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Original Article

Duration, Stress, and Pain Evaluation of Laparoscopic versus Conventional Heineke-Mikulicz Pyloroplasty

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ABSTRACT

Pyloric stenosis is an uncommon but important gastric outflow disease. Heineke-Mikulicz (H-M) pyloroplasty is one of the pyloroplasty techniques used for the treatment of such diseases. A laparoscopic pyloroplasty is an effective and preferred alternative technique to conventional surgeries. This study aims to compare the duration of surgery, surgical stress level measurement, and postoperative pain in laparoscopic H-M pyloroplasty in normal dogs with a conventional pyloroplasty technique. Eight intact adult mixed breed dogs (5 females and 3 males) were used in this study. Animals were randomly divided into two groups of conventional open (n = 4) and laparoscopic (n = 4) H-M pyloroplasty. Blood glucose concentration, plasma cortisol level, as well as pyloric features including a pyloric lumen, pyloric diameter, pyloric width with ultrasonography, and gastric emptying time with contrast radiography and the University of Melbourne Pain Scale (UMPS) value, were measured in both groups. The mean operation time in the laparoscopic group was longer than that of the conventional group (55.00 ± 15.00 vs. 35.00 ± 4.56 min); however, this difference was not statistically significant. Blood glucose concentration in the laparoscopic group elevated rapidly until 3 hours after the operation and then decreased in 24 hours while blood glucose concentration in the conventional group slowly increased until 24 hours. The UMPS value at 3 hours after conventional H-M pyloroplasty was higher than that of laparoscopic H-M pyloroplasty (19.25 ± 0.75 vs. 6.50 ± 0.96, $p < 0.001$). Gastric emptying time significantly decreased in both groups. According to the results, in addition to reducing pain and stress, laparoscopic H-M pyloroplasty decreased gastric emptying time in all patients with no morbidity and appears to be a less invasive alternative technique for the management of gastric outflow disease.

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Introduction

Pyloric stenosis is an uncommon but important gastric outflow disease which can be congenital or acquired in both humans and animals.[1] Both congenital and acquired forms have similar clinical symptoms but the congenital form usually happens in younger animals while the acquired form more common in older dogs.[2] Chronic hypertrophy of circular muscle layer of the pyloric canal results in a benign hypertrophic pyloric stenosis and usually occurs in pure-bred, small, middle age to old dogs. An over representation was seen in the Lhasa Apso, Shih Tzu, and Miniature Poodle breeds.[3] Pyloric stenosis is diagnosed using physical examination, radiographic findings, endoscopic evaluations, and histologic examinations.[1] Pyloric surgery has frequently been recommended as an effective method for the treatment of pyloric stenosis and accelerating gastric emptying.[4]

There are several surgical approaches for the treatment of pyloric stenosis with different outcomes. These procedures may increase, not affect, or decrease gastric emptying time.[5-7] Pyloroplasty is one of the proven surgical options to enlarge the gastric outflow lumen in human and veterinary practice.[8] To date, several pyloroplasty techniques have been implemented in dogs such as Finney pyloroplasty (FP), Heineke-Mikulicz (H-M) pyloroplasty, and Y to U pyloroplasty.[9] With recent advances in surgical instrumentation and fiberoptic video technology, various types of abdominal surgical techniques are carried out using minimally invasive techniques that have several proven advantages over standard open approaches. It has been reported that laparoscopic surgery is feasible in dogs and is a viable alternative to many traditional open procedures.[10] However, sometimes the duration of laparoscopic surgery is longer than the same open procedure.[11]

H-M pyloroplasty surgery is one of the basic forms of pyloroplasty in which the pylorus is incised full-thickness longitudinally and sutured transversely.[12] However, there are few studies about the advantages of the laparoscopic H-M pyloroplasty in dogs.

This study aims to investigate the effects of the laparoscopic H-M pyloroplasty on pyloric lumen and diameter, the width of the pyloric ring, gastric emptying time, serum glucose and cortisol, and UMPS score and to compare these finding with those obtained following traditional open H-M pyloroplasty.

Materials and Methods

Animals

All procedures performed in this study were in accordance with the "Guide for the Care and Use of Laboratory Animals" (Institute of Laboratory Animal Resources, Commission on Life Sciences, National Research Council) and approved by Research committee of University of Tehran. Eight adult mixed-breeds dogs (5 female and 3 male) weighing 15.56 ± 3.74 kg were used and randomly divided into two groups: 1) Traditional open H-M pyloroplasty (n = 4); and 2) laparoscopic H-M pyloroplasty (n = 4). Dogs were hospitalized from 14 days before surgery for adaptation.

Pre-Surgical Measures

Physical examination, heart and respiratory rates, CBC, blood glucose concentration, plasma levels of cortisol were measured and University of Melbourne Pain Scale (UMPS) evaluated by an examiner who was blinded to surgical groups before the operation.[13] Also, all animals underwent ultrasonographic measurement of the pyloric lumen (pyloric orifice), pyloric diameter, and pyloric length before surgery using a GE Volusion 730 ultrasonography device. Also, gastric emptying time was assessed radiographically using commercial canned food (8 g/kg) mixed with a colloidal suspension of barium sulfate 60% (7 ml/kg). The radiographs were obtained 15 minutes after finishing the meal and then every 2 hours until the stomach got emptied. Twelve to 14 hours of food (not water) deprivation was considered after procedures.

Anesthesia was induced by intramuscular injection of ketamine (10 mg/kg, Alfasan, Netherlands) and xylazine (3-6 mg/kg, Alfasan, Netherlands) and maintained by a constant flow of vaporized isoflurane using a Fabius Dragger anesthesia machine. Cefazolin (22 mg/kg, q 12 h, Exir, Iran) was administered intravenously as prophylactic and postoperative antibiotic therapy. Heart rate, respiratory rate, SpO_2, and end-tidal CO_2, were regularly monitored during operation. Besides, operative time was recorded from the beginning of skin-incision to the last suture in both groups. Due to accurate pain assessment no analgesics was used in 24 hours after surgery.

Conventional H-M Pyloroplasty (Group 1)

After positioning and draping of the surgical site, a 15 cm midline incision above the umbilicus was made

to access the pylorus. Moistened laparotomy sponges were used to isolate pylorus from the surrounding viscera. A full-thickness 5 to 8 cm longitudinal incision was made in the ventral surface of the pylorus and then was sutured transversely in a one-layer pattern, simple interrupted, using 2-0 absorbable synthetic suture material (polyglycolate coated). After an omental patch placement, the laparotomy incision was closed routinely in 3 layers.

Laparoscopic H-M Pyloroplasty (Group 2)

The patients were positioned in dorsal recumbency. A 3 mm incision was made over the umbilicus and using a bluntly inserted Veress needle, the abdomen was insufflated by CO_2 to reach pneumoperitoneum pressure of 15 mmHg. With the surgeon standing between the legs, and the assistant on the patient's left side, a three ports laparoscopic technique (two 5 mm and one 10 mm) was performed: A 10 mm trocar was inserted approximately 1 cm caudal to the umbilicus, the second and third ports were placed 10 cm right of the first port, and 10 cm left and 5cm cranial to the first port, respectively (Figure 1). The pylorus was grasped at its proximal border, a 5 to 6 cm longitudinal incision was made with a monopolar forceps of an electrosurgery system along the gastroduodenal junction and the defect was closed transversely with absorbable synthetic suture material (polyglycolate coated) in a simple interrupted method (Figure 2). An omental patch was placed to reinforce the suture line. There were no conversions to open technique or other intraoperative complications.

Post-Surgical Measures

Blood glucose concentration and plasma cortisol levels as one of the indicators of postoperative pain and stress were assessed in samples collected from animals of both groups at 3, 5, and 24 hours after the operation. At each time interval, sample collection was performed by jugular catheterization. To measure plasma cortisol levels, blood collected in EDTA was immediately centrifuged for 15 minutes and then 2 aliquots of plasma were stored at -80° C. All specimens were assayed by Electrochemiluminescent Immunoassay after study completion. To obtain blood glucose levels, a drop of blood was placed on the glucometer (AlphaTrack) at each interval. Besides, for postoperative pain evaluation, the UMPS score was measured at 3 and 24 hours after surgical intervention as described above. Pyloric lumen, diameter, and width were assessed in all dogs before and 14 days after the operation. Gastric emptying time was also reevaluated two weeks after surgery as described before.

Figure 1. Location of incisions and instruments used in laparoscopic H-M pyloroplasty.

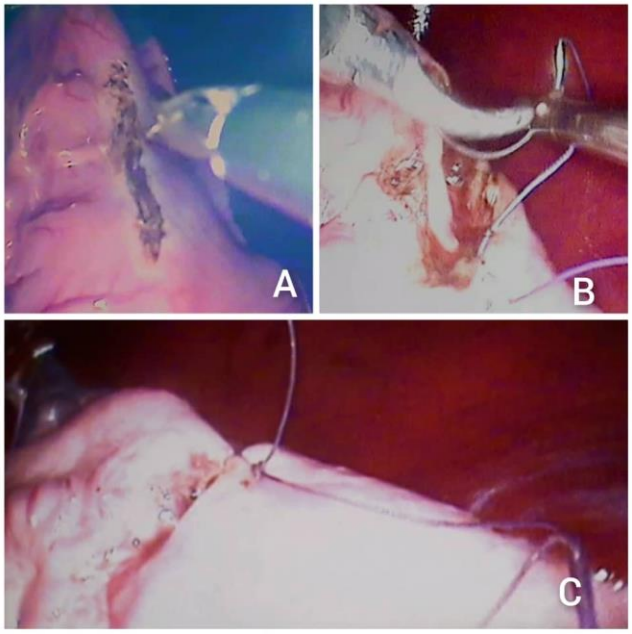

Figure 2. Surgical technique and suture placement for laparoscopic H-M pyloroplasty: **A**, longitudinal incision was made along the gastroduodenal junction. **B** and **C**, the defect was closed transversely with absorbable synthetic suture material in a simple interrupted method.

Statistical Analysis

SPSS software version 24.0 (SPSS, Inc., Chicago, IL, USA) was used for statistical analysis of collected data. The changes in the blood glucose concentration and plasma cortisol levels over time were analyzed using the General Linear Model (GLM) procedure for times trends measures. To compare the gastric emptying time and the operating time one- way analysis of variance (ANOVA) was used. Independent t-test and Tukey post hoc tests were used to compare the variable between the study groups. *p* values less than 0.05 were considered significant.

Results

The mean operation time in the laparoscopic H-M pyloroplasty group was higher than that of the conventional H-M pyloroplasty group (55.00 ± 15.00 vs. 35.00 ± 4.56 min); however, this difference was not statistically significant.

Blood glucose concentration in the conventional H-M pyloroplasty group slowly increased until 24 hours after the operation while blood glucose concentration in the laparoscopic H-M pyloroplasty group significantly increased until 3 hours after the operation and then decreased in 24 hours (which was significantly less than 5 hours after surgery) (Figure 3).

Plasma cortisol concentration in group 1 elevated until 3 hours after the operation and then decreased to 24 hours but it was not statistically significant. However, the plasma cortisol concentration in group 2 increased rapidly until 5 hours after the operation and then suddenly decreased until 24 hours after operation but it was not statistically significant (Figure 4).

Width of the pyloric ring, pyloric lumen, as well as pyloric diameter, were increased and gastric emptying time was decreased in both groups, however, this alteration in gastric emptying time was statistically significant with *p*-values of 0.014 and 0.013 for conventional and laparoscopic groups respectively. In Table 1, the width of the pyloric ring, pyloric lumen, pyloric diameter, and gastric emptying time before and after the operations in dogs undergoing conventional and laparoscopic H-M pyloroplasty are demonstrated.

The UMPS values at 3 and 24 hours after conventional and laparoscopic H-M pyloroplasty revealed that the values at 3 hours after the conventional procedures were higher than that of the laparoscopic ones (19.25 ± 0.75 vs. 6.50 ± 0.96, $p < 0.001$). Despite the significant reduction in the UMPS value at 24 hours after conventional and laparoscopic H-M pyloroplasty ($p = 0.002$ and $p = 0.007$, respectively), the value in group 1 was still higher than that of group 2 (10.50 ± 0.29 vs. 3.25 ± 0.63, $p < 0.001$).

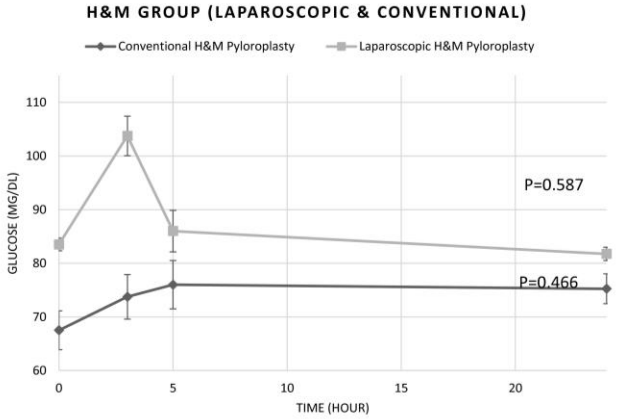

Figure 3. Blood glucose concentration at 0, 3, 5, and 24 hours after operation in dogs undergoing conventional and laparoscopic H-M pyloroplasty. Blood glucose concentration in the conventional H-M pyloroplasty was significantly less than the laparoscopic group in times 0, 3 ($p < 0.05$), but had no statistical difference in 5 and 24 hours after surgery ($p < 0.05$).

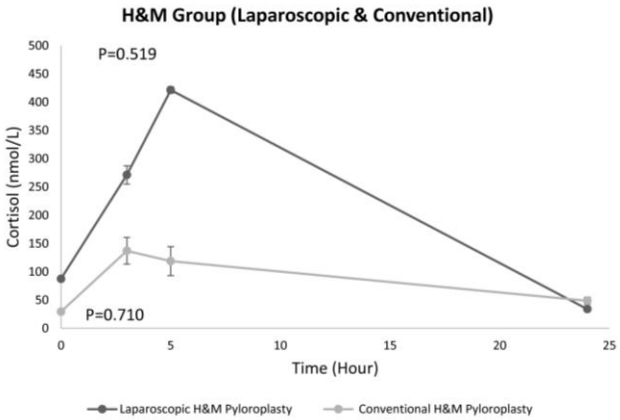

Figure 4. Plasma cortisol concentration at 0, 3, 5 and 24 after surgery in conventional and laparoscopic H-M pyloroplasty. Plasma cortisol concentrations were higher in the laparoscopic group with no statistically significant difference until 5 hours after surgeries, but it was significantly higher than the conventional group 24 hours after the operations.

Discussion

To date, various surgical techniques have been used to treat pyloric stenosis in both humans and animals. However, most of these surgical techniques have been performed as an open surgical method. Nowadays, due to the advancements in surgical instrumentation and fiberoptic video technology, various types of abdominal surgical techniques (laparoscopic) are implemented using minimally invasive procedures in both humans

Table 1. Width of the pyloric ring, pyloric lumen, pyloric diameter, and emptying time before and after the operation in dogs underwent conventional and laparoscopic H-M pyloroplasty.

	Group	Before	After	P-value
Width of pyloric ring mm	Conventional H-M Group (mean±SEM)	1.47±0.12	1.71±0.10	0.065
	Laparoscopic H-M Group (mean±SEM)	2.01±0.29	3.15±0.21	0.087
Pyloric lumen mm	Conventional H-M Group (mean±SEM)	0.53±0.05	0.55±0.05	0.391
	Laparoscopic H-M Group (mean±SEM)	0.43±0.07	0.51±0.11	0.357
Pyloric diameter mm	Conventional H-M Group (mean±SEM)	1.40±0.20	1.95±0.08	0.057
	Laparoscopic H-M Group (mean±SEM)	1.68±0.13	1.79±0.08	0.149
Emptying time mm	Conventional H-M Group (mean±SEM)	8.0±0.0	5.0±0.58	0.014*
	Laparoscopic H-M Group (mean±SEM)	7.25±0.48	4.25±0.25	0.013*

and animals.[10] Our results showed that laparoscopic H-M pyloroplasty is more time consuming than conventional H-M pyloroplasty. This study is in line with previous studies that report that laparoscopic surgeries require more time than open surgeries.[14] Considering the limited incision length, rapid recovery, and decreased post-surgical pain in the laparoscopic technique, its long operation time can be ignored. Moreover, this factor is much subjective to the surgeon's skills and the experience of the patient care team and can be decreased by practice. Therefore, long operation time cannot be considered as a notable disadvantage for laparoscopic H-M pyloroplasty.

It has been suggested that blood glucose and plasma cortisol concentrations are the indicators of postoperative pain and stress.[15] It has been reported that plasma cortisol concentration is a reliable indicator of surgical stress in the canine model.[16] Glucose and cortisol levels increase and remain elevated until 12 to 24 hours after open abdominal surgery in both human and canine patients.[17] On the other hand, studies suggest that pneumoperitoneum in laparoscopic surgery causes a rise in cortisol concentration levels.[16] Also, cortisol levels have a positive relationship with the duration of surgery.[16] since the anesthesia protocol was same in all dogs, it seems that anesthesia alone could not explain the difference in cortisol concentrations. We believe that the rise in these two factors in the laparoscopic group can be due to pneumoperitoneum and longer duration of procedure which affected the baseline concentrations of cortisol and glucose and the next measurements of these blood factors. Also, electrosurgery was used in the laparoscopic group, which results in more tissue destruction leading to possibly more elevation of cortisol levels. There could be few researches over the correlation of electrosurgery and the plasma cortisol; that of, the author suggests further future studies. Although glucose levels started to fall 24 hours after laparoscopic surgery and had no significant difference with the conventional method. Previous studies suggest laparoscopic surgeries such as laparoscopic ovariectomy have less pain and stress compared to open surgeries.[18]

Besides glucose and cortisol concentrations, the UMPS scoring system is another accepted indicator of pain which is more sensitive and specific. Accurate pain assessment in dogs is controversial. To this end, UMPS is one of the multiparametric scales centered on behavioral and physiological parameters. This information divided into six sections: mental status, physiologic response, reaction to palpation, activity, posture, and vocalization.[13] Our results showed that the UMPS value in the conventional H-M pyloroplasty group at 3 and 24 hours after surgery was higher than those of the laparoscopic H-M pyloroplasty group. These results are in agreement with previous studies and indicate that the dogs undergoing laparoscopic pyloroplasty have less post-operative pain than those undergoing conventional surgery.[18,19]

It has been reported that pyloric surgery may have different effects on pyloric features i.e., it may increase, not affect, or decrease these factors.[20-22] The results of the present study showed that among all pyloric features, conventional and laparoscopic H-M pyloroplasty could only make a significant change in the gastric emptying time. Several studies have also reported a decrease in gastric emptying time following H-M pyloroplasty.[23,24] Although the effectiveness of laparoscopic H-M pyloroplasty on the reduction of gastric emptying time is approved in this study, further researches are required to evaluate its role in the relief of gastric outflow disease.

In conclusion, laparoscopic H-M pyloroplasty was feasible, can induce less post-operative pain, and utilizes smaller surgical incisions which makes it a superior alternative technique for managing gastric outflow disease.

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Conflict of Interest

The authors report no conflicts of interest.

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