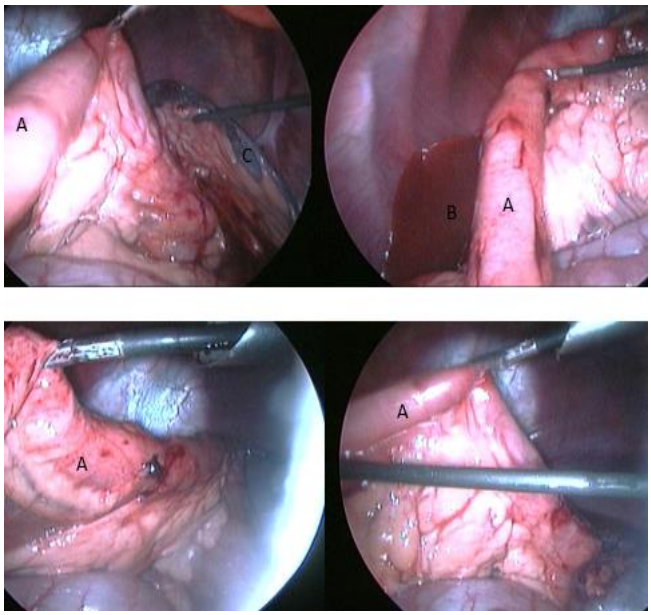

Figure 3: These forms show the stomach's tubular form following the gastric sleeve technique. A(stomach), B(liver), C(spleen).

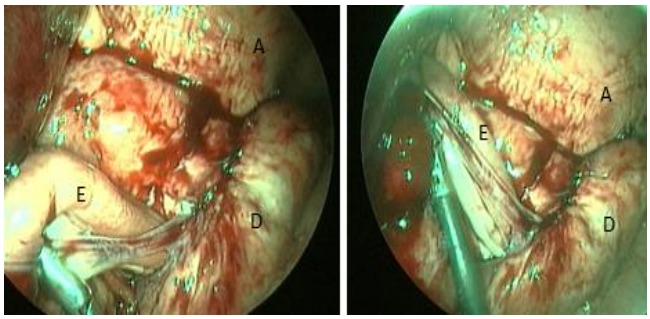

Figure 4: Y-shape stomach after bypass operation. A (stomach), D (jejunum), E (duodenum).

Table 2: The mean of iron measurement of the animals before and after surgical operation in two groups

Groups	Iron (µg/dl) in different weeks post operation				
	Zero time	2nd weeks	4th weeks	6th weeks	8th weeks
Sleeve gastrectomy	134.3± 5.3 ^{a,A}	105.8± 7.2 ^{a,B}	100.3±6.6 ^{a,B,D}	95.1± 7.4 ^{a,B,D}	87.6±6.3 ^{a,C,D}
Gastric bypass	113.5±3.8 ^{b,A}	99.1±2.7 ^{a,B}	86.6±1.8 ^{a,B,D,}	76.6±2.0 ^{b,C,D}	65.0±1.7 ^{b,C}

^{a,b} the different small letters refer to a significant variation between the rows (P≤0.05). $^{A-D}$ the different capital letters refer to a significant variation between the columns (P≤0.05)

Table 3: The mean of B_{12} measurement of the animals before and after surgical operation in two groups

Groups	B_{12} (ng/ml) in different weeks post operation				
	Zero time	2nd weeks	4th weeks	6th weeks	8th weeks
Sleeve gastrectomy	280.6± 13.4 ^{a,A}	251.3± 8.6 ^{a,B}	227±2.9 ^{a,C}	214.5± 1.3 ^{a,C,D}	204.8±1.6 ^{a,D}
Gastric bypass	297.5±2.5 ^{a,A}	253.3±4.9 ^{b,B}	216.6±2.4 ^{a,C}	196.6±3.3 ^{a,D}	183.3±3.8 ^{bD}

^{a,b} the different small letters refer to significant variation between the rows (P≤0.05). $^{A-D}$ the different capital letters refer to a significant variation between the columns (P≤0.05).

Discussion

The results showed that the gastric bypass surgery was accompanied by a clear decrease in the animals weight this is due to the face that the operation including the fundus of the stomach and since this part of the stomach contain secretory cells that produce appetite hormones, this will consequently reduce appetite the animals is in addition to the small size of the stomach, and this is consistent will what was mentioned by Ghanbari *et al*. (8) Bariatric surgery has many benefits, including promoting weight loss and other comorbidities of obesity. In addition, bariatric surgery appears to be a more viable option for treating morbid obesity compared to conventional treatment (22). The weight loss in sleeve gastrectomy before and after surgical operation this method is preferred by many researchers, including Turkur *et al*. (23). The other reason for weight loss comes from the significant decrease in ghrelin levels after resection of the fundus of the stomach, which is the predominant area of ghrelin production (24). also, the study showed that the second method, which is Roux-en-Y gastric bypass, causes greater loss of weight than the first method due to food restriction and malabsorption. In these surgeries, the duodenum is cut and removed and the small intestine is excluded, and a small gastric pouch is created as part of the RYGB procedure. This bag is connected to the jejunum area, where food passes without absorption, because the part designated for absorption, the duodenum, has been removed. The study showed that weight loss in Roux-en-Y gastric bypass surgery is more severe than gastric sleeve surgery this is supported by Ghanbari *et al.* (8). while the others and this result was the opposite. The findings of Han *et al*. (25) who found that the two experiences had the same effect on weight loss.

Laparoscopic examination is considered one of the best methods used to follow up surgical operations and determine if there are any complications in the operation (25). The results of the study animals with a laparoscopic after two and eight weeks showed that there is no leakage in the contents of the stomach or intestines, and this is due to the method of suturing used, which makes the edges inverted in the first group prevents the leakage of stomach and intestinal contents from the operation site into the abdominal cavity, which is consistent with Ralphs *et al*. (26). In the second group, which used the opposite edges method, no leakage of contents was observed; although many researchers confirm that it is possible for leakage to occur (26). The results obtained were contrary to what the researchers mentioned, confirming that the surgeon's skill is one of the most important factors that prevent leakage as mentioned by Tang *et al*. (27). Adhesions were found in both groups but were found to be less severe in the sleeve group. This apparent difference in the degree of adhesion may be due to the type of suture technique used, as the inverted suture technique produces much less severe adhesions than the prosthetic suture technique and this is consistent with Kachiwal and Kalhoro (28). They reported that when apposition sutures, such as simple interrupted sutures, simple continuous sutures, and modified Cambee sutures, are used, minimal inflammation occurs because the epithelial layer protrudes, causing adhesions to form this is consistent with Eggleston *et al*. (29). When an inverted suture technique is used, such as lumpert, connell, or cushing, adhesions are restricted to keep the inner epithelial layer from penetrating the outside. This prevents the chance for bacterial spread and, as a result, reduces the chance of adhesion formation at the anastomosis site and this is consistent with Jardel *et al*. (30).

The results showed a clear decrease in the iron level in dogs that underwent gastric sleeve surgery the same result was shown in dogs of group two were Roux-en-Y gastric bypass. The percentage of iron begins to decrease gradually after the surgical operation for both groups and the decreases were more severe in the second group, the same result confirmed by kwon *et al*. (31). Changes in the gut anatomical

structure affect iron digestion and absorption, in addition, decreased hydrochloric acid secretion impedes the conversion of ferric iron to absorbable ferrous iron this agrees with Steenackers *et al*. (32), Roux-en-Y gastric bypass surgery was more invasive than the sleeve gastrectomy, which further contributes to the anemia and decreases iron levels as adverse effect, Salgado *et al*. findings confirm this theory (17). Also, the Roux-en-Y gastric bypass of the principal site of absorption in the duodenum and proximal jejunum may lead to the development for iron deficiency and anemia after surgery this agrees with Ghanbari *et al*. (8).

The results of the study showed that there was a clear decrease in the level of vitamin B_{12} in the dogs of both groups after the operation, and the decrease was more pronounced in the second group of dogs that had a gastric bypass operation. This result was not consistent with what was reported by Ghanbari *et al*. (8), as they proved that there is no difference in the level of vitamin B_{12} in the dogs of both groups after the operation. Between the two methods. The cause of vitamin B_{12} deficiency is due to the loss of the intrinsic factor that produces parietal cell mass, and this loss of intrinsic factors is responsible for vitamin B_{12}, and this is consistent with Majumder *et al*. (33). In addition, Roux-en-Y gastric bypass surgery means the loss of the organ designated for absorbing vitamin B_{12}, and this is consistent with what he mentioned with Majumder *et al*. (33).

Conclusion

Gastric sleeve surgery, and gastric bypass surgery, are among the most common Bariatric surgeries that can be performed on dogs. Roux-en-Y gastric bypass surgery was more invasive than gastric sleeve surgery, but it caused greater weight loss than gastric sleeve surgery. The most common complications recorded for both methods were a clear decrease in the level of iron and vitamin B_{12}, which causes anemia. Therefore, it is recommended to give iron and vitamin B_{12} to the animals undergoing the operation.

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Conflict of interests

The authors declare that there is no conflict of interest regarding the publication of this paper.

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دراسة مقارنة بين المجازة المعدية وتكميم المعدة في الكلاب

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فرع الجراحة وعلم تناسل الحيوان، كلية الطب البيطري، جامعة الموصل، الموصل، العراق

الخلاصة

الهدف من هذه الدراسة للمقارنة بين عملية تحويل مسار المعدة وتكميم المعدة لتقليل الوزن الزائد لدى الكلاب بأقل مضاعفات. أجريت الدراسة على اثنا عشر كلبا من الذكور كانوا يعانون زيادة في الوزن وقد تراوحت أوزانهم بين ٣٣-٣٩ كيلوغراما فيما تراوحت أعمارهم بين ٢٠-٣٨ شهرا. تم تقسيم الكلاب بشكل عشوائي الى مجموعتين متساويتين خضعت المجموعة الأولى لعملية تكميم المعدة بينما خضعت المجموعة الثانية لعملية تحويل مسار المعدة. تم استخدام المعايير التالية لتقيم النتائج. تم فحص أوزان الحيوانات كل أسبوعين ولمدة ثمانية أسابيع بعد العملية الجراحية كما تم تنظير البطن بعد أسبوعين وثمانية أسابيع من العملية الجراحة لتقيم أي مضاعفات في موقع العملية الجراحية وللتأكد من عدم تسريب محتويات المعدة والأمعاء الى التجويف البطني. تم اخذ عينة دم من كل حيوان قبل العملية الجراحية (وقت الصفر) وفي الأسبوع الثاني والرابع والسادس والثامن بعد العملية الجراحية لقياس مستوى الحديد وفيتامين ب ١٢. انخفضت أوزان الحيوانات في كلا المجموعتين خلال الأسبوع الثاني والرابع والسادس والثامن ولكن حيوانات المجموعة الثانية فقدت وزنا معنويا أكثر من حيوانات المجموعة الأولى. وأظهرت نتائج الفحص بالمنظار عدم وجود أي تسريب لمحتويات المعدة والأمعاء الى التجويف البطني ومع ذلك لوحظ التصاقات في موقع العملية مع الثرب ومع الأعضاء المجاورة ومع أجزاء أخرى من الأمعاء. وكانت هذ الالتصاقات اقل في المجموعة الأولى عما هو علية في المجموعة الثانية. وكانت نتائج اختبار الحديد الى انخفاض مستواه في المجموعة الثانية أكثر من المجموعة الأولى. وكانت مستوى فيتامين بي ١٢ في المجموعة الثانية اقل من المجموعة الأولى. بالاستنتاج إن طريقة تحويل المسار لها تأثير على الحديد وفيتامين بي ١٢ وكذلك الالتصاقات وفقدان وزن الجسم أكثر مما هو عليه في عملية تكميم المعدة.

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