# Entero-anastomosis by Different Invagination Techniques in Buffalo Calves – An Experimental Study

**Thesis**

**Submitted to the Faculty of Veterinary Science**

RAJENDRA AGRICULTURAL UNIVERSITY, BIHAR

**in Partial Fulfilment of the Requirements**

FOR THE DEGREE OF

**Master of Science**

(VETERINARY)

By

*Satyendra Kumar*

B. V. Sc. & A. H.

Junior Research Fellow, R. A. U., Bihar

**Post-Graduate Department of Surgery**

BIHAR VETERINARY COLLEGE

PATNA

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**P A T N A,**

Dated, the 5th June, 1975.

This is to certify that the work embodied in this Thesis entitled "ENTERO-ANASTOMOSIS BY DIFFERENT INVAGINATION TECHNIQUES IN BUFFALO CALVES -- AN EXPERIMENTAL STUDY" is the bonafide work of Dr. Satyendra Kumar and was carried out under my guidance and supervision.

A. Khan

( A.A. KHAN ).

# C E R T I F I C A T E

Certified that the research work incorporated in this Thesis has not been published in part or in full in any other journal.

Satyendra Kumar.

( SATYENDRA KUMAR ).

DEDICATED TO
MY
TEACHERS AND PARENTS

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Lastly, the author expresses his gratefulness to his well wishers for their good wishes.

( S. K. )

# C O N T E N T S



Number of Tables - 9

Number of Fig. - 16

Number of Diag. - 1

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## ABBREVIATION AND SYMBOLS FREQUENTLY USED.

| | | |
|---|---|---|
| cm. | - | Centimetre. |
| C.D. | - | Critical difference. |
| D.F. | - | Degree of Freedom. |
| *et al.* | - | And others. |
| Fig. | - | Figure. |
| Gm | - | Gramme. |
| KG | - | Kilogramme. |
| ml | - | Millilitre. |
| No. or no. | - | Number. |
| P. | - | Probability. |
| S.D. | - | Standard Deviation. |
| S.E. | - | Standard Error. |
| S.S. | - | Sum of Square. |
| % | - | Per cent. |
| °F | - | Degree Fahrenheit. |
| = | - | Is equal to. |

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# INTRODUCTION

# INTRODUCTION

Development of the intestinal surgery is much fascinating in the history of medicine. Since the advent of intestinal surgery, it has been the dream of surgeons to resect and re-establish the continuity of the gut with perfect anatomical and physiological competence. Innumerable techniques have been advised and mastered but none have attained the status of being ideal. The methods and techniques of anastomosis have varied concomitantly with the changes in the aim of surgery.

It was Traverse (1812) who demonstrated for the first time that it was feasible to obtain primary closure of intestinal wounds by sutures.

In course of treatment, the intestinal maladies requiring resection and anastomosis very often reported are intussusception, strangulation, volvulus, benign and malignant neoplasms, foreign body impaction, enterolith, mesenteric embolism, ileus etc., and rarely accidental trauma and post-operative selfmutilation of the intestine. Recent research on versatility of intestinal pedicle graft for repair of defects in various organs, has further stressed the importance and need of a safe and reliable technique for entero-anastomosis.

The search for the ideal has inevitably resulted in multiplicity of methods for entero-anastomosis. However, with

the passage of time and exponential growth of knowledge of different techniques, the end-to-end entero-anastomosis has met with much favour. But during the past decade several controvercial comments came into light, like problems of narrowing at the anastomotic site, excess time requirement, adhesion formations, anastomotic failure, leakage and death, poor healing at the anastomotic site etc.

Many research works have been conducted to solve these problems in different parts of the world, specially in canines but scanty informations are available of this work being carried out anywhere in bovine.

In the present work efforts have been made to study the same problems in buffalo calves by applying two different techniques of entero-anastomosis after invaginating the proximal part into the distal part with and without removal of the mucosa from the distal part, so as to make a comparative evaluation regarding superiority over each other in terms of physiological, mechanical and histopathological aspects.

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# REVIEW OF LITERATURE

## REVIEW OF LITERATURE

Towards the end of the 14th century Lanfrank had described the treatment of intestinal wounds in his memorable treaties "Science of Cirurgie". His ancient technique survived unquestioned for more than four centuries till the famous monograph of Traverse (1812) — 'An enquiry into the process of nature in repairing injuries of the intestine' — was published. Traverse made a series of experiments on horses and dogs, and was the first to suggest that it was feasible to obtain primary closure of intestinal wounds by sutures. He believed that the healing of such wounds was by agglutination of the visceral peritoneum at the edges of the wound in intestine to the parietal peritoneum of the adjacent viscera.

Jobert (1820) described the interrupted through and through inverting sutures. It was later supported by the work of Bichat (1825), who observed a greater degree of adhesions in the serosa to serosa apposition as compared to the mucosa to mucosa apposition. In those days, adhesions were thought to be requisite for adequate healing of intestinal wounds.

Lambert (1826) introduced the seromuscular sutures which later acquired the name of "Lambert Sutures". He established that intestinal wounds heal by adhesion of the inverted peritoneal coats and not by reciprocal healing of adjacent cut

edges.

Halsted (1887) disproved the beliefs of earlier workers. He demonstrated that the true holding layer was the submucosa, not the serosa while anastomosing the intestine to ensure strength.

Murphy (1892) invented the 'Button' which automatically united all coats of the intestine and held them in position.

Parker and Kerr (1907) introduced the 'Basting Stitch' technique. They described it as a method that was aseptic, practical and applicable to all forms of anastomoses. Asepsis was obtained by temporarily closing the cut edges of the intestine and by continuous cushing sutures which were removed on completion of the anastomosis.

Kerr (1923) presented a paper on development of intestinal surgery and put forward the following conclusions which remained as guide line for years to come :

'(i) Intestinal wounds heal, not by reciprocal healing of adjacent cut edges, but by adhesions of the inverted peritoneal coats.

(ii) Each bite of the suture should be securely anchored in the fibrous coats thus necessitating only one suture.

(iii) All openings of the intestine, whether perforations or anastomoses, should be closed transversely by a continuous suture.

(iv) Ideal aseptic intestinal resection is readily

performed by the 'Basting Stitch' method.

(v) The method is applicable to all forms of anastomoses of the viscera covered by peritoneum".

Extensive works were done to compare the efficacy of everted and inverted intestinal anastomosis by Healey et al. (1967), Hamilton (1967), Loeb (1967), Buyers and Meier (1968), Olsen et al. (1968), Singleton et al. (1968), Mellish et al. (1968) and Kumar et al. (1973).

Getzen et al. (1964, 1966), Getzen (1966, 1969) advocated the use of eversion technique of end-to-end entero-anastomosis than inverting one.

At the same time several workers like Lamis et al. (1968), Gill et al. (1969), McAdam et al. (1968), Abramowitz and McAlister (1969), Trueblood et al. (1969), Hear and Cohn (1970) and McAdam et al. (1970) gave their verdict against everted intestinal anastomosis.

Weilbaecher et al. (1964) described non-suture intestinal anastomosis using adhesive monomer, Methyl 2-Cyanoacrylate (Eastman, 910). Further they concluded that there was no significant reduction in time for performing such anastomosis as compared with conventional suture technique and did not consider the glue technique superior to the suture method of anastomosis.

The problems of narrowing of the intestinal loop, time consumption, leakage, dehiscence or adhesions at the anastomotic site were never solved by any of the above mentioned

techniques.

It is obvious, however, that most of these deviations from the time honoured procedure were met with controversy or doubt.

The invagination technique is one such method that has been successfully used but never widely acclaimed.

Sonnenberg in the last decade of 19th century, was the first man to use this technique for ileo-colic anastomosis as reported by Moore and Forrest-Hamilton (1953). Maylard (1913) practiced same technique, though he was unaware of Sonnenberg's discovery. In their practice, ileum was invaginated into a longitudinal incision in the colon.

Goepel (1927) successfully used this technique for entero-anastomosis in 1923.

Babcock (1926) described 10 partial gastrectomies by means of telescopic anastomosis in which duodenum was turned into the open end of the gastric stump. He advocated this technique, as the opening of the stomach is always bigger than that of the size of the intestine, therefore, this proved a better method over conventional end-to-end anastomosis.

After a lapse of twenty years, Pringle (1945) an army surgeon practiced the same invagination technique. He concluded that this method was easy to perform and at the same time leakage at the mesenteric angle was impossible. There was less resistance to normal peristaltic movements along the gut in comparison

to conventional technique.

In case of large bowel anastomosis, Prioleau (1950) and Ferrara (1966) used invagination technique for rectosigmoid anastomoses. Although they got success, but cautioned against rectosigmoid invagination, except in the presence of dense scar tissue resulting from chronic inflammation in the rectal stump.

Kimbarovskij (1951) described a method in which 4-5 cm. of small intestine was introduced into the lumen of colon in an attempt to reproduce the equivalent of an ileo-caecal valve.

McCaughan (1955) successfully performed experimental axial enteroenterostomy in 11 dogs. After preparing cuffs, denuded proximally of the seromuscular layer and distally of the mucosal layer, he telescoped the ends of the intestines and united them by a continuous stitch. He concluded that this was a simple, safe and rapid method of anastomosis.

Shrum et al. (1965) investigated the fate of the telescoped segment of ileum in ileocolostomies in 20 dogs. A segment from the ileo-colic junction was later excised for gross and microscopic examination, thus the continuity was re-established by the same experimental procedure. They found that the segments were decreased in size and eventually covered by ileal mucosa. They concluded that the experimental method was superior to the conventional end-to-end procedure. Later they employed this method on 13 human patients.

Frier (1966) practiced this entero-anastomosis by invagination technique for 8 years without any adverse effect. He found that this method of anastomosis permitted rapid and leak-proof closure of the segments. He invaginated half an inch of the proximal intestinal loop into the distal one with the help of mattress sutures. Then, simple interrupted sutures employing 2/0 vetafil (Bengin) were used to join both the intestinal wall without penetrating the intestinal lumen around the entire periphery of the anastomotic juncture and lastly the mattress sutures were removed.

Linn et al. (1966) performed invagination and gluing method of end-to-end anastomosis of small and large intestines on dogs and compared it with that of conventional suture anastomosis. The method of invagination and gluing comprised of : -

(i) Dissection of the extraluminal fat and vessels from the terminal inch of the proximal bowel.

(ii) Dissection of the mucosal lining from the terminal inch of the distal bowel.

(iii) Application of temporary stay sutures to invaginate the proximal bowel into the lumen of the distal bowel.

(iv) Application of surgical adhesives (methyl 2-cyanoacrylate) between the overlapping bowel edges and cut edges of the mesentary; and

(v) removal of stay sutures.

They concluded that there was no significant difference

in bowel function between the experimental and conventional suture. There was less time consumption in invagination and gluing procedure than conventional method and single technical failure was 40 per cent stricture in invagination and gluing method. Microscopically, in conventional method where suture material was used, they observed that sutured anastomosis had marked to moderate degree of inflammation and continuity of the mucosa was not completely restored; whereas the invagination and gluing anastomosis were free of inflammation in half of the cases and exhibited complete continuity in 75 per cent cases.

Grier (1968) experimented three different invagination techniques of entero-anastomosis in 22 dogs, as detailed below:-

In Group I - by dissecting the mucosa about 2 cm. up the distal segment, with proximal segment left intact.

In Group II - by resecting the muscularis externa of the proximal segment and dissecting the mucosa of the distal segment; and

In Group III - only the muscularis externa of the proximal segment was resected.

In all these three groups the proximal segment was drawn into the distal one by the help of 2 or 3 mattress sutures of 4-0 chromic catgut which were left in place, in case of Group III, the invagination of the proximal loop was kept somewhat deeper.

He further concluded that the method employed in Group II was best in comparison of Group I and III, though danger of leakage was greater in that group due to lack of tissue integrity at the apposed ends. He cautioned at the same time that until and unless a consistent and rapid method for total dissection of the distal segmental mucosa is achieved, these invagination techniques are not unequivocally recommended over conventional anastomosis.

Linn et al. (1968) studied forty eight intestinal procedures in 24 dogs. These were equally divided into : -

(A) Control end-to-end procedures.

(B) Invagination with mucosal dissection.

(C) Invagination without mucosal dissection.

They analysed the data on these groups by comparison of clinical function, gross and microscopic appearances and operative speed. A significant finding was noticed that the invagination anastomoses were always performed two to three times faster than the end-to-end procedures. They observed a death in Group C, and suggested that this technique requires more experimental study. On the other hand, invagination with mucosal dissection always compares favourably in function and appearance to the control procedures. They recommended careful clinical trials of the invagination procedure with mucosal dissection, especially where operative speed is considered to be a critical factor for the patient.

Singleton et al. (1968) reported that an overlapping technique was superior to either eversion or inversion for end-to-end anastomosis, provided the proximal segment was not much larger than the distal. They observed that the overlapping caused a stronger union with less narrowing of the lumen than inversion.

Prasad and Ahmed (1972) studied in canine, the non-suture intestinal anastomosis by invaginating the proximal segment of the intestine into the 2.5 cm. mucosal dissected distal loop of intestine, by help of two stay sutures, which were removed after suturing the cut mesenteric border of the corresponding segment of the intestine. The intestinal edges were left without stitches. They reported that this method was superior to Parker-Kerr technique in terms of gross, histological and operative time consumption.

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# MATERIALS AND METHODS

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## MATERIALS

### SELECTION OF THE EXPERIMENTAL ANIMALS.

Eighteen apparently healthy male buffalo calves aged about one and half to two years, weighing between 80 to 110 KGs. were selected for the present study. The experimental animals were procured at different intervals and kept under close observation for a period of one week to check up their health. Pulse, respiration and temperature were recorded during this period. The animals were kept under similar environment and diet after the selection.

### SUTURING MATERIALS.

The following suturing materials were used in all the animals :

(1) Ethicon black braided silk 3/0 - for intestinal anastomosis.

(2) Hanks ligature silk - for ligating the blood vessels and closing the abdominal wall and skin.

DESIGN OF EXPERIMENT.

The present study was conducted on a total number of eighteen experimental animals. All the animals were placed into two different groups (A and B), by random selection, consisting of nine animals in each group.

In Group A, entero-anastomosis (jejunal portion of small intestine), after invaginating the proximal part into distal part, was performed without removal of the mucosal lining of the distal part and in Group B, after removal of 2.5 cm.of the mucosal lining of the descending part. Black braided silk No. 3/0, was used as suture material in entero-anastomosis.The temperature, pulse and respiration were recorded pre and post-operatively for a week.

The operated animals were kept on liquid and soft diet like linseed cake, rice-gruel, partly on green berseem for four days. The operated animals were kept on observation for a period of 7, 21 and 42 days respectively for any clinical change. Then they were euthanised and materials were collected for gross, radiological and histopathological studies.

## M E T H O D S

(A) METHODS OF STUDY USED.

Entero-anastomoses were studied by the following parameters :

(1) Time required for performing the particular anastomosis and whole operative procedure : - Time required for each anastomosis and for whole of the operative procedure were recorded.

(2) Clinical assessment of the return of physiological functions : - Post-operatively the calves were kept under close observation. Any diarrhoea or distension of the abdomen was noted. The time of acceptance of first diet was recorded. The bowel movement was assessed from the passage of the first faeces.

(3) Anastomotic failure, leakage and mortality : - Careful watch was kept for features of intestinal obstruction, anastomotic leakage and peritonitis.

(4) Assessment of adhesion found : - After euthanising the animal, the peritoneal cavity was opened and an attempt was made to deliver out the anastomotic sites and the amount of adhesions was assessed according to the following grades :

Grade 0 : Complete absence of adhesions.

Grade 1(+): Single thin and easily separable adhesions.

Grade 2(++) : Two to three stands of omental adhesions.

Grade 3(+++): Numerous extensive dense visceral adhesions with no viscero-parietal adhesions.

Grade 4(++++): Numerous extensive adhesions involving adjacent mesentry, intestines and omentum with dense viscero-parietal adhesions.

In both grades 3 and 4, there was difficulty in delivering the viscera from the peritoneal cavity.

Nature of adhesions : - The nature of adhesions was also noted and classified as omental, visceral, parietal and viscero-parietal.

(5) Degree of stenosis and size of the effective lumen : - To assess the degree of stenosis qualitatively, a radiological technique was used. The intestinal loop containing the anastomotic site was resected out. One end was tied with thread and through the other end a polythene tube was fixed. With the help of a syringe 15 per cent Barium sulfate solution was injected through the polythene tube till the intestinal segment was distended. Radiographs of the dye filled segments were taken in one plane only.

For an accurate measurement the segment of intestine was then slit open along the antimesentric border. Diameters of the gut were measured with the help of a sliding caliper :

(i) at the anastomotic site (A)

(ii) 3 cm. proximal to the nastomotic site (B)

(iii) 3 cm. distal to the anastomotic site (C).

From the measurement the index of stenosis and the percentage of reduction in the lumen was calculated by the following formula :

$$\text{Index of stenosis} = 100 \times \left(1 - \frac{2A}{B+C}\right)$$

(6) Histopathological study : - A piece of tissue from each anastomotic site was taken out and paraffin blocks of these tissues were made by standard technique. Sections through the junctions of the proximal and distal segments were made and slides were stained with standard technique (H & E) and mounted. Then the slides were examined under microscope for histopathological changes.

(B) PREPARATION OF EXPERIMENTAL ANIMAL A DAY BEFORE OPERATION.

The animal was selected at random on the previous day of operation. The right flank of the animal was clipped, shaved and washed thoroughly with carbolic soap 5 per cent and water. The shaved area was disinfected with savlon lotion (I.C.I.), sponge-dried and swabbed with spt. mercurochrome. The animal was fasted for twenty four hours and only water was allowed to drink. It was then separated to a clean dry stall.

(C) PREPARATION ON THE OPERATION DAY.

The operation was carried out in the morning to get maximum time for observation during the rest of the day.

(i) Preparation of the animals :

The temperature, pulse and respiration were recorded. Prior to operation the shaved area was thoroughly scrubbed with

soap and water, again sponge-dried and finally swabbed with spt. mercurochrome 1 per cent.

(ii) Sterilization :

The instruments, drapes, gauzes, silk thread and other appliances were sterilized in autoclave at 130°C temperature, & 15 lb/sq inch pressure for 30 minutes. B.P. blades were sterilized with savlon lotion (I.C.I.).

(iii) Anaesthesia :

(a) Narcosis : Chloral hydras in the doses of 4 Gm/ 50 KG body weight was used as sedative and the animals were drenched at least half an hour prior to the operation.

(b) Local infiltration anaesthesia : On all the eighteen experimental animals laparotomies were performed under deep linear infiltration anaesthesia, which was achieved simply by infiltration of subcutaneous tissue, muscles tissue and the peritoneum with a 2 per cent solution of Procain hydrochloride on the proposed line of incision.

(D) OPERATION.

The animal was restrained in left lateral recumbency. Then, the right flank laparotomy was performed in usual manner taking all aseptic measures.

(i) Withdrawal of the jejunum :

The omentum was pushed aside to expose the intestinal loops. A loop of intestine was exteriorised and kept on sterile towel. The direction of intestinal loop was detected by following methods :

(1) By peristaltic movement :

The peristaltic movement starts right from the anterior part of the alimentary canal and goes towards the rectum. It was detected by its slow wavy motion.

(2) By mesenteric arteries :

A segment of the intestine was elevated closest to the animals head and the fingers were slit along the mesenteric arteries towards mesenteric roots. When the arteries remained untwisted, the portion of the intestine was being held as proximal.

(3) By locating the caecum :

When the upper mentioned methods were not confirming the proximal and distal parts, the caecum was taken out and by its help the confirmation of the same was made.

Subsequently, the jejunum was detected because of its irregular, constricted and dilated parts and also after grasping between the fingers where circular folds could be felt throughout the wall of the gut. After this the terminal portion of the

jejunum was brought out of the laparotomy wound. A 30 cm. loop of jejunum was retained outside for resection and anastomosis, and the rest were packed off with sterilized towels.

(ii) Intestinal resection :

In each technique, only 10 cm. of the jejunum was to be resected out. At first, the blood supply to the section of jejunum to be resected was shut off by ligation. Collateral branches of the blood vessels of the mesentery were also ligated close to the intestine. At proximal end of the segment of jejunum to be removed, a rubber shod Doyan clamp was applied and the intestinal content was milked out by help of thumb and index finger. Then 20 cm. away from the first clamp the other rubber shod Doyan clamp was fixed. Then the intestine was resected with scalpel between the two clamps after leaving 5 cm. portion of the intestine on each. end. The section of intestine along with 'V' shaped mesentery and blood vessels, was removed. The bowel ends were cleaned and the intraluminal content was sponged out.

The scalpel and scissors used for intestinal resection were discarded before proceeding further.

TECHNIQUE OF ANASTOMOSIS AFTER INVAGINATION.

GROUP A - Without Mucosal Dissection :

After bowel resection, the extra luminal vessels and

removed and the anastomosed bowel was placed gently in the abdominal cavity.

GROUP B - With Mucosal Dissection :

The intestine was resected as in Group A. About 2.5 cm. of the mucosal lining of the distal segment was dissected out bluntly with the help of sterilized gauze (Fig. 4). The extraluminal fat and vessels were also dissected away from the terminal portion of the bowel to be invaginated as in previous group. Three stay sutures were used to pull the proximal end into the distal end of the bowel. Suturing of the incised mesentery and of the transected intestinal parts were made similarly as in Group A. Lastly, all the three stay sutures were cut short and removed.

Closing of the abdominal wall :

The abdominal packs were removed and the abdominal cavity was flushed with warm saline solution. It was mopped off clearly with sterile cloth and Terramycin liquid (Topical) was applied over the operated viscera. After replacing the intestine in its normal position, the abdomen was closed in the usual manner, using silk as suturing material. Terramycin liquid was again applied over the suture line and a protective pad of sterile gauze piece was applied to avoid contamination. The pad was fixed with the help of adhesive tape. The surrounding area was properly cleaned. The animal was then ambulated in a byre

and allowed complete rest.

Post-operative care and management :

The animals were kept in a clean and dry byre. 10 lacs unit of Procain Penicillin (Squibb) was injected intramuscularly for three days after operation. In a few cases abdominal pain was manifested by the animals after operation and in such condition 5 ml of Novalgin (Hoechst) was injected intramuscularly. These animals were maintained mainly on rice gruel, linseed cake for the first two days post-operatively. For the next two days, the animals were fed with berseem grass and by 5th day onward they were allowed to graze in the field.

The temperature, pulse and respiration were recorded daily in the morning and evening for one week post-operatively (Table 1). The skin sutures were removed on the 8th day of operation and Terramycin skin ointment (Pfizer) was applied over the suture line. The animals were kept under close watch during the observation period until euthanised at different intervals. The routine check for any systemic change or reaction was kept and attended accordingly.

Euthanesia of the animals :

The experimental animals were euthanised at 7, 21, and 42 days interval, post-operatively in each group by intravenous administration of saturated solution of Magnesium sulfate.

Autopsy was conducted to detect any gross lesion in and around the anastomotic site of the intestine. Then, the intestine 10 cm. proximal and 10 cm. distal to the anastomotic site was resected off and kept in 10 per cent formaline solution for further gross, radiological and histopathological examinations.

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# OBSERVATIONS AND RESULTS

## OBSERVATIONS AND RESULTS

Entero-anastomosis by two different invagination techniques were studied in eighteen buffalo calves, with particular reference to their operative time, clinical function, macroscopic, radiographic and microscopic appearances. The time consumed for whole of the operative procedure and for particular anastomosis were recorded.

The clinical function of the anastomosis included bowel function, defecation and mortality. The macroscopic observations remained confined to adhesion, stricture, dilatations, thickening and obstruction of the lumen resulting from adhesions. The radiological examination was done only for stenosis at the anastomotic site. The microscopic examination included histopathological changes found at the site of anastomosis.

### G R O U P - A

In this group of animals entero-anastomosis was performed after invaginating the proximal segment into distal one without removal of mucosal lining of the distal segment. All the nine operated animals survived well.

CLINICAL MANIFESTATIONS.

On average, the entire operative procedure took about 144.33 ± 3.64 minutes, whereas the anastomosis alone took 15.78 ± 1.09 minutes (Table - II).

On the day after operation the animal showed dullness and subnormal temperature. On the second day following surgery the calf Nos. 1 and 4 manifested abdominal pain, arched back, kicking on the abdomen, anxious expression and restlessness, which were absent in rest of the animals. These symptoms were combated by intramuscular injection of Novalgin. There was slight rise in temperature from second post-operative day which continued for 2-3 days (Table - IA). They also exhibited accelerated pulse for 3-4 days, which normalized in due course. However, there was no marked change in respiration. The animals of this group in general accepted their first diet on the same evening of operation except calf Nos. 1, 4 and 8 which accepted first diet on the following morning (Table - III). The calf Nos. 2, 3, 7 and 9 defecated 2 days after operation, whereas the calf Nos. 1, 4, 5, 6 and 8 defecated after 3 days. The first defecations in all the cases were hard, black and shining in colour and thereafter the stool became normal (Table - III). In calf Nos. 1 and 4, an enema of soap-water was administered to help evacuate the stool and thus the restlessness of the animal was relieved. All the animals were found ruminating and defecating normally after three days of operation. Local incisional line

on the abdominal region showed primary healing in almost all animals and therefore the sutures were removed on 8th post-operative day, except from those animals which were euthanised on the 7th post-operative day as per schedule. Other animals were euthanised at 21 and 42 days interval to detect and evaluate the macroscopic, radiologic and microscopic changes at the site of anastomoses.

MACROSCOPIC AND RADIOLOGIC OBSERVATIONS.

At necropsy, soft tissues adhesions were found around the anastomotic site as well as on the surrounding visceras in almost all the cases. The adhesions of varying degree were graded and tabulated accordingly (Table - IVA. No leakage was found in any case. Segments of intestine including the anastomosed part were resected out and radiographed as described in materials and methods. Radiographs of the dye-filled segment of intestine gave an insight of the patency of the lumen. Radiograph taken after 7th post-operative day indicated marked stenosis at the site of anastomosis. Subsequent radiograph taken after 21 days exhibited comparative diminition in the degree of stenosis. Final radiographs taken after 42 days demonstrated that the anastomosed intestine had assumed an almost normal lumen.

Measuring of the anastomotic site and its comparison with the corresponding ascending and descending part of the

intestine by a sliding caliper gave an accurate idea of the degree of stenosis and size of the effective lumen at the site in question. Some degree of stenosis was present at the site of anastomosis in all the cases. The maximum degree of stenosis was recorded at the end of 1st week and minimum on the 6th week (Table - VIA).

MICROSCOPIC OBSERVATION:

The microscopical studies on 7th day revealed that the invaginated portion of the ascending loop of intestine was still present and there was slight gap between both the two walls of the intestine.

At the anastomotic site the serous layer of the descending loop of the intestine was fused with the corresponding serous layer of the ascending loop of the intestine with thin fibrous tissue. The mucous layer of the invaginated part of the intestine was desquamated. The lining epithelium cells did not present the typical columnar pattern at the anastomotic point. The villi like projections were apparently lacking. Leucocytic infiltration was marked around the suturing material.

On 21st day the invaginated part of intestine appeared almost degenerated in the form of a small and compressed part of tissue. The mucosa was absent at the anastomotic site as a result of tissue reaction to the suturing material. Fibrous tissue was present in abundance at the anastomotic site but

there was absence of regular healing in respect of different corresponding layers of the descending and ascending loops.

On 42nd day the invaginated portion of the intestine was completely absent and the junction of the two cut ends of the intestine was healed up with fibrous tissues. There was little growth of mucous layer on the anastomotic site.

## GROUP - B

In this group entero-anastomosis was performed after invaginating the proximal segment into the distal one after removing 2.5 cm. of mucosal lining of the distal segment. All the nine operated animals survived well.

### CLINICAL MANIFESTATIONS.

On an average, the whole operative procedure took 156.67 ± 2.50 minutes and the anastomoses alone took 18.00 ± 0.71 minutes (Table - II). The conditions after operation and on following days remained more or less same as that of previous group, except the calf No. 12, in which temperature rose upto 104.5°F (Table - IB). The calf Nos. 11 and 12 appeared more dull, depressed and anorexic two days following operation. These animals received Calboral ( M & B) 200 ml partly by intravenous and partly by subcutaneous routes. The calf Nos. 15, 16 and 18 accepted their first diet on the same evening of operation and

rest of the animals on the following morning (Table - III). The defecation was noticed in calf Nos. 10, 15 and 18 on the following day of operation, whereas, in calf Nos. 11, 14 and 17 on the 2nd day and in calf Nos. 12, 13 and 16 on the 3rd post-operative day. The stool was black in colour and brittle in nature. Later on, all the animals defecated normal stool (Table - III). They were allowed free grazing from 5th post-operative day. Thereafter the animals displayed the normal physiological phenomena and no change in their habitus could be detected upto the last day of observation.

The local incisional wounds of all animals healed up uneventfully.

MACROSCOPIC AND RADIOLOGIC OBSERVATION.

At autopsy, a varying degree of soft tissue adhesions were noticed in and around the anastomotic site and the surrounding viscera in most of the cases (Table - IVB). Leakage or any other marked pathological lesions could not be detected in any case. The anastomotic site of the intestine was felt comparatively more hard and narrow on 7th post-operative day than 21 and 42 days.

The anastomotic site was completely covered up with serous and soft tissues and even after 7 days it was difficult to detect the suture line.

The resected segments of the anastomosed intestine

were radiographed and the radiographic findings in this group were almost similar to that of Group A. The degree of stenosis was measured with the help of a sliding caliper in similar manner as that of Group A (Table - VIB).

Maximum stenosis was noticed at the end of first week which gradually decreased on subsequent periods of observation after third and sixth weeks.

MICROSCOPIC OBSERVATION.

The microscopic examination on 7th day revealed the fusion of the anastomotic site with thin granulation tissue. The mucous lining of the invaginated part was showing the process of degeneration and desquamation on the anastomotic site. The suture site was heavily infiltrated with leucocytes. There was almost negligible gap between the serous layer of the invaginated part of intestine and submucosal layer of the receiving loop of the intestine. The submucosa and muscularis of the receiving loop were infiltrated with leucocytes.

On 21st day the microscopic examination showed the complete healing at the anastomotic site between the corresponding layers of the intestine except the mucous one. The invaginated portion remained as a small bulb-like projection at the anastomotic site. The suture was surrounded by fibrous tissues.

The histological findings of 42nd day revealed that

there was no gap between the two ends of the mucosa at the anastomotic site as the mucosa regenerated. All other layers healed up regularly. The suture was surrounded by fibrous tissues.

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## TABLE - IA

**Showing the body weight, pre and post-operative temperature, pulse and respiration (Group A).**

| Calf No. | Body weight in KG | Pre-operative | | | Post-operative | | |
|---|---|---|---|---|---|---|---|
| | | Temperature °F | Pulse/ minute | Respiration/ minute | Temperature °F | Pulse/ minute | Respiration/ minute |
| 1 | 86 | 100.8 | 54 | 24 | 101.7 | 53 | 24 |
| 2 | 110 | 100.6 | 48 | 20 | 101.1 | 51 | 19 |
| 3 | 101 | 101.2 | 52 | 18 | 101.5 | 54 | 17 |
| 4 | 105 | 101.1 | 48 | 22 | 101.9 | 57 | 23 |
| 5 | 90 | 99.8 | 54 | 23 | 100.7 | 55 | 24 |
| 6 | 96 | 101.4 | 46 | 18 | 101.9 | 53 | 22 |
| 7 | 92 | 101.2 | 50 | 20 | 101.9 | 53 | 21 |
| 8 | 98 | 101.1 | 51 | 22 | 101.8 | 54 | 23 |
| 9 | 95 | 100.7 | 49 | 24 | 101.6 | 52 | 25 |

## TABLE - IB

**Showing the body weight, pre and post-operative temperature, pulse and respiration (Group B).**

| Calf No. | Body weight in KG | Pre-operative | | | Post-operative | | |
|---|---|---|---|---|---|---|---|
| | | Temperature °F | Pulse/ minute | Respiration/ minute | Temperature °F | Pulse/ minute | Respiration/ minute |
| 10 | 85 | 99.9 | 52 | 24 | 101.2 | 54 | 26 |
| 11 | 100 | 101.6 | 46 | 16 | 102.2 | 51 | 19 |
| 12 | 96 | 100.5 | 48 | 22 | 104.2 | 53 | 26 |
| 13 | 110 | 100.7 | 49 | 20 | 101.3 | 51 | 19 |
| 14 | 98 | 101.3 | 48 | 17 | 101.6 | 52 | 19 |
| 15 | 86 | 100.8 | 49 | 19 | 101.8 | 51 | 20 |
| 16 | 88 | 100.1 | 50 | 23 | 101.4 | 51 | 25 |
| 17 | 98 | 100.4 | 52 | 24 | 101.7 | 53 | 26 |
| 18 | 105 | 100.8 | 48 | 21 | 101.8 | 51 | 23 |

## TABLE - II.

**Showing the time consumed in performing the anastomosis and whole of the operative procedures (Group A and B).**

| Group A | | | Group B | | |
|---|---|---|---|---|---|
| Calf No. | Anastomosis (in minute) | Whole operative procedure (in minute) | Calf No. | Anastomosis (in minute) | Whole operative procedure (in minute) |
| 1 | 16 | 145 | 10 | 18 | 155 |
| 2 | 15 | 148 | 11 | 17 | 160 |
| 3 | 16 | 140 | 12 | 18 | 155 |
| 4 | 16 | 140 | 13 | 18 | 160 |
| 5 | 16 | 146 | 14 | 19 | 155 |
| 6 | 14 | 145 | 15 | 17 | 155 |
| 7 | 18 | 145 | 16 | 19 | 155 |
| 8 | 16 | 140 | 17 | 18 | 160 |
| 9 | 15 | 150 | 18 | 18 | 155 |
| Mean | 15.78 | 144.33 | | 18.00 | 156.67 |

For anastomosis only

$t = 5.12$

For whole of the operative procedure.

$t = 8.33$

The value of t .05 and t .01 at 16 d.f. are 2.120 and 2.921 respectively.

**For anastomosis only**

S.D./Unit (Group A) = ±1.09
S.E./Mean (Group A) = ±0.36
S.D./Unit (Group B) = ±0.71
S.E./Mean (Group A) = ±0.24

**For whole operative procedure**

S.D./Unit (Group A) = ± 3.64
S.E./Mean (Group A) = ± 1.21
S.D./Unit (Group B) = ± 2.50
S.E./Mean (Group B) = ± 0.83

## TABLE - III

**Showing the days following operation for the acceptance of first diet and first defecation.**

| Group A | | | Group B | | |
|---|---|---|---|---|---|
| Calf no. | Acceptance of first diet following operation in days | First defecation following operation in days | Calf No. | Acceptance of first diet following operation in days. | First defecation following operation in days |
| 1 | 1 | 3 | 10 | 1 | 1 |
| 2 | 0 | 2 | 11 | 1 | 2 |
| 3 | 0 | 2 | 12 | 1 | 3 |
| 4 | 1 | 3 | 13 | 1 | 3 |
| 5 | 0 | 3 | 14 | 1 | 2 |
| 6 | 0 | 3 | 15 | 0 | 1 |
| 7 | 0 | 2 | 16 | 0 | 3 |
| 8 | 1 | 3 | 17 | 1 | 2 |
| 9 | 0 | 2 | 18 | 0 | 1 |

## TABLE - IVA

**Showing the degree of adhesion present at the anastomotic site after necropsy (Group A).**

| Days after operation | No. of animals | Degree of adhesion | | | | |
|---|---|---|---|---|---|---|
| | | 0 | + | ++ | +++ | ++++ |
| 7 | 3 | - | 1 | 2 | - | - |
| 21 | 3 | - | 1 | - | 2 | - |
| 42 | 3 | - | 2 | 1 | - | - |
| Total | 9 | - | 4 | 3 | 2 | - |
| Per cent | 100 | - | 44.45 | 33.33 | 22.22 | - |

## TABLE - IVB

**Showing the degree of adhesion present at the anastomotic site after necropsy (Group B).**

| Days after operation | No. of animals | Degree of adhesion | | | | |
|---|---|---|---|---|---|---|
| | | 0 | + | ++ | +++ | ++++ |
| 7 | 3 | - | 1 | 2 | - | - |
| 21 | 3 | - | 2 | 1 | - | - |
| 42 | 3 | - | 1 | 1 | 1 | - |
| Total | 9 | - | 4 | 4 | 1 | - |
| Per cent | 100 | - | 44.44 | 44.44 | 11.12 | - |

TABLE - V

Showing the nature of adhesions present on the anastomotic site in both the Groups after necropsy.

| Group No. | Total animals | Omental | Visceral | Parietal | Viscero-parietal |
|---|---|---|---|---|---|
| A | 9 | 4 | 3 | 2 | - |
| Per cent | 100 | 44.45 | 33.33 | 22.22 | - |
| B | 9 | 4 | 4 | 1 | - |
| Per cent | 100 | 44.44 | 44.44 | 11.12 | - |

## TABLE - VIA

**Showing the degree of stenosis at the anastomotic site in Group A.**

| Calf No. | Days after operation | Measurement in cm. at A | Measurement in cm. at B | Measurement in cm. at C | Degree of stenosis | Average |
|---|---|---|---|---|---|---|
| 1 | 7 | 3.11 | 4.31 | 5.00 | 33.22 | |
| 2 | 7 | 3.20 | 4.32 | 5.00 | 31.33 | 33.60 |
| 3 | 7 | 3.17 | 4.69 | 5.25 | 36.28 | |
| 4 | 21 | 3.68 | 4.39 | 4.96 | 21.28 | |
| 5 | 21 | 3.73 | 4.50 | 5.08 | 22.10 | 21.78 |
| 6 | 21 | 3.71 | 4.50 | 5.01 | 21.97 | |
| 7 | 42 | 4.70 | 5.02 | 5.10 | 7.11 | |
| 8 | 42 | 4.77 | 5.06 | 5.17 | 6.72 | 7.05 |
| 9 | 42 | 4.79 | 5.13 | 5.21 | 7.34 | |

## TABLE - VIB

**Showing the degree of stenosis at the anastomotic site in Group B.**

| Calf No. | Days after operation | Measurement in cm. at A | Measurement in cm. at B | Measurement in cm. at C | Degree of stenosis | Average |
|---|---|---|---|---|---|---|
| 10 | 7 | 3.25 | 4.08 | 5.20 | 29.95 | |
| 11 | 7 | 3.37 | 4.41 | 5.29 | 30.51 | 29.88 |
| 12 | 7 | 3.32 | 4.12 | 5.25 | 29.13 | |
| 13 | 21 | 3.89 | 4.47 | 5.18 | 19.31 | |
| 14 | 21 | 3.85 | 4.40 | 5.10 | 18.94 | 19.04 |
| 15 | 21 | 3.82 | 4.35 | 5.07 | 18.89 | |
| 16 | 42 | 4.56 | 4.65 | 4.95 | 4.89 | |
| 17 | 42 | 4.55 | 4.60 | 4.91 | 4.31 | 4.48 |
| 18 | 42 | 4.61 | 4.65 | 4.98 | 4.25 | |

## TABLE - VIB

Showing the degree of stenosis at the anastomotic site in Group B.

| Calf No. | Days after operation | Measurement in cm. at A | Measurement in cm. at B | Measurement in cm. at C | Degree of stenosis | Average |
|---|---|---|---|---|---|---|
| 10 | 7 | 3.25 | 4.08 | 5.20 | 29.95 | |
| 11 | 7 | 3.37 | 4.41 | 5.29 | 30.51 | 29.88 |
| 12 | 7 | 3.32 | 4.12 | 5.25 | 29.13 | |
| 13 | 21 | 3.89 | 4.47 | 5.18 | 19.31 | |
| 14 | 21 | 3.85 | 4.40 | 5.10 | 18.94 | 19.04 |
| 15 | 21 | 3.82 | 4.35 | 5.07 | 18.89 | |
| 16 | 42 | 4.56 | 4.65 | 4.95 | 4.89 | |
| 17 | 42 | 4.55 | 4.60 | 4.91 | 4.31 | 4.48 |
| 18 | 42 | 4.61 | 4.65 | 4.98 | 4.25 | |

## TABLE - VIC

**Showing the transformed value of the percentages of the stenosis at the anastomotic site (Group A and B).**

$$( Y = \sin^{-1}\sqrt{P} )$$

| Days after operation | % stenosis in Group A | % stenosis in Group B | Mean of days value |
|---|---|---|---|
| 7 | 33.21 | 35.18 | |
| 7 | 33.52 | 34.02 | 34.27 |
| 7 | 32.65 | 37.05 | |
| Total | 99.38 | 106.25 | |
| 21 | 26.06 | 27.49 | |
| 21 | 25.77 | 28.04 | 26.85 |
| 21 | 25.77 | 27.97 | |
| Total | 77.60 | 83.50 | |
| 42 | 12.79 | 15.45 | |
| 42 | 11.97 | 15.00 | 13.79 |
| 42 | 11.83 | 15.68 | |
| Total | 36.59 | 46.13 | |
| TOTAL | 213.57 | 235.88 | |
| Mean of Group value | 23.73 | 26.21 | 24.97 |

S.D./Unit = ± 0.72
S.E./Mean (days) = ± 0.29
S.E./Mean (Group) = ± 0.24
C.D. at 5% (days) = 0.91
C.D. at 1% (days) = 1.27
C.D. at 5% (Group) = 0.74
C.D. at 1% (Group) = 1.04

# DISCUSSION

# DISCUSSION

In the present series of eighteen entero-anastomoses by invagination techniques, nine buffalo calves were operated upon in Group A without removal of the mucosal lining of the descending loop of intestine and in Group B, nine operations were performed after removing a 2.5 cm. of the mucosal lining of the said loop.

Dissection of mucosal lining eliminates the sources of intestinal secretion and provides a chance for union of submucosa with serosa. The mucosal dissection of the distal end for a distance of 2.5 cm. has been found adequate to effect successful healing at the anastomotic site. O'Neill et al. (1962) and Weilbaecher et al. (1964), in their eversion techniques of non-suture entero-anastomosis employed uterine curetter for removal of mucosa. Linn et al. (1966, 1968) used scissors for dissection of the mucosa. In the present study sterilised moist gauze was used to remove the mucosa bluntly by brushing.

1. Time requirement :

Generally the least important aspect of an entero-anastomosis is the speed with which it can be accomplished but in critical cases, time does attain the highest significance.

No reference is available as regards the time requirement to accomplish an entero-anastomosis in bovine. The diameter of the lumen of the small intestine of buffalo calves is about 0.5 cm. bigger than that of canines. Hamilton (1967) compared the time requirement of Standard, Halsted, Gambee and Navy sutures in canines and recorded an average time of 20 minutes. Linn et al. (1968) recorded time requirement for conventional end-to-end entero-anastomosis as 46 minutes and for invagination technique with and without mucosa 16 and 18 minutes respectively in canines. In the present study on buffalo calves the time requirement in Group A and Group B were 15.78 ± 1.09 and 18.00 ± 0.71 minutes respectively. Though the intestinal lumen of the bovine is somewhat bigger than that of canine, but there is much difference between the nature of the mucosal coats in both the species. The mucosal lining of the canine intestine has extra-ordinary tendency to evert and curl over the intestinal wall after resection, hence it also disturbs during the process of suturing but on the other hand there is no such problem with the mucosa of bovine intestine. There may be variation in the time consumption of the anastomosis, which is explainable as the speed of anastomosis is a question of individual practice.

The time requirement for whole operative procedure in Group A (144.33 ± 3.64 minutes) was highly significant to that of Group B (156.67 ± 2.50 minutes). This was due to extra consumption of time to remove the mucosal lining of the receiving loop of the intestine in Group B.

2. Return of Physiological Functions :

It was observed that the return of physiological functions were delayed whenever any complication like abdominal pain, distension or anastomotic obstruction occurred. Similarly in calf Nos. 1 and 4 luke-warm soap and water enema was administered to evacuate the stool so as to ease the intraluminal pressure of the bowel. Calboral (M & B) was administered to calf Nos. 11 and 12 to tone up their physiological functions, as they appeared dull and depressed on the day following operation. The late defecation was perhaps due to diminished intestinal movement which was probably caused by post-operative pain, specially in Group B, where the mucosa was removed from the descending loop of the intestine. Archibald (1967) also stated that in such conditions constipation is a must. According to Gibbons (1966) and Boddie (1969), whenever the stool is retained in the rectum for a longer period it becomes hard and brittle as a result of over absorption of water content. In author's opinion the variations in colour, quantity and consistency of first defecation after operation were probably due to mixing of blood with faeces at the anastomotic site as well as diminished persistaltic movement caused by injury and prolonged stasis in the rectum.

3. Anastomotic Failure, Leakage and Mortality :

The two problems most commonly encountered with intestinal anastomosis are stenosis and leakage. The volume of

published reports starting in the early 1800's indicates the lack of satisfaction with current techniques (Bennett and Zydeck, 1970).

Linn et al. (1966) reported a death due to leakage and anastomotic failure in entero-anastomosis by invagination and gluing in canine out of 22 cases.

Healey et al. (1967) also reported leakage at the colonic anastomotic site where peritonitis developed and resulted into death in conventional inverting and everting bowel anastomosis. Hardy (1968) also recorded a leakage with one layer technique utilizing two interrupted sutures placed 1.6 cm. apart.

Linn et al. (1968) reported an anastomotic failure and death in case of entero-anastomosis by invagination where the mucosa of the distal bowel was kept intact. Pringle (1945) and Linn et al. (1968) noticed that these complications were primarily due to the result of the technical failure.

In the present study no anastomotic failure, leakage and mortality were recorded in any of the groups.

4. Assessment of Adhesion found :

In spite of many advances in clinical abdominal surgery, the problem of post-operative peritoneal adhesion is still unsolved.

the basis of the number of quadrants of the bowel circumference covered by adhesions. Abramowitz and Butcher (1971) have graded adhesions as the percentage of suture line sealed from view by adhesions. This method is fallacious as it does not take into consideration the density and nature of adhesions. For all practical purposes, the classification of Knightly et al. (1962) was found most accurate and acceptable and hence has been used in the present study.

In Group A, 44.45 per cent of the cases were having single thin and easily separable adhesions and in 33.33 per cent there were two to three strands of visceral adhesions. In 22.22 per cent of the cases there were numerous extensive dense visceral adhesions and at the same time there was difficulty in delivering the viscera from the peritoneal cavity. In Group B, for the same gradings the results were 44.44 per cent, 44.44 per cent and 11.12 per cent respectively.

5. Degree of stenosis and Size of the effective lumen :

Extensive stenosis gives rise to intestinal obstruction but mild to moderate degree of stenosis can only be detected by specialized techniques. Linn et al. (1968) concluded that stricture less than 40 per cent of the normal has no clinical significance.

Getzen et al. (1966) took the help of alginate dental modelling composition. They filled the intestinal lumen with

alginate and allowed it to be harden. The intestinal segment was then split longitudinally and the intraluminal casts were obtained. The casts gave a fair idea of the degree of stenosis.

A radiological method devised by Letwin and Williams (1967) was later on used by Olsen et al. (1968) and Bennett and Zydeck (1970). They filled the segment of intestine containing the anastomotic part with hypaque or sodium iodide solution till it was properly distended and then X'rayed in two planes.

The above method was also used in the present study using 15 per cent Barium sulfate solution and the segment was radiographed in one plane only. This gave a rough idea of the effective lumen size along the anastomotic juncture.

McAdams et al. (1969) attempted at a more quantitative evaluation of the degree of stenosis from radiographs but the results obtained were not very accurate.

In the present study direct measurements of the different parts of the anastomotic loop of intestine were taken with the help of a sliding caliper to arrive at an index of stenosis for each anastomosis. The maximum degree of stenosis was noticed at the end of 1st week. This fact has also been noted by McAdams et al. (1969), Gambee (1951) and Getzen (1966) while using conventional methods of anastomosis. Contrary to this Letwin and Williams (1967) and Olsen et al. (1968) found the maximum degree of stenosis on the day following anastomosis. This seems less likely as the anastomotic oedema — an impairment contributory

factor to stenosis, takes some time to develop. The maximum stenosis noted in the present work was 36.28 per cent in Group A and 30.51 per cent in Group B.

The present study elucidated that the Group A was having 2.47 to 5.77 per cent more stenosis than the Group B. Olsen et al. (1968) also noted a maximum difference of 35 per cent in conventional methods of anastomosis in canines.

The Group A and Group B were compared statistically for different values of degree of stenosis at the anastomotic sites with particular reference to effect of post-operative days.

$\sin^{-1}\sqrt{P}$ transformation was carried out to bring the data of stenosis in normal distribution. After analysing them the difference between the groups percentages were found highly significant. The effect of post-operative days within the groups were also highly significant.

The effects of 7, 21 and 42 post-operative days of Group A were also tested by the 't' test with the corresponding periods of Group B. The differences on the 7th day was non-significant, whereas on 21, and 42 days were highly significant.

Therefore it was recorded statistically that the Group B was significant over Group A.

The present study also revealed that the degree of stenosis decreased gradually with the duration of post-operative days.

The maximum degree of stenosis in either of the groups, in present study did not produce any clinical impairment.

The above mentioned findings did tallied with the findings of Linn et al. (1968), who described that the anastomotic technique with removal of mucosa was highly significant to without removal of mucosa.

6. Microscopic observation :

In the present study 3/0 black braided silk was used. The use of non-absorbable suture materials for intestinal surgery has been recommended by various workers over absorbable sutures because of the lesser inflammatory reaction and more rapid healing (Madsen, 1958; Haxton, 1965). Kumar et al.(1973) also advocated the use of silk in comparison to catgut and vetafil.

The healing rate in intestinal anastomosis varies with the amount of trauma caused in different techniques. Dennis (1943) studied the healing of aseptic end-to-end enteroanastomosis and observed that 18 days after operation, single layer of epithelium was found to cover the granulating laminal bed and a few leucocytes were present in the mucosal edges. Fortyeight days after operation the healing was complete and anastomotic region was almost imperceptible.

Armstead (1956) found complete re-alignment of all

the layers of an intestine in six weeks following conventional method of anastomosis. Leighton (1967) observed incomplete mucosal regeneration in two weeks but there was complete union of mucosal, muscularis and serosal layers in four weeks time in dogs. In the present study of entero-anastomosis by invagination techniques, in Group B there was mucosal regeneration with muscularis and serous layer re-alignment in six weeks, whereas in Group A the mucosal regeneration was incomplete. The rate of healing observed under the present investigation was comparable to the earlier studies, even though the technique adopted in the present quest was quite dissimilar to the previous works.

The presence of heavy infiltration of the leucocytes around the suture and healing zone was similar to the finding of Dennis (1943). This was due to presence of suturing material.

Prasad and Ahmad (1972) reported that in case of non-suture intestinal anastomosis by invagination in canines, there was complete regeneration of the mucosa in 70 per cent and union of muscularis in 100 per cent cases. They also observed the presence of varying degree of leucocytic infiltration in 40 per cent cases. The observations recorded under the present work are in agreement with them in respect to leucocytic infiltration. The idea of Prasad and Ahmad, that the dissection of mucosal lining eliminates the source of intestinal secretion and the union of submucosa with serosa results promptly, does not talley with the findings of the present work. The present observations revealed that the invaginated portion of intestinal loop gradually

degenerated and vanished. The anastomosis took place only at the anastomotic site and not over all the invaginated portion.

The mucosa in Group A did not regenerate completely upto six weeks at the anastomotic site, which might be due to the presence of suturing material and lack of inflammatory reactions at the descending loop of the intestine and that might be a stimulating factor, because in cases of Group B there was complete regeneration of mucosa after six weeks. The apposition and healing of different layers of the cut ends of intestine with corresponding layers of the segment was satisfactory in Group B but not in Group A. Linn et al. (1968) claimed superiority of entero-anastomosis without mucosa over that of with mucosa histologically in invagination techniques. The histological studies in the present work also revealed the superiority of Group B over Group A.

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# SUMMERY AND CONCLUSION

## SUMMARY AND CONCLUSIONS

Entero-anastomosis by two different invagination techniques were studied on eighteen male buffalo calves, dividing them into Group A and B, consisting of nine animals in each group. In Group A, the mucosa of the descending loop of the intestine was kept intact and in Group B, 2.5 cm. of mucosa was removed. The anastomotic site was held by 3/0 black braided silk.

In this study, the following parameters were used in respect of :

(i) Time requirement to perform anastomosis and for the entire operative procedure.

(ii) Return of physiological functions.

(iii) Adhesion formations at and around the anastomotic site.

(iv) Anastomotic failure, leakage and mortality after anastomosis.

(v) Degree of stenosis and size of the effective lumen at the anastomotic site.

(vi) Microscopical changes at the anastomotic site.

These studies were carried out at 7, 21 and 42 days interval in both the groups and after comprising their results

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(vi) Microscopical changes at the anastomotic site.

These studies were carried out at 7, 21 and 42 days interval in both the groups and after comprising their results

the following conclusions were arrived at :

1. The average time consumed to perform anastomosis as well as the entire operative procedure in Group A was significantly less than that of Group B.

2. Return of physiological functions were somewhat delayed in Group B.

3. Varying degree of adhesion formations on the anastomotic site was found in almost all the cases and the technique had no relationship to the amount of adhesion formed.

4. There was no anastomotic failure or leakage or mortality.

5. The degree of stenosis and the effect of post-operative days were statistically analysed within the group and in comparison to other group by standard methods and Group B was found significant to Group A.

6. The degree of stenosis was observed to be maximum on the 7th post-operative day which gradually decreased as the period of study increased.

7. The maximum degree of stenosis did not produce any clinical change in the present study.

8. Radiological observations afforded only a rough idea regarding the degree of stenosis and size of the effective lumen at the anastomotic juncture.

9. Histologically there was evidence of uniform healing

in Group B as compared to Group A.

10. Under limited observations, Group B was found superior to Group A, in terms of adhesion formations, degree of stenosis and size of the effective lumen as well as healing at the anastomotic site.

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10. Under limited observations, Group B was found superior to Group A, in terms of adhesion formations, degree of stenosis and size of the effective lumen as well as healing at the anastomotic site.

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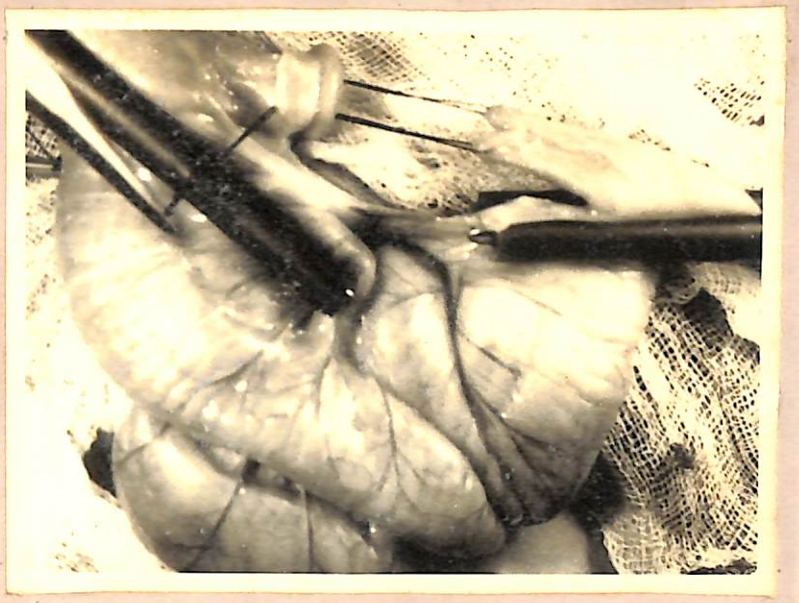


Fig. 1 : Stay sutures while invaginating the proximal end of the intestine into the distal one.

Fig. 2 : Proximal bowel end after invagination into distal one.

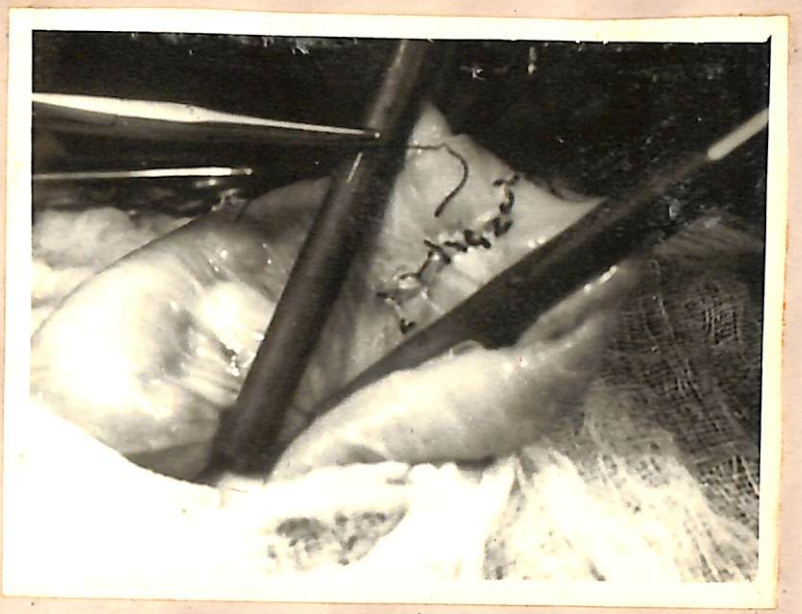


Fig. 3 : Showing the mesenteric vent and bowel end sutured and stay sutures being removed.

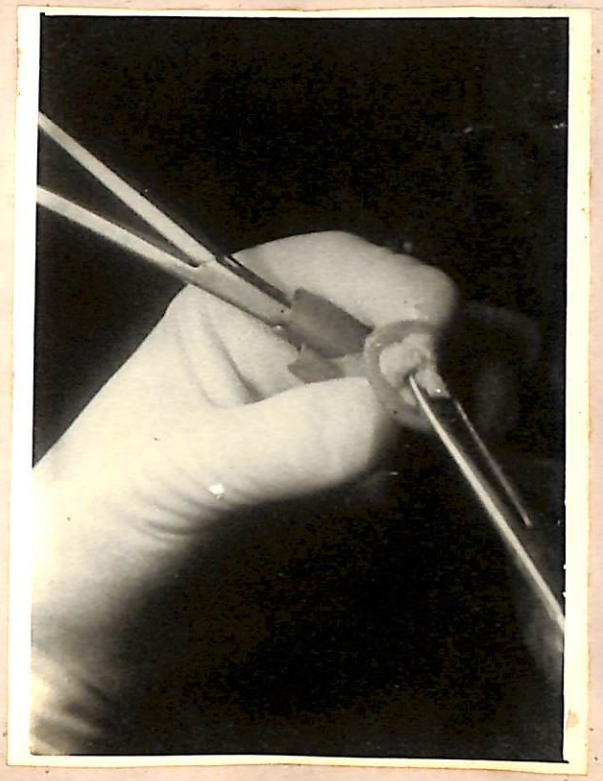


Fig. 4 : Showing removal of mucosal lining by sterilised moist-gauze.

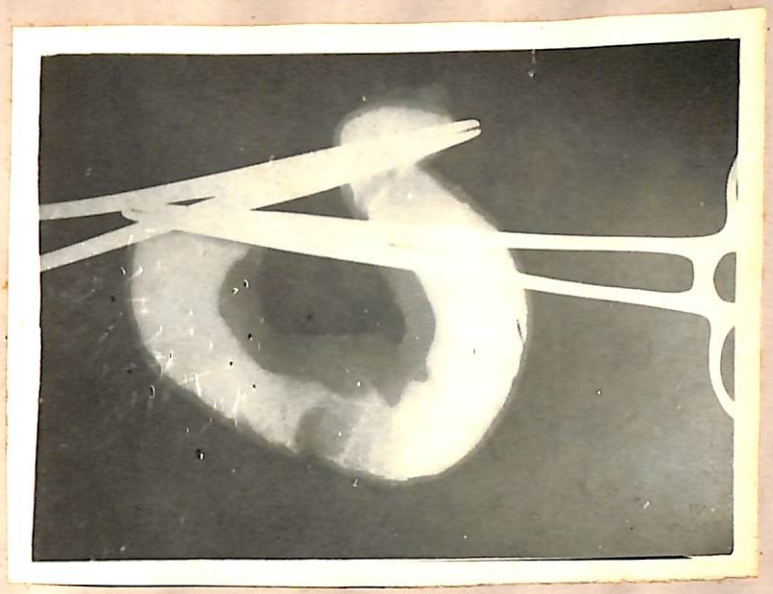


Fig. 5 : Radiograph taken on 7th post operative day, showing maximum stenosis at anastomotic site.

Fig. 6 : Radiograph taken on 21st post operative day, showing the stenosis and size of effective lumen at the anastomotic site.

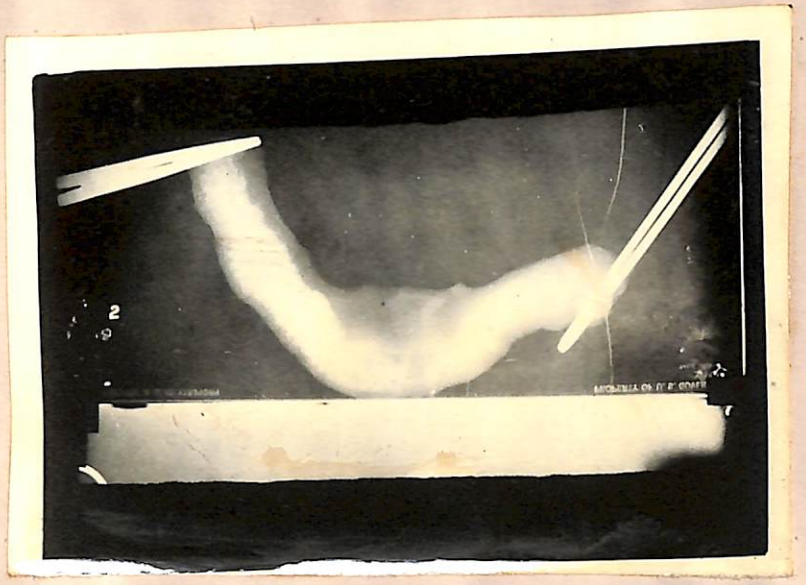


Fig. 7 : Radiograph taken on 42nd post operative day, showing the stenosis and size of the effective lumen at the anastomotic site.


Fig. 8 : Intestine opened on 7th post operative day, showing anastomotic line and presence of invaginated part of intestine (Group A & B).


Fig. 9 : Intestine opened on 21st post operative day, note the anastomotic line and absence of invaginated part of intestine (Group A & B).

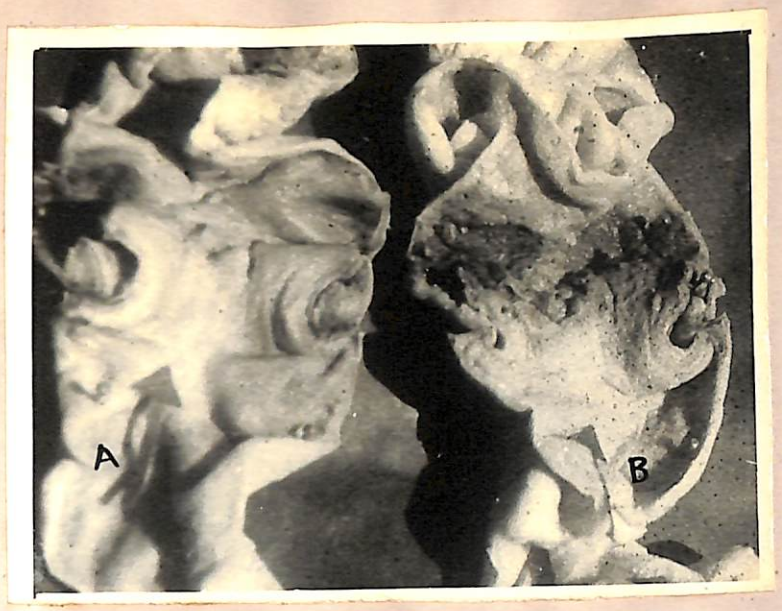



Fig. 8 : Intestine opened on 7th post operative day, showing anastomotic line and presence of invaginated part of intestine (Group A & B).

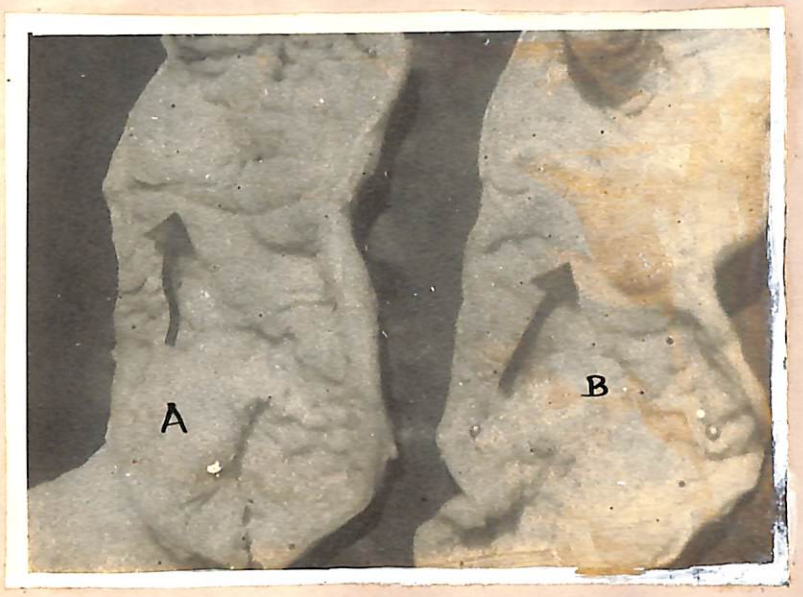



Fig. 9 : Intestine opened on 21st post operative day, note the anastomotic line and absence of invaginated part of intestine (Group A & B).

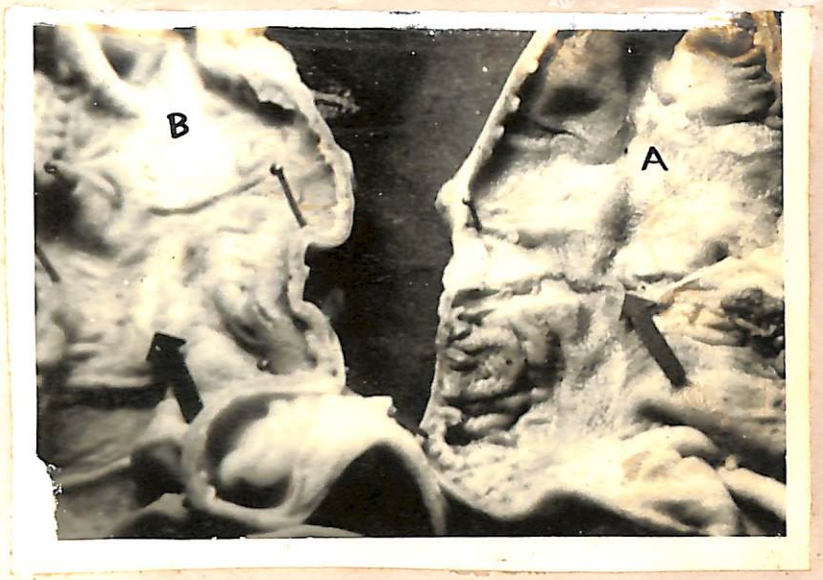
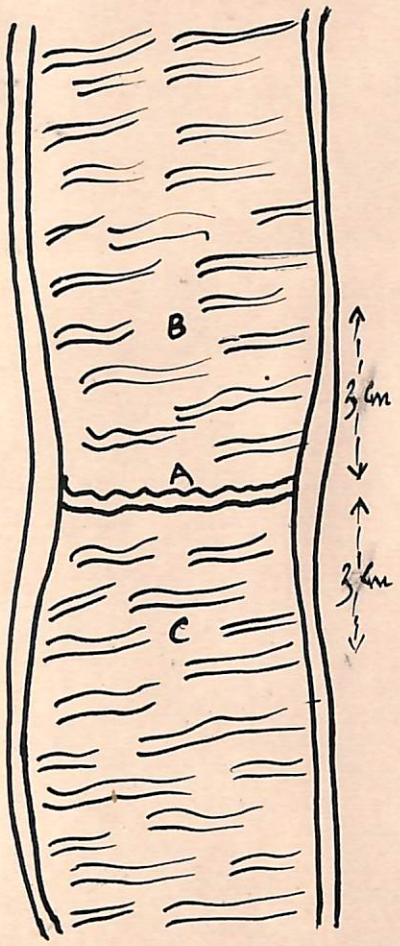



Fig. 10 : Intestine opened on 42nd post operative day, arrow shows the anastomotic line, note the absence of interrupted mucosa in Group B.




INDEX OF STENOSIS =

$$100 \times 1 - \frac{2A}{B+C}$$

DIAG. 1

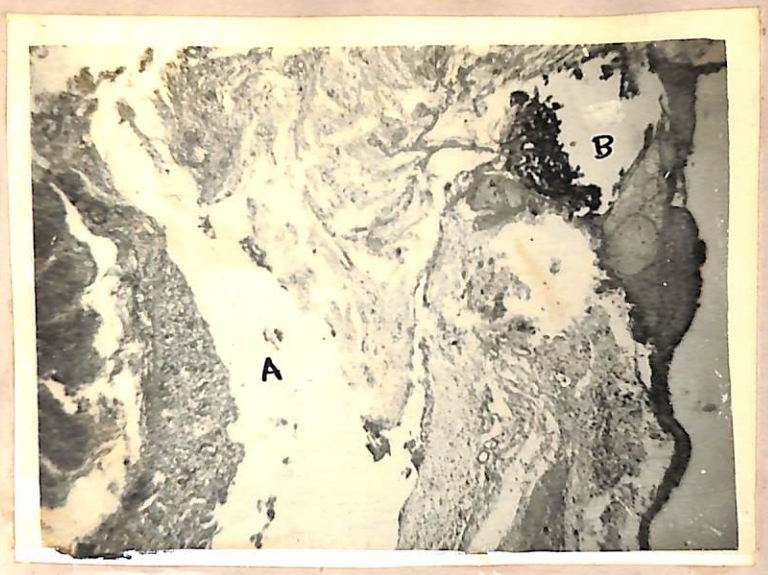



Fig. 11 : Group A on 7th post operative day, showing
A - Gap between mucous layer and serous layer of invaginated parts.
B - Suture site. (x100)


Fig. 12 : Group B on 7th post operative day, showing
A - Desquamation of epithelium. (x100)


Fig. 13 : Group A on 21st post operative day, showing
A - Healing by serosa only at the anastomotic site. (x 50)

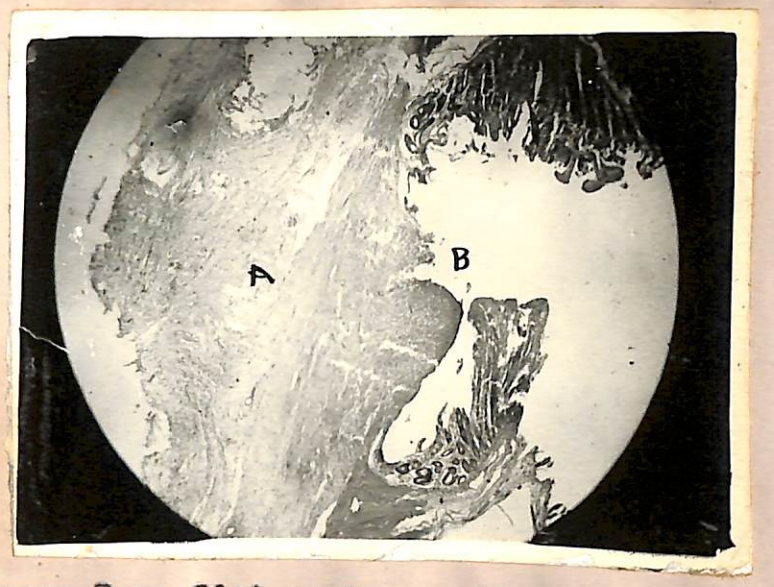



Fig. 14 : Group B on 21st post operative day, showing
A - Regular healing between two different ends of the intestine.
B - Absence of mucous layer at the anastomotic site. (x 40)


Fig. 15 : Group A on 42nd post operative day, showing
A - Anastomotic site.
B - Regeneration of very thin layer of mucosa. (× 40)

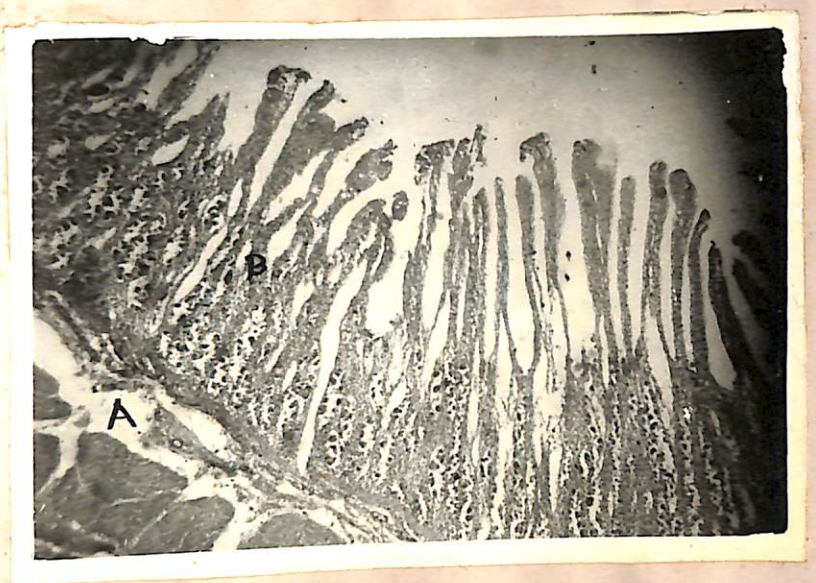



Fig. 16 : Group B on 42nd post operative day, showing
A - Anastomotic site.
B - Complete regeneration of mucosal layer. (×100)

# REFERENCES

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Abramowitz, H.B., McAlister, W.H. (1969). A comparative study of small bowel anastomosis by angiography and micro-angiography. Surgery, 66: 564.

Abramowitz, H.B. and Butcher, H.R. (1971). Everting and inverting anastomosis — an experimental study of comparative safety. Amer.J.Surg., 121: 52.

Archibald, J., Chappel, C. and Grahem, J.B. (1953). Radical enterectomy in colonic coprostasis. North Amer.Vet., 34: 264.

Armstead, W.W. (1956). An experimental method for intestinal anastomosis in small animals. North Amer.Vet.,37:968.

Babcock, W.W. (1926). A Method of Partial Gastrectomy with Telescopic Anastomosis. Surg.Gynec. & Obst., 42: 403.

Bennett, R.R. and Zydeck, F.A. (1970). A comparison of single layer suture patterns for intestinal anastomosis. J.Am.Vet.Med.Ass., 157: 2075.

Bichat (1825). Quoted by Gill, W., Frazer, S.J., Carter, D.C. and Hill, R. (1969). Everting intestinal anastomosis. Surg. Gynec. & Obst., 128: 1297.

Boddie, G.F. (1969). Diagnostic Methods in Veterinary Medicine, Oliver & Boyd. Edinburgh.

Boys, F. (1942). The prophylaxis of peritoneal adhesions. Surgery, 11: 118.

Buyers, R.L. and Meier, L.A. (1968). Surgery, 63: 475.

Dennis, C. (1943). Oblique, Aseptic, End-to-End Ileac Anastomosis, procedure of choice in strangulating small bowel obstruction. Surg.Gynec. & Obst., 77: 225.

Ferrara, B.E. (1966). Colorectal Anastomosis by Invagination. Dis. Colon & Rectum, 9: 113.

Frier, P.A. (1966). A simplified method of intestinal anastomosis. Mod.Vet.Pract., 46: 72.

Gambee, L.P. (1951). A single layer open intestinal anastomosis applicable to the small as well as the large intestine. West. J. Surg., 59: 1.

Geopel, R. (1927). Cited by Linn, B.S., Reisman, T.M., Yurt, R.W. and Polk, H.C.Jr. (1968). Intestinal anastomosis by Invagination. Ann.Surg., 167: 393.

Getzen, L.C., Roe, R.D. and Holloway, C.K. (1964). Gross and microscopic chronological comparative study of inverted and everted intestinal anastomosis. Exhibit, Amercian College of Surgeons meeting. October, 14-19. Chicago.

Getzen, L.C., Roe, R.D. and Holloway, C.K. (1966). Comparative study of intestinal anastomosis healing in inverted and everted closure. Surg.Gynec. & Obst., 123: 1219.

Getzen, L.C. (1966). Clinical use of everted intestinal anastomosis. Surg. Gynec. & Obst., 123: 1027.

Getzen, L.C. (1969). Intestinal suturing I — The development of intestinal sutures. Curr. Probl. Surg., 3: 48.

Gibbons, W.J. (1966). Clinical Diagnosis of Diseases of Large Animals. Lea & Febiger. Philadelphia.

Gill, W., Frazer, S.J., Carter, D.C. and Hill, R. (1969). Everting intestinal anastomosis. Surg. Gynec. & Obst., 128: 1297.

Grier, L.R. (1968). Invagination technics in small bowel anastomosis. J.Amer.Vet.Med.Ass., 153: 528.

Halsted, W.S. (1887). Quoted by Kumar, A., Singh, H. and Singh, R. (1973). Evaluation of chromic catgut, silk and 'vetafil' as suture materials in intestinal anastomosis in dogs. Indian Vet.J., 50: 282.

Hamilton, J.E. (1967). Reappraisal of open intestinal anastomosis. Ann. Surg., 165: 917.

Hardy, K.J. (1968). Suture Technics for Intestinal Anastomosis. Arch. Surg., 97: 586.

Haxton, H. (1965). Brit. J. Surg., 52: 372.

Healey, J.E., McBirdie, C.M. and Gallagher, H.S. (1964). Is serosa-to-serosa approximation necessary in intestinal anastomosis. Surg. Forum., 15: 297.

Healey, J.E., McBirdie, C.M., Gallagher, H.S. (1967). Inverting Vs Everting Bowel Anastomosis. J.Surg.Res., 7: 299.

Hearn, D. and Cohn, I.Jr. (1970). Inverted versess everted gastro-intestinal anastomosis - The role of everted mucosa in anastomotic break down. Am.Surg., 36: 728.

Jobert (1820). Quoted by Gill,W.,Frazer,S.J.,Carter,D.C. and Hill,R. (1969). Everting intestinal anastomosis. Surg. Gynec. & Obst., 128: 1297.

Kerr, H.H. (1923). The development of intestinal surgery. J. Am. Med. Ass., 81: 641.

Kimbarovskij, M.A. (1951). A new method of anastomosis of the small and large intestines. Abstracts of World Surgery, Obstetrics and Gynaecology, 9: 191.

Knightly, J.J., Agostino, D. and Cliffton, E. (1962). Effect of fibrinolysin and heparin on the formation of peritoneal adhesions. Surgery, 52: 250.

Kumar, A., Singh, H. and Singh, R. (1973). Evaluation of chromic catgut, silk and 'vetafil' as suture materials in intestinal anastomosis in dogs. Indan Vet.J.,50:282.

Lambert, A. (1826). Qoted by O'Neill, P., Healey, J.E.Jr., Clark, R.L. and Gallager, H.S. (1962). Nonsuture intestinal anastomosis. Am.J.Surg., 104: 761.

Lamis, P.A., Richards, J.T. and Chapman, W.T. (1968). Intestinal anastomosis — A reappraisal of the controversy. J.Med.Ass.Georgia, 57: 497.

Lanfranks (1396). Quoted by Kerr, H.H. (1923). The development of intestinal surgery. J.Am.Med.Ass., 81: 641.

Leighton, R.L. (1967). Everting end-to-end intestinal anastomosis in the dog. Small Animal Clinician, 7: 239.

Letwin, E. and Williams, H.T.G. (1967). Healing of intestinal anastomosis. Cand. J. Surg., 10: 109.

Linn, B.S., Cecil, F., Conly, P., Canady, W.R.Jr. and Wolcott, M.W. (1966). Intestinal anastomosis by invagination and gluing. Am. J. Surg., 111: 197.

Linn, B.S., Reisman, T.M., Yurt, R.W. and Polk, H.C.Jr. (1968). Intestinal anastomosis by invagination. Ann. Surg., 167: 393.

Loeb, M.J. (1967). Comparative strength of inverted, everted and end-to-end intestinal anastomosis. Surg. Gynec. & Obst., 125: 301.

Madsen, E.T. (1958). Surg. Gynec. & Obst., 106 : 216.

Maylard, A.E. (1913). Cited by Linn, B.S., Reisman, T.M.,Yurt, R.W. and Polk, H.C.Jr. (1968). Intestinal anastomosis by invagination. Ann. Surg., 167: 393.

McAdam, A.J., Meilkle, A.G. and Medina, R. (1969). An experimental comparison of inversion and eversion in colonic anastomoses. Dis. Colon & Rectum, 12: 1.

McAdam, A.J., Meilkle, A.G. and Taylor, J.O. (1970). One layer or two layer colonic anastomosis. Am.J.Surg.,120:546.

McCaughan, J.M. (1955). Axial Entero-enterostomy by a Telescopic Cuff Method Using a Single Row of Continuous Sutures : An Experimental Study. Surgery, 37: 446.

Mellish, R.W.P., Ty, T.C. and Keller, D.J. (1968). J.Paediat. Surg., 3: 286.

Moore, W.I. and Forrest-Hamilton, J. (1953). The Maylard - Sonnenburg Method of Intestinal Anastomosis. Brit. M. J., 2: 1407.

Murphy, J.B. (1892). A contribution to abdominal surgery, ideal approximation of abdominal viscera without suture. N. Amer. Pract., Chicago, 4: 481.

Olsen, G.B., Letwin, E. and Williams, H.T.G. (1968). Clinical experiences with the use of a single layer intestinal anastomosis. Canad. J. Surg., 1: 97.

O'Neill, P., Healey, J.E.Jr., Clark, R.L. and Gallager, H.S. (1962). Nonsuture intestinal anastomosis. Am. J. Surg., 104: 761.

Parker, E.M. and Kerr, H.H. (1907). Intestinal anastomosis without open incision by means of basting stitches. Bull. Jhon. Hopkins Hosp., 19: 132.

Prasad, B. and Ahmed, S.A. (1972). Non-suture intestinal anastomosis by invagination. J.Small Anim.Pract., 13: 641.

Pringle, J.E. (1945). A new method of End-to-End Anastomosis in the Small Instestine. Brit.M.J., 2: 256.

Prioleau, W.H. (1950). Rectosigmoid Anastomosis by Invagination in Chronic Inflammatory Conditions. J. Internat. Coll. Surgeons, 13: 388.

Shrum, R.C., Gaylord, S.W., Allen, M.S.,Jr. and Kenneweg, D.J. (1965). A simplified Technique of Ilecolostomy. Virginia Medical Monthly, 92: 515.

Singleton, A.O., White, D. and Montalbo, P. (1968). A comparative study of intestinal anastomosis. Arch. Surg., 96: 563.

Travers, B. (1812). Quoted by Linn, B.S., Reisman, T.M., Yurt, R.W. and Polk, H.C.Jr. (1968). Intestinal anastomosis by Invagination. Ann. Surg., 167: 393.

Trueblood, H.W., Nelsen, T.S., Kohatsu, S. and Obserhelman, H.A. (1969). Wound healing in the Colon — Comparison of inverted and everted closure. Surgery, 65: 919.

Weilbaecher, D.A., Mathieu, F.J. and Cohn, I. (1964). Non-suture intestinal anastomosis. A. J. Surg., 107: 353.

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