

## Laparoscopic Versus Conventional Y-U Pyloroplasty in Dogs: A Comparative Study of Pain, Stress, and Duration

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### Abstract

**BACKGROUND:** Background: Y-U pyloroplasty is a surgical approach that is used to relieve pyloric stenosis. The study of different aspects of laparoscopic Y-U pyloroplasty instead of conventional approaches seems to be an appropriate alternative for the development of such surgeries in animals, as pyloric stenosis is an uncommon but important disease.

**OBJECTIVES:** The present study aimed to describe the laparoscopic Y-U pyloroplasty in small animals as a new surgical technique, and to compare the duration of surgery, level of surgical stress, and postoperative pain of this method with the conventional Y-U pyloroplasty. It is important to note that this is the first time that laparoscopic Y-U pyloroplasty was performed in dogs.

**METHODS:** A total of eight intact male and female mixed breed dogs were randomly divided into two groups of conventional (n=4) and laparoscopic (n=4) pyloroplasty. Operation time, blood glucose concentration, plasma cortisol levels, gastric emptying time, pyloric lumen, and diameter and width of pyloric ring, as well as the University of Melbourne Pain Scale (UMPS) were measured in both groups during pre and postoperative intervals.

**RESULTS:** As a result, the mean operation time for conventional group was significantly lower than that for laparoscopic group (38.75±3.15 min vs. 116.25±14.34 min,  $P<0.05$ ). Blood glucose concentrations in both groups elevated rapidly until 3 hours after surgery and then decreased until 24 hours. Plasma cortisol level in laparoscopic group, however, elevated rapidly until 5 hours after surgery. On the other hand, pyloric diameter and width of pyloric ring significantly increased in both groups. The UMPS in dogs undergoing conventional Y-U pyloroplasty was significantly higher than that in those undergoing laparoscopic Y-U pyloroplasty ( $P<0.001$ ). Furthermore, pain and gastric emptying time decreased in all dogs.

**CONCLUSIONS:** This study suggests that laparoscopic Y-U pyloroplasty is an applicable minimal invasive surgery that is performed through small incisions for the treatment of pyloric stenosis in dogs.

**KEYWORDS:** Cortisol, Dog, Laparoscopy, Surgery, Y-U pyloroplasty

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## Introduction

There are several gastric diseases that may cause partial or complete obstruction. Although most of the diseases are uncommon, treatment of patients with such problems is necessary (Amorim *et al.*, 2015). Gastric diseases such as pyloric stenosis and hypertrophic gastropathy in dogs have been recognized for at least 50 years (Bellenger *et al.*, 1990). Despite the absence of laboratory and clinical abnormalities in patients with chronic hypertrophic pyloric gastropathy, abdominal distention and weight loss might be observed on physical examination of the patients (Biller *et al.*, 1994). Chronic intermittent vomiting is the most common clinical sign of pyloric obstruction in dogs, and it is often observed within minutes to hours after feeding (Holak *et al.*, 2016).

Veterinarians commonly perform pyloroplasty to treat dogs with functional gastric outlet obstruction (Monnet, 2020). Different surgical approaches have been described for the treatment of gastric diseases. In the past decades, the Finney (FP) and Heineke-Mikulicz (HM) pyloroplasty methods were two highly popular approaches, and it has been postulated that there is no significant difference between the outcomes of these two procedures (Khan *et al.*, 2015). Y-U pyloroplasty is another procedure performed in recurrent hypertrophic pyloric stenosis, and it has been reported that the use of Y-U pyloroplasty in dogs significantly increases pyloric diameter (da Cruz *et al.*, 2016). The Y-U pyloroplasty technique has considerable advantages, including excellent visualization of ulcers in the duodenum, facilitated resection of the ulcers, and preservation of pyloric function and local motility (Szeuer *et al.*, 1977).

Laparoscopic pyloroplasty is an effective, safe, and viable alternative to standard open approaches and is applied for the treatment of patients with gastric outflow diseases (Sanchez-/Margallo *et al.*, 2007). Faster recovery, reduced hospitalization, quicker return to normal activities besides excellent magnification and visualization during operation are the advantages of laparoscopic surgery. This technique triggers less postoperative complications and pain. However, the laparoscopic procedure requires expensive and specialized surgical instrumentation,

video equipment, and hours of training to acquire the skills (Shariati *et al.*, 2014).

Assuming that a laparoscopic Y-U pyloroplasty would have the advantages of minimally invasive surgeries rather than conventional open surgery, our objective in the present study was to evaluate the laparoscopic Y-U pyloroplasty in dogs compare it with conventional open surgery.

One of the multiparametric scales used to assess accurate pain based on physiological and behavioral parameters asserted in dog studies is the University of Melbourne Pain Scale (UMPS). This scale is divided into mental status, physiologic response, reaction to palpation, activity, posture, and vocalization (Firth and Haldane, 1999).

Ultrasonography is one of the methods for finding gastric outlet obstructions, especially pyloric stenosis (Couto and Nelson, 2009). Muscular hypertrophy could be detected by ultrasonography as a thick hypoechoic layer, which in moderate hypertrophy could reach 3 mm, and in severe condition to 8 mm (Biller *et al.*, 1994.).

In all cases, normal preoperative sonographic features of pyloric sphincter morphology and also its changes after conventional abdominal and laparoscopic surgery were assessed.

## Materials and Methods

### Animals

The Institutional Animal Care and Use Committee of the Veterinary University of Tehran approved this protocol (75050, the Third of March, 2016). A total of eight intact (5 males and 3 females) mixed breed dogs (body weight, 20–25 kg) were randomly divided into two groups: group 1, the conventional Y-U pyloroplasty group (n=4); group 2, the laparoscopic Y-U pyloroplasty group (n=4). The adaptation period for both groups was 14 days, and all dogs were boarded in separate cages. At the end of the study, which lasted about three months, all the dogs were transferred to a suburban shelter after spaying.

### Pre-surgical Measures

Physical examination, blood glucose level, plasma cortisol concentration, and packed cell volume, as well as heart and respiratory rates were measured prior to operation. Furthermore, UMPS was measured by an examiner who was blind to the surgical groups. Animals had free access to water, but food was withheld for 8 hours prior to surgery. All dogs received intravenous Cefazolin (22 mg/kg) as a prophylactic antibiotic through the cephalic vein and were followed every 12 hours after surgery for 5 days. Tramadol was administered intramuscularly (2 mg/kg) every 12 hours after surgery for 3 days.

### Surgical Procedure

Dogs were premeditated by intramuscular injection of Midazolam (0.2 mg/kg, Exir, Iran) and Morphine (0.2 mg/kg, Daroupakhsh, Iran). In the subsequent stage, anesthesia was induced by the intravascular injection of Ketamine (5 mg/kg, Alfasan, Netherlands) and xylazine (10 mg/kg, Alfasan, Netherlands). An endotracheal tube was placed to secure the airway and anesthesia was continued using Isoflurane (vaporizer setting at a concentration of 1.4%, flow rate of oxygen; 5 L/min) as maintenance. Ringer solution (11 mL/kg/h) was infused intravenously during the operation. End-tidal CO<sub>2</sub>, breathing rate, heart rate, ECG (derivation II), and pulse oximetry were monitored regularly. In addition, surgical time was recorded from the initiation of skin-incision to the last suture in both groups.

### Conventional Y-U Pyloroplasty:

Supra-umbilical midline laparotomy incision was applied. Moistened laparotomy sponges were used to isolate pylorus from the surrounding viscera. Stomach was held in place by placing stay sutures at caudal and cranial aspect of the incision site. The sutures also prevented the leakage of gastric content into the abdominal cavity. A Y-shaped full-thickness incision was made over the pylorus. The longitudinal incision was made over the anti-mesenteric border of the duodenum, followed by two divergent incisions extended into pyloric antrum. Vascular supply to the enclosed tissues was maximized by making a curved form of the Y arms. Therefore, a full-thickness flap was created and elevated from the gastric wall, and then it was sutured to the farthest extent of the original incision by 2-0 absorbable monofilament suture

material (polyglycolate coated violet). An omental patch was placed on the pyloroplasty region, and the abdominal wall was closed routinely.

### Laparoscopic Y-U Pyloroplasty

The procedure was performed at pneumoperitoneum pressure of 15 mmHg using a three-port (two 5 mm and one 10 mm) technique: A 10 mm trocar was inserted in the approximately caudal to the umbilicus, and laparoscopic 30-degree lens camera (29 cm, Carl Storz endoscopy) was introduced into the abdominal cavity through the umbilical port. The second and third ports were placed under laparoscopic view, 10 cm right to the first port and 10 cm left and 5 cm cranial to the first port, respectively. Grasping the pylorus at its proximal aspect, a Y shaped full-thickness incision was made by a monopolar forceps of an electrosurgery system along the gastroduodenal junction and then was closed in a U-shaped structure with absorbable synthetic suture material (polyglycolate coated) in a simple interrupted method. An omental patch was placed to reinforce suture line. There were no complications and conversions into open surgery.

### Postoperative Measurements

All dogs underwent abdominal ultrasound examination by a mid-range 4D ultrasound system (GE Volusion 730) before and 7 days after the surgery. To assess pyloric sphincter, overall transverse external diameter (pyloric diameter), transverse diameter of the pyloric lumen (pyloric lumen), and width of the pyloric ring (pyloric width) were measured. Ultrasonographic examination of the pyloric sphincter was conducted in a consistent order. A longitudinal view was obtained for the entire pyloric lumen with the probe positioned on the ventral aspect of the gastroduodenal segment. In addition, the overall transverse external diameter, transverse diameter of the pyloric lumen, and the width of the pyloric ring were measured. Blood glucose concentration and plasma cortisol level were also measured in blood samples collected from dogs at 0 (prior to surgery), 3-, 5-, and 24-hour intervals after the operations. To measure plasma cortisol level, sample was collected by cephalic catheterization at each time interval and blood collected in EDTA was instantly centrifuged for 15 minutes and then was stored at -80°C. All specimens

were assayed by Electro chemiluminescent Immunoassay after study completion. An AlphaTrcak glucometer was used to measure blood glucose levels; thus, a drop of blood was placed on the

glucometer at each time interval. Moreover, one individual blinded to the study assessed the UMPS on the basis of increase from baseline of heart rate, respiratory rate, behavior, and response to wound palpation at 3 and 24 hours after surgery ([Table 1](#)).

**Table 1.** Criteria used for pain scores obtained from percentage increase in heart rate, respiratory rate, and body temperature; behavior; and response to surgery site palpation.

Criteria	Description	Pain score
<b>Mental status</b>	Submissive	0
	Sociable	1
	Cautious	2
	Aggressive	3
<b>physiologic response</b>	Normal pupil	0
	Dilated pupil	2
	Increase in hear rat:	
	<20%	0
	>20%	1
	>50%	2
	>100%	3
	Increase in respiratory rate:	
	<20%	0
	>20%	1
>50%	2	
>100%	3	
<b>reaction to palpation</b>	Increase in body temperature	1
	salivation	2
	No changes	0
<b>Activity</b>	Reaction to palpation	2
	Reaction before being palpate	3
	Resting: asleep, semiconscious	0
	Resting: awake, alert	1
<b>Posture</b>	Eating	0
	Restless and moving around	3
	Lateral position	0
	Fetal position (protects the affected area)	2
	Sitting or standing	1
	Prone position	1
	Moving	1
Abnormal position	2	
<b>vocalization</b>	None	0
	Crying when palpate	2
	Intermittent crying	2
	Continuous crying	3

Preoperative complete gastric emptying time was measured radiographically after feeding the animals with commercially canned dog food (Pootee canned

food, rice and chicken, Iran, 8 g/kg body weight), thoroughly mixed with a colloidal suspension of barium sulfate 60% (7 mL/kg). Initial radiographs were

obtained 15 minutes after finishing meal and then every two hours until the stomach was empty. Two weeks after the surgery, gastric emptying time was measured as described.

### Statistical Analysis

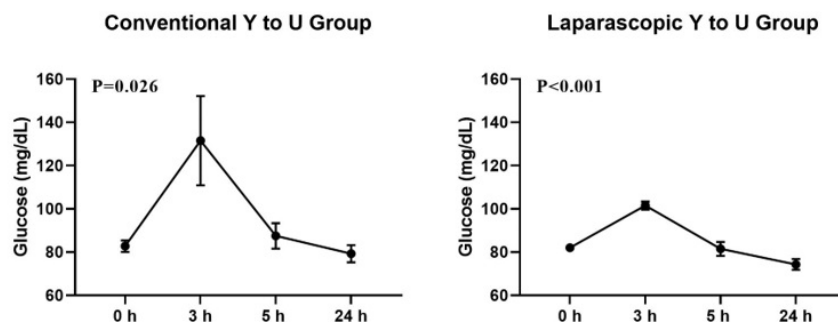
Statistical analysis was performed by SPSS software version 16.0 (SPSS, Inc., Chicago, IL, USA). The changes in the blood glucose concentration and plasma cortisol levels in particular time intervals were analyzed by the general linear model (GLM) procedure. One-way analysis of variance (ANOVA) was used to compare the gastric emptying time and the operating time. The results of gastric emptying time and operation period are reported as mean ± standard error of measurement (SEM). Independent

t-test and Tukey post-Hoc tests were also used to compare the variable between the study groups ( $P < 0.05$ ).

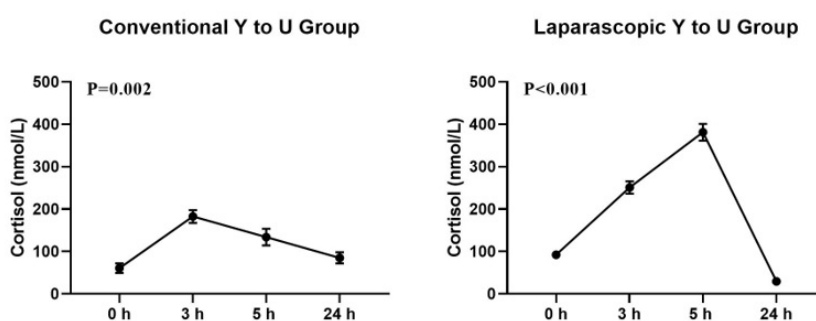
### Results

The results of this study showed that the mean operation time of group 1 was lower than that of group 2 ( $38.75 \pm 3.15$  min vs.  $116.25 \pm 14.34$  min) and the difference was statistically significant ( $P < 0.05$ ; [Figure 1](#)).

Moreover, similar to group 2 ( $P < 0.001$ ), the mean blood glucose concentration in group 1 had a significant change at 24 hours after surgery ( $P < 0.05$ ). However, these changes were not significantly different in both groups ([Figure 2](#)).



**Figure 1.** Blood glucose concentration at 0, 3, 5, and 24 hours after operation in dogs undergoing conventional and laparoscopic Y-U pyloroplasty.



**Figure 2.** Plasma cortisol concentration at 0, 3, 5, and 24 hours after operation in dogs undergoing conventional and laparoscopic Y-U pyloroplasty.

Plasma cortisol concentrations obtained for group 2 were higher than that for group 1 at 0, 3, and 5 hours after surgery. However, this amount for group

2 was lower than that for group 1 at 24 hours after surgery with no significant difference ( $P > 0.05$ ).

Pyloric width significantly increased after surgery ( $P<0.05$ ) in both groups. Likewise, pyloric lumen raised after surgery in both groups of study though with no remarkable change ( $P>0.05$ ). Pyloric diameter in groups 1 and 2 elevated significantly after surgery ( $P<0.05$ ).

Furthermore, gastric emptying time was decreased significantly in both groups after surgery ( $P<0.001$ ).

Width of pyloric ring, pyloric lumen, pyloric diameter, and emptying time before and after operation in groups 1 and 2 are represented in [Table 2](#).

The mean UMPS in group 1 was remarkably higher than in group 2 ( $22.0\pm 1.15$  vs.  $8.75\pm 0.63$ ;  $P<0.001$ ).

The UMPS showed a remarkable decrease at 24 hours after surgery in both study groups. Nevertheless, dogs of group 1 had higher UMPS compared to those of group 2 ( $11.50\pm 0.50$  vs.  $3.0\pm 0.41$ ;  $P<0.001$ ) ([Table 3](#)).

Although laparoscopic surgery may have some potential risks, such as gastric or splenic perforation, subcutaneous emphysema, and splenic hemorrhage, none of these complications occurred in our study.

**Table 2.** Width of a pyloric ring, pyloric lumen, pyloric diameter, and emptying time before and after operation in dogs underwent conventional and laparoscopic Y-U pyloroplasty.

	Group	Before	After	P-value
Width of pyloric ring (mm)	Conventional Y to U Group (mean±SEM)	1.42±0.04	1.6±0.04	0.010
	Laparoscopic Y to U Group (mean±SEM)	1.73±0.29	2.52±0.06	0.048
Pyloric lumen (mm)	Conventional Y to U Group (mean±SEM)	0.59±0.09	0.80±0.15	0.181
	Laparoscopic Y to U Group (mean±SEM)	0.27±0.04	0.60±0.17	0.097
Pyloric diameter (mm)	Conventional Y to U Group (mean±SEM)	1.43±0.14	1.78±0.09	0.044
	Laparoscopic Y to U Group (mean±SEM)	1.34±0.25	1.99±0.15	0.037
Emptying time (hr.)	Conventional Y to U Group (mean±SEM)	8.25±0.48	4.00±0.25	<0.001
	Laparoscopic Y to U Group (mean±SEM)	8.0±0.0	4.0±0.0	0.008

**Table 3.** UMPS values 3h and 24h after operation.

	Group	UMPS0	UMPS24	P-value
University of Melbourne Pain Score	Group 1 (mean±SEM)	22.00±1.15	11.50±0.50	0.002
	Group 2 (mean±SEM)	8.75±0.63	3.0±0.41	0.003

## Discussion

In veterinary practice, the Y-U pyloroplasty is a common surgical approach for the treatment of gastric outlet obstruction (Sarosiek *et al.*, 2015) and is usually carried out in the conventional form. In the

present study, laparoscopic Y-U pyloroplasty was performed for the first time. There are several advantages in laparoscopic surgery, including excellent

exposure of the abdominal cavity, less adhesion formation, and shorter recovery time (Sánchez-Margallo *et al.*, 2003). However, there could be some potential risks in animal surgery in this regard, including subcutaneous emphysema, gastric (or splenic perforation), splenic hemorrhage, and suture reaction or anastomotic leak. Expensive equipment and long-term training period also are the limitations of laparoscopic surgeries (Wilson *et al.*, 1996; Davidson *et al.*, 2004; PRICE *et al.*, 1996).

The increase of intra-abdominal pressure due to pneumoperitoneum in laparoscopic surgery may affect the cardiopulmonary function of anesthetized patients (DUKE *et al.*, 1996; Gross *et al.*, 1993). However, during this study, none of these potential complications occurred.

Different parameters (e.g., gastric emptying time, duration of surgery, pain, level of stress, and morphologic changes of pylorus) were compared in the dogs treated with two methods of laparoscopic Y-U pyloroplasty and conventional Y-U pyloroplasty before and after surgery. Serum cortisol and glucose concentrations are functional measures of surgical stress (Walsh *et al.*, 1999; Fox *et al.*, 1994). It has been shown that glucose and cortisol levels increase and remain elevated until 12 to 24 hours after operation in humans and canines (Rutberg *et al.*, 1984). The serum cortisol and blood glucose levels significantly increased at 3 hours after surgery that agreed with previous studies. Moreover, the plasma cortisol level in the laparoscopic Y-U pyloroplasty group elevated more than in the conventional Y-U pyloroplasty group. This increase of the cortisol level in the laparoscopic group may be due to the longer operation time in this group and pneumoperitoneum that causes a detectable elevation in the serum cortisol level in laparoscopic surgeries (Marcovich *et al.*, 2001). The glucose and cortisol levels were normal at 24 hours after the operation, which could be the result of pain management. Previous studies have considered blood glucose and plasma cortisol concentrations in quantifying the postoperative pain level (Evangelista *et al.*, 2014). The present study results revealed that the UMPS of the dogs undergoing both conventional and laparoscopic Y-U pyloroplasty, after the third hour of the surgery was significantly higher than that at 24 hours

after surgery. That was similar to blood glucose and plasma cortisol level alterations in the study groups. The decreased UMPS at 24 hours after surgery in both study groups is in accordance with the decrease in plasma cortisol and blood glucose levels, declaring that the animals experienced a decreased degree of physiologic stress. Moreover, our results showed that the UMPS in group 1 was significantly higher than that in group 2. These results are in line with those of other research, including one study conducted by Devitt *et al.* (2005), who compared postoperative stress and pain in dogs, in both conventional ovariohysterectomy and laparoscopic-assisted ovariohysterectomy. They claimed that the dogs undergoing laparoscopic surgery had less stress and pain compared to the other group. One study reported that laparoscopic ovariectomy had less stress and faster recovery compared to open ovariectomy in dogs (Vasiljević *et al.*, 2015).

As mentioned in the present study, it has been postulated that the operation time in laparoscopic approach is longer than that in conventional surgery (Wei *et al.*, 2015). However, it should be considered that the time of surgery depends on several factors besides the type of surgery, such as the skills of a surgeon and the experience of the healthcare team. Laparoscopic surgery needs advanced surgical skills, which affect operation time. The results of the present study showed that gastric emptying time was decreased in both study groups. In accordance with the present study, several previous studies have shown that pyloroplasty decreases gastric emptying time (Sánchez-Margallo *et al.*, 2005).

## Conclusion

To our knowledge, no previous study has used laparoscopic pyloroplasty to treat dogs with pyloric stenosis. The present study was conducted to decrease gastric emptying time in healthy dogs. However, previous studies have reported good results in the treatment of ill dogs through conventional surgeries. There is no study about the effect of Y-U pyloroplasty on the width of pyloric ring and lumen. Our results showed that laparoscopic Y-U pyloroplasty can effectively be performed without any complication for pyloric stenosis and appears to be a suitable replacement for conventional

Y-U pyloroplasty. However, more studies are necessary to clarify the advantages and disadvantages of laparoscopic Y-U pyloroplasty in treating pyloric stenosis. Finally, the comparison of laparoscopic Y-U pyloroplasty with other laparoscopic pyloroplasty techniques in future researches is strongly recommended.

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## Conflict of Interest

The authors declared that they have no conflict of interest.



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## جراحی پیلوروپلاستی Y-U باز و لاپاروسکوپیک در سگ، مقایسه درد، استرس و مدت زمان جراحی

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## چکیده

**زمینه مطالعه:** مطالعه: پیلوروپلاستی Y-U یک روش جراحی است که از آن به جای سایر روش‌های پیلوروپلاستی برای درمان اختلالاتی مثل تنگی مجرای معدی استفاده می‌شود. پیلوروپلاستی با استفاده از روش لاپاروسکوپی یک روش مؤثر و جایگزین مناسب برای روش‌های پیلوروپلاستی باز محسوب می‌شود.

**هدف:** در مطالعه حاضر پیلوروپلاستی Y-U با استفاده از روش لاپاروسکوپی در سگ‌های سالم ارزیابی شد و با پیلوروپلاستی به روش باز مقایسه گردید. این مطالعه برای اولین بار روش جدید پیلوروپلاستی Y-U با استفاده از روش لاپاروسکوپی بررسی شده است.

**روش کار:** هشت قلاده سگ نر نژاد مخلوط بالغ به‌طور تصادفی به دو گروه شامل گروه پیلوروپلاستی Y-U با استفاده از روش باز (تعداد ۴ قلاده) و گروه پیلوروپلاستی Y-U با استفاده از روش لاپاروسکوپی (تعداد ۴ قلاده) تقسیم شدند. غلظت گلوکز خون، میزان کورتیزول پلاسما، زمان تخلیه معده، اندازه مجرای معده، اندازه قطر معده، اندازه حلقه پیلور و شاخص UMPS در هر دو گروه ارزیابی شدند.

**نتایج:** میانگین زمان جراحی در گروه پیلوروپلاستی Y-U با استفاده از روش باز به‌طور معنی‌داری کمتر از زمان جراحی در گروه پیلوروپلاستی Y-U با استفاده از روش لاپاروسکوپی بود (به ترتیب  $0/15 \pm 55$  و  $14/34 \pm 116/25$  دقیقه،  $P=0/008$ ). میزان غلظت گلوکز خون در هر دو گروه مطالعه و میزان کورتیزول پلاسما در گروه پیلوروپلاستی Y-U با استفاده از روش باز به‌سرعت تا سه ساعت پس از جراحی افزایش پیدا کرد و ۲۴ ساعت پس از جراحی کاهش یافت. اما میزان کورتیزول پلاسما در گروه پیلوروپلاستی Y-U با استفاده از روش لاپاروسکوپی به‌سرعت تا پنج ساعت پس از جراحی افزایش پیدا کرد. مقدار UMPS در سگ‌هایی که تحت جراحی پیلوروپلاستی Y-U با استفاده از روش باز قرار گرفته بودند به‌طور معنی‌داری بیشتر از مقدار آن در سگ‌هایی بود که تحت جراحی پیلوروپلاستی Y-U با استفاده از روش لاپاروسکوپی قرار گرفته بودند ( $P<0/001$ ). در هر دو روش جراحی پیلوروپلاستی Y-U زمان تخلیه معده کاهش پیدا کرد و اندازه قطر معده و حلقه پیلور افزایش یافت.

**نتیجه‌گیری نهایی:** با توجه به نتایج به‌دست‌آمده می‌توان نتیجه گرفت که روش پیلوروپلاستی Y-U می‌تواند یک روش مؤثر در درمان تنگی پیلور در سگ‌ها باشد. همچنین به‌نظر می‌رسد پیلوروپلاستی Y-U با استفاده از روش لاپاروسکوپی درد کمتری به نسبت جراحی پیلوروپلاستی Y-U به روش باز ایجاد می‌کند و می‌تواند به‌عنوان یک جایگزین مناسب با جراحی‌های باز مورد توجه قرار گیرد.

**واژه‌های کلیدی:** باز‌آرایی، جراحی، پیلوروپلاستی Y-U، لاپاروسکوپی، سگ، کورتیزول