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Feasibility Study of Laparoscopic Gastrostomy Tube Placement in Beagle Dogs

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Abstract : Aim of this study is demonstrate the feasibility of Laparoscopic gastrostomy (LG) tube placement in dogs by comparing with percutaneous endoscopic gastrostomy (PEG) tube placement, based on operative time, complications and gastro-peritoneal adhesion evaluation. Eight intact male beagle dogs were used in this study. Tri-Funnel Replacement Gastrostomy tube (Bard Inc., USA) of 20 Fr was used for LG technique and PEG kit (Ponsky "Pull" PEG Kit®, Bard Inc., USA) with soft silicone retention dome consisting of a 20 Fr gastrostomy tube was used. Feeding via gastrostomy tube was performed in two weeks, maintenance energy requirement (MER) divided into 3 separate feeding. LG and PEG were evaluated at intraoperative, postoperative and postmortem period. Mean operative time for the PEG group was significantly shorter when compared with the LG group ($p < 0.05$). Successful maintenance of gastrostomy tube was confirmed in all dogs. Gastric and peritoneal wall adhesions were formed successfully in each group. The mean adhesion length (AL) and width (AW) were significantly larger in LG group compared with in PEG group ($p < 0.05$). The mean adhesion distance (AD) was not significantly different between two groups ($p = 0.182$). Consequently, LG is an effective minimally invasive, safe and easy to perform technique for providing enteral nutritional support in dogs.

Key words **:** laparoscopic gastrostomy, percutaneous endoscopic gastrostomy, gastrostomy tube placement, enteral feeding, dog.

Introduction

Providing adequate nutritional support to critically ill patients is essential for recovery illness. Early use of enteral nutritional support enhances wound healing, augments immune function, and reduces morbidity and mortality in sick dogs (13,14,16,21,26). Other benefits of earlier implementation of enteric feedings include improved preservation of nutritional status and intestinal motility, as well as superior immunologic function and tissue healing (1,9,10,20). When possible, nutrition should be delivered enterally because it is easier, less expensive, and more physiologic than parenteral feeding. Intestinal morphological structure is sustained, and function is preserved by providing nutritional support to the gastrointestinal tract through the abatement of villous atrophy, preservation of the mucosal barrier, and maintenance of immunological function (13,20,21).

Enteral nutritional support as a component of therapy in small animals has received increasing recognition within the veterinary profession (1). Therefore, several methods have been adapted for enteral nutritional support in veterinary uses. Methods of enteral nutritional support include orogastric intubation, nasogastric intubation, pharyngostomy tubes, jejunostomy tubes and gastrostomy tubes (11). Gastrostomy tubes have traditionally been successfully used as enteral feeding routes for veterinary patients and considered as the most, well-tolerated enteral feeding device (5,7,21).

The classic operative gastrostomy was described for use in the veterinary patient by Crane in 1980 (8). Although the operative gastrostomy has been used for effective long-term enteral feeding device, it was found to be associated with a number of complications, such as wound infection, leakage, dehiscense, hematoma and excessive granulation tissue formation (19,23).

From the laparotomic gastrostomy, new alternatives have arisen that do not require a laparotomy. Advances in percutaneous endoscopic gastrostomy (PEG) and laparoscopic gastrostomy (LG), these techniques offer alternatives to the standard open gastrostomy technique (4,6,12,19,24,27). These methods have advantages such as avoidance of a laparotomy, with less associated postoperative pain, earlier return of gastrointestinal function, and decreased hospital stay.

PEG, first reported in 1980 by Gauderer et al, is a common technique that has gained popularity because of the minimal invasiveness, low cost, and patient tolerance (12). However, the use of PEG poses the risk of peritonitis and sepsis associated incomplete adhesion formation between the gastric and peritoneal walls. These life-threatening complications are a concern with premature tube removal prior to 2

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weeks after placement (5,11,22).

The LG technique of gastrostomy tube placement was developed to obviate many of the limitations of the PEG technique (3,19,24,27). The main advantage of LG technique is ability to see the stomach during direct placement of the tube, thus eliminating the risk of undetected hollow viscous injury without the addition of large incisions. In human medicine, more recently, the LG have gained popularity as alternative approaches that may combine the advantages of the PEG with the safety of the open procedure (2,11,15,27). The placement and use of LG tubes in dogs has been evaluated only to a limited extent.

To the authors' knowledge, clinical feasibility evaluation of LG technique has not been previously reported in veterinary literature. The purpose of this study is to demonstrate the feasibility of LG tube placement in dogs by comparing with PEG tube placement, based on operative times, complications and gastro-peritoneal adhesion evaluation.

Materials and Methods

Animals

This study was approved by Chungnam National University Animal Care and Use Committee. Eight intact male beagle dogs in weight range from 6.8 to 10.9 kg (mean body weights: 9.2 kg) were used in this study. Dogs were randomly assigned to receive PEG tube placement (n = 4 dogs; PEG group) and LG tube placement (n = 4 dogs; LG group). All dogs determined to be healthy by normal results of physical examination, complete blood count, serum biochemical analysis, urinalysis, and negative results on direct fecal smear. All dogs were acclimated 1 month before the experiment. Based on routine surgical preparation, dogs were fasted for 12 hours before the procedure. Water was provided until 6 hours before the procedure.

LG

Anesthesia

All dogs receiving general anesthesia were premedicated with atropine sulfate (Atropine sulfate®, Daihan Pharm. Co, Korea, 0.04 mg/kg SC) butorphanol tartrate (Butornol®, Guju Pharm. Co, Korea, 0.05 mg/kg IV) and diazepam (Diazepam®, Samjin Pharm. Co, Korea, 0.1 mg/kg IV). Anesthesia was induced with propofol (Provive®, Myungmoon Pharm. Co, Korea, 6 mg/kg IV) and maintained with isoflurane (Ifran Liq®. Hana Pharm Co, Korea, 1.5 MAC) and pure oxygen. Cefazolin (Cefazolin®, Chongkundang Pharm. Co, Korea, 20 mg/kg IV) was administered as a prophylactic antibiotic. Tramadol (Toranzin®, Samsung Pharm Co, Korea, 2 mg/kg IV) was administered as post-operative analgesics.

Operative technique

The technique of LG tube placement was modified slightly from the original description of Rothenberg (24). In this study, a Tri-Funnel Replacement Gastrostomy tube (Bard Inc., USA) of 20 Fr was used. Each dog was positioned on dorsal recumbency and abdominal region was prepared aseptically. LG technique was performed by 2 port technique. Primary trocar was placed in the umbilicus and secondary trocar was placed in the left upper quadrant of the abdomen. A 5 mm, 0° laparoscope (Scope: 1188 HD camera, Stryker Inc., USA) was placed through the primary port after insufflations with 12 mmHg of intra-abdominal pressure. A second portal site was chosen and placed under visualization in the left upper quadrant well below the costal margin (at least 2 cm away from the costal margin) over the stomach at the site of preferred tube placement. Using a laparoscopic Bobcock forceps (5 mm, Stryker Inc., USA), non-vascular area of the stomach was grasped and delivered directly through the abdominal wall when the secondary port was removed. Anchoring traction sutures were placed between the stomach and abdominal wall fascia. A gastrostomy tube was placed directly into the stomach through a gastrotomy incision, and the balloon of gastrostomy tube was bulged under visualization of laparoscopic guide.

Postoperative care

Dressing of surgical site was performed daily for 14 days. Cefovecin sodium (CONVENIA®, Zoetis Inc, USA, 8 mg/kg SC) and meloxicam (Metacam®, Boehinger Ingelheim Vetmedica, Spain, 0.2 mg/kg PO) were administered for postoperative prophylactic antibiotics and analgesics respectively. The nutritional requirements of each dogs were derived by calculation of their maintenance energy requirement (MER): MER (kcal/d) = 132 × body weight $(kg)^{0.75}$. Feeding via gastrostomy tube was performed 6 hours after gastrostomy tube placement with the following schedule: Day 1- 1/3 MER divided into 3 separate feedings: Day 2- 2/3 MER divided into 3 separate feedings: Day 3 and after- full MER divided into 3 feedings. All dogs fed exclusively by gastrostomy tube for consecutive days. A commercial balanced veterinary diet (Vetessential™, Hills Pet Nutrition Inc., USA) blended and mixed 1:3 with water was fed to all dogs. The gastrostomy tube was flushed before and after gastric feeding with 10 mL of lukewarm water to prevent clogging. Body weight (BW) and body condition score (BCS) were recorded for each dog every 7 days.

PEG

Anesthesia

The anesthetic protocol in PEG group was same manner in LG group.

Operative technique

The technique of PEG tube placement conforms to the original description by Gauderer *et al* (12). In this study, a PEG kit (Ponsky "Pull" PEG Kit®, Bard Inc., USA) with soft silicone retention dome consisting of a 20 French (20 Fr) gastrostomy tube was used. Each dog was positioned on right lateral recumbency and abdominal region was prepared aseptically. A single-working channel endoscope (Scope: EG-250HR2, Processor: EPX-201H, Fujinon™, Fuji Photo Optical Co. LTD, Japan) was used as gastroscope.

Postoperative care

The postoperative care in PEG group was same manner in

Table 1. Evaluation parameters after LG and PEG in dogs

Intraoperative evaluation	Operative times	Operative times were calculated during procedure.
	Intraoperative complication	Procedure-specific complications, degree of bleeding and organ damage were evaluated.
Postoperative evaluation	Tube maintenance	Tube chewing, scratching at the tube and bandage, tube nozzle dislodgement, tube obstruction were evaluated.
	Postoperative complications	Peristomal inflammation, vomiting, stomal site infection, aspiration pneumonia, airway obstruction were evaluated.
	Endoscopic examination	Endoscopic visualization of gastric lumen and gastrostomy tube placement was performed to examine mucosal apposition.
Postmortem evaluation (POD 14)	Gross examination	Adhesion between gastric and peritoneal wall, confirmation of gastrostomy tube placement, complication such as peritonitis were evaluated.
	Microbiological examination	Peritoneal swab was collected with sterile swab. Then, samples were cultured aerobically and an-aerobically.
	Gastro-peritoneal adhesion	Adhesion length, width, and distance were measured.

LG group.

Evaluation

LG and PEG were evaluated at intraoperative, postoperative and postmortem period. Evaluation parameters were summarized in Table 1.

Intraoperative evaluation

Operaive times, procedure-specific complications, degree of bleeding and organ damage were evaluated during the procedure.

Postoperative evaluation

Pain and inflammation on surgical site, tube maintenance, BW changes and enteral complications were observed during the experimental period.

Complications were characterized as minor, moderate or major in each dog. Minor complications were defined as those that posed no health risk to the patient (5,7,9,21). These included peristomal inflammation, tube chewing, scratching at the tube and bandage, tube nozzle dislodgement, and tube obstruction (15). Moderate complications were defined as those that posed a nonlife-threatening health risk to the patient. These included vomiting, tube migration, stomal site infection and LG tube removal by patient. Major complications were defined as those that posed a life-threatening health risk to the patient. Examples would include aspiration pneumonia, airway obstruction, PEG tube removal < 14 days after placement, and peritonits.

On POD 14, endoscopic visualization of gastric lumen and gastrostomy tube placement conditions from the mucosal aspect was performed to examine mucosal apposition.

Postmortem evaluation

After the endoscopic examination, all dogs were humanely euthanized on postoperative day 14 for postmortem evaluation. Necropsies were performed immediately after euthanasia. Gross examination was done to assess following: gastric and peritoneal wall adhesion, confirmation of gastrostmy tube placement, complication such as peritonitis, Microbiological sampling at the peritoneal surface was performed by sterile swab (Culture swab^{TM}, BD Diagnostic Systems, Le Pont de Claix, France). Samples were aerobically and anaerobically cultured in BHI enrichment broth (Brain heart infusion agar, Difco^{TM}, Beckton Dickinson and company, USA). The length (AL) and width (AW) of the adhesions and distance (AD) between the body wall and stomach measurement were recorded for all adhesions. Adhesion length (AL) was defined as a measurement of the adhesion base parallel to the long axis of the pyloric antrum. Adhesion width was the measurement of the adhesion at a 90 degree angle to AL or the measurement perpendicular to the long axis of the pyloric antrum (25).

Statistical analysis

Descriptive statistics (median, mean, and SD) were performed on all appropriate variables. Data analyzed between the surgical techniques (PEG versus LG) were compared using computer statistical package (IBM SPSS statistics 21.0, SPSS Inc, USA), and $p < 0.05$ was considered as significant difference.

Results

Intraoperative evaluation

The average operative time of PEG was 7.45 ± 1.15 minutes (mean ± SD) and that of LG was 36.41 ± 3.07 minutes for LG. Mean operative time for the PEG group was significantly shorter when compared with the LG group ($p < 0.05$). There were two mild intraoperative complications in LG group including the bleeding at the incisional site of the abdominal and gastric wall. The bleeding was controlled using electrocautery or hemostatic suture. There was no other organ damage during the procedure. And there was no intraoperative or postoperative mortality during study period.

Table 2. Summary of intraoperative, postoperative and postmortem evaluation in LG and PEG in dogs

Technique	Dog No.	Intraoperative evaluation		Postoperative evaluation			Postmortem evaluation	
		Operative Time (min)	Intraoperative complication	Tube Maintenance	Postoperative complication	Endoscopic examination	Gross examination	Microbiological examination
LG	1	40.42	Bleeding	None	None	Normal.	Normal	No growth
	2	36.17	None	T ube removal	None	Normal	Normal	No growth
	3	32.57	None	None	Nausea	Normal	Normal	No growth
	4	36.52	Bleeding	None	None	Normal	Normal	No growth
PEG	1	9.08	None	None	None	Normal	Normal	No growth
	2	7.4	None	Tube chewing	Vomiting	Normal	Normal	No growth
	3	6.82	None	None	Soft stools	Normal	Normal	No growth
	4	6.5	None	None	None	Normal	Normal	No growth

Table 3. Summary of adhesion site evaluation

	AL (mm)	AW(mm)	AD(mm)
LG (4 dogs)	$14.75 \pm 2.99^{*}$	$14.00 \pm 1.41^{\dagger}$	2.50 ± 0.58
PEG (4 dogs)	$8.75 \pm 0.96^{*}$	$8.00 \pm 0.82^{\dagger}$	2.00 ± 0

AL (Adhesion Length): parallel to the long axis of the pyloric antrum
AW (Adhesion width): 90 degree angle to AL
AD (Adhesion distance): between the body wall and stomach
*Indicates significant differences between group: AL ($p < 0.05$)
†Indicates significant differences between group: AW ($p < 0.05$)

Postoperative evaluation

Tube maintenance and postoperative complications are listed in Table 2. Significant alteration in BW and BCS of all dogs were not observed during the study period. Four dogs gained weight (median weight gain, 0.3 kg; range 0.1-0.6 kg), one dog lost weight (0.1 kg) and three dogs were maintained during the 14-day feeding trial.

On POD 14, endoscopic observation of gastric lumen was performed. Successful maintenance of gastrostomy tube was confirmed in all dogs.

Postmortem evaluation

The recorded measurements for each group are shown in Table 3. On observation of gastric and peritoneal wall on POD 14, gastric and peritoneal wall adhesions were formed successfully. On microbiological assessment, results of all peritoneal culture were negative in all dogs.

The mean adhesion lengths (AL) and widths (AW) were significantly larger in LG group compared with in PEG group ($p < 0.05$). The mean adhesion distances (AD) for both groups was not significantly different ($p = 0.182$).

Discussion

The PEG technique of gastrostomy tube insertion was developed to help reduce the morbidity, mortality and the cost associated with surgical gastrostomy (12). The efficacy of this procedure and the avoidance of the need for a laparotomy have led to the adaptation of this technique as the preferred method (17,27). Complications associated with PEG tube insertion were reported in the previous study (5). Although the PEG technique eliminates the need for a laparotomy incision, it still has many problems and limitations. Physical limitations on PEG tube insertion in human patients include morbid obesity, which makes it difficult to penetrate the stomach with the cannula (18), and conditions under which the stomach cannot be apposed to the body wall (space occupying lesions, severe ascites, and adhesions) (12). In addition, severe esophageal stricture may preclude passage of the endoscope. The single fatality occurring during tube placement in this series of cases was associated with splenic laceration. This complication was likely attributable to insufficient gastric insufflation. If the stomach is adequately distended with air and the room lights are dimmed, the margins of the spleen are easily visualized by trans-illumination with the endoscope. The stomach should not be distended for prolonged periods, as venous return to the heart may be impaired. However, these situations were not encountered in this study.

LG technique offers better exposure of the stomach than does the laparotomy, in which the incision is usually quite small (24). Compared with the PEG technique, the LG technique also allows for the stomach to be sutured to the abdominal wall, which provides greater safety if the tube should become dislodged (2). In this study, it was confirmed that the benefit of having the stomach sutured to the abdominal wall using the LG technique. Though one dog (LG No.2) had the tube dislodged from the stomach, and there were no complications associated with separation of the stomach from

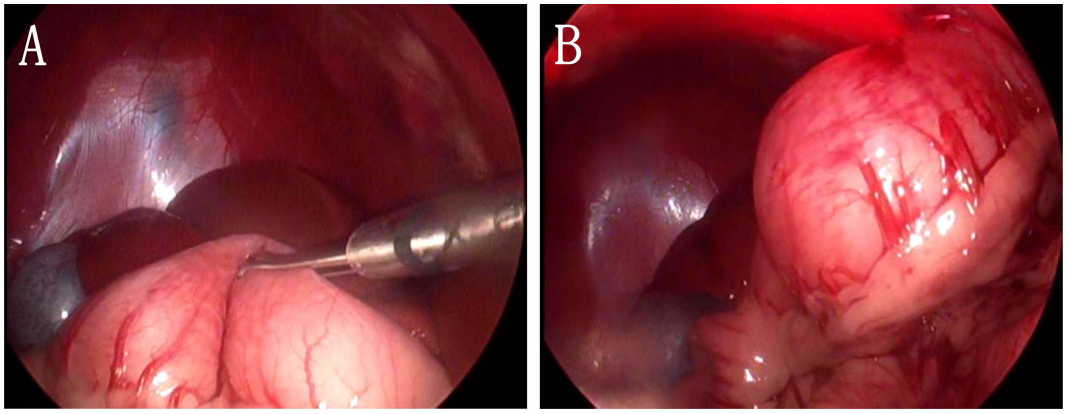

Fig 1. Laparoscopic images of the LG tube placement technique. (A) The stomach was visualized and grasped along the greater curvature. (B) Proper tube position was confirmed using the laparoscope.

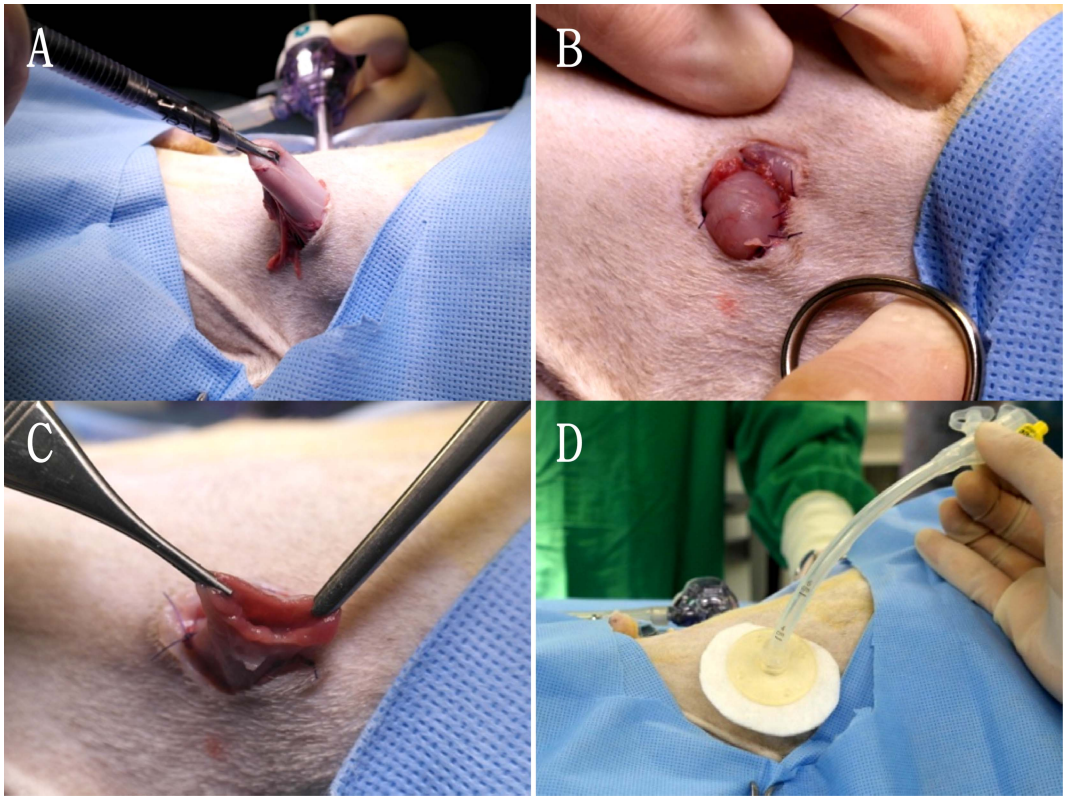

Fig 2. Images of LG placement techniques. (A) Two portal site was inserted, one in the umbilicus introduced and another in the left upper quadrant of the abdomen. Laparoscope was placed through an umbilical port. Using a laparoscopic Bobcock forceps, the stomach was grasped and delivered directly through the abdominal wall by removing the secondary port. (B) Anchoring traction sutures were placed between the stomach and abdominal wall fascia. (C) Gastrotomy incision between the anchoring suture was performed. (D) Postoperative photograph of LG placement.

the abdominal wall during a tube change. The LG technique also obviates the need for a second procedure and possible general anesthesia for tube exchange (4,27).

In this study, the operative time for PEG technique was shorter than LG technique that was expected. Even though the operative time for PEG technique formed less time compared with LG technique, if the patient needs a reoperation for replacement of the tube, it should not be overlooked that the total operating time can take a long time.

Two dogs in the LG group had an intraoperative complication. There were mild to moderate bleeding around the incisional site of the abdominal and gastric wall. The bleeding could be easily controlled because of the bleeding site was easy to find and the ability to fix the stomach to the abdominal wall. After that any problems associated with bleeding did not occur.

One dog in each group chewed and damaged inserted gastrostomy tube in the postoperative period of during 14 days. The PEG tube was trimmed to the recycling without a separate operation. On the other hand, the LG tube had to be

replaced because of balloon of the LG tube was shrinked. It is because of the structural difference of the two tube systems.

Endoscopic examination, gross examination and microbiological examination on POD 14 days were conducted to evaluate safety and feasibility of both techniques. On postmortem necropsy evaluation, the result reveals that LG technique had a wider gastro-peritoneal adhesion site than PEG technique. Therefore, it was suspected that LG technique is much safer than PEG technique within 14 days after inserting gastrostomy tube.

In this study, the comprehensive result reveals that both techniques are effective minimal invasive technique for providing enteral nutritional support in dogs. The method of gastrostomy tube placement must be carefully chosen for each patient with specific attention to patient comorbidities, patient's size, associated conditions, prior abdominal surgeries and body habitus. The success of gastrostomy tube placement mostly depends on correct technique and tube type selection for each patient. The prevention of tube removal by dogs is most important point for tube maintenance.

Conclusion

The feasibility of LG technique was evaluated in this study. The LG technique could obviate many limitations of the PEG technique and has a advantage of greater safety and there might be no need to replace the tube in long term maintenance. Conclusively, laparoscopic gastrostomy tube placement is an effective, minimal invasive, safe and easy to perform technique for providing enteral nutritional support in dogs.

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비글견에서 복강경을 이용한 위관삽입술의 유용성 평가 연구

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요 약 : 본 연구는 개에서 복강경 위관삽입술(LG)을 시행, 수술시간, 합병증, 유착부를 평가하여 수의분야에서 LG의 유용성을 내시경 유도하 경피 위관삽입술(PEG)에 준하여 확인하였다. 정상 비글견 8마리를 두 군으로 나누어 Tri-Funnel Replacement Gastrostomy tube (Bard Inc., USA, 20 Fr.)와 PEG kit (Ponsky "Pull" PEG Kit®, Bard Inc., USA, 20 Fr.)를 이용하여 LG 및 PEG를 실시하였다. 위관을 통한 영양 공급은 유지 열량 요구량(MER)을 1일 3회로 나누어 2주간 진행하고 LG와 PEG의 수술 중, 수술 후, 사후로 나누어 평가하였다. 모든 개체에서 위관삽입은 성공적이었고, PEG 군에서의 평균 수술 시간이 LG군에 비해 유의적으로 짧았다($p < 0.05$). 위-복막간 유착은 군간 모든 개체에서 양호하게 형성되었으나 평균 유착 길이(AL)와 너비(AW)의 수치가 LG군에서 PEG군에 비해 유의하게 높았다($p < 0.05$). 평균 유착 거리(AD)는 군간 차이를 보이지 않았다($p = 0.182$). 본 연구를 통해 개에서 LG는 최소 침습적이면서 쉽고 안전하게, 그리고 효과적으로 장관 영양 공급을 실시할 수 있는 방법임이 확인되었다.

주요어 : 복강경 위관삽입술, 내시경 유도하 경피 위관삽입술, 위관 장착, 장관 영양법, 개