

Comparative study of three methods of esophageal anastomosis in dogs

Z. T. Abd Al-Maseeh and M. J. Eesa*

Department of Veterinary Surgery and Theriogenology, College of Veterinary Medicine, University of Mosul, Mosul, Iraq

*Department of Surgery and Obstetrics, College of Veterinary Medicine, University of Baghdad, Baghdad, Iraq

(Received May 19, 2008; Accepted May 20, 2009)

Abstract

This study was performed to compare three methods of esophageal anastomosis. Twenty four healthy adult dogs were used in this study. The animals were divided into three groups; each one consisted of 8 animals. In group 1; two layers were used to perform the esophageal anastomosis. The first layer represented simple interrupted suture to close the mucosa with knot inside the lumen, and the second layer represented horizontal mattress interrupted suture to close the other layers of esophagus. While in group 2; one layer of cross interrupted mattress suture was used to close all layers of esophageal wall, and in group 3; one layer of Schmieden's suture was used to close all layers of esophageal wall. The results of clinical, radiological and histopathological studies after 15 and 30 days of surgical operation revealed that most of the animals showed different degrees of difficulty concerning the moderate dysphagia and regurgitation. The radiological study showed significant difference of stenosis. The best results were recorded in the second group where the mean degree of stenosis was 7.69%, however the mean degree of stenosis was 42.80% in the first group, while the mean degree of stenosis in the third groups was 37.81%, through 30 days. The histopathological study of group 2 showed rapid healing of the site of anastomosis, lack of granulation tissue and consequently the less degree of stricture and other complications as compared with groups 1 and 3. The Schmieden's suture was characterized by its standard short time as compared with group 1 and 2, although accompanied by some complications. In conclusion this study revealed that the cross mattress suture used in the second group characterized by faster healing and minimal amount of fibrous tissue formation manifested by decrease in moderate degree of stenosis as compared with the two other suture patterns used in the first and third groups.

Keywords: Esophagus, Anastomosis, Dysphagia

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دراسة مقارنة لثلاث طرائق لمفاغرة المريء في الكلاب

زياد طارق عبد المسيح و محمد جواد عيسى*

فرع الجراحة البيطرية وعلم تناسل الحيوان، كلية الطب البيطري، جامعة الموصل، الموصل
*فرع الجراحة والتوليد، كلية الطب البيطري، جامعة بغداد، بغداد، العراق

الخلاصة

أجريت هذه الدراسة لمقارنة ثلاث طرائق لمفاغرة المريء. تم استخدام أربعة وعشرون حيواناً من الكلاب البالغة والسليمة من الأمراض سريريا، والتي قسمت إلى ثلاث مجاميع ضمت كل منها ثمانية حيوانات، استخدم في المجموعة الأولى صفتين من الخياطة لمفاغرة المريء، تمثل الصف الأول بإغلاق الطبقة المخاطية بواسطة الخياطة المتقطعة البسيطة مع عقد الغرز داخل تجويف المريء وأما الصف الثاني فقد تمثل بغلق الطبقات الأخرى للمريء بواسطة الخياطة الأفقية المتقطعة البسيطة. أما في المجموعة الثانية فقد استخدمت طريقة المفاغرة بصف واحد بواسطة خياطة المنجد المتصالب المتقطعة لغلق جميع طبقات جدار المريء. في حين استخدمت طريقة المفاغرة بصف واحد بواسطة خياطة شميدن لغلق جميع طبقات جدار المريء في المجموعة الثالثة. أظهرت نتائج

الدراسة السريرية للمجاميع الثلاثة بعد ١٥ و ٣٠ يوماً من إجراء العملية الجراحية أن معظم الحيوانات كانت تعاني من درجات متفاوتة في صعوبة البلع المتوسط والقلس. كما أظهرت الدراسة الشعاعية إن هناك فروقات معنوية لمتوسط درجة التضيق وتم الحصول على أفضل النتائج في المجموعة الثانية حيث بلغ متوسط درجة التضيق ٧,٦٩% أما في المجموعة الأولى فقد بلغ متوسط درجة التضيق ٤٢,٨٠% في حين كان متوسط درجة التضيق في المجموعة الثالثة ٣٧,٨١% خلال فترة ٣٠ يوماً. وأظهرت الدراسة المرضية النسجية للمجموعة الثانية سرعة التئام أنسجة المريء وقلة النسيج الحبيبي لمكان المفاغرة والتي نتج عنها قلة التضيق وقلة المضاعفات الأخرى عند مقارنتها مع المجموعتين الأولى والثالثة. كما تميزت طريقة شميدن المستخدمة في المجموعة الثالثة بقلة الوقت اللازم لإنجازها بالرغم من مصاحبتها ببعض المضاعفات.

Introduction

Different suture techniques were used in anastomosis of esophagus in one or two layers. Simple interrupted suture by two layers and one layer were used to anastomose the esophagus in dogs and showed that one layer had better healing than two layers (1). Also other workers (2,3) obtained a similar result in pigs by using simple continuous suture by one layer. While (4) showed that there were some complications associated with one layer of esophageal anastomosis such as leakage and stenosis. The esophageal anastomosis leakage was clinically or radiologically evident in (5%) of 298 patients after the esophageal surgery in human (5). The esophageal anastomosis by using interrupted suture in two layers had observed better results as compared with other methods (6-8). On the other hand others find that one layer suture technique was better than two layers suture technique for esophageal anastomosis in pigs, dogs and cats (9,10). The leakage from anastomosis in the gastrointestinal tract is a major complication that is often associated with increased morbidity, mortality and prolonged hospital stay (11). The esophageal anastomosis by inverted techniques were more successful than the everted techniques (12). The surgical resection remains the primary treatment modality for esophageal carcinoma as it provides sustained palliation of dysphagia and the best chance of cure (13). Esophageal anastomosis mostly associated with major complications. Thus in this study we introduce two new techniques, cross interrupted mattress suture and Schmieden's suture by one layer and compared with other routine method of simple interrupted of mucosa and horizontal mattress suture of other layers of esophageal wall that means by two layers.

Materials and Methods

Twenty four adult dogs of local breed were used in this study. The animals were divided into three groups, eight animals for each:

Group 1: Two layers suture were used for the esophageal wall anastomose. In the first layer the mucosa was closed by simple interrupted suture with knot tied inside the

esophageal lumen. Horizontal mattress suture was used to close the other layers of esophageal wall (14).

Group 2: One layer of cross interrupted mattress suture was used to close all layers of esophageal wall.

Group 3: One layer of Schmieden's suture was used to close all layers of esophageal wall.

The animals were anaesthetized by using atropine sulphate (0.04 mg / Kg. B.W.) intramuscularly as a premedication followed 10 minutes later by a mixture of Ketamine hydrochloride 5% and Xylazine 2% (15 mg and 5 mg / Kg. B.W.) respectively intramuscularly. The site of operation which extended from the larynx to the thoracic inlet was prepared for aseptic technique. In dorsal recumbence, mid-line incision was made extending from larynx to about 12 cm caudally (15). The brachiocephalic and sternohyoidus muscles bluntly separated. The esophagus were exposed between trachea and muscles in the left side. About 5 cm of esophagus were bluntly separated and fixed from two sides by staying suture using silk (0). 2-3 cm of esophagus were resected, then anastomosis of both ends by using catgut (3.0), according to the suture pattern mentioned above for each group. After that the esophagus returned to the normal position. The muscle and skin were sutured routinely. The post operative care include: intravenous fluid therapy for three days, soft food for one week and systemic antibiotic (penicillin-streptomycin 10.000 IU + 10 mg / Kg. B.W., intramuscularly) for 5 days.

The clinical and radiological study of experimental animals were recorded along the duration of operation during 15 and 30 days after operation. The radiographic examination performed by taking 10-12 centimeters of esophagus at the site of anastomosis after euthanasia of animals. This part of esophagus was filled with barium sulphate (100% w/v) and the following formula was used to determine the degree of stenosis (16-18):

- Stenosis index % = $100 \{1 - 2a / (b + c)\}$
- a: diameter of esophagus in centimeters at the site of anastomosis.
- b: diameter of esophagus in centimeters at 2 centimeters over the site of anastomosis.
- c: diameter of esophagus in centimeters at 2 centimeters below the site of anastomosis.

Statistical study was performed by analysis of variance, Duncan at the level of 0.05 to determine the difference between these three groups during the duration of 15 and 30 days. Histopathological findings of these three groups were done by staining of haematoxyline-eosin and Mallory trichrome stains to compare the changes between these groups along the duration of 15 and 30 days.

Results

Clinical Findings

The results of clinical study revealed that there was swelling at the site of operation which subsided in seven days after operation except for two animals of the third group which continued for ten days. In the second group, two animals appeared hoarseness, while regurgitation and moderate dysphagia was seen during solid food feeding especially in the first and third groups. Postmortem findings included slight adhesion between esophagus and surrounding tissues at the site of anastomosis especially in the group 1 and slight degree of adhesion in group 3.

Radiography

The degree of stenosis in the esophagus was considered as slight in the second group (7.69%) as in (Fig.1), (table 1) after 30 days of operation and moderate in the first and third groups, (42.80%) as in (Fig.2) and (37.81%) as in (Fig.3), (table 1) respectively during 30 days after operation. There was no significant differences of moderate degree of stenosis between these three groups at 15 days after operation, while there was significant difference of moderate degree of stenosis inside each of the groups at 15 and 30 days after operation (table 1).

Histopathology

The histopathological results of the three experimental groups during 15 and 30 days after operation are summarized as following:

Group 1

15 days

- Formation of multiple stratified epithelial layer in some regions and incomplete in other regions.
- Intensive infiltration of mononuclear inflammatory cells, giant cells, lymphocytes and neutrophils around suture materials with beginning of fragmentation of suture materials (Fig. 4).
- Hyperplasia of the esophageal glands.
- Hyaline degeneration of muscle fibers and necrosis near the anastomotic site.
- Proliferation of fibroblasts and then granulation tissue formation.
- Angioblasts proliferation and beginning of new blood vessels formation in the submucosal layer.

30 days

- Complete formation of squamous epithelium.

- Notice the suture materials surrounded by intensive focal inflammation.
- The muscle fibers especially in the site of anastomosis suffering from advanced stage of necrosis and surrounded by capsular membrane.
- Dense granulation tissue in the site of anastomosis.

Group 2

15 days

- Complete formation of squamous epithelium in some regions and incomplete in other regions.
- Fragmentation and lysis of suture material which surrounded by collagen fibers, and infiltrated by mononuclear, giant cells with rapid absorption of suture material when compared with group 1.
- Hyperplasia of epithelial cells lining the esophageal glands with obstruction of lumen of some them.
- Slight degeneration of some muscle fibers near the anastomosis site.
- Appearance of the granulation tissue with fibrin deposition between the external adventitia.
- Formation of new blood vessels in the lamina propria.

30 days

- Complete formation of squamous epithelium with intensive proliferation of fibrous tissue (Fig. 5).
- Appearance of suture material with a very little cellular infiltration around it.
- The muscle fibers suffering from a mild necrosis.
- Intensive proliferation of fibrous tissue more than the last period with extension of the collagen fibers from the lamina propria to the tunica adventitia.
- Hyperplasia of esophageal glands with little accumulation of these glands in formative stage in both sides of anastomosis region.

Group 3

15 days

- Beginning of formation and proliferation of epithelial stratified squamous layer with extension of collagen fibers between the muscle bands (Fig. 6).
- Fragmentation of suture material surrounded by collagen fibers which infiltrated by intensive inflammatory cells.
- Hyperplasia of esophageal glands.
- Hyaline degeneration and necrosis of muscle fibers which surrounded by capsular structure.
- Fibroblasts with the collagen fibers along the lamina propria and submucosal layer.
- Proliferation of Angioblasts and beginning of formation of new blood vessels between the granulation tissue fibers.

30 days

- This period is more advanced in formation of squamous epithelial layer.

- Incomplete absorption of suture material with intensive inflammatory cells infiltrated around it and between the fibrous tissue fibers.
- Hyper atrophy of muscle fibers and oedema between these muscle fibers.
- Intensive fibrous tissue at the line of anastomosis infiltrated by inflammatory cells.
- The esophageal glands are still suffering from hyperplasia.

Table 1: Percentages of moderate degree of stenosis at the site of anastomosis in the three experimental groups at 15 and 30 days after operations.

Group	% Degree of stenosis at site of anastomosis at 15 days after operation	% Degree of stenosis at site of anastomosis at 30 days after operation
Group 1	28.72% (± 2.4) a	42.80% (± 5.2) b
Group 2	21.55% (± 3.6) a, c	7.69% (± 2.3) d
Group 3	23.53% (± 1.8) a, c	37.81% (± 2.6) f

The data were expressed as mean \pm SD.

Different letters mean significant different at $P < 0.05$.

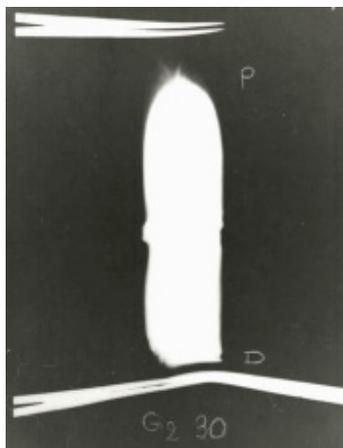


Fig. 1: Site of anastomosis with low degree of stenosis in one animals of the second group after 30 days of operation.

Discussion

The swelling appeared at the site of operation may be due to vasodilatation and increased permeability. This change disappeared 5 days after operation and this observation agreed with (19,20). The swelling remained for more than

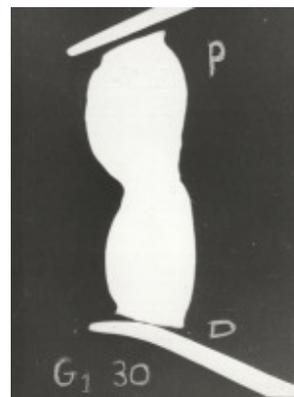


Fig. 2: Site of anastomosis with higher degree of stenosis in one animals of the first group after 30 days of operation.

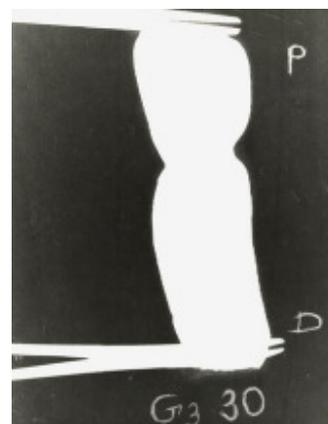


Fig. 3: Site of anastomosis with higher degree of stenosis in one animals of the third group after 30 days of operation.



Fig. 4: Remnant of suture material surrounded by inflammatory cells in the first group after 15 days of operation (H & E, X416).

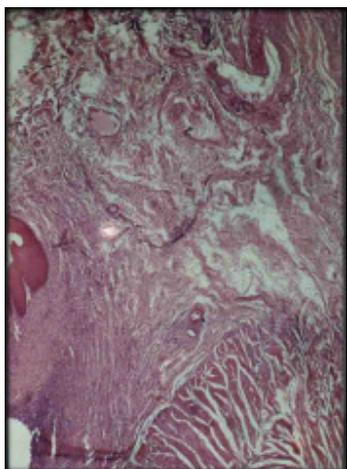


Fig. 5: Formation of squamous epithelium with intensive proliferation of fibrous tissue in the second group after 30 days of operation (H & E, X166).

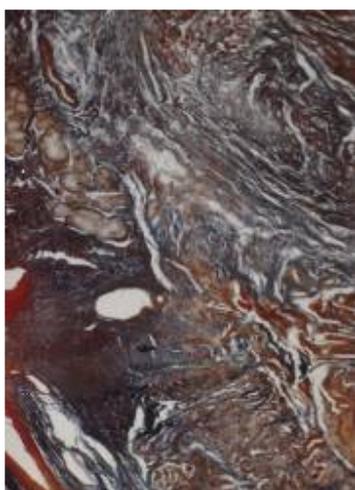


Fig. 6: Fibrosis (f) extending from lamina propria to the muscular layer and proliferation of epithelial stratified squamous layer in the third group after 15 days of operation (Mallory trichrome, X416).

10 days after operation in two animals of the 3rd group. This may be due to leakage of fluid from the site of anastomosis (21-24). In the 2nd group the hoarseness appeared in two animals, it may be due to partial paralysis of vocal cord resulting from trauma of recurrent laryngeal nerve during exposure of esophagus (25). The appearance of regurgitation and moderate dysphagia in 10 days, at the start of giving solid food especially in the animals of 1st and 3rd groups, may result from the stenosis at the site of anastomosis and this was indicated by the radiographic results. Similar observation was made by others showing

that signs of regurgitation may become evident within few days or weeks after esophageal surgery (24,26-30). There were different degrees of adhesions around the site of anastomosis especially in the 1st group. This may be due to horizontal mattress suture which was applied as a 2nd layer that provided good environment for adhesion with surrounding tissue. Horizontal mattress suture of one layer caused adhesion with surrounding tissue due to the eversion of the edges of the esophageal wall toward the surrounding tissue (31). Also the severity of adhesion appeared on day 15 more than day 30, this may be related to period of inflammation, when the healing decreases inflammation (32).

Radiological examination revealed slight stenosis in the 2nd group (7.96 %) after 30 days of operation was due to good apposition of the esophageal wall by one layer. A similar finding was recorded by others (31) who mentioned that the esophageal anastomosis by one layer is better than two layers. Others explained that the 1-layer, suture technique of esophageal anastomosis is safe and economical, and subsequent anastomotic problems are infrequent. This approach is recommended for surgeons who perform esophageal surgery (33). Others conclude that either a continuous or an interrupted monolayer esophagogastric anastomosis techniques can give satisfactory results after esophagectomy for cancer and the continuous technique has the advantages of being time-saving, cheaper, and easier to perform and to teach (34).

In the 1st and 3rd groups the moderate degree of stenosis increased 30 days after operation, as compared with 15 days. This may indicate that the fibrous tissue formation at the site of anastomosis continued 30 days after operation, suggesting incomplete healing and this result was supported by histopathological findings. Others mentioned that the gap in the muscle is filled by fibrous connective tissue, and the width of the scar is reduced by wound contraction and collagen remodeling and this leads to narrowing of the esophageal lumen (12,30,35,36). In the 2nd group the moderate degree of stenosis decreased 30 days after operation as compared with 15 days. This result indicated that the healing of the 2nd group was faster than the 1st and 3rd ones.

Histopathological of the 2nd group revealed that regeneration of epithelial layer completed 30 days after operation, while uncompleted in the 1st and 3rd groups at the same period. This agreed with (37-39) and disagreed with (31), who said that the epithelial layer completed at 2 weeks after operation. In the 1st group the replacement of muscular mucosa by collagen fibers and degeneration of muscle fibers, may be due to ischemia of the area resulting from the suture pattern used. The stenosis of the anastomosis site especially in the 1st group and to a lesser degree in the 3rd group may be related with amount of fibrous tissue formation (35).

In conclusion this study revealed that the cross mattress suture give better results, characterized by faster healing and minimal amount of fibrous tissue formation manifested by decrease in moderate degree of stenosis as compared with the two other suture patterns used in the 1st and 3rd groups.

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