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A Comparison of Three Suture Techniques on Adhesion in End-to-end Intestinal Anastomosis of Dogs

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Abstract : In this study, we evaluated effects of three anastomotic techniques of small intestine on adhesions in the dog. Twenty six healthy mixed dogs were randomly assigned to three groups. Group I(n = 8) was sutured with a simple continuous suture, group II(n = 7) was sutured with a simple interrupted approximating suture and group III(n = 11) was sutured with a single layer continuous Connell suture. On completion of any intestinal anastomosis, a pedicle of greater omentum was wrapped around the suture line in all experimental dogs. One percent sodium carboxymethylcellulose (5 ml/kg) was administrated into the abdomen by feeding tube prior to closing the last part of peritoneum in all dogs. Postoperative adhesions were evaluated at 14th day after operation. The adhesions consisted primarily of omental attachments to the anastomotic site. The adhesion formation between intestinal serosal surfaces has occurred in two dogs in group I, three dogs in group II and group III. There were adhesions between intestinal serosal surfaces in eight dogs in all groups, but there were no intestinal serosa-visceral peritoneum adhesion and intestinal serosa-mesentery adhesion. Mean adhesion scores were less than score 2 in all goups. Between anastomotic site and omental graft, there were 13.13±4.97 mm (mean±S.D.) adhesion formation in group I and 17.29±4.68 mm in group II and 14.64±3.80 mm in group III. A simple continuous suture resulted in the least adhesion formation and a simple interrupted approximating suture resulted in the greatest adhesion formation among the groups. However, there were no significant differences among three suture techniques in the severity of adhesions. Intestinal intussusception only encountered in one dog during the 14 days, the dog operated and survived. Daily monitoring of temperature, activity, appetite, defecation and micturition were done. All of those vital signs were within normal values and there were no obvious differences among the groups. In conclusion, even though there were no significant differences among three groups, a simple continous suture pattern is recommended to prevent adhesions when operating intestinal anastomosis in dogs.

Key words **:** intestinal anastomosis, suture techniques, adhesion, dogs

Introduction

Intestinal anastomosis is one of the most common surgical procedures performed within the abdomen and performed to remove foreign body, neoplasia, intussusception, volvulus or ischemic and necrotic segments of intestine[1-5].

The principle aim of an intestinal anastomosis is for it to be functional and safe with minimal morbidity or mortality. One of the most concerns is adhesion. The incidence of adhesions in intestinal anastomosis varies greatly. Adhesions may compromise bowel lumen diameter and prevent normal distention of the small intestine[6].

Fibrous adhesions are a major cause of intestinal obstruction and by far the most common cause of intra-abdominal adhesions is previous surgical intervention in human[7]. But intra-abdominal adhesions are almost inevitable after major abdominal surgery. Weibel and Majno reviewed 298 subjects at post-mortem who had had previous laparotomy, and 67% of these showed adhesion in human. After multiple operations, the incidence rose to 93% in human patients[8]. Thesedays, it is becoming more and more important issue among veterinary surgeons.

The causes of adhesion formation have been divided into three main types <1> tissue anoxia <2> serosal injury: traumatic handling or desiccation <3> presence of foreign material: gauze lint, talc powder[9], glove powder, wood fiber, etc. Persistent severe inflammatory conditions, including infection and intraperitoneally placed antibiotics and other antimicrobial agents also have been implicated in adhesion formation[7,10-11].

Since adhesions may have serious consequences, it is not surprising that a very large number of techniques have been devised with the aim of preventing their development. Many previous studies have showen the effects on adhesion of various intestinal anastomotic patterns. Experimental evaluation of adhesion formation indicated an advantage of approximating techniques over inverting or everting techniques[12]. Inflammation is more severe and healing time is slower with inverting patterns than with approximating techniques[2]. Therefore, inverting patterns create more adhesions than approximating patterns. Other experimental studies in dogs have shown that inverting suture patterns cause less adhesion than everitng patterns in dogs[10]. Everting anastomoses are not recommended because they have a greater tendency to leak and because of delayed mucosal healing, prolonged inflammatory response, and increased adhesion formation compared with approximating anastomosis. The continuous inverting-suture pattern resulted in significantly fewer adhe-

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sions than the interrupted pattern in some studies[13]. However, we need more information to find out the best anastomotic suture technique that makes less adhesion formation. There were no studies that make a comparison on adhesion among three different intestinal anastomotic patterns, specifically.

The purpose of this study is to compare three suture patterns on adhesions in dogs with the endtoend intestinal anastomosis.

Materials and Methods

Experimental animals

The present study was carried out on twenty six healthy mongrel dogs of both sexes weighing 2-10 kg. There were six females, four spayed females, eight males and eight castrated males. Mean age was 3 years (range, 7 months to 10 years). The dogs were randomly divided into three groups. In group I (n = 8), the anastomosis was performed with a simple continuous suture. In group II (n = 7), the anastomosis was performed with a simple interrupted approximating suture. In group III (n = 11), the anastomosis was performed with a single layer continuous Connell suture.

Each dog was given a complete physical examination and vaccinations were given against canine distemper, infectious canine hepatitis, and parainfluenza. Fecal examination (flotation technique) and examination of blood for Dirofilaria immitis using WHITNESS™ HW were performed; only dogs with negative were used. To check the health, complete blood counts (CBC) using HEMAVET® 850 (CDC Technologies MASCOT™) and blood chemistry using IDEXX VetTest 800 chemisty analyzer were performed. Food and water were available ad libitum.

Preparation of sodium carboxymethylcellulose

Sodium carboxymethylcellulose (SCMC) was prepared as 1% by weight per volume of distilled water and sterilized in 121°C for 30 minutes.

End-to-end intestinal anastomosis

Preparing and premedication. Complete blood count and blood chemistry (ALT, AST, ALKP, BUN, CRSC) were evaluated one day before experimental surgery. Food was withhold 24 hrs and water for 4 hrs before surgical operation. Broad spectrum antibiotics (enrofloxacin 5 mg/kg) and dexamethasone (0.5 mg/kg) were given intramusculary to the dogs one hour before surgery

Anesthesia. General anesthesia was induced by intravenous Tiletamine/Zolazepam (Zoletil 5 mg/kg) and atropine sulfate (0.05 mg/kg) followed by immediate endotracheal intubation and maintenance of anesthesia with isoflurane by inhalation under 100% O_2.

Operation procedures. A balanced electrolyte solution was administered at 10 ml/kg/hr during the surgical procedure. The dogs were positioned dorsal recumbency. The skin of dogs were sterilized with 2% povidone iodine and 70% alcohol. Draping in a sterile fashion was performed during anesthesia. A ventral midline abdominal incision was made in each dog in a sterile fashion. Before pulling internal organs out of abdomen, gauze moistened with warm sterilized saline was spread around incision site and the area to be resected is packed away from the abdomen with the moistend gauze. Checked intestinal viability by color of intestine, peristaltic movement and mesentery artery pulse. About 20 cm prior to ileocecal junction was exteriorized and it's inner content was squeezed out by second and third fingers. The bowel is held between two Doyen intestinal forceps 4 to 5 cm from the proposed resection site. Mesenteric and arcadial vessels are double ligated at the area of proposed resection. The bowel is transected with a scalpel blade outside of the clamps, and the mesentery is incised with dissecting scissors. Then a simple continuous suture (Group I), a simple interrupted approximating suture (Group II), a single layer continuous Connell suture (Group III) were performed with polyglycolic acid 3-0, respectively.

Group I. A simple continuous technique was used to form the anastomosis. The first knot is tied at the mesenteric border. The second knot is placed at the antimesenteric border. Then, from the first knot the sutures are advanced around the perimeter approximately 3 mm apart and 2 to 3 mm from the cut edge and make two to three more knots over the second knot and tied. Again from the second knot the sutures are advanced in opposite directions around the perimeter of the bowel and make two to three more knots over the first knot. The final suture exits and are gently tied.

Group II. When the anastomosis is performed with a simple interrupted approximating suture pattern, the first suture is placed at the mesenteric border and the second suture is placed on the antimesenteric border. All other sutures are placed 3-4 mm apart and 2-3 mm from the wound edge. Once one side of the anastomosis is sutured, the bowel is flipped over, and the opposite site is completed.

Group III. The anastomosis is securely sutured using a single layer Connell suture technique. Sutures are placed approximating 2 to 3 mm from the cut surface and 3-4 mm apart.

The defect in the mesentery is closed with a simple continuous suture in all groups. After all the anastomosis has been completed, it is checked by filling the occluded segment with sterilized normal saline. If there was leakage, a simple interrupted suture was done on the leakage region.

On completion of any intestinal anastomosis, a pedicle of greater omentum tacked to the serosa with two simple interrupted sutures of 3-0 polyglycolic acid placed on each side of the bowel wall, 2-3 cm from the suture line. Peritoneum was sutured with 3-0 polyglycolic acid. 5 ml/kg of 1% sodium carboxymethylcellulose was administrated into the abdomen by feeding tube just prior to closing the last part of peritoneum. Muscle and subcutaneous was sutured with 3-0 chromic catgut and skin was sutured with 3-0 nylon.

Postoperative management

During 3 days after surgery no food and water was given and dexamethasone, enrofloxacin was injected and dextrose lactated ringer solution (Hartmann dextrose solution, 50 mg/kg/day) was injected intravenousely. From the fourth day after operation, dogs were given soft food and water. Dressing of the incision site was done and bandages were changed everyday.

Postoperative evaluation

Vital signs. Appetite, activity, status of defecation, returns of defecation, micturition and temperature were checked every 14 days.

Complete blood count. Complete blood counts were obtained 1 day before operation and again 1 day before reoperation.

Adhesions

Reoperation. Reoperation was done 14th days after operation. General anesthesia was induced by atropine sulfate (0.05 mg/kg) intramusculary and intravenous Tiletamine/Zolazepam (Zoletil 5 mg/kg). The anesthesia was maintained with Tiletamine/Zolazepam (Zoletil 5 mg/kg). Ventral midline laparotomy was done in the same way as previous operation and adhesions were evaluated.

Evaluation of adhesions. The presence of adhesion was checked and predominant adhesion sites of the intestine were classified. The length of adhesions between intestinal anastomotic site and omental graft, intestinal serosal-intestinal serosa, intestinal serosa-viseral peritoneum and intestinal serosa-mesentery were measured. Adhesions were also evaluated according to a 0-4 grade scale by Yaacobi Y *et al*[53] (Table 1).

Statistic analysis

The data of this study for the groups were compared statistically by ANOVA test.

Results

Intraoperative findings

Location of adhesions. The location of adhesion in intestinal anastomotic site at 14th day after operation is described in Table 2. The adhesions consisted primarily of omental attachments to the anastomotic site. The adhesion formation between intestinal serosal surfaces has occurred in two dogs in group I, three dogs in group II and group III. There were adhesions between intestinal serosal surfaces in eight dogs, but there were no intestinal serosa-visceral peritoneum adhesion and intestinal serosa-mesentery adhesion.

Length of adhesions. The length of adhesions between anastmotic site and omental graft is described in Table 3 and Fig 1. Between anastomotic site and omental graft, there were 13.13±4.97 mm (mean±S.D.) adhesion formation in group I and 17.29±4.68 mm in group II and 14.64±3.80 mm in group III. A simple continuous suture result in the least adhesion formation and a simple interrupted approximating suture result in the greatest adhesion formation among groups. However, its difference is not statistically significant ($p > 0.05$).

Adhesion scores. Evaluation of adhesions were performed by scoring 0 to 4 point according to severity of adhesions (Table 1). Mean adhesion scores in each group are recorded in Table 4. In this study, mean adhesion scores were less than score 2 in all groups.

Hematologic findings. The complete blood count was monitored on 1 day before operation and on 1 day before reoperation. Total WBC counts ranged from 6200 to 15100/μl preoperatively and from 7000 to 11800/μl before reoperation. Hemogram from all were within acceptable normal limits.

Postoperative findings

Heart rate, respiratory rate and body temperature were recorded once a day throughout the experiment and it is showen in Fig 2 and Fig 3. All of those vital signs were within normal value. There was no significant differences among three groups.

Status of vitality, appetite and vomiting for 14 days after

Table 1. Postoperative adhesions grading scale

Postoperative adhesions score	Observation
0	No adhesions
1	Filmy, fibrin adhesions, easily removed by blunt dissection (mild)
2	Fibrous adhesions, easily dissected (moderate)
3	Thick fibrous adhesions, dissectable (severe)
4	Thick fibrous adhesions, not dissectable without damage to the adherent tissue (very severe)

Table 2. Location of adhesion in intestinal anastomotic site at 14th days after operation, in dogs with intestinal anastomosis using a simple continuous suture (Group I) , a simple interrupted approximating suture (Group II) and a single layer continuous Connell suture (Group III)

Group	Location of adhesion			
	AS-OG	IS-IS	IS-VP	IS-ME
I	8/8	2/8	0/8	0/8
II	7/7	3/7	0/7	0/7
III	11/11	3/11	0/11	0/11

AS-OG, anastomotic site-omental graft; IS-IS, intestinal serosa-intestinal serosa; IS-VP, intestinal serosa-visceral peritoneum; IS-ME, intestinal serosa-mesentery

Table 3. Adhesion length between intestinal anastomotic site and omental graft (AS-OG) and between intestinal serosa and intestinal serosa (IS-IS) in dogs using a simple continuous suture (Group I), a simple approximating interrupted suture (Group II) and a single layer continuous Connell suture (Group III) at 14th days after operation

Groups	Dog no.	Adhesion formation (mm)	
		AS-OG	IS-IS
I	1	13	
	2	16	
	3	23	
	4	15	8
	5	8	11
	6	8	
	7	12	
	8	10	
	Mean±S.D.	13.13±4.97	
II	1	14	10
	2	14	13
	3	14	
	4	16	
	5	17	11
	6	19	
	7	27	
	Mean±S.D.	17.29±4.68	
III	1	9	
	2	11	
	3	14	9
	4	15	
	5	15	
	6	18	
	7	22	
	8	14	11
	9	15	
	10	10	
	11	18	9
	Mean±S.D.	14.64±3.80	

Table 4. Postoperaitve adhesion scores and number of dogs with adhesions

Group	Adhesion site		Adhesion score
	AS-OG	IS-IS	(Mean±S.D)
I (n=8)	8	2	1.25±0.46
II (n=7)	7	3	1.87±0.75
III (n=11)	11	3	1.64±3.80

AS-OG, anastomotic site-omental graft; IS-IS, intestinal serosa-intestinal serosa

intestinal anastomosis is recorded in Table 5. All of experimental dogs were in good condition except one dog in group I. There was no vomiting after 7th day of operation in all dogs.

Status of feces for 14 days and time of first defecation

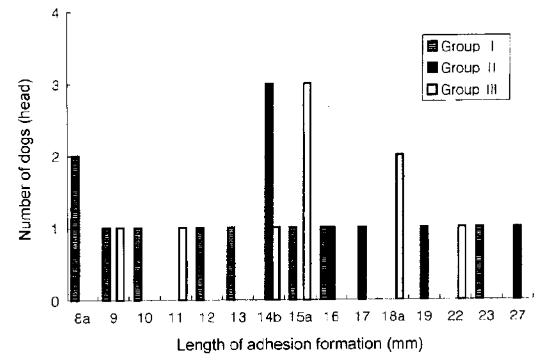

Fig 1. Adhesion length between intestinal anastomotic site and omental graft in dogs using a simple continuous suture (Group I), a simple approximating interrupted suture (Group II) and a single layer continuous Connell suture (Group III) 14 days after operation; a and b, eight dogs which occurred adhesion between intestinal serosa and intestinal serosa (each one dog in a, two dogs in b).

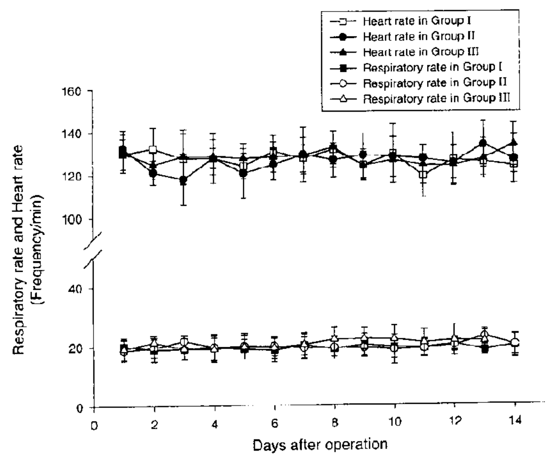

Fig 2. Heart rate and respiratory rate after intestinal anastomosis using a simple continuous suture (Group I), a simple approximating interrupted suture (Group II) and a single layer continuous Connell suture (Group III) in dogs for 14 days after operation.

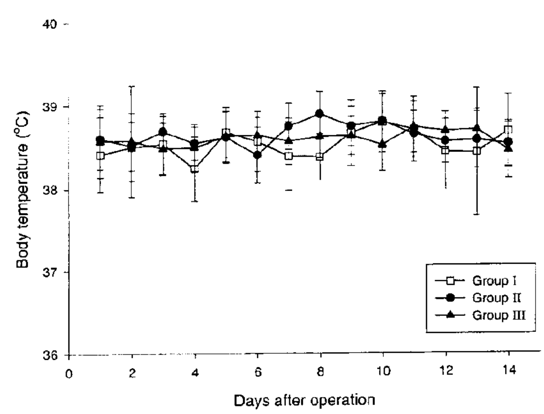

Fig 3. Body temperature after intestinal anastomosis using a simple continuous suture (Group I), a simple approximating interrupted suture (Group II) and a single layer continuous Connell suture (Group III) in dogs during 14 days after operation.

Table 5. Status of vitality, appetite and vomiting for 14 days after intestinalanastomosis using a simple continuous suture (Group I), a simple interrupted approximating suture (Group II) and a single layer continuous Connell suture (Group III) in dogs

Groups		Days after operation												
		1	2	3	4	5	6	7	8	9	10	11	12	13
Depression (No. of dog)	I	0	0	0	0	1	1	0	0	0	0	0	0	0
	II	0	0	0	0	0	1	1	1	1	1	1	1	1
	III	1	0	0	1	2	2	1	0	0	0	0	0	0
Anorexia (No. of dog)	I	-	-	-	0	0	1	0	0	0	0	1	0	0
	II	-	-	-	0	1	0	1	1	1	1	1	1	1
	III	-	-	-	1	1	2	2	0	0	0	0	0	0
Vomiting (No. of dog)	I	0	0	0	0	0	0	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	1	0	0	0	0	0	0
	III	0	0	0	0	1	2	0	0	0	0	0	0	0
Rectal Prolaps (No. of dog)	I	0	0	0	0	0	0	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 6. Status of feces for 14 days and time of first defecation after intestinal anastomosis with intestinal anastomosis using a simple continuous suture (Group I), a simple interrupted approximating suture (Group II) and a single layer continuous Connell suture (Group III) in dogs

	Groups	Days after operation					
		1	2	3	4	5	6
Number of dogs showed first defecation (Head)	I	1	0	1	0	1	1
	II	2	2	1	0	1	1
	III	0	6	2	2	0	1
Number of dogs showed at least one more abnormal feces (diarrhea, bloody feces) (Head)	I	2					
	II	2					
	III	4					
The first time which all dogs defecated on the same day (Day)	I	6					
	II	6					
	III	6					

after intestinal anastomosis is showen in Table 6. The time of first defecation after surgery was between 1st day and 6th day in group I, group II and between 2nd day and 6th day in group III. One dog in group and three dogs in group had diarrhea. After surgery the first time when every dog in all groups had defecation was postoperative 6th day.

Postoperative complications and survival rate of end-to-end intestinal anastomosis using three suture patterns is demonstrated in Table 7. Complication was reported only in one dog in group that had intussusception. Also, there were no postoperative deaths in all experimental dogs.

Table 7. Postoperative complications and survival rate of end-to-end intestinal anastomosis using three patterns in dogs

Suture patterns	Complications			Survival rate
	Dehiscence	Intussusception	Illeus	
I	0/8	0/8	0/8	100%
II	0/7	1*/7	0/7	100%
III	0/11	0/11	0/11	100%

I, a simple continuous suture;
II, a simple interrupted approximating suture;
III, a single layer continuous Connell suture;
*, reoperated and survived.

Discussion

With the advent of more sophisticated anesthetic and surgical techniques, abdominal surgery for the treatment of intesinal obstruction or strangulation in dogs has become commonplace.

Several complications can occur as a result of small intestinal surgery, including dehiscence, abdominal adhesions, intussusception, postoperative short bowel syndrome, and ileus[6]. One of the most concerns is adhesion.

By far the most common cause of intra-abdominal adhesions is previous surgical treatment[7]. Adhesions that distort the linear morphology of the intestinal potentially cause extraluminal simple obstruction or strangulation obstruction.

Anastomotic adhesions are a undesirable consequence of intestinal anastomosis. Therefore, surgeons must try to prevent adhesion.

In 1919 Hertzler[14] stated that adhesions are a result of "healing by fibrosis". Adhesions are fibrinous or fibrous bands that form abnormal unions between two or more surfaces that are normally covered with serosas and are not attached to each other.

Buckman[15] had demonstrated the pathophysiology of adhesion formation in his study. The normal peritoneal membrane possess an enormous capability for lysing and removing intraperitoneal fibrin deposits. Large volume of clotted blood could be completely absorbed by normal peritoneum within 48 hrs[14]. Plasminogen activator activity might be important in clearing fibrinous deposits from mesothelium-lined spaces. Peritoneal crushing, abrasion, and ischemia, stimuli which consistently produce permanent adhesions are associated with local depression of peritoneal plasminogen activator. Prolonged local failure of peritoneal fibrinolysis is a unifying pathogenetic mechanism in permanent adhesion formation caused by several types of peritoneal injury[15]. Postoperatively, adhesions may result from excessive drying of serosal surfaces, infection, traumatic handling of serosal tissue, and contamination with foreign materials such as gauze lint, glove powders[10].

The literatures describing techniques for postoperative abdominal adhesion prevention are extensive and continue to grow. Of course, meticulous surgical technique is prime factor in the prevention of postoperative adhesions[16]. To prevent adhesion formation, the following precautions should be followed. Tissues should be handled as little as possible. Care must be taken to remove all foreign bodies from the operating field. All tissues should be kept moist during surgery. With the exception of those things, there might be a good anastomotic suture technique that makes less adhesions than other techniques.

The present study has made a comparison among three groups about anastomotic suture techniques on adhesion. There were omental adhesions with all anastomoses, but all were confined to the anastomotic sites. There were adhesions between serosal surfaces in eight dogs, but there were no intestinal serosa-visceral peritoneum adhesions and intestinal serosa-mesentery adhesions. Singer *et al.*[17] reported that adhesions had occurred in serosa-serosa (65.8%), serosa-mesentery (26.2%), serosa-omentum (5.4%), serosa-incision (2.4%) in sequence after intestinal serosal scarification in the rabbit. Adhesion formation occurrence is different from this study, its difference may be caused by species difference and we did an omental graft in each anastomotic site in this experiment, so it caused more adhesions at anastomotic site-omental graft than other sites.

There were less adhesions in a simple continuous sutured group (group I) than in a simple interrupted approximating sutured group (group II). In Ellisons study in dogs, a continuous single-layer appositional suture pattern produced more accurate apposition and alignment of intestinal layers and fewer adhesions than did an interrupted single-layer appositional pattern[18]. Suture material is a major cause of peritoneal adhesions in humans[19]. Interrupted patterns expose more suture material to the peritoneum than do continuous patterns; thus adhesion may be more commonly associated with anastomoses sutured in interrupted patterns than in continous patterns. In addition, postoperative peritoneal adhesions at the anastomotic site are formed at a rate directly proportional to the amount of mucosa everted[10,20]. Because eversion results in a delay in the healing process; excessive inflammation and subsequent adhesions to the everted mucosa may also developed[12]. The simple interrupted pattern does not prevent mucosal eversion[18]. Thus, the simple interrupted pattern causes more mucosal eversion and more postoperative peritoneal adhesion formation than than the continuous approximating pattern. A single layer continuous suturing technique may also be less likely to produce focal strangulation and less tissue damage than a single-layer interrupted technique because the continuous technique distributes tension more evenly around the lumen[21-24].

Some of experimental evaluation of adhesion formation indicated an advantage of approximating techniques over inverting or everting techniques[10,12]. Approximating patterns reportedly produce less adhesions than either inverintg or everting techniques[25,26]. Approximating patterns offer several other advantages over inverting patterns: ease of application, increased luminal diameter at the anastomotic site, more rapid mucosal regeneration and less adhesion formation[2,10]. Approximating patterns also offer some advantages over the everting suture pattern: minimal adhesion formation, more rapid early healing, and better protection against leakage[10].

In this study, there were more adhesions in a simple interrupted approximating sutured group (group II) than in a a single layer continuous Connell suture (Group III). Results of the this study are consistent with a recent report by Paul and Robertson[13]. The continuous inverting suture pattern resulted in significantly fewer adhesions than the interrupted pattern in the study of Paul and Robertson[13]. But the difference of adhesions among groups was not as significant as in the study of Paul. Connell patterns has been used commonly since 1963[27]. Inverting anastomoses using Connell patterns provide a more leak-resistant serosa-to-serosa approximation but create an internal cuff of tissue, which may cause luminal stenosis. Inflammation is more severe and healing time is slower with inverting patterns than with approximating techniques[2]. Therefore, inverting patterns create more adhesions than approximating patterns. But, other studies have showed that the continuous inverting suture pattern resulted in significantly fewer adhesions than the interrupted pattern because interrupted patterns cause more eversion than continuous inverting patterns[13,66].

Results of the current study are consistent with other recent reports. In this study, a simple continuous pattern resulted in the least adhesions and a single layer continuous Connell pattern caused the second least adhesions among the groups. A simple interrupted pattern resulted in the greatest adhesion formation among the groups. However, those differences are not statistically significant ($p > 0.05$).

With continuous patterns, bacterial contamination may spread along the entire suture line. Bacterial infection is a cause of peritoneal adhesions; there it is a paradox that fewer adhesions were associated with the continuous anastomoses that had the most intense reaction to the suture material[19]. In Shin YGs study[67], there was more adhesion formation in a simple continuous suture than in a single layer continuous Connell suture. Possibly, it is because of that theory and it might be the reason of three suture techniques have no significant differences for adhesion formation in this study.

Many and varied suture techniques have been used for intestinal anastomosis in small animals. Construction of the intestinal tract after resection can apply endto-end, end-to-side, side-to-side technique. The most common technique in small animals is the end-to-end anastomosis[28,29]. Main types of end-to-end intestinal anastomoses in dogs are inverting, everting, invaginating, and approximating suture patterns. It may be in single or multiple layers and can be sutured in an interrupted or continuous fashion. A single layer of suture is currently recommended because it results in less ischemia, tissue necrosis, less luminal narrowing than double-layer closure and it is also easier, quicker and saving time, anesthetic consumption, and suture material[28,30-33]. In addition, previous studies have reported that the single layer patterns produce less adhesion than the two-layer patterns[34,35].

An end-to-end approximating suture technique has been popular with small animal surgeons. Approximating end-to-end intestinal anastomoses can be created with various simple interrupted suture patterns or with a simple continuous suture pattern. Interrupted pattern was the first appositional anastomosis technique to be commonly used in small animal surgery[2,18,25,28,30] and it is still widely accepted. This technique was developed to improve intestinal healing by accurate realignment of cut layers of the intestinal wall and to minimize the possibility of luminal reduction, which may occur with an inverting suture pattern[10,34,36].

Everting anastomoses are not recommended because they have a greater tendency to leak and because of delayed mucosal healing, prolonged inflammatory response, and increased adhesion formation compared with approximating anastomosis.

Mechanical stapling devices, tissue adhesive, intestinal intraluminal stents, approximation plates and biofragmeatable anastomotic rings have been used. Mechanical Stapling is easier than suturing at this site, but it is conceded that, because these devices insert staples through the full thickness of the bowel wall, healing is theoretically inferior to that achieved by suturing and it is relatively expensive than suturing[37]. No clear advantage of other devices over conventional suturing for anastomosis has been shown[10,36].

Numerous investigations also have been performed to determine pharmacologic agents of minimizing adhesions after surgery[7]. Antibiotics, progestins[38], antihistamines, corticosteroids[39], anticoagulants[40], dextran[19], anti-inflammatory drugs[38] and fibrinolytic agents[41] and some barrier methods[42] have been used in attempt to prevent postoperative adhesion formation, but none of them has been found to be efficacious[43].

Recently, it has been shown that sodium carboxymethylcellulose (SCMC) is effective in reducing adhesion formarion[44-50]. SCMC has been used successfully in models to prevent adhesions in rats[5,44,49], rabbits[17,46-47], ewes[51], ponies[52] and horses[26]. Solutions of this material can be prepared to mimic the viscosity of body fluids such as synovial fluid and aqueous humor. Sodium carboxymethylcellulose is a high molecular weight water soluable polysaccharide polymer, available in various molecular weights and viscosities. The high molecular weight (350,000) and slow peritoneal absorption of SCMC enhance its ability to separate serosal and peritoneal surfaces during epithelial regeneration[44,49]. The postulated mechanism of action for SCMC is the creation of a: flotation bath during the period of epithelial regeneration which prevents the apposition of serosal and peritoneal surface blocking the formation of adhesions[5,26,44,48-49,52]. Another tenable explanation is that SCMC produce its beneficial effect by curtailing fibroblast activities or proliferation and preventing fibrin deposition on the serosal surfaces of the injury[50]. It may also inhibit the movement of inflammatory cells and cellular elements during the period of peritoneal repair[50].

In 1984, Elkins *et al.*[44] reported that SCMC was significantly more effective than dextran in reducing adhesion formation. Hedrick *et al.*[45] compared the efficacy of saline, dextran and SCMC in a rabbit uterine horn model. Yaacobi *et al.*[53] repoted that tissue coating after cecal abrasion failed to inhibit adhesion formation, while tissue coating with SCMC prior to abration significantly reduced adhesion formation. Dermatologic and toxicologic studies demonstrate that SCMC shows that no evidence of being toxic to white rats, dogs, guinea pigs, or human beings[46]. Peritoneal administration of SCMC in the intestine also does not compromise normal healing[54]. Intraperitoneal administration of SCMC also can prevent reformation of adhesions after surgical lysis[5].

In this study, the mean score of all group were less than score 2. This showed that it is of benefit to prevent adhesion formation. 5 ml/kg of SCMC was used in this study, but in other studies[46], 7 ml/kg of SCMC was used and 12 ml/kg for preventing reformation of adhesions[5]. This study has demonstrated that 5 ml/kg of SCMC is enough to prevent adhesions but more studies about adequate volume of SCMC for preventing adhesions should be done.

Several subsequent studies have demonstrated that omental wrapping reduces leak rates and mortality from experimentally devascularized or technically inadequate anastomoses involving small intestine[55-57].

As early as 1888 Senn[58], experimenting on dogs, discovered that omentum can be used both as a free graft and as an omental flap to protect intestinal anastomoses. Since then a great number of studies on omental wrapping have been performed and have showed that it is beneficial [2,10].

Morison[59] characterized the omentum as the "abdominal policeman" because of its ability to "wall-off" inflammatory process in adhesions. To prevent adhesion it is advisible to cover the suture line with omentum, creating less rigid, unrestricting omental adhesion. Many studies have demonstrated that omental wrapping reduces leak rates and mortality from experimentally devascularized or technically inadequate anastomoses involving small intestine[2,6]. Vascular omental adhesions may provide a valuable alternative blood supply to ischemic tissue[60,61] and encourage healing[62]. These attributes have led to the established use of the omentum to promote healing in a range of applications.

There were omental adhesion with all anastomosis, but all were confined to the anastomotic sites. Wilkie[63] found that free omental grafts produce extensive adhesions. The omentums ability to seal the anastomosis in adhesion might have caused adhesion formation of anastomotic site-omental graft in all experimental dogs. Even though it cause adhesions in anastomotic site, omental wrapping can be helpful to prevent adhesion formation, because local tissue ischemia is one of the most common cause of adhesion formation (for example, laparotomy incision or to an anastomotic line). Thus, omentum should be drawn over abdominal organ.

Dehiscence is also one of the most serious problems in small intestine surgery. The small animal intestinal dehiscence rate approaches 7% to 16% with 74% to 80% of those patients dying[64]. Unless the leak is small, abscess formation or generalized peritonitis results[6]. Though mortality with septic peritonitis has been suggested as high as 67%[65], in this experiment it did not happen. Using of omentum can decrease dehiscence rate[37]. Omental graft in this study might have been helpful to prevent dehiscence.

Stenosis is potentially one of the most serious complications after small intestinal anastomoses. None of these dogs showed any signs of stenosis complication. Single-layer anastomotic techniques have been shown to produce less stenosis than double-layer patterns[35]. In this study, we did a single layer anastomosis in all dogs. Thus, it might have been beneficial to prevent stenosis.

In summary, this study has made a comparison and evaluated effects of three anastomotic techniques of small intestine on adhesions in dogs. Evaluation of adhesion formation at 14th day after intestinal anastomosis showed that there was least adhesion formation in a simple continuous suture pattern and greatest adhesion formation in a simple interrupted approximating suture pattern. However, there were no significant differences between three techniques in the amount of adhesions. Although there were no significant differences among three groups, a simple continous suture pattern is recommended. Because it causes less adhesion than other suture patterns.

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개에서 세가지 단단장문합 봉합법에 따른 유착비교

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요 약 : 이 연구에서는 개의 소장에 세가지 장문합법이 유착에 어떠한 영향을 미치는 지 알아보았다. 스물 여섯 마리의 개를 무작위로 세 군으로 나누었다. Group I은 단순 연속봉합을 실시하였고, Group II은 단순 결절 접합봉합을 실시하였으며, Group III는 단층 연속 코넬 봉합을 실시하였다. 모든 실험견에 단단장문합술 후 대망막이식을 실시하고, 복막을 닫기 바로 전에 1% Sodium carboxymethylcellulose을 체중 kg당 5 ml되는 용량으로 복강안에 주입하였다. 수술후 14일째 되는날 실험견들의 수술후의 유착소견을 관찰하였다. 모든 개에서 장문합 부위와 대망막이식 부위 사이의 유착이 발견되었으며, 장막끼리의 유착이 Group I에서 두마리, Group II에서 세마리, Group III에서 세마리가 관찰되었다. 모든 군의 평균 유착 점수는 2이하였다. 장문합부와 대망막사이의 유착길이는 Group I에서 13.13±4.97 mm(mean±S.D.), Group II에서 17.29±4.68 mm, Group III에서 14.64±3.80 mm가 관찰되었다. 단순 연속 봉합법이 유착을 가장 적게 일으켰고, 단순 결절 접합 봉합법이 가장 유착을 많이 일으켰다. 그러나 유착정도에 있어서 세가지 봉합법의 유의성 있는 큰 차이는 나타나지 않았다. 수술후 합병증인 장중적이 한마리에서만 나타났고, 수술후 생존하였다. 14일간 매일 체온, 활력, 식욕, 배변 및 배뇨를 관찰하였다. 모두 정상범위에 속했으며, 군간의 뚜렷한 차이는 없었다. 결론적으로 개에서 세가지 단단장문합 봉합법이 유착정도에 미치는 영향에서 군간 유의성 있는 차이가 관찰되지 않았지만, 단순 연속 봉합법이 유착을 가장 적게 일으키므로 단단장문합법시에 다른 두가지 봉합법보다 더 권장될 수 있을것이라 사료된다.

주요어 : 장문합, 봉합법, 유착, 개