COMPARATIVE STUDIES ON DIFFERENT TECHNIQUES OF INTESTINAL ANASTOMOSIS IN SMALL RUMINANTS

A thesis Presented

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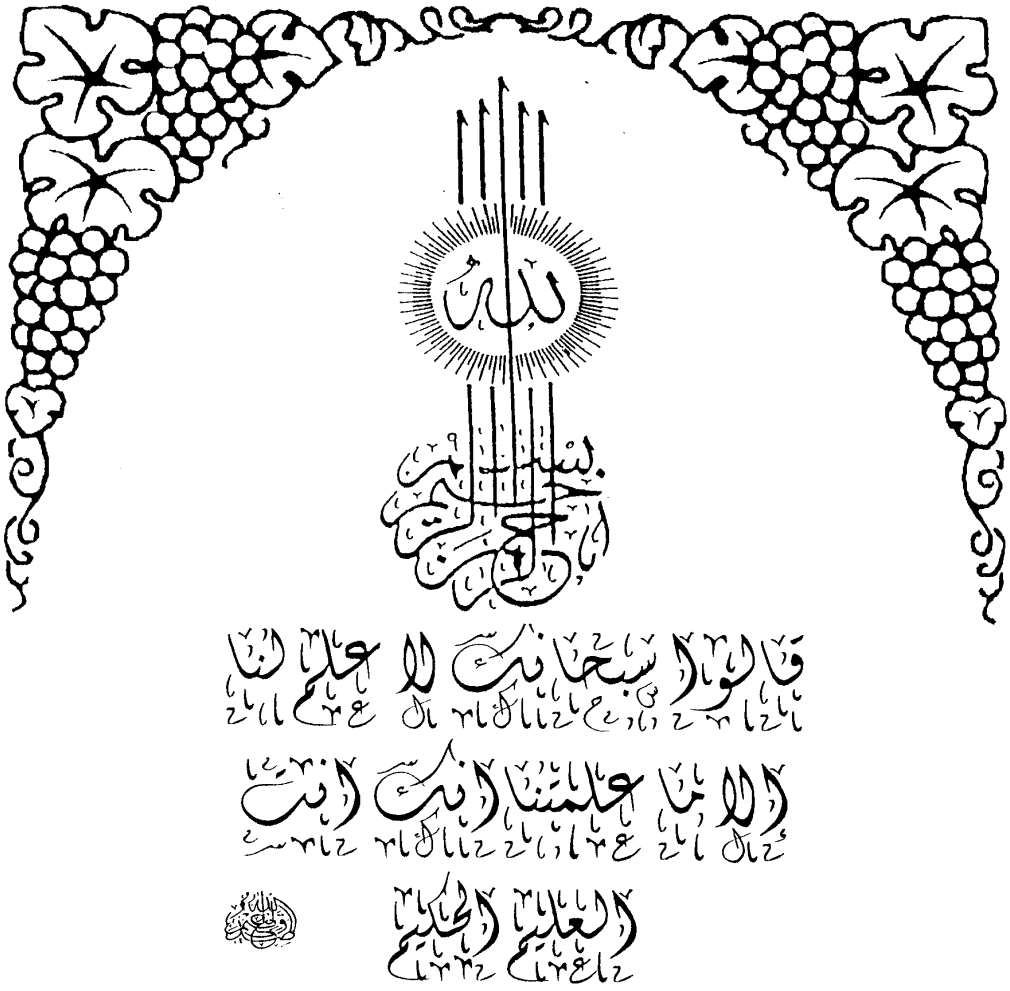

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1- INTRODUCTION

Ruminants including cattle, sheep, and goats, are of the animals which man has domesticated over the centuries to meet his own needs of food, clothing, power, or companionship **(Hafez, 1974).** They are attributed to the class **Mammalia**, suborder **Ruminantia,** and family **Bovidae (Simpson, 1945).** Domesticated sheep **(Ovis aries)** and goats **(Capra hircus)** are distinct species in the family Bovidae **(Gordon, 1996 and Jainudeen, Wahid, and Hafez, 2000).** In **2001,** the estimated Egyptian small ruminant population (sheep and goats) was given as **8,072,600** heads. They are distributed as **4,545,110** heads of sheep; and **3,527,490** heads of goat **(FAO, 2001).**

The digestive system is an important system in the animal body. It is considered the factory by which the animal converts food into meat, milk, and wool **(Frandson and Whitten, 1981).** The intestine is the part of the digestive system that extends from the pylorus to the anus. Physiologically, it is the site of catabolism, continuous and gradual absorption, formation of feces, intermediate metabolism, and finally endocrine activity **(Pavaux, 1983).**

Disorders of intestine are a common cause of abdominal pain, and they are often fatal. Early identification and prompt surgical treatment is the only sure way to reduce mortality (**Mueller, Parks, and Baxter, 1992).**

Intestinal resection and anastomosis is indicated for many intestinal disorders. Two segments of intestine can be successfully re-united by a number of methods and materials. Several experimental techniques have been used, non of them has fulfilled the ideal requirements **(Shnain, Rebesko, Rahman and Aswad, 1975).** Controversy exists in the literatures over the best technique for apposing two intestinal segments. One versus (vs) two layers closure; absorbable vs non-absorbable suture materials; everting vs inverting appositional techniques; end-to-end, end-to-side, and side-to-side variations; telescoping patterns; and opened vs closed anastomosis has been described **(Singlton, White and Monalbo, 1968 and DeHoff, 1971).** Arrays of procedures and devices for bowel anastomosing has introduced since 1800s. They have progressively been controversial, gained acceptance, and then fallen into disfavor.

Surgery of the ruminant digestive system has been the subject of renewed research interest as veterinarians continue to improve techniques to correct gastrointestinal problems. The goal of a century of research in intestinal anastomosis has been to minimize their complications, but obviously, using the multitude of techniques and materials that have been examined and advocated as a criterion the ideal method is yet to be found **(Bone, Duckett, Patton, and Kranhwinkel, 1983).**

Aim of the work:

The present study aimed to:

- Evaluate and compare between three techniques of intestinal anastomosis, End-to-end (EE), Side-to-side (SS), and End-to-side (ES) anastomosis in sheep and goats.
- Evaluate three types of suture materials according to their tissue reactions during performing of the intestinal anastomosis.

II- REVIEW OF LITERATURE

11.1- Indications of Intestinal Anastomosis:

Sharp foreign body escaping from the reticulum may be considered a mechanical cause of intestinal obstruction. Obstruction may be secondary to local inflammation, swelling and fibrous tissue formation. Very occasionally in cattle, sheep and goat, a zootrichobezoar or phytotrichobezoar forms around a center of hair, wool or vegetable fibers specially in calves that lick each other. This forms in the abomasums and may find its way into small intestine to cause obstruction. Strangulating obstruction often require emergency resection and anastomosis. Adhesions, intestinal herniation, Meckel's diverticulum and atresia ilei were also indicated for intestinal resection and anastomosis. Torsion of the jejunum may occur partially or completely. The affected animals are mainly calves. In complete torsion, the manifestations and course are indistinguishable from those of complete intestinal volvulus and surgical correction is similar **(Oehme and Prier, 1989).**

Mueller et al. (1992) classified the small intestinal diseases into functional obstruction (non-surgical), physical non strangulating

obstruction (surgical), and physical strangulating obstruction (surgical).

Smith (1986) reported that in the cases of intussusception, the telescoping of one segment of bowel into another, was the most common cause of intestinal obstruction in cattle. Most cases occur in winter and early spring in cattle of any age.

Weaver (1986) reported that intestinal intussusception (invagination or telescoping of bowel) occasionally affects jujenum and ileum in cattle.

Pseudo-obstruction due to postpartum atony of small and large intestine may lead to strangulation in Holstein cow **(John, Baker, Ronald and Georg, 1985).**

Volvulus of the intestine with two cecae, rectal stenosis, and a cardiac anomaly was encountered in a neonatal calf **(West, Johnson, Murry, and Bearley, 1988).**

Fistula of the small intestine in a cow resulted from external violence due to goring by another cow was recorded as a case necessitated intestinal anastomosis **(Kumar, Tanwar, Sharma, Saxena, Joshi and Pradhan, 1982).**

Rowley (1983) reported a case of telescoped ileum into the colon in an intussusception. The colon was distended by the ileal intussusceptum along its entire length.

Bojrab, Birchard and Tomlinson (1990) found that lodged intraluminal foreign bodies often cause local bowel wall necrosis or perforation that may necessitate intestinal resection. Intramural lesions caused by strictures, neoplasm or fungal granulomas such as phycomycosis must be removed by resection of the affected section of bowel. Extramural lesions caused by adhesions, secondary to previous surgery, regional peritonitis or abdominal abscess, required also resection of obstructed segment of intestine.

Intestinal resection and anastomosis was used for treatment of intestinal obstruction due to intestinal tumor, either intramural or extraluminal tumors being squmous cell carcinoma,

adenocarcinoma, lipoma, multicentric lymphosarcoma and leiomyoma in equines **(Douglas, David and BelKnap, 1989).**

Gift, Gaughan, Debowes, Pintchuk, Nichels and Foreman (1993) found that jejunal resection was necessary in horses suffering from jejunal intussusception.

Small intestinal strangulations are one of the most serious causes of abdominal pain in horses **(Baxter, Hunt, Tyler, Parks and Jackman, 1992).**

In recent years, significant advances in abdominal surgery have increased the survival rate for horses with intestinal intussusception, volvulus, malposition, incarceration, strangulation, obstruction and infarction **(Adams, 1985).**

Giselle, Monica and Mark (1992) found that strangulating obstruction of the small intestine is an infrequent cause of small intestinal obstruction in dogs. Strangulation of the small intestine through an omental defects has been reported in horses but not in dogs. They examined a dog after being hit by a car six hours earlier.

Jejunum was incarcerated by an omental tear, and needed intestinal resection and anastomosis.

Lipowitz, Charles, Dennis and Anthony (1996) found that intussusception of the small intestine most frequently occur in dogs and cats younger than one year of age often associated with enteritis and parasites and less associated with small intestine and cecum tumor. Conditions necessitating removal of extensive segments of bowel include; small intestine infarction, thrombosis, trauma, linear foreign bodies with multiple perforation, neoplesia, and fungal infection (phycomycosis). Colonic resection and anastemosis are indicated for removal of colonic tumors and idiopathic megacolon in cats.

Stashak (1987) classified the pathology occurring within the large intestine into; non-strangulating obstruction (NSO), strangulating obstruction (SO), and non-strangulating infarction (NSI).

Kantrowitz and Biller (1992) classified the intestinal affections into functional obstruction not require surgery (as

proximal enteritis, post-operative ileus and idiopathic ileus), and physical obstruction that require exploratory surgery including physical non-strangulating obstruction and physical strangulating obstruction (as volvulus, hernias, intussusception and neoplasms).

Annis and Allen (1967) performed enterotomy for removal of an intestinal foreign body in the absence of gangrene.

Berge and Westhues (1966) indicated enterotomy for ileus caused by foreign body lodged in the intestine. The intestinal resection was indicated for neoplasia of the intestine, perforation or necrosis of the gut wall, torsion, foreign bodies, adhesions or intussusception that could not be corrected.

Shackelford and Dugan (1961) and Geib and Abrevaya (1965) reported that colotomy or colectomy was required as a surgical treatment of polyps of the gastro-intestinal tract.

Fellenbaun (1978) indicated the partial colectomy for recurrent megacolon in cats, colonic spasm and non-salvageable injuries of the colon.

Dutoit, Homan, Smith, Mcshane, French, Denton and Merris (1981) found that intussusception of small intestine had developed in dogs given renal transplants and in puppies given intrasplenic autografts of dispersed pancreatic fragments after total pancreatectomy. Factors contributing to the development of the intussusception in the puppies included; round warms infestation, recent dietary changes following weaning, malabsorption and diarrhoea due to pancreatic insufficiency following pancreatectomy.

Speirs, Van-Veenedal, Christie, Lavelle and Gay (1981) considered the possibility of traumatic hematoma as well as the more dramatic rectal perforation as indicators for colonic resection and anastomosis.

Fouad, Saleh and Shokry (1985) indicated intestinal resection and anastomosis in either mechanical or strangulating obstruction of the intestine.

Edwards (1986) studied about 27 horses, of 310 undergoing laparotomy because of abdominal pain. It was found that intussusception involved 16 cases of small intestine and 11 cases of

cecum. After the surgical mangement of such cases, it was found that the ileal-ileal intussusception and ceco-cecal intussusception carrying a better prognosis than jujunal or ileu-cecal types that resulted in complete occlusion of the intestinal lumen and were accompanied by a greater degree of infective changes.

White (1987) found that the physical obstruction of the small intestine was due to an impaction or stricture caused by adhesions, while that of the large intestine was due to impaction or displacement of the colon and/or cecum.

Wheaton (1987) reported that the intestinal obstruction either to be simple due to intraluminal mass or be strangulated due to intussusception, volvulus, and strangulated hernias.

Green (1987) mentioned that intestinal surgery or enterotomy in dogs and cats was usually for emergency conditions and indicated for partial or complete obstruction, tumors, intussusception, foreign bodies, neoplasm and for performing intestinal biopsies.

Strombeck (1979) and Burrows (1980) reported that the acquired megacolon resulted from mechanical obstruction caused by rectal or colonic neoplasm, stricture or extraluminal mass and from neorologic or endocrine disease.

Tate (1987 a) mentioned that surgical intervention was indicated for the abdominal diseases not respond to the medical therapy in equine. Resection of cecum and large colon was indicated in case of infarction, intussusception, hypertrophy, torsion and strangulation. Surgical intervention was contraindicated when deterioration or devitalization of the bowel to the point that surgical correction would not resolve the problem.

11.2- Diagnosis of Intestinal Affections:

Regardless of the cause, there is great similarity in the clinical appearance of all complete bowel obstruction. In ruminants, in contrast to equine particularly and the omnivore to some extent, acute bowel obstruction does not give rise to acute severe clinical signs and certainly does not end fatally in 8-24 hrs., unless bowel gangrene has supervened. Signs of colic are manifested in cattle only

after some hours., and the course may drag out for 8-14 days **(Oehme and Prier, 1989).**

Lokal (1984) found that decision to perform surgery should be based on a number of factors, such as findings of physical examination, laboratory results, condition and value of the animal, and the owner wishes.

The onset of signs following intussusception was sudden and was characterized by anorexia, colic and rapid decrease in milk production. After the initial phase of colic, only mild abdominal discomfort was evident and the cow becomes increasingly dull and lethargic. If untreated, death usually occur in 5-10 days, although some cows survive up to 14 days after the onset of the clinical signs **(Smith, 1986).**

The cardinal signs of small intestinal obstruction are abdominal pain and intestinal distention that identified by rectal palpation. With earlier recognition of the problem and improvements in treatment for endotoxaemia and shock, the perioperative mortality rate appears to be decreased **(Baxter et al., 1992).**

White (1987) reported that the diagnostic features of the physical obstruction of the small intestine due to impaction or stricture were the pain, distended intestine and massive distention of the bowel felt rectally.

An obstruction of cranial portion of the small intestine was suspected in one case showing signs of depression, anorexia, and decrease milk yield, in addition to bilateral abdominal distention and decreased fecal output. Exploratory surgery revealed presence of a mass of gravel in the descending duodenum that removed by enterotomy **(Cebra, Cebra, and Garry, 1996).**

Hooper (1989) recommended exploratory surgery for treatment of small intestinal strangulation caused by Meckel's diverticulum in a horse on the basis of the response to treatment, and results of rectal palpation and abdominal centesis.

Beard, Barbra, Richard and Henninger (1992) diagnosed ileocecal intussusception in horses through; acute abdominal pain that is characterized by intermittent, severe, and unresponsive to repeated administration of xylazine and flunixin meglumine; high

heart rate and the horse was tachypnic. Rectal palpation not revealed abnormal findings. A small volume of dark green nasogastric reflux was retrieved via nasogastric tube. Abdominal fluids were within normal limits.

Edens, Tylor, Murry, Spurlock, and Anver (1992) diagnosed a case of intestinal myxosarcoma in a thoroughbred mare through intermittent abdominal pain, anorexia, weight loss, and rectal palpation. Abdominal paracentesis yielded a transparent pale yellow fluid characterized as a modified transudate.

Bojrab et al. (1990) used fluorescene dye to determine intestinal viability.

Palminteri (1966) used in addition to the rectal examination, the endoscopy and radiography using the barium and air as contrast media in the confirmation of the diagnosis of the lower bowel polyps.

Radiography provided substantiating evidence of intestinal intussusception, obstruction, or both **(Frimann-Dahl, 1974).**

Wolf (1978) diagnosed a case of compound intussusception in a kitten by a physical examination and confirmed by survey radiographs that demonstrated the soft tissue density of the intussusception and localized gaseous distention of the small intestine.

Quick and Randano (1978) used the contrast enemas for chronic bloody diarrhea, tensmous and ileo-colic intussusception and contraindicated following colonic wall biopsy or suspected colonic rupture or perforation.

Bright (1987) mentioned that the cecal inversion could be diagnosed by abdominal radiography, where a soft tissue density was seen in the region of cecum and there was absence of the gas felt cecum in case of plain films. Using of barium enema was helpful and added immeasurably to the diagnosis, where a radiolucent filing defect in the proximal colon was seen.

Rosin, Walshaw and Mehlhaffey (1988) used the radiography for confirmation of the diagnosis of chronic

constipation in cat non responsive to the medical treatment and associated with idiopathic megacolon.

Shealy and Henderson (1991) stated that despite of early suspicion and intensive management, the mortality rate in canine intestinal volvulus was nearly 100 %. Positive prognostic factors were not known and survival seemed fortuitous. Incidental diagnosis and timely operative intervention were the factors associated with successful outcome.

11.3- Techniques of Intestinal Anastomosis:

Bojrab (1975) used the anastomosis of the intestine by end-to-end, side-to-side, or end-to-side anastomosis. **Fouad et al. (1985)** used the side-to-side anastomosis to avoid the possibility of stenosis and differences in the diameter of the bowel stumps.

Adamu, Chaudhari and Paul-Bokko (1998) reported that invagenated intestinal anastomosis is better than everting intestinal anastomosis in goats.

Tate (1987 a) reported that the diameter differences precluded the use of an end -to-end anastomosis and supported the necessity of using side-to-side anastomosis in equine.

Hofmeyr (1989) advised using side-to-side anastomosis. It avoids the possibility of post-operative stenosis, and differences in the diameter of the two bowel stumps are consequential.

Noordsy (1989) reported that treatment of intestinal obstruction was carried out by resection of bowel segment and mesentery, and performing end-to-end, or end-to-side anastomosis.

Bone et al. (1983) found that in the usual end-to-end small intestinal anastomosis, various inverting, everting, and approximating patterns are used. Both single-and double-layer patterns are used. Recently, intestinal stapling devices have become available.

Ulmann, Pavletic, and Clark (1991) found that the most common technique of intestinal anastomosis in small animals was the sutured end-to-end anastomosis. When everted staple lines were

compared to everted suture lines, the former had a significantly lower dehiscence rate.

Rose, Schumacher and Tylor (1991) used side-to-side anastemosis after resection of the affected portion of the colon of calves.

Rose and Bradly (1992) treated strangulating volvulus of the large colon by closing of the resection with a continuos Lembert pattern and side-to-side anastomosis using staples with automatic stapling equipment.

Smith, Ducharme, Fubini, Donawick and Erb (1991) resected the dilated proximal blind end of the spiral colon in calves. Intestinal continuity was restored by side-to-side or end-to-side anastomosis of the proximal blind end of the spiral colon to the descending colon. Side-to-side anastomosis of the proximal to the distal blind end of the spiral colon was an alternative. The different types of anastomosis used did not affect survival rates of discharged calves.

Horn (1991) had performed 5 cm side-to-side anastomosis between the base of the cecum and the first centripetal coil of the spiral colon in a six weeks old, 55 kg Holstein heifer calf with colonic intussusception. Meanwhile, **Hofmyer (1989)** recommended the end-to-end eversion technique for intestinal anastomosis following resection as a method of treating intestinal intussusception of the jejunum in cattle.

Rosin et al. (1988) used the sub-total colectomy and enterocolostomy in cats for treatment of chronic constipation associated with idiopathic megacolon. The ileum or the distal part of the jejunum was joined to 2- 4cm segment of distal portion of the colon by end-to-end anastemosis after surgery. There were no significant abnormalities.

Ross (1986) had poor results with enterotomy and evacuation for treatment of cecal impaction. Using of side-to-side anastomosis of the cecum to the right ventral colon appeared to offer the best results.

Wheaton (1987) treated the intussusception firstly manually after exploratory laparotomy. If manual correction did not succeed, the incision was indicated and reduction was occurred even after an intestinal resection and anastomosis using end-to-end, side-to-side and end-to-side anastomosis.

Mclachlin and Denton (1973) excised the entire intussusception and the bowel was repaired with end-to-end oblique anastomosis. An omental patch was placed over the site of the anastomosis.

Rowley (1983) succeeded in anastomosis of the distal ileum and remaining colon using two-layered end-to-end anastomosis in a kitten.

Kumar et al. (1982) treated a fistula of the small intestine by removing 50 cm. length of intestine including some healthy tissue at each end. The fresh ends of intestine were apposed using an end-to-end anastomosis.

Koike (1976) reported that side-to-side intestinal anastmosis was superior to standard end-to-end anastomosis, but an end-to-end technique using decalcified bone tube was the most satisfactory in dogs.

Redlich, Souffrant, Laplace, Henning, Berg and Mouwen (1997) concluded that there was no major disturbance after ileo-rectal anastemosis (IRA). End-to-end procedure was most beneficial for the structural integrity of the small intestine.

Baxter et al. (1992) found that there was no significant difference in surgery times, intra-abdominal adhesion scours, stomal area or histopathological scours between small intestinal end-to-end and side-to-side anastomosis in horses. Using of the stapling techniques did not significantly reduce the time required to perform small intestinal resection and anastomosis. The continuous Cushing suture pattern resulted in rapid closure and probably represented the fastest end-to-end anastomotic technique. Interrupted pattern excluding mucosa for end-to-end ananstomosis would probably require more time to complete than continuous patterns.

Ford (1991) succeeded to treat chronic reducable intestinal intussusception in horse surgically with side-to-side ileo-cecostomy. Meanwhile, **Englelbert, Tate, Bowman and Bristol (1993)** used end-to-end jejunal or jejuno-cecal anastomosis for treating horses with incarceration of the small intestine.

Beard et al. (1992) have used the hand suture two layers end-to-side jejuno-cecostomy as a routine fashion. While, **Douglas, David, and Belknap (1989)** used side-to-side with automatic stapling device for anastomosis of the proximal and distal jejunum in horse.

Although numerous suture techniques have been used for end-to-end intestinal anastomosis in small animals, **Ellison (1981)** recommended the approximating pattern. On the same time, **Richardson (1981)** found that the sutured end-to-end anastomosis was the common and preferable in small animals.

Dean and Robertson (1985) performed three techniques for anastomosis of the small intestine in the horse. The study revealed that the two layers inverting techniques of the small intestinal

closure was superior to the single layer technique because of its reduced incidence of adhesion with maintenance of adequate lumen diameter. They classified the intestinal anastomosis techniques to; invert, evert, or oppose the incised edges of bowel and as whether they were performed in single or double rows.

The single layer opposing suture pattern in dogs has the advantages of excellent apposition of intestinal layer **(Dehoff, Nelson, and Lumb, 1973; Bennett and Zydeck, 1970; Reinerston, 1976; and Loeb, 1967).**

Mueller et al. (1992) reported that although there were many techniques for end-to-end anastemosis, they preferred a two layers anastomosis using 2/0 synthetic monofilament absorbable suture materials with a simple continuous pattern in the mucosa followed by a continuous Cushing or Lembert in the seromuscular layer.

Bone et al. (1983) compared inverting versus everting, inverting versus approximating and everting versus approximating pattern. The studies revealed that the approximating pattern had found to be superior.

End-to-end simple interrupted crushing suture pattern was compared with the end-to-end interrupted inverting (Connell) suture pattern using 3/0 dexon. The crushing pattern had a comparatively weaker intestinal strength but a closer return to pre surgical anatomy. The inverted pattern equaled normal intestine in bursting strength, but maintained a large degree of stenosis at anastomotic site. Adhesions were minimal and did not grossly interfere with mechanical function of the intestine **(Richardson, Duckett, Krahwinkell and Shipman, 1982).**

Everting and inverting stapled end-to-end triangulation methods of small intestinal anastomosis similar to those performed in human were not recommended in horses due to the resultant significant adhesion formation **(Sullins, Stashak and Mero, 1985; Bristol and Cullen, 1989; and Pascoe and Peterson, 1989).**

Bristol and Cullen (1989) found that a little or no advantages to perform an inverting triangulated stapled anastomosis as compared to the everting technique.

Using of an end-to-end stapling device was limited to young horses and ponies due to the small diameter of the resulting anastomosis. There was no postoperative colic and the adhesions involved 23 % of the circumference of the bowel at necropsy despite the inverted nature of the anastomosis **(Robertson - Smith and Adams, 1987).**

Stanley, Mugeren, and Nyaga (1983) reported that the modified simple interrupted suture placement is more desirable than the simple interrupted through-and-through pattern.

Sandh (1991) noticed that modifications of the cutting thread technique for intestinal anastomosis using diathermy appeared to be of value in certain clinical operations as implantation of the small intestine into the cecum or colon following an ileal respective caecal resection in the horse.

Use of intestinal stapling device has been added to the list of techniques **(Reiling, Reiling and Bernie, 1980; Dorn, allen, Baxter and Park, 1991; Young, Snyder, Pascoe, Olander and Hinds, 1991; and Ullman et al., 1991).** Each technique has been shown to

have its own advantages and disadvantages, as determined by extensive clinical, histopathological, and biomechanical studies **(Loeb, 1967; Bennett and Zydeck, 1970; Yale and Gemert, 1971 and DeHoff et al., 1973).**

Dorn et al. (1991) concluded that the use of stapling instruments to perform intestinal anastomosis has been reported as a safe and time efficient alternative to conventional hand sutured anastomotic technique.

Marvinal, Elliot, Thomas, Melvin and the Voltrac (BAR) study Groups (1989) found that there was no significant difference in the morbidity, mortality, and clinical course following Biofragmentalble Anastomotic Ring (BAR). The BAR affected re-establishment of intestinal continuity somewhat more rapidly, but its major advantage is its uniform applicability to all areas of the intestinal tract, except the lower rectum.

Tate (1987 b) found that malabsorption, weight loss and liver damage were developed following resection of about 40-60 % of the the small intestine in ponies.

Many dogs would tolerate loss of up to 80% of the small intestine if the ileo colic valve was intact **(Bojrab, 1975 and Fouad et al., 1985).** On the other hand, **White (1987)** mentioned that the amount of the bowel that could be safely removed during treatment of certain intestinal affections of equine was 50% of the total length. Removal of more than that could result in weight loss, and chronic malnutrition unless the diet was modified to substitute a highly digestible feed stuff.

11.4- Tissue Reactions Against Suture Materials:

The basic principles of intestinal suture were established more than 100 years ago by Travers, Lembert, Czerny, and Halsted, and have since undergone little modifications. However, these pioneers have recognized the dangers of intestinal anastomosis. Breakdown or disruption of a suture line in the intestine may result in peritonitis, fecal fistulation, and serious or fatal septic complications. It is apparent that safety in anastomosis of the intestine depends to a large extent on the technical expertise and judgement of the operating surgeon **(Thomas, 1995).**

Haxton (1965) discussed the influence of suture material on healing and omitted catgut for internal wounds, as it looses its tensile strength rapidly and produces intensive inflammatory reactions in the surrounding tissues. Silk was preferred for gastric and intestinal wounds. On the other hand, **Fechner (1965) and Brand, Browen and Scheller (1966)** reported that catgut is more satisfactory than silk.

Fouad et al. (1985) mentioned that all suture materials produced tissue reactions that lasted at least five days. They attributed these reactions partly to the trauma of passing the needle and suture materials through tissues, and partly to the physiochemical properties of the suture materials. Synthetic monofilament sutures produced less tissue reactions than multifilament sutures. Catgut produced the greatest reactions. Tensile strength of the polyglycolic acid was greater than that of the surgical gut, silk and cotton.

Reynolds (1966) performed comparative studies between chromic catgut and reconstructed collagen sutures in colon anastomosis. He reported that there were three disadvantages of

collagen suture. Meanwhile, **Alder, Montes, Dayer, and Harrod (1967)** proved the superiority of collagen suture to catgut.

Brumback and Mcpherson (1967) observed less inflammatory cellular reaction to reconstructed collagen when compared with catgut and silk.

Riquelme, Alonso, Vale, Nava, Hoet, Camacho and Loanid (1998) found that the tissue reaction was least for vicryl, greater for catgut and polypropylene and greatest for silk. The reaction against propylene was almost as severe as that against silk in enterotomiesin dogs.

Igna, Marce, Bolte and Radea (1996) reported that inflammation was least following implantation of absorbable rather non-absorbable suture materials in digestive tract of dogs.

Baxter et al. (1992) noticed severe inflammation associated with the end-to-end anastomosis sutured with polyglyconate than with those sutured with polydioxonone. Polyglyconate was

considered to have better handling character knot security and strength than polydioxanone.

Quessada, Bernis, Guimaraes, Araujor and Cordose (1987) strongly advocated the use of cotton on single layer extramucous suture of the stomach wall of the dogs. It produced a very discrete or even no reaction at all. On the other hand, plain catgut produced a high degree of inflammatory reactions, and its use in gastrorrhaphy of dogs was considered inadvisable.

Freeman, Pettit, Robinette, Lincolin and Person (1987) studied the tissue reactions to some suture materials in feline linea-alba. The least inflammation occurred when the linea alba was sutured with polyglactin 910 and the subcutaneous tissues were not sutured, rather that when it was sutured with surgical gut and polydioxanone with and without subcutaneous tissue closure.

Al-Dahash, Al-Sultan, Yasin and Singh (1990) compared three techniques of uterine suturing; single - layer inverting suture, double - layers inverting suture, and Schmieden's technique and three suture materials (chromic catgut, silk and nylon). On days 7,

14 and 21, an omental adhesions were noticed more marked with Schmieden's technique and around catgut rather other suture patterns and suture materials. All sutures induced varying tissue reactions with peak on days 7. However, reactions were more intense to catgut and were least to nylon. At latter stages, reaction to catgut remained the same but regressed progressively to nylon. Healing was better where nylon and silk were used as suture materials.

According to histopathological examination of hysterotomy wounds after cesarean section in goats, **Kassem (1983)** classified the suture materials from little to severe cellular and vascular reactions into silk, nylon, mersiline, ethicon, prolene, plain and chromic catgut.

Van Ee, Nasisse, Helman and Sanders (1986) studied the effects of monofilament polyglactin 910 and nylon on standardized perforating perilimbal clear corneal wound healing. The inflammatory responses were similar. Epithilization and suppuration around the suture tracts were observed more frequently when polyglactin 910 was used. Both nylon and polyglactin 910 were

associated with a foreign body (granulation) response. The authors advised that the corneal suture materials should remain in place for at least 16 days, and the absorbable ones were only appropriate if they retained tensile strength for 16 days.

Varma, Johnson, Ferguson and Lumb (1981) reported that the cellular reactions varied with the suture materials. There were large numbers of neutrophils indicating local infection in wounds containing plain catgut, chromic catgut, silk and braided dacron. While with nylon, steel and polyglycolic acid (Dexon), the numbers of neutrophils decreased rapidly.

111- MATERIALS AND METHODS

Animals:

The present experimental study was performed on 54 clinically healthy small ruminant 27 Sheep and 27 Goats of both sex (males and non-pregnant females). Animals aged between 9 months to 3 years old, and weighed 10-40 kg. Two doses of broad-spectrum anthelmentic (Ivermectin *) were given for each animal, with 21 days interval. Animals were kept under clinical observation for one month. The only apparently healthy animals were used. They included two main classes; class I, included 27 sheep and class11, included 27 goats. Animals of each class were divided into three groups. Each group (included 9 animals) was subdivided into three subgroups, 3 animals of each **(Table, 1).**

End-to-end (EE), side-to-side (SS), and end-to-side (ES) techniques of intestinal anastomosis were carried out in the first, second, and third group in each class, respectively.

4/0 chromic Catgut **, 4/0 Vicryl ***, and 4/0 Prolene**** were selected as the suture materials for performance of the anastomosis, Each one of them was used and evaluated within one subgroup for each type of anastomosis **(Table, 1).**

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* Ivomec Super (Merial, Netherland).
** Ethicone.
*** Polygalactin 910.
**** Polypropylene .

Table (1): *Showing No. of Animals , techniques, and types of sutures adopted in the present study.*

Animals	Total (54)																	
	Class I, Sheep (27)									Class II, Goats (27)								
Groups	1st G (9)			2nd G (9)			3rd G (9)			1st G (9)			2nd G (9)			3rd G (9)		
Techniques	End-to-End			End-to-Side			Side-to-Side			End-to-End			End-to-Side			Side-to-Side		
Suture materials	Catgut	Vicryl	Prolene	Catgut	Vicryl	Prolene	Catgut	Vicryl	Prolene	Catgut	Vicryl	Prolene	Catgut	Vicryl	Prolene	Catgut	Vicryl	Prolene
Subgroups	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

G, means group.

111.1- Preparation of Animals:

24 hours before the operation, the selected animal for surgery was isolated and fasted. A purgative (200 ml. paraffin oil) was given to the animal 12 hours before the operation. Broad-spectrum antibiotic (Streptopencid *) was given in a dose of 20 mg./kg. Body weight, one day before the operation and continued for 3-5 days.

111.2- Preparation of the Seat of Operation:

An area of 10 X 15 square cm in the right flank or in the ventral midline was prepared aseptically for laparotomy. The skin was clipped, shaved and washed, then carefully disinfected using Povidine iodine** and surrounded with four sterile surgical towels fixed by towel clamps (Fig., 1).

111.3- Anesthesia:

All operations were carried out under the effect of xylazine HCl *** as a sedative given by intramuscular rout in a dose rate 0.1 mg/kg body weight. Linear infiltration local anesthesia at the seat of laparotomy incision using 2% xylocaine Hcl.**** Was performed.

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* CID **Betadine (El-Nile Com.)

*** Chanazine, Chanelle Pharmaceuticals Manufacturing Ltd., Loughrea Co., Galway, Ireland.

**** Debacaine, El-Nasr Pharmaceuticals Co., Egypt.

111.4- Operative Techniques:

111.4.1- Laparotomy:

Incision in abdominal wall was done via two approaches; ventral midline celiotomy, or lateral right flank laparotomy. Length of incision was long enough till reach the abdominal cavity.

111.4.2- Intestinal resection:

The part of intestine would be resected was pulled into the wound. Abdominal wound was then completely packed off by the use of sterile gauze and the protruding loop of gut was carefully spread out on surgical towels (Fig., 2).

The extent of the gut to be resected was determined. Double ligation of the visible mesenteric vessels of the mesentery of determined part was carried out and mesentery was then removed. Care was taken that the remained end of the gut are well supplied with blood. Cut off with scissors taking the end of the gut between finger and thumb, milking the content, and apply intestinal clamps with piece of gauze to avoid tearing (Fig., 3).

111.4.3- Intestinal anastomosis:

111.4.3.1- End-to-end anastomosis:

The two ends were brought close together (Fig., 4). Two methods were done to perform end-to-end anastomosis. The first was done using the Schmieden's suture pattern to oppose both intestinal ends according to the technique described by **Berge and Westhaues (1966).** A second alternative method using four-stay sutures. It was carried out by creating four sutures in both intestinal ends; two sutures were inserted at the mesentric and antimesentric border of the intestine, and two were inserted at the midpoint of the anterior and posterior aspect of the anastomosis (Figs., 5 & 6). Completion of anastomosis was performed using one layer of simple continuous pattern between each two stay sutures (Figs., 7, 8, & 9). A piece of Macaron (2-3 cm. Length) was inserted in the lumen of both ends during the oppositing. Intestinal clamps were removed. The defect in the mesentery was closed with few stitches of interrupted pattern (Fig., 9). Intestinal loop was then reposited inside the abdominal cavity. Greater omentum was pulled over the operation site. Suspension of penicillin - streptomycin was distributed inside the abdominal cavity, especially over the operation

site and inbetween the layers of the abdominal wall. Abdominal wall was then routinely closed.

111.4.3.2- Side–to–side anastomosis:

First of all, the gut ends were closed. Ends of the gut were stitched with Purse-string suture or continuos Lembert suture, only serosa and musculosa were penetrated (Fig., 10). The two stumps of the intestine were laid side by side in isoperstaltic direction (Fig., 11 a & b). The contents were milked back and the intestine was fixed in position by means of intestinal clamps as in end–to–end anastomosis. Opposite to the insertion of the mesentery, the two opposed surfaces of the gut wall were joined by means of a continuous Cushing Suture (the so – called lower serosa suture (Fig., 12). The lumen of the gut in both bowel segments after closure was then opened. The wall was perforated with scalpel and the scissors were used to complete the incision. The length of the incision was shorter than the previously inserted Cushing suture. Both openings were stitched in apposition by means of Schmieden's suture (Figs., 13 & 14) and externally by continuous Cushing suture (the so-called upper serosa suture) (Fig., 15). The intestinal clamps were removed and the defect in the mesentery was closed. Penicillin-

streptomycin was introduced into the abdominal cavity. Intestine was replaced and the abdominal wall was closed.

111.4.3.3- End–to-side anastomosis:

Firstly, the lower gut end was closed. Its contents were milked back and the intestine was fixed in position by means of intestinal clamps. 2-3 cm away from the distal closed intestinal end in the antimesentric part, a perforation in the gut wall in form of stoma was created using scalpel and scissors (Fig., 16). Size of this stoma represents the same size of the lumen of the upper opened intestinal end. The upper opposed gut end was then stitched in the newly created stoma in the lower gut end using Schmieden's suture pattern (Fig., 17). Intestinal clamps were removed and the defect in the mesentery was closed. Penicillin-streptomycin suspension was introduced in the abdominal cavity. Intestine was replaced and the abdominal wall was routinely closed.

111.5- Post –operative care:

- Follow-up of the operated animals was carried out for three weeks post operatively.

- Animals were withhold of food for 2-3 days post-operatively and kept on easily digested diet for six days.
- Fluid therapy (5% dextrose and 0.9% saline) were used during the operation and for 2-3 days post-operation using about 300 cc / animal / day via intravenous or subcutaneous routes.
- Systemic course of antibiotic, using 400.000 IU penicillin and 2 gm. streptomycin) was administered one day before the operation and continued for three successive days post operation, as one vial / day intramuscularly.
- A prophylactic dose (1.500 I.U.) of antitetanic serum was given also in the day of the operation.
- Daily dressing of the abdominal wound was carried out using Betadine.
- Skin stitches were removed 7-10 days post operation.

111.6- Postmortem examinations:

On the 21 post operative day, all operated animals were subjected to exploratory laparotomy to evaluate presence of and severity of intra-abdominal adhesions, the pathologic changes within the abdominal cavity and at each anastomoses, areas of ananstomotic stoma, and histologic quality of anastomotic healing.

111.6.1- Adhesions:

Each anastomoses was given an adhesion score (from 0 to 4) based on the findings described by **Baxter et al. (1992),** where :

0 = No adhesions present.

1 = Surface omental adhesions only.

2 = Localized fibrous adhesions.

3 = Several fibrous adhesions resulting in distortion of the anastomosis or mesentery or adherence of bowel loops.

4 = Massive adhesions with several bowel loops adhered to each other.

111.6.2- Gross Pathology:

The abdominal cavity was examined for signs of peritonitis, defects in the abdominal incisions, and adhesions involving the ananstomoses. Each anastomosis was evaluated grossly for adhesions, fibrosis, impactions, distention of the bowel proximal to the anastomosis, and anastomotic healing.

111.7- Radiographical examination:

21 days postoperation, the part of the intestine (about 25 cm length) in which the anastomosis was performed, was subjected to

contrast radiography (enterogram) using 50% weight / volume of barium sulphate. The selected loop was closed by two intestinal forcepes about 10-15 cm from both sides of the stomal area. Barium solution was injected inside the loop. Contrast Radiography was carried out for intestine in which anastomosis was performed by EE anastomosis by four-stay sutured technique, EE anastomosis by Schmieden's sutured technique, SS anastomosis and ES anastmosis.

111.8- Histological examination:

The collected samples were fixed in buffered 10 % formalin, embedded in paraffin, sectioned, and stained with Hematoxylin and Eosin stain according to the technique described by **Culling (1983).** Three criteria were evaluated and scored; degree of inflammation, degree of fibrosis, and healing of intestinal layers.

- Degree of inflammation was defined by leukocytic infiltration (scored from 0-3; where 0 = none and 3 = severe).
- Degree of fibrosis (scored from 0-3; where 0 = none, and 3 = severe).
- Healing of intestinal layers (from 0-3; where 0 = perfect healing of mucosa, 1 = normal mucosal healing, 2 = delayed mucosal healing, and 3 = mucosal ulceration).

111.9- Statistical analysis:

Mean times for completing the EE, SS, and ES anastomosis, intra-abdominal adhesion scores, and histopathology scores (degree of inflammation, degree of fibrosis, and degree of healing) were compared using statistically **(SAS, 1987).**

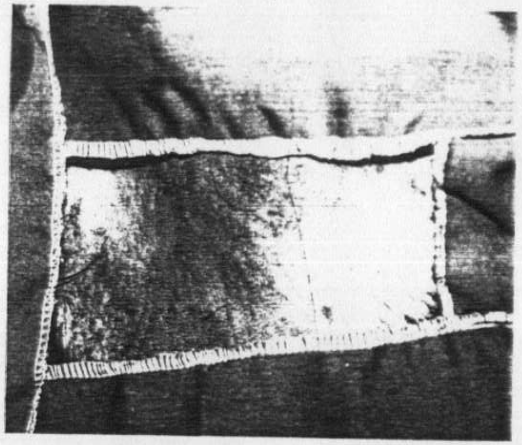

Fig. (1): Showing the seat of operation prepared for aseptic surgery.

Fig. (2): Showing the selected intestinal loop exteriorized and spread out on a surgical towel for resection.

Fig. (3): Showing two ends of intestinal segments closed by two intestinal forceps.

Fig. (4): Showing the two ends are brought close together.

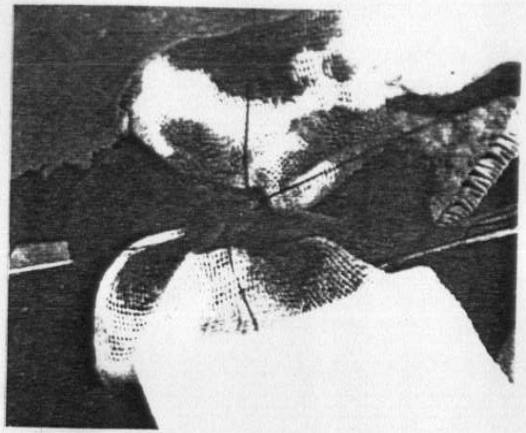

Fig. (5): Showing two sutures of the four – stay sutures in the mesenteric and antimesenteric border.

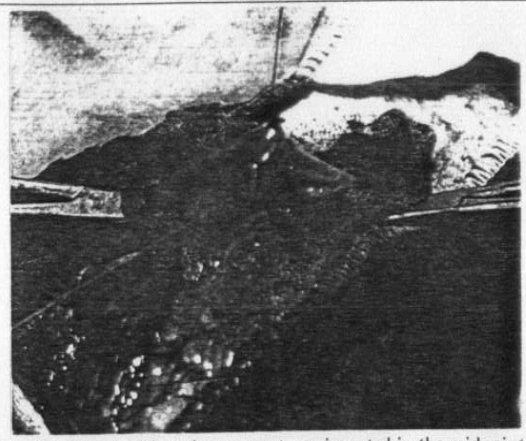

Fig. (6): Showing the other two sutures inserted in the midpoint and posterior aspect of the anastomosis.

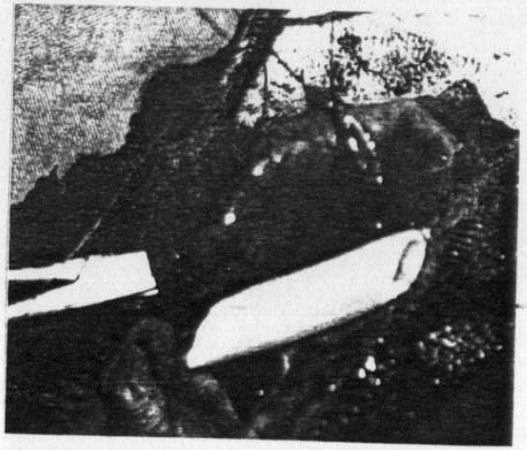

Fig. (7): Showing piece of Macaron similar to that introduced in both ends.

Fig. (8): Showing the duodenum during completion of the anastomosis by simple continuous pattern.

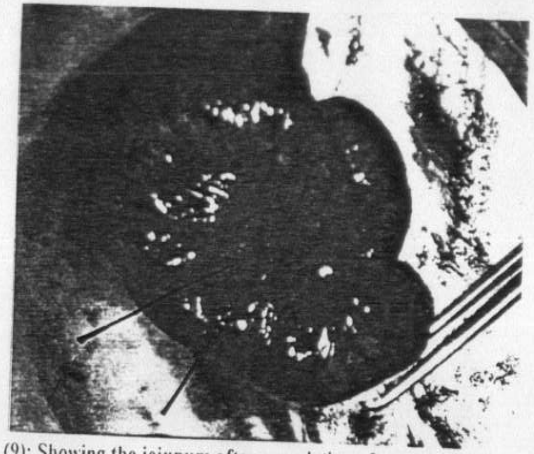

Fig. (9): Showing the jejunum after completion of anastomosis (short arrow). Defect in the mesentery is closed (long arrow).

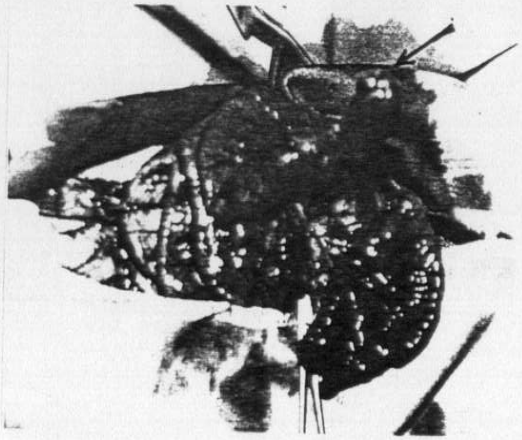

Fig. (10): Showing closed intestinal ends after resection. Upper end is closed by purse-string suture (arrow).

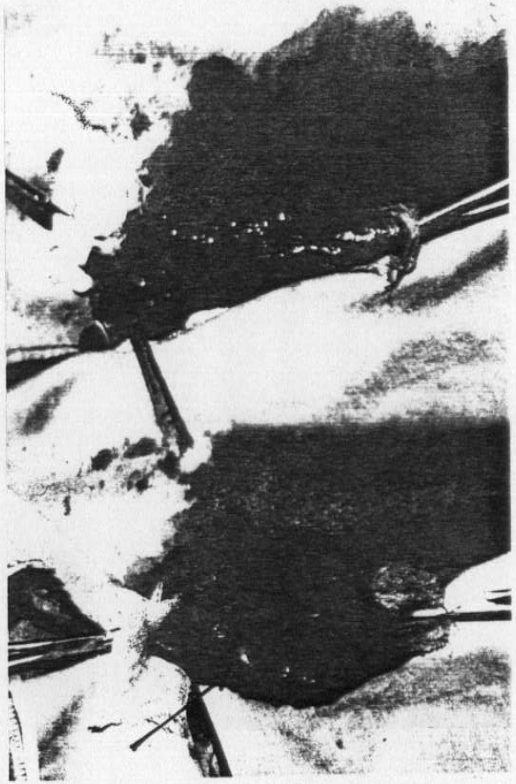

Fig. (11): Showing the two stumps after closure, are laid side by side in isoperistaltic direction. Upper arrow shows the closed end of the upper loop. Lower one shows the closed end of the lower loop.

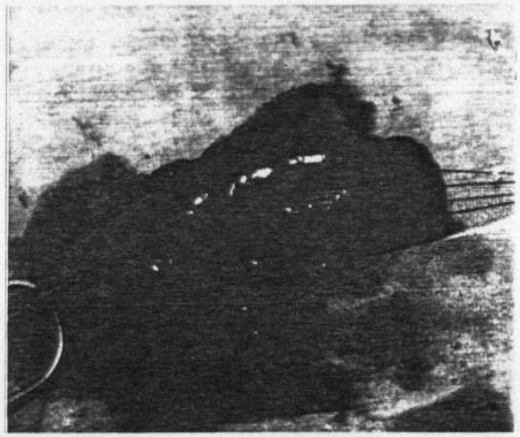

Fig. (12): Showing the two opposed surfaces of the gut are joined by lower serosal suture.

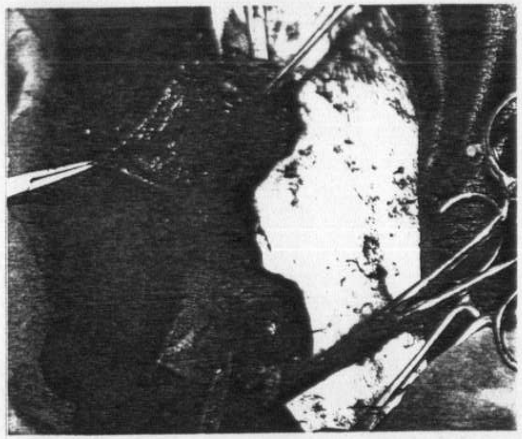

Fig. (13): Showing the incised intestinal loop during its suturing by Schmieden's suture.

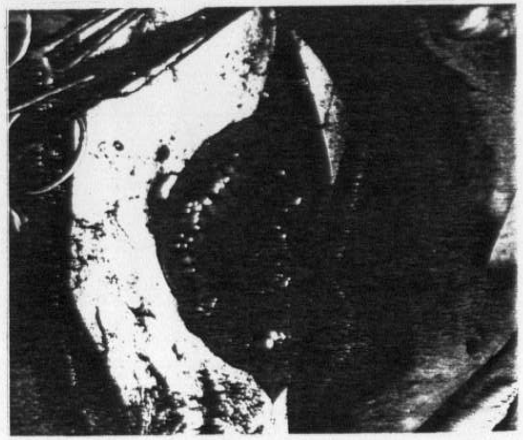

Fig. (14): Showing complete suturing of the incision by Schmieden's pattern.

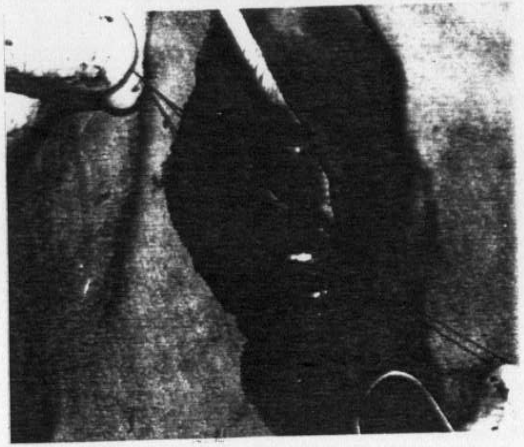

Fig. (15): Showing the intestinal loop after the upper serosal suture.

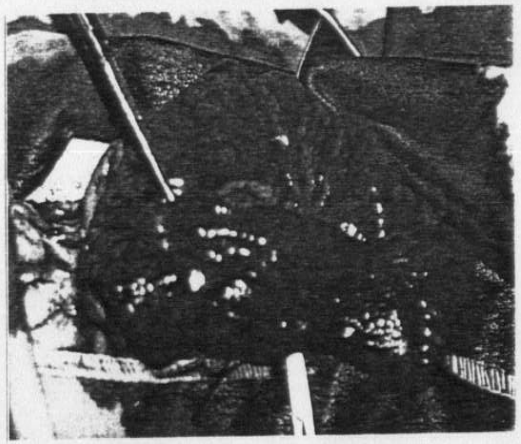

Fig. (16): Showing the created stoma in lower closed gut end (arrow). The upper gut end is not closed.

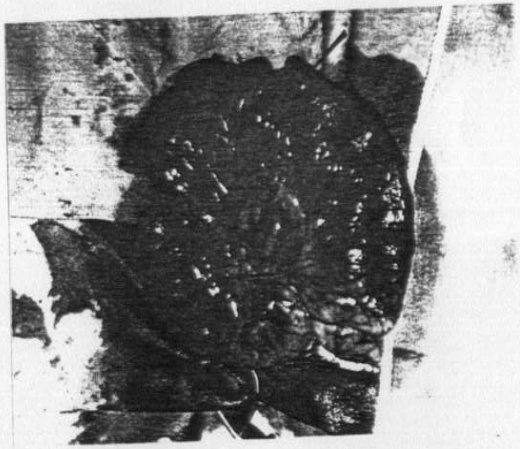

Fig. (17): Showing joined upper gut end in the lower closed one (arrow) via the created stoma by Schmieden's pattern.

IV- RESULTS

IV.1- Surgical Findings:

- Mean surgical times for EE, SS, and ES anastomotic techniques were 20.33 ± 2.41 minutes (range 18-23 minutes), 44 ± 5.15 minutes (range 38-50 minutes), and 31 ± 2.5 minutes (range 27-35 minutes), respectively (Table, 2). There was significant difference between surgical times required for completion of EE anastomoses as compared with that required for ES anastomoses, and high significant difference between surgical time for the EE anastomosis as compared with that required for SS anastonoses (Table, 2).

- Two goats had signs of abdominal pain on second and third post operative days for ES and SS anastomoses, respectively. Both conditions responded to IV fluid therapy (0.9 % saline and 5 % dextrose in a dose of 250 cc/ day / animal), and there were no further problems. However, a jejunal impaction proximal to the SS anastomosis was present at necropsy (Fig., 18). Other animals had no signs of post-operative abdominal pain.

IV.2- Postmortem finding:

- At postmortem examination (21 days post-operation), no animals had evidence of peritonitis or defects in the abdominal incisions.

- Intra-abdominal adhesions were not severe. Score of adhesion ranged between 0-3. Only one goat developed modrate intra-abdominal adhesions. The adhesions involved mesoduodenum and lateral abdominal wall following duodenal anastomoses using EE anastomotic technique. No dilatation or distortion was seen in the anastomotic site, and the anastomosis was palpably thickened (Fig., 19).

- Few fibrous tissues on the serosal surface of the bowel, in the area of anastomoses were found in two cases (one goat and one sheep). They were operated using Catgut in ES and SS jejunal anastomosis, respectively. Both animals also had adhesions involving both anastomoses. Adhesion scores for the two cases showed no significant difference, represented as 2 and 1, for ES and SS anastomosis, respectively (Table, 2). Adhesions only involved the anastomotic area and mesojejunum (Fig., 20).

- 21 days following EE anastomosis, there was neither distention of the bowel proximal to the anastomosis nor anastomotic distortion. The loop appeared normal without gross pathologic changes, especially those operated using four-stay sutured EE ananstomotic technique (Fig., 21). Mucosal surface appeared also grossly normal and tightly sealed without any mucosal ulceration (Fig., 22).

- Mild to detectable impactions and distention in the jejunal loop related to the area of anastomosis were observed in two cases following ES and SS anastomosis (Figs., 23 and 24).

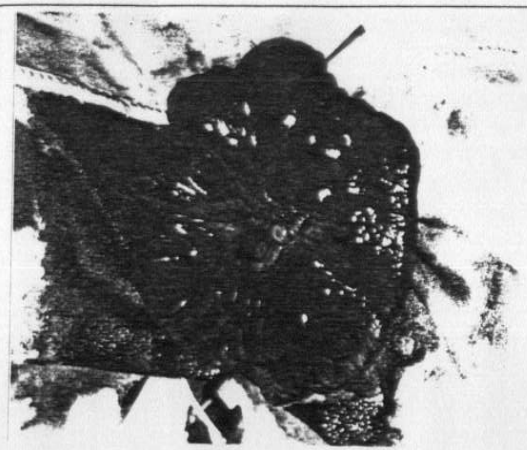

Fig. (18): Showing jejunal impaction (arrow) proximal to the site of SS anastomosis in a goat.

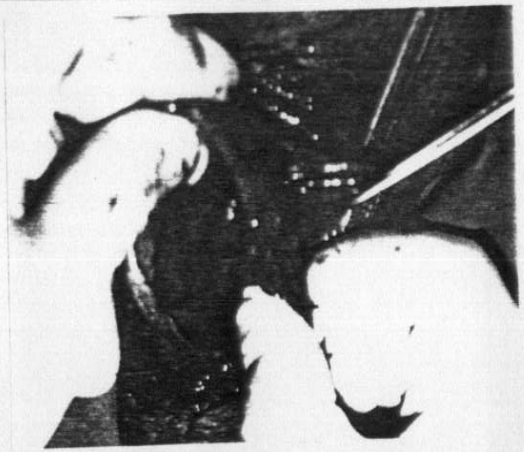

Fig. (19): Showing moderate adhesions involving mesoduodenum and abdominal wall. The anastomosis is palbably thickened.

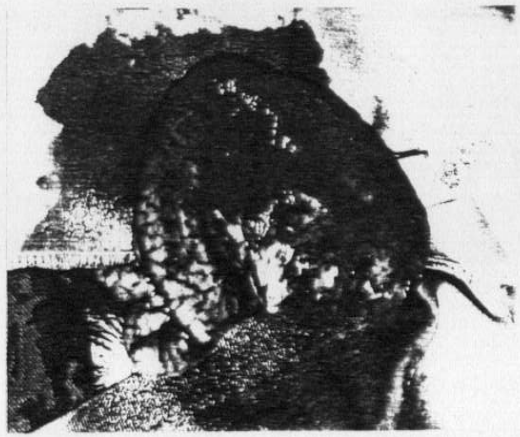

Fig. (20): Showing slight adhesions involving anastomotic area and meso-jejunum (serosal scarring).

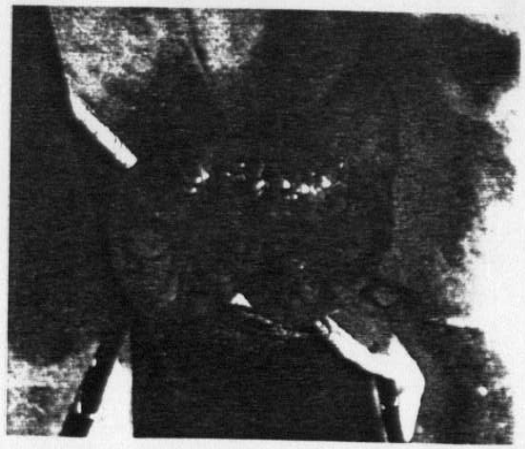

Fig. (21): Showing jejunal segment without gross pathologic changes 21 days following four-stay sutured EE anastomosis in a goat.

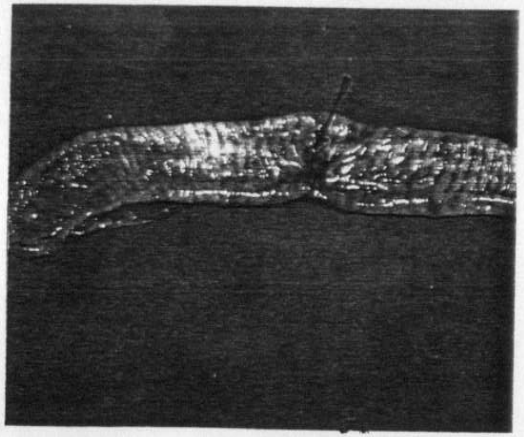

Fig. (22): Showing mucosal surface at necropsy, appeared normal and tightly sealed. Suture material (Prolene) is still present (arrow).

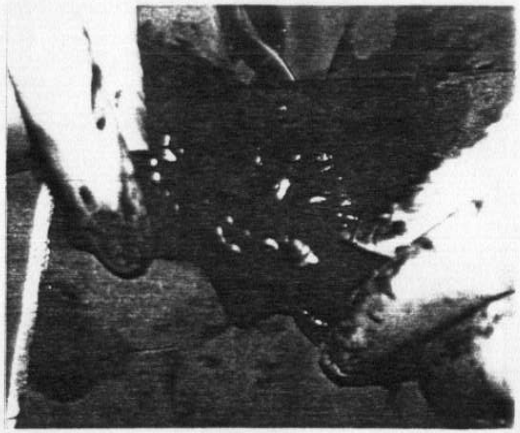

Fig. (23): Showing mild distention and thickening (arrow) following SS jejunual anastomosis in a sheep.

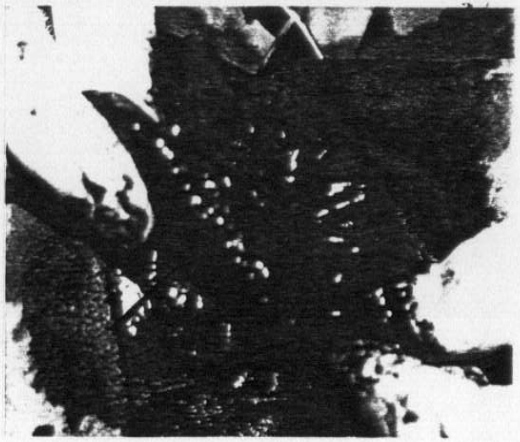

Fig. (24): Showing detectable distention and thickening (arrow) following ES jejunal anastomosis in a goat.

IV.3- Radiographical Findings:

- Contrast enterogram 21 days post operation for EE anastomosis showed no significant difference in the luminal diameter on both sides of the stomal area after four-stay sutured EE anastomotic technique (Fi g, 25). Stomal area appeared normal.

- Following EE anastomosis by Schmieden's suture technique, there was mild dilatation in the upper intestinal loop (Fig, 26).

- Contrast enterogram following SS anastomosis revealed normal loop diameter on both sides of anastomotic area. Stomal area appeared wider than the intestinal lumen (Fig., 27).

- For the bowel subjected to ES anastomosis enterogram revealed narrow stomal area and clear dilatation and distention in the upper intestinal loop (Fig, 28).

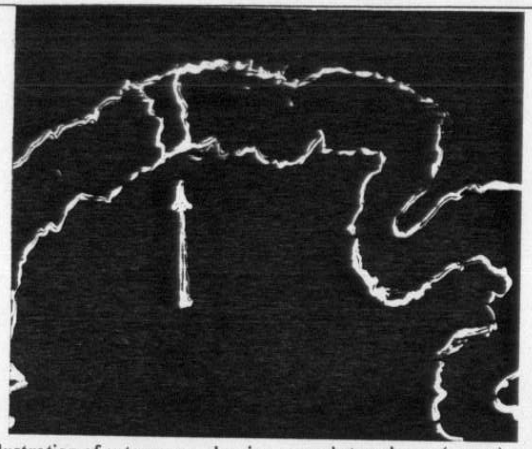

Fig. (25): Illustration of enterogram showing normal stomal area (arrow) and luminal diameter, following four-stay sutures.

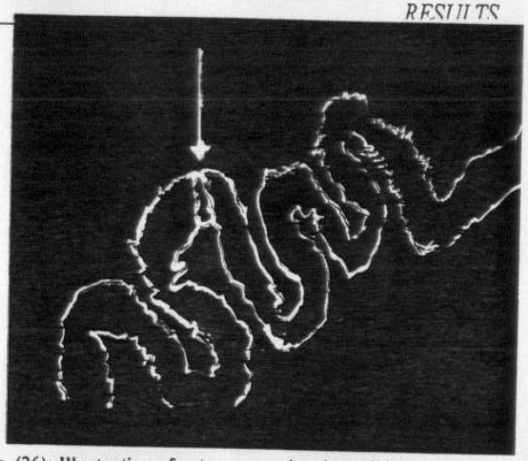

Fig. (26): Illustration of enterogram showing mild dilatation in upper intestinal loop following standard EE technique.

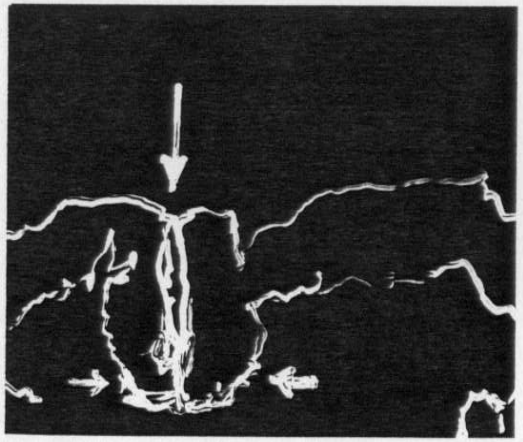

Fig. (27): Illustration of enterogram showing wide stomal area (arrow) with normal lumen diameter following SS technique.

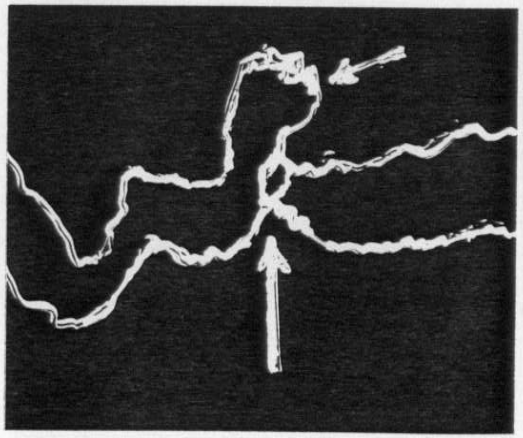

Fig. (28): Illustration of enterogram showing narrow stomal area with clear dilatation in the intestinal loop following ES technique.

IV.4- Histopathological findings:

- No major differences in handling characteristics between Catgut, Prolene and Vicryl were recognized. At postmortem examination, the anastomoses sutured with Prolene appeared to be thickened and the suture material was often clearly visible, whereas, Catgut was usually less obvious.

- In samples collected 3 weeks post operatively, remnants of catgut appeared as homogenous esinophilic strucurless material surrounded by layer of inflammatory cells and C.T. in mature collagen fiber (Figs., 29 & 30). Type of inflammatory cells was mainly macrophages (Fig., 31). Interrupted musculosa with mature collagen fiber were noticed in addition to scattered inflammatory cells throughout the intestinal wall sutured with catgut (Fig., 32).

- Prolene appeared in the submucosa surrounded with massive fibroplasias with intact covering mucosal lining (Fig., 33). Down growth regeneration of intestinal glands within large amount of fibrous tissue in the submucosa was clear in the site of operation (Fig., 34). Following Prolene suturing, intestinal healing was complete characterized by complete healing of mucosa (glands, lamina propria and muscolaris) with somewhat increased fibrous

tissue submucosa (Fig., 35).

- Remnants of Vicryl was present surrounded with intensive chronic inflammatory reaction (Fig., 36). Area of operation showed invasion of the suture material with inflammatory cells, necrosis and sloughing of lining epithelium, massive fibroplasia in submucosa and distructed serosa (Fig., 37).

- Histopathological examination showed also an invagination through intestinal wound in the site of operation, with fibrous tissue around the suture material (Fig. 38).

- Following SS anastomosis , intestine in the site of operation appeared with intact serosa with slight regenerating mucosa and musculosa with invagination inside the intestinal lumen (Fig., 39).

- There was detectable variation in the degree of inflammation between the three suture materials. It was moderate to severe following Catgut (scored as 2-3), slight to severe following Vicryl (1-3) and slight to moderate (1-2) for Prolene (Table, 3).

- Degree of fibrosis was undetectable following Catgut (scored: 0-1), moderate after Vicryl (0-2) and evident following Prolene (2-3) characterized by massive fibroplasia in form of large amount of fibrous tissues in the submucosa (Table, 3).

- Healing of intestinal layers varied between perfect to normal mucosal healing (scores were 0-1) following Prolene, to normal to delayed mucosal healing (scores, 1-2) following Catgut. Necrosis and sloughing of lining epithelium and distructed serosa were evident following Vicryl (Fig., 37 and Table, 3).

Table (2): Showing Surgical Time (Minutes), adhesion scores and pathologic scores following EE, SS and ES techniques.

Technique	Surgical time (Mean ± SD)	Adhesion (Scores)	Pathologic Scores
EE Technique (Standard)	20.33 ± 2.41	1-2	1-2
EE Technique (Four-stay sutured)	22.33 ± 2.88	1-2	1-2
SS Technique	44.0 ± 5.15	1-3	0-2
ES Technique	31.25 ± 2.33	2-3 *	1-3 *

Means within the same column carrying different letters are significantly different ($P < 0.01$).
* Significant disadvantage.

Table (3): Showing average scores for the degree of inflammation, fibrosis and healing following different sutures.

Sutures / Scores	Catgut	Prolene	Vicryl
Inflammation Scores	2-3 **	1-2	1-3
Fibrosis Scores	0-1 *	2-3 **	0-2
Healing Scores	1-2	0-1 *	2-3 **

* Significant advantage. ** Significant disadvantage.

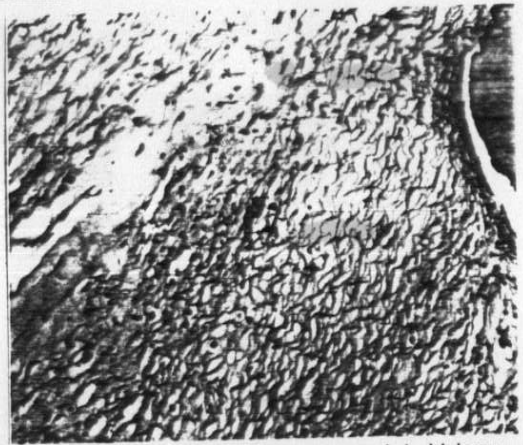

Fig. (29): Showing remnants of Catgut surrounded with large number of inflammatory cells and few C.T. (H & E, 10 X 5).

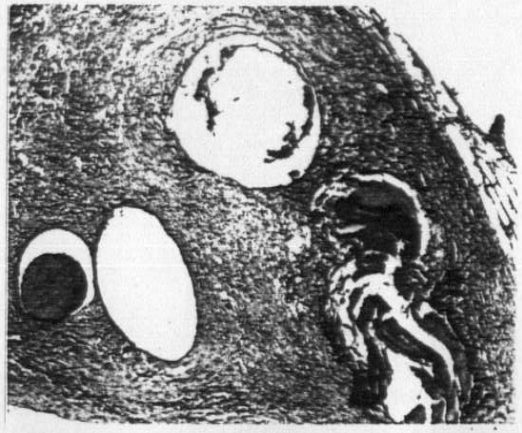

Fig. (30): Showing remnants of Catgut surrounded with numerous inflammatory cells and few C.T. (H & E, 10 X 20).

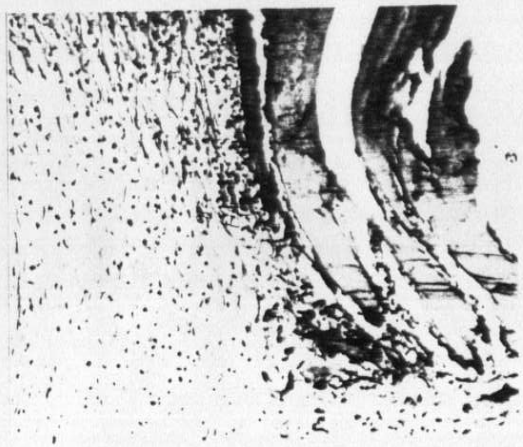

Fig. (31): Showing that the inflammatory cells surrounding Catgut are Macrophages (H & E, 10 X 20).

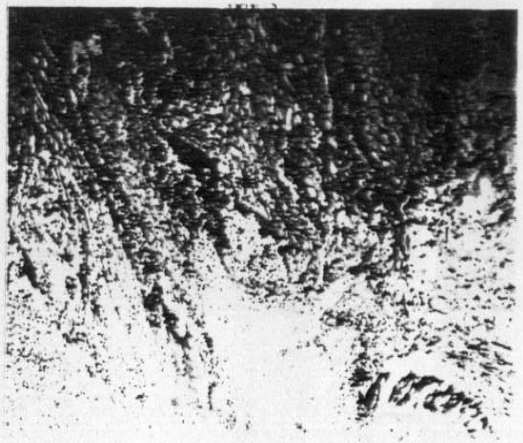

Fig. (32): Showing interrupted musculosa, mature collagen fiber with scattered inflammatory cells (H & E, 10 X 10).

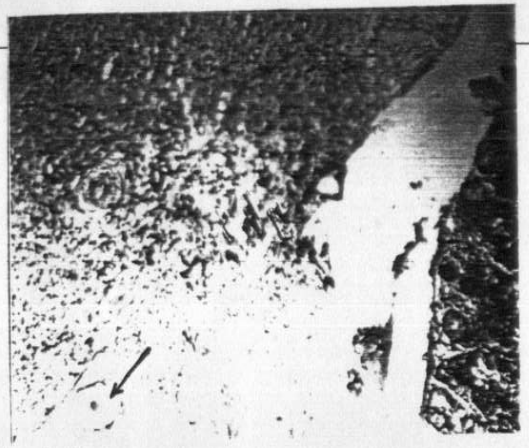

Fig. (33): Showing Prolene in submucosa (arrow) surrounded by massive fibroplasia without covering mucosal linning (H & E, 10 X 10).

Fig. (34): Showing regeneration of intestinal glands within large amount of fibrous tissue in the submucosa (H & E, 10 X 2.5).

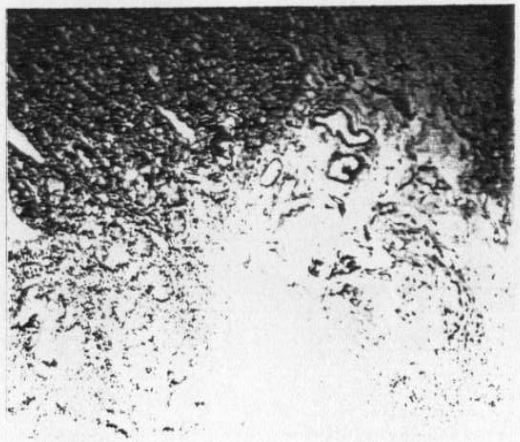

Fig. (35): Showing complete healing of mucosa and its layers with some fibrous tissues in submucosa (H & E, 10 X 10).

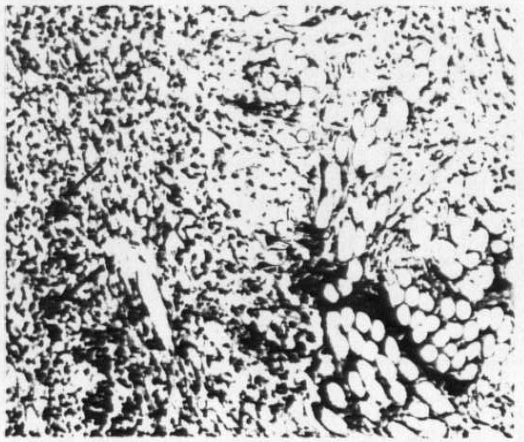

Fig. (36): Showing remnants of Vicryl (arrows) surrounded with intensive chronic inflammatory reactions (H & E, 10X20).

Fig. (37): Showing remnants of Vicryl invaded with inflammatory cells, necrosis and sloughing of epithelium and destructed serosa (H & E, 10 X 2.5).

Fig. (38): Showing an invagination through the intestinal wound with fibrous tissues surround the suture material (H & E, 10 X 2.5).

Fig. (39): Showing intact serosa, slight regenerating mucosa and musculosa with invagination inside the intestinal lumen in the site of SS anastomosis.

DISCUSSION

Intestinal resection and anastomosis is indicated for many intestinal disorders. Two segments of intestine can be successfully re-united by a number of methods and materials. Several experimental techniques have been used, non of them has fulfilled the ideal requirements (***Shnain et al., 1975).*** Controversy exists in the literature over the best technique for apposing two intestinal segments. One versus (VS) two layers closure; absorbable VS non-absorbable suture materials; everting VS inverting appositional techniques; End – to - End, End – to – Side, and Side – to – Side variations; telescoping patterns; and opened VS closed anastomosis has been described ***(Singlton et al., 1968 and Dehoff, 1971).***

In the present study, three techniques for intestinal anastomosis were performed; EE, SS and ES anastomotic techniques to re-unite the two intestinal segments after experimentally induced intestinal resection in Sheep and Goats. The data obtained showed that EE anastomotic technique was superior. Several literatures for describing and evaluating these techniqurs in different animal species are available. These results coincided with that mentioned by

Bojrab (1975) and Redlich et al. (1997). While, ***Fouad et al. (1985); Tate (1987 a); Douglas et al. (1988) and Hofmeyre (1989)*** found that the intestinal diameter differences precluded the use of an EE anastomosis and supported the necessity of using SS technique. That avoids the possibility of post- operative stenosis. On the other hand, ***Beard et al. (1992)*** used the ES technique as a routine fashion.

Significant differences between EE, SS and ES anastomosis were found for some or all of the parameters measured in this study. There was significant difference in the surgical time required for completion of the EE and that required for ES, and high significant difference between these times required for EE and for SS anastomosis. These may be attributed to the increasing of the length of lines in size and suture to create the stoma between the two intestinal segments after their closing specially, after SS technique. These findings do not coincide with these recorded by ***Baxter et al (1992)*** as they found that there was no significant difference in the surgery time between EE and SS technique when they compared the sutured EE and stapled SS technique for equine jujenal anastsomosis.

EE anastomosis by continuous Schmiden's pattern resulted in rapid closer of the intestine and probably represented the fastest EE anastomostic technique. Four-stay sutured EE technique would probably require more time to complete the technique than the continuous Schmieden's pattern, but appeared the most beneficial, as it insured normal structured integrity of the intestinal loop, avoiding kinking of the intestine that predisposes it to obstruction. The same results were confirmed by ***Mueller et al. (1992)*** who obtained a better results following two layers anastomosis using 2 / 0 synthetic monofilament absorbable sutures in a simple continuous pattern in the mucosa followed by a continuous Cushing or Lembert in the seromuscular layer. On the other side, ***Edwareds (1986)*** reported that interrupted patterns such as Lembert, Gambee, and simple interrupted pattern excluding mucosa for EE anastomosis would probably require more time to complete than the continuous patterns. While, ***Richardson et al. (1982)*** found that the non- inverting pattern had a comparatively weaker intestinal strength but a closer return to pre-surgical anatomy. The inverting patterns equaled normal intestine in bursting strength, but maintained a large degree of stenosis it at anastomotic site. They added that adhesions were

minimal and did not grossly interfere with mechanical function of the intestine.

Regarding the gross pathologic changes in the three techniques, it was found that no changes were noticed following EE technique specially those operated using the four- stay sutures. Mucosal surface appeared grossly and pathologically normal and tightly sealed without any ulceration. The loop appeared normal, neither distention of the bowel nor anastomotic distorsion. Based on these findings, the four-stay sutured EE anastomotic technique is an advantageous to the ordinary technique by continuous Schmieden's pattern. These results come in agreement with that of ***Mueller et al. (1992).*** Therefore, performing of these four-stay sutures could be cosidered as a necessary step during performing of the EE anastomosis.

Following some cases of ES and SS anastomosis, there was mild to detectable impaction and distention in the intestinal loop related to the area of anastomosis. ***Baxter et al. (1992)*** who used the ultrasonography to determine the degree of bowel distention following anastomosis obtained the same results.

In the present study, the SS anastomotic technique was relatively superior to the ES technique because of reduced incidence of adhesion with maintenance of adequate lumen diameter. A tendency for the adhesion scores to be slightly higher and the stomal areas slightly smaller and more inflammation were found in the ES anastomosis. These findings simulated those of ***Hofmeyr (1989)*** who advised using of SS anastomosis to avoid the possibility of post-operative stenosis.

Adhesions are not in all instances attributed to the adopted technique. Our findings agreed those of ***Baxter, Broome and Moore (1989)*** who reported that health of the small intestine being anastomosed might be more important than the anastomotic technique used. They added that ischemia of the intestine would predispose the intestine to more sever adhesion formation.

In the present study, the recorded intra-abdominal adhesions and fibrosis were in form of few fibrous tissues involving the serosal surface of the bowel in the area of anastomosis and the mesojujenum. On the other hand, ***Baxter (1989)*** and ***Pascoe and Peterson (1989)*** explained such alterations and attributed the

mesentric and serosal scaring associated with nearly all of the anastomosis probably to tissue manipulation, serosal drying or focal ischemia. They added that mesentric scarring, if severe enough, has the potential to cause distortion and contracture, resulting in kinking of the intestine that predispose it to obstruction.

Among this investigation, contrast radiography was helpful to fulfill all data about the stomal size and degree of dilation proximal or distal to the loop of the intestine in area of anastomosis. Enterogram immediately before necropsy revealed that the EE anastomotic technique applied by the four-stay sutured pattern was superior to the other techniques, because of its negative effect on the structural integrity of the intestinal loop. A clear dilatation of the intestine was detected in the enterogram taken for anastomoses operated by ES technique. Such dilatations could be considered as a sequence of the state and size of the stomal size or diameter in the area of anastomosis. On the other hand, ***Baxter et al. (1992)*** measured the length of anastomotic stoma on radiographs, but their measurement might have underestimated the true reduction in stomal length because of the partial fusion of stomal edges. More accurate

length might be obtained by also performing radiographgy on nondistended anastomosis.

Results of this study showed that the anastomotic stomal area had a very wide range, and significant differences between the surgical techniques were found. Normal stomal area and adequate lumen diameter were maintained following EE anastomotic technique using four-stay sutured pattern. A wide stomal length was obtained following SS anastomosis. Meanwhile, reduced stoma was developed in anastomosis operated by ES technique. The same results were obtained by ***Dean and Robenson (1985) and Baxter et al. (1992)*** who added that many factors could have contributed to the size differences including; the size of the intestine at the anastomotic site, tissue inverted, mesentric and bowel contracture contributing to the kinking of the anastomosis, and the amount of fibrosis and scarring

Using of a piece of Macaron during performing of the EE anastomotic technique was helpful. This piece of Macaron acted as a tube inserted in-between the two intestinal segments facilitating their handling and their appositoning during suturing and also reducing

inversion of large amount of mucosa allowing adequate diameter of the lumen. A similar intervention was carried out by ***Koike (1976)*** who used a decalcified bone tube during performing of the EE anastomosis technique. While, the author concluded that SS anastomosis was superior to the standard EE anastomosis, the EE anastomosis using decalcified bone tube proved most satisfactory in dogs.

Sings of abdominal pain that were detected in two goats on day two and day three post surgery have been related to the anastomosis. Both animals were operated by ES and SS technique. Necropsy showed jujenal impaction proximal to the SS anastomosis. A similar observation was recorded by ***Baxter et al. (1992)*** following EE anastomosis in horses. They attributed their finding to changes in the peristalsis around the EE anastomosis as result of obstruction. They added that the size of the anastomotic stoma is not the only factor contributing to obstruction at anastomosis.

No major differences in handling charecteristics between Catgut, Prolene and Vicryl were recognized. At postmortem examination, the anastomoses sutured with Prolene appeared to be

thickened and the suture material was often clearly visible, whereas, the Catgut was usually less obvious. That finding come in agreement with those of ***Haxton (1965) and Riquelme et al. (1998).***

Histopathological findings revealed that all suture materials used in the present investigation produced tissue reaction. That could be attributed to correlating factor between all sutures that may be the process of suturing itself. The results in the present investigation coincided with those of ***Fouad et al. (1985)*** who found that all sutures produce tissue reaction that lasts at least 5 days. They attributed such effects to the trauma during passing of the needle and suture through the tissue and to the physico-chemical properties of the suture material. In the same time, Kassem (1983) concluded that Catgut produce severe tissue reactions more than silk and nylon in suturing of the hysterotomy wounds in goats.

Presence of remnants of catgut as homogenous esinophilic structureless material may be due to the reaction between the proteineous nature of the suture and the basic part of the stain (Eosin). Presence of layer of inflammatory cells and C.T. is referred to the subject responsible for its engulfing or absorption. A similar

findings were reported by ***AL-Dahash et al.(1990).*** They found that neutrophils are initially the predominant cells, but later, the macrophages and fibroplasts are predominate, while, plasma cells, lymphocytes and giant cells are occasionally seen.

Degree of inflammation associated with catgut was moderate to severe. These results come in agreement with that observed by ***Haxton (1965), Quessada et al. (1987) and AL-Dahash et al. (1990)*** who discussed the influence of suture material on healing and omitted catgut for internal wounds, as it looses its tensile strength rapidly and produces intensive inflammatory reaction in surrounding tissues. While, ***Fouad et al. (1985)*** found that all sutures produce tissue reaction, and catgut produced the greatest reactions. Inflammatory reactions following Vicryl were greater than that observed following Prolene among this experiment. On the contrary, ***Freeman et al. (1987)*** found that Vicryl produced less inflammatory reaction when used for suturing of linea-alba. Also, ***Riquelme et al. (1998)*** added that the inflammatory reactions were least for Vicryl, greater for catgut and Prolene and greatest for silk. They added that the reaction against Prolene was almost as severe as that against silk.

Regarding the scores describing of healing of intestinal layers, it was found that intestinal healing was characterized by complete healing of mucosa with its layers and glands following Prolene suturing. Meanwhile, necrosis and sloughing of lining epithelium was encountered in addition to destructed serosa in area of the intestine sutured with Vicryl. Similar findings were recorded by ***Abdel-Wahed (1993)*** who found that Prolene is most preferable for surgical closure of G.I.T, as it caused good healing and least tissue reactions.

Degree of fibrosis wsa neglected following Catgut, moderate following Vicryl, and severe following Prolene. The same findings were recorded by ***Haxton (1965)*** and ***Fouad et al. (1985)*** who attributed these findings to rapid descentigration and absorption of Catgut Meanwhile, ***Abdel-Wahed (1993)*** found that the fibrous tissue capsule surrounding Prolene as the only tissue reaction. Numerous macrophages were infilterating the capsule trying to phagocyte this foreign suture, but its synthetic nature stands against that.

Based on the previously mentioned, It is possible to conclude that EE anastomotic technique proved to be advantageous for intestinal anstomosis in sheep and goats, and considering the four-stay sutures as a necessary step for performing of this technique. Also prolene (Polypropylene) was the most suitable suture material for intestinal anastomosis in small ruminanats as it offers a satisfactory healing.

SUMMARY AND CONCLUSION

The present experimental study was performed on 54 clinically healthy small ruminant 27 Sheep and 27 Goats of both sex. Animals aged between 9 months to 3 years old, and weighed 10-40 kg. They included two main classes; class I, included 27 sheep and class11, included 27 goats. Each class was divided into three groups. Each group (included 9 animals) was subdivided into three subgroups, 3 animals of each. Animals were prepared for aseptic surgery. All operations were carried out using xylazine HCl as a sedative given by intramuscular rout in a dose rate 0.1 mg/kg body weight associated with 2 % xylocaine HCl in form of line of infiltration at the seat of incision (in the flank or ventral midline). Incision in abdominal wall was done via two approaches; ventral midline celiotomy, or lateral right flank laparotomy. Length of incision was long enough till reach the abdominal cavity. The part of intestine would be resected was pulled into the wound.

- End-to-end (EE), side-to-side (SS), and end-to-side (ES) techniques of intestinal anastomosis were carried out in the first, second, and third group in each class, respectively. 4/0 Catgut, 4/0

Vicryl, and 4/0 Prolene were selected as the suture materials for performance of the anastomosis.

- Two methods were done to perform end-to-end anastomosis. The first was done using the Schmieden's suture pattern to oppose both intestinal ends according to the technique described by **Berge and Westhaus (1966).** A second alternative method was carried using four-stay sutures. It was carried out by creating four stitches in both intestinal ends; two sutures were inserted at the mesentric and antimesentric border of the intestine, and two were inserted at the midpoint of the anterior and posterior aspect of the anastomosis. Completion of anastomosis was performed using one layer of simple continuous pattern between each two stay sutures. A piece of Macaron was inserted in the lumen of both ends during the oppositing. Abdominal wall was then routinely closed.

- Side–to–side anastomosis and End–to-side anastomosis were performed using Schmieden's suture as described by Berge and Westhaues (1966).

- Post– operative care was performed routinely.

- Evaluation of techniques was carried out by comparing the surgical time, postmortem findings, radiographical and histopathological findings for samples collected 21 days postoperation.

- It was found that mean surgical times for EE, SS, and ES anastomotic techniques were 20.33 ± 2.4, 44 ± 5.158, and 31 ± 2.5 minutes, respectively. There was significant difference between surgical times.

- At postmortem examination, no animals had evidence of peritonitis or defects in the abdominal incisions. Intra-abdominal adhesions were not severe.

- 21 days following EE anastomosis ,mucosal surface appeared grossly normal and tightly sealed without any mucosal ulceration.

- Mild to detectable impactions and distention in the jejunal loop related to the area of anastomosis were observed in two cases following ES and SS anastomosis.

- Radiographical examination revealed that the stomal area was wide enough following SS anastomosis and no changes in luminal diameter following EE technique.

- Histopathological examination showed that no major differences in handling characteristics between Catgut, Prolene and Vicryl were recognized. At postmortem examination, the anastomoses sutured with Prolene appeared to be thickened and the suture material was often clearly visible, whereas, Catgut was usually less obvious. Healing of intestinal layers varied between perfect to normal

mucosal healing following Prolene, to normal to delayed mucosal healing following Catgut. Necrosis and sloughing of lining epithelium and distructed serosa were evident following Vicryl.

CONCLUSION

Based on the previously mentioned, It is possible to conclude that EE anastomotic technique proved to be advantageous for intestinal anstomosis in sheep and goats, and considering the four-stay sutures as a necessary step for performing of this technique. Also prolene (Polypropylene) was the most suitable suture material for intestinal anastomosis in small ruminanats as it offered satisfactory healing.

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الملخص العربى

(دراسات مقارنة لطرق توصيل الأمعاء فى المجترات الصغيرة)

- أجريت هذه الدراسة التجريبية على عدد ٥٤ حيواناً من المجترات الصغيرة منها عدد ٢٧ من الأغنام و ٢٧ من الماعز من كلا الجنسين وتراوحت أعمارهم ما بين ٩ شهور إلى ٣ سنوات وأوزانهم ما بين ١٠ إلى ٤٠ كيلوا جرام .

- قسمت الحيوانات الى مجموعتين ٢٧ من الماعز و ٢٧ من الأغنام وقسمت كل مجموعة الى ٣ مجموعات صغيرة كل منها ٩ حيوانات .

- تم تجهيز الحيوانات لأجراء الجراحة تحت تأثير مخدر الزيلازين هيدروكلوريد والذى تم حقنة بالعضل بجرعة قدرها ٠,١ ملجم / كجم من وزن الحيوان مصاحباً بحقن الزيلوكايين ٢% بالحقن الارتشاحى مكان العملية .

- تم فتح بطن الحيوان فى إحدى مكانين . إحداهما فى منطقة الخاصرة اليمنى للحيوان والثانى على الخط الوسطى لجدار البطن السفلى .

- حيث تم تجربة ٣ طرق لتوصيل الأمعاء فى الحيوانات من خلال هذه المجموعات :

الطريقة الأولى : توصيل الأمعاء بخياطة نهاية كل طرق مع الاخر (توصيل طرفى – طرفى) .

الطريقة الثانية : توصيل الأمعاء بخياطة جانبى الأمعاء مع بعض (توصيل جانبى – جانبى) .

الطريقة الثالثة : توصيل الأمعاء بخياطة نهاية طرف مع جانب من الأمعاء (توصيل طرفى – جانبى) .

وتمت عمليات التوصيل فى جميع المجموعات بتجربة ثلاثة أنواع من الخيوط هى : خيط امعاء القط رقم ٠/٤ المعامل بالكروم وفيكريل ٠/٤ وبرولين ٠/٤

- استخدمت طريقتين فى توصيل الأمعاء بطريقة خياطة نهاية كل طرف مع بعض (توصيل طرفى – طرفى) :-

- الطريقة الأولى خياطة طرفى الأمعاء باستخدام طريقة إشميدن . والطريقة الثانية بعمل أربع غرز متقطعة حول الأمعاء وتم تغطيتهم بخياطة بسيطة مستمرة لاتمام عملية التوصيل .

- أما طريقة توصيل الأمعاء بخياطة جانبى الأمعاء (توصيل جانبى – جانبى) وكذلك طريقة توصيل نهاية طرف مع جانب من الأمعاء (توصيل طرفى – جانبى) تمت كما ذكرها بعض المؤلفين فى المراجع العلمية السابقة (Berge and Westhaues, 1966) .

- تم تقييم الطرق المختلفة لتوصيل الأمعاء من حيث تحديد الوقت الذى تمت فيه إجراء العملية والصفة التشريحية والصور الاشعاعية والتغيرات الهستوباثولوجية فى العينات التى تم جمعها من الجزء الذى تم توصيله فى الأمعاء بعد ٢١ يوم .

- وقد وجد أن الوقت اللازم لإجراء العملية الجراحية لتوصيل نهاية طرفى الأمعاء ببعض كانت حوالى ٢٠ دقيقة وتوصيل جانبى الأمعاء بعد فتحهما حوالى ٤٤ دقيقة وتوصيل نهاية طرف من الأمعاء بأحد الجوانب كانت ٣١ دقيقة وهناك اختلاف متباين فى الوقت المستخدم فى كل طريقة .

- بالفحص العينى وإجراء الصفة التشريحية وجد أنه لا توجد أى مظاهر من التهابات البريتون أو أى خلل فى التئام جدار البطن وكذلك لا توجد التصاقات كبيرة داخل البطن مع الأمعاء فى كل المجموعات .

- بعد ٢١ يوم من عملية توصيل طرفى الأمعاء مع بعض وجد أن الغشاء المخاطى المبطن للأمعاء طبيعى جداً بدون أى قرح او تغيرات باثولوجية .

- وقد أظهر الفحص وجود حالتين بهما أتساع بمكان التوصيل فى حالات توصيل طرف من الأمعاء مع جانب منه وكذلك فى التوصيل بخياطة جانبى الأمعاء .

- لكن بالفحص العينى وإجراء الصفة التشريحية وجد أن خيط البرولين ظاهر مكان التوصيل بينما خيط أمعاء القط أختفى تماماً .

- أما الفحص الهستوباثولوجى فقد اظهر أن استخدام خيط البرولين فى عمليات توصيل الأمعاء أفضل من استخدام خيط أمعاء القط حيث وجد أن الأول يسرع من عملية الالتئام بينما ظهرت بعض الحالات بها تآكل وانفصال فى الغشاء المخاطى المبطن للأمعاء مكان التوصيل عند استخدام خيوط الفيكريل .

الخلاصة والتوصيات

- مما سبق يتضح أن طريقة توصيل الأمعاء في الأغنام والماعز باستخدام الطريقة الأولى (توصيل طرفى – طرفى) هى أفضل الطرق وخاصة الطريقة المبتكرة والحديثة وهى خياطة الأمعاء على الجوانب بأربعة غرز جراحية ثم تغطيتها بالخياطة البسيطة المستمرة وهذه الطريقة أدت الى أفضل النتائج من حيث عدم أحداث ضيق فى تجويف الأمعاء وكذلك عدم حدوث اتساعات او أى تغيرات فى الجدار المبطن للأمعاء .
- وقد وجد أيضاً أن استخدام خيط البرولين فى توصيل الأمعاء يعطى نتائج جيدة فى قدرة جدار الأمعاء على الالتئام ولا ينتج عن استخدامه أى تغيرات باثولوجية فى الغشاء المخاطى المبطن للأمعاء .
- نوصى بالاعتماد على فتح البطن من خلال الخط الوسطى لجدار البطن السفلى(كان أنسب الأماكن للوصول لأى جزء من الأمعاء).
- كما نوصى باستخدام طريقة التوصيل الطرفى (توصيل طرفى – طرفى) مع جعل الأربعة غرز خطوة أساسية وكذلك استخدام البرولين كخيط جراحى.

تحت إشراف

الأستاذ الدكتور / أحمد عبد المنعم قناوي

أستاذ الجراحة و التخدير و الأشعة

كلية الطب البيطري

جامعة الاسكندر يه

و

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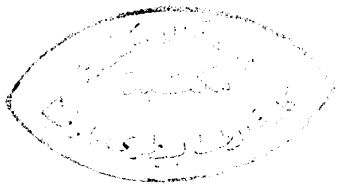
جامعة الاسكندر يه



دراسات مقارنه لطرق توصيل الأمعاء في المجترات الصغيرة

رسالة مقدمة من

ط.ب / مفيد يوسف أحمد إسماعيل

(بكالوريوس العلوم الطبية البيطرية – جامعة طنطا ١٩٩٥)

للحصول علي درجة الماجستير في العلوم الطبية البيطرية

(جراحـــــــــة)

مقدمة إلى

قسم الجراحـــــــة

كلـــــية الطب البيـــــطري

جامعة الاسكندر يه

(٢٠٠٤)