

**Technique of
Cervical Oesophageal end-to-end Anastomosis
in Buffalo Calves with Different Suturing
Materials Including Surgical Pathology**

A THESIS

**Submitted to the Faculty of
Veterinary Science and Animal Husbandry
Magadh University
In Partial Fulfilment of the Requirements
for the Degree of
Master of Science (Veterinary)
In
SURGERY**

NOVEMBER, 1965

BY

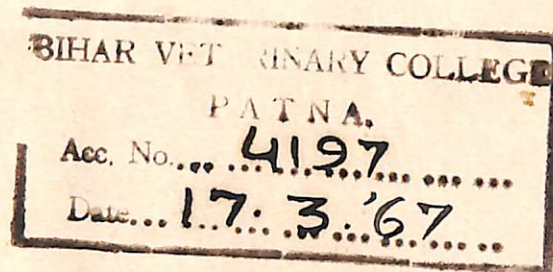
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Dated the

November, 1965.

I certify that this Thesis has been
prepared under my supervision by Sri S.C.Ojha, a candidate
for the degree of M.Sc. (Vet.) with major subject as Surgery,
and that it incorporates the results of his independent study.


(S. A. Ahmed) 10/11/65

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S.C.OJHA

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C H A P T E R - I

INTRODUCTION

Surgical management of the disturbances of the Oesophagus has been of lately a modern development in the field of Surgery. The progress, however has been limited in the bovines due to multiple factors.

Surgery of the Oesophagus has steadily developed since years as long back as 1871 when Billroth performed the resection of 1.5 cms. of cervical Oesophagus in two experimental dogs, according to Ahmed (1965). Bircher in 1894 described the use of skin tubes to bypass the obstructed oesophagus from its cervical portion to the stomach in human beings. As cited by Munre, Tabah, and Moseley (1959), Phemister and Adams were the first to perform a successful one stage resection of the oesophagus at the cardiac portion of the stomach, in 1938. For oesophageal reconstruction, free skin grafts (1917 - Esser), Jejunal transplants (1907 - Roux and Herzen), stomach tubes (1905 - Back and Carrel), Inert tubes, Heterogenous grafts, Colon (1911 - Kelling and Vulliet) and Caecum etc. have been used and recorded in human Surgery.

Recent advances in the treatment have been made in

affections such as, cardiospasm, replacement of oesophagus with various portions of the bowel, peptic oesophagitis, hiatus hernia, caustic strictures. Oesophageal rings and webs, oesophageal varices, carcinoma and tracheo-oesophageal fistula.

According to Adams (1964), the surgical management of the benign lesions of the oesophagus can best be classified into three categories:-

- (i) Congenital obstructing lesions;
- (ii) Acquired obstructing lesions; and
- (iii) Miscellaneous types of symptomatic lesions.

Congenital lesions include atresia, webs, reduplication cyst and mucosal rings, in which resection of the fistula and primary anastomosis are indicated. Acquired lesions of the Oesophagus are caustic strictures, oesophagitis, cardiospasm and achalasia, in which certain agents produce progressive inflammatory changes, resulting into structural changes with subsequent obstruction. Miscellaneous group consists of diverticulum formation and development of benign tumours.

This, in brief is the picture of the advancement in human oesophageal surgery. In contrast, the progress in this field of Veterinary Surgery is indeed limited.

In bovines intussusception, papillomatous growth,

obstruction due to bone, glass pieces, iron sewing needle, root, potato and placenta, and extrathoracic lesions leading to Actinobacillosis and obstruction with unusual symptoms have been recorded, in which, to a very limited extent, surgical interference has been attempted. Few workers like Hoban (1923), Ross (1944), and Dakshinkar (1950), have successfully attempted oesophagotomy to relieve choking.

In equines, strictures, diverticulum, and cervical choke have been recorded. Lowe (1964) has attempted successfully for oesophageal resection and end-to-end anastomosis in a case of stricture.

In cats and dogs extra-thoracic and intra-thoracic obstructions, carcinoma, stricture, oesophageal sarcoma with spirocerca lupi infection (in dogs only) have been extensively recorded.

From the foregoing account, available, it appears that in cases of surgical oesophageal disorders among the large domestic animals, resection and end-to-end anastomosis were rarely attempted or recorded, while in dogs, a sound approach to this problem has been made by both human and Veterinary Surgeons. Little or no progress in this field has so far been made in bovines. In this context, an effort has been made to tackle this problem from different angles having direct bearing on

its application in the field. Particular emphasis has been laid to perform resectional operation to relieve different surgical affections as it occurs in the cervical portion of the oesophagus.

Surgery of the thoracic part of oesophagus though considered important, could not be taken up due to lack of suitable anaesthetic appliances necessary in thoracic surgery.

Prerequisite for a successful anastomosis would mean the use of a good suture material and technique which should ensure a patent lumen during the early phases of the healing process and confirm to the highest standard of functional results. To use a suture material which should cause least tissue reaction and avoid minimum decrease in the intraluminal diameter, is yet another objective of the experiment.

According to Gage and Lyons (1949) the biologic experiment for the comparative evaluation of suture materials has been complicated by the presence of multiple variables. The most important of these are the -(i) amount of tissue trauma; (ii) degree of bacterial contamination; (iii) integrity of hemostasis; and (iv) the amount of tension. The aforesaid authors believe, and it is well recognised, that for optimal

wound healing, technical perfection in wound management is more important than the choice of a suture material.

The healing of wound forms an important part of the success of the operation, and healing of surgical wound is always expected by "First Intention" under complete aseptic measures. Gage and Lyons (1949) state that the optimal healing of a wound, histologically, should be like what is described as "dry healing". Similarly, the aseptic inflammatory changes in wound healing is termed as "Wet healing".

According to Johnson and Kerby (1958), as cited by Ahmad (1965) greater care is necessary in executing any surgical manoeuvre on the oesophagus although it is based on the same general principles as for the other portions of the gastrointestinal surgery.

According to Archihald and Reed (1964) surgery of the Oesophagus in dogs needs to be carried out much more precisely than normally necessary due to following factors:-

- (i) Lack of Serosa, which is of vital importance for the integrity of the anastomosis;
- (ii) Muscular layer being fragile, in particular, the inner circular one being tenuous, has poor suture holding power;

- (iii) Want of an ideal suture material;
- (iv) Constant movement may result in poor healing.
- (v) Lack of omentum to seal the suture line,
which would check the oesophageal contents
from escaping into the thorax;
- (vi) Considerable expanding power of the
esophagus;

The same factors hold good in bovines as well.

Considering the importance of esophageal surgery in bovines in which very limited work has so far been recorded, was taken up for study. The technique of oesophageal resection and end-to-end anastomosis with special reference to different suturing materials and their histopathology formed the basis in the present plan.

In bovines, Buffalo calves (*Bos bubalis*), which could be easily available were selected for the study.

C H A P T E R - II

REVIEW OF LITERATURES

No record of any literature on the bovine oesophageal anastomosis as such could be available to the author. Main source of knowledge in this field has been derived from the researches and experiences made in the human and canine oesophageal Surgery.

As cited by Ahmad Rakeeb (1965) the history of cervical oesophageal resection dates back to 1871, when Billroth performed 1.5 cms. of cervical oesophageal resection in two experimental dogs.

Dobermysslow (1901) reported the successful resection of 2-3 cms. of thoracic oesophagus in dogs, and anastomosis with two layers of silk sutures. Successful resection and end-to-end anastomosis has been later on reported by Sauerbruch (1905), Omi and Krasawa (1913) and Enderlen, Hotz and Porzelt (1914).

Omi and Karasawa (1913) used silk sutures in three layers, after the resection for anastomosis of the thoracic oesophagus in dogs. The first layer of sutures passed through the mucosa, the second one through the muscular layer and the adventitia, and finally

a continuous external Lambert sutures.

Carrington (1927) states to have used two rows of interrupted Lambert silk sutures including muscles and adventitia only for the cervical oesophageal anastomosis in dogs. In their next series, three rows of sutures were indicated for the anastomosis. The first continuous suture through all the layers, the second one of interrupted Lambert sutures, and lastly six Lambert sutures which took in a long bite of tissue and were drawn only sufficiently tight to relieve tension, on the first two rows. He concluded from the series of such operations-

- (i) a limited success;
- (ii) stricture at the site of operation can be avoided to a great extent by doing the anastomosis with the viscous fully expanded; and
- (iii) unabsorbable suture material is comparably more satisfactory than catgut, though resulting in the formation of marginal ulcers.

Miller and Andrus (1923) on the basis of the experimental reports, and on the results of their own experiments, concluded that only limited resection of the oesophagus is feasible. According to them, failures were due to-

- (i) lack of firm tissue, that is, sub-mucosa

- for the suture to hold;
- (ii) difficulty in avoiding suture tension;
- and
- (iii) sometimes necrosis resulting from
freeing the oesophagus from its bed.

Saint and Mann (1929) reported to have performed anastomosis 4 cms. of cervical oesophageal resection in dogs. Two rows of silk sutures were applied, the inner one placing interrupted horizontal mattress sutures, passing through the whole thickness of the wall, and the outer row of continuous Lambert sutures, passing through the muscular coat only. The percentage of success was only 33%. The failures were due to sloughing of the suture line with ensuing infection, adhesions around the oesophagus at the level of anastomosis and dilatation above the stricture.

Adam (1938) performed experimental oesophagectomy of the thoracic region using interrupted and continuous sutures, for the anastomosis. Strictures resulted when continuous sutures were used. He concluded that the incidence of strictures, infection and leakage is definitely related to the method of suturing in the anastomosis.

According to Swenson and Megruder (1944), Johnson and Megruder attempted in 1941-42 intrathoracic anastomosis between a Beck-Jianu gastric tube, and the proximal third of the oesophagus , and succeeded to the extent that several animals survived 10-15 days. All of

these animals had antiperistaltic oesophagogastric anastomosis, which could have been the cause of persistent vomiting.

Swenson and Megruder (1944) concluded the experiment to find the best type of sutures for the oesophageal anastomosis. They observed that continuous or inverting type of sutures, lead to considerable post operative swelling with consequent stricture formation. While by placing interrupted non-inverting type of sutures in mucous and the muscular layers in two separate layers with silk sutures, stricture formation was avoided to a great extent. Antiperistaltic oesophagogastric anastomoses are perfectly feasible as long as the gastric tube does not contain pyloric musculature.

Gross and Scott (1946) reported a case in which the operation for the tracheo-oesophageal fistula and oblique end-to-end anastomosis was conducted in a two year old child. The tracheo-oesophageal fistula was ligated with No: 4/0 silk close to the trachea and was divided. Stay sutures of 5/0 silk were placed in the four quadrants of each oesophageal end. The near ends of the stay sutures were first tied, following which the far ends were tied, and thus the walls of the oesophagus were folded inward at the anastomosis. No: 7 or 8 interrupted sutures were used to join and turn the muscularis between the stay sutures. An effort was made

to establish the oblique type of union, in the belief that this might have less tendency to subsequent stricture formation.

According to Higgins and Orr (1958), other modifications of end-to-end oesophageal anastomosis for oesophageal atresia have been described by Haight, Damal, Humphreys and Ladd, besides Gross and Scott, just discussed above.

Swenson and Clatworthy (1949) studied partial oesophagectomy, and end-to-end two layer anastomosis with interrupted silk sutures in thirty dogs. A row of interrupted 0000 braided silk sutures was placed just beyond the clamps including the full thickness of the muscular coat and some of the submucosal layer. The segments of the oesophagus were brought together by gentle traction on the clamps, and portion of the oesophagus to be resected were cut free. The row of sutures was then tied. A second row of interrupted 0000 silk sutures was then placed in the mucosal layer, with all knots being tied within the lumen. By continuing the row of interrupted sutures to the muscular layer, the anastomosis was completed.

In this series of studies, there were twenty survivals with an average resection of 51.5% of the thoracic

oesophagus. There was no failure of any animal in which less than 50% of the intrathoracic oesophagus had been resected.

Parker and Brockington (1949) employed cotton sutures in two layers for end-to-end anastomosis of the thoracic oesophagus after resecting 4-7 cms., in twenty one dogs. Out of them seven died, and among the fourteen surviving only one developed stricture.

Kleinsasser, Carmer, and Warshaw (1950) studied anastomosis of the cervical oesophagus, and experimental evaluation of peritoneal grafts in eighteen dogs. In fourteen dogs, two rows of sutures with cotton No: 70 were used. Inner row of interrupted sutures were passed through the entire thickness of the wall with the knots tied inside the lumen, while the second layer included the muscularis with inverting row of interrupted sutures. In this emphasis is laid to follow the technique of suturing anastomosis in two layers, one layer of which must include the submucosa.

Of the above eighteen dogs, nine anastomoses were made with a peritoneal graft, and the rest without any peritoneal graft. Authors concluded that there appeared to be no particular advantage of peritoneal grafts in a

two layer anastomosis, although the grafts became intimately adherent to the oesophagus, and microscopically were indistinguishable from the adventitia of the oesophagus.

Hertzler and Tuttle (1952) state that an everting method which would permit an anatomical end-to-end approximation of the individual layers of the sutures to be anastomosed leaving no intraluminal diaphragm would fulfil the requirements best. Their technique consisted of placing through and through everted mattress sutures with No: 000, 0000 silk. A second layer of running continuous suture No: 0000 silk, was used to approximate the muscularis. The sutures when placed approximately 4 m.m. from the cut ends of the wall, cause the everted flange 2-3 mm deep. A smaller bite was taken through the mucosa and then the muscular layer.

This method of oesophageal anastomosis was first applied and was carried out successfully in eight cases.

Menon (1953) successfully performed partial oesophagectomy for the removal of spirocerca tumours in two dogs. He used three week chromic catgut 1-0, for suturing the muscular layer in one dog.

Siobold et al. (1955) as cited by Ahmad (1965), performed resection and anastomosis of the thoracic oesophagus to remove the malignant portion in two dogs, but

both died within two days of the operation. The details of the surgical technique were not discussed.

Grove (1961) states that the anastomosis involving the oesophagus should be generally done in three layers, the two outside layers by interrupted sutures using black silk followed by careful approximation of mucosa to mucosa. The suture should be so placed and tied, that the knots will be on the inside of the lumen. This is done, so that there will be minimum amount of foreign material between the layers of the anastomosed oesophagus thereby least interference in the healing.

He further describes the operation for congenital tracheo-oesophageal fistula, in which after dividing the fistula's tract as close to the trachea as possible, the anastomosis of the two ends of the oesophagus is accomplished in two layers using 5/0 ~~for~~ 6/0 black silk for both the layers. No attempt is made to invert the outside layers, as the sutures then ~~tend~~ to cut through.

✓ Munro, Tabah and Moseley (1959) describe Phemister and Adams as the first to perform successfully in human beings, one stage resection of oesophagus at the cardiac portion of stomach.

Haight Cameron (1961) in the management of

congenital oesophageal atresia and tracheo-oesophageal fistula states that the type of anastomosis to be employed will depend upon the extent of development of the two portions of the oesophagus. He is also of the opinion that if the wall of the lower oesophagus is sufficiently well developed, so that muscularis and mucosa can be readily identified, it is preferable to that of two layers standard type of anastomosis. The anastomosis is begun from the distended portion of the circumstance.

Archibald and Reed (1964) in their study of examination and Surgery of the canine oesophagus have employed simple interrupted sutures using silk, with knots placed within the lumen of the oesophagus, keeping 2 m.m. from the out cut edge and 2 m.m. apart. However, they have reported successful closures by applying ~~matte~~ mattress sutures, provided the cut ends were either everted or inverted.

Boyd (1964) for the operation of oesophageal diverticulum in human beings, practices the closure of the mucosal layer with interrupted sutures using fine silk or catgut. The muscular layer is easily approximated over the first line of closure. In many cases the second suture line can also be placed in the transverse plane.

Lowe (1964) reports a case of oesophageal

stricture and successful anastomosis in a horse. An incision parallel with the long axis and extending approximately 1.25 cms. on each side of the stricture point was made on the oesophageal musculature. The mucosa was then incised and the material causing choke was removed. Circular incisions were then given at each end of the longitudinal oesophageal incision. Incising and suturing was so done that the oesophagus was never completely severed without being partially sutured. Interrupted verticle sutures with No: 1 chromic catgut were placed to approximate the cut edges. The edge of the mucosa was included in the deep portion of the mattress suture. To complete the anastomosis, a single continuous row of suture using No: 0 chromic catgut, was placed in the oesophageal muscle, close to the incised edges.

Dorsey et al. (1958) described the use of fine interrupted silk sutures in the mucous membrane and in the submucous layer. Multiple sutures were used with particular attention to include the serous covered organ by overlapping the suture line, in gastrointestinal anastomosis. When resection of the oesophagus and oesophago-gastric anastomosis is indicated, it has been shown that, the reflex oesophagitis can be reduced or avoided by providing angulation at the anastomic site.

Schultz, Rodriques and Clastworthy (1962) made an experimental study of different suture materials in the anastomosis in growing animals (Puppies) to evaluate the tendency to produce strictures of the oesophagus. Study was made by placing two layer end-to-end anastomosis, using silk chromic catgut, dacaron and wire. A 3 cms. long segment of oesophagus was resected in twentyfive puppies, and the continuity re-established avoiding tension. Twenty of the animals survived.

In the surviving animals, four anastomoses were performed, and each anastomosis was studied by serial roentgenograms, by silicon rubber molds of the oesophagus and by microscopic tissue sections. The roentgenograms and rubber molds, showed strictures in few cases. Two of these occurred with the catgut, one with silk and one with cotton. No strictures occurred with dacaron or wire.

Experimental study was however, too small to draw any definite conclusions.

Hopper et al. (1963) made an experimental study on oesophageal anastomosis with and without pericardial grafts on twentyone dogs. A two layer anastomosis was performed by placing single interrupted sutures using 4/0 chromic catgut for the mucosal layer

and interrupted horizontal mattress stitches in 4/0 silk for the outer layer.

Of the twentyone dogs, ten had a strip of pericardium. During the first three days of healing, the anastomosis in both the principals and controls were relatively weak, but after the 4th day, the anastomoses with the graft grew stronger, more rapidly than those in the control, and shortened the healing period by several days. Anastomoses in principals increased rapidly in strength since relatively wide deposit of fibrin was laid down at the suture line, and a greater area became adherent through hyperplasia. Stricture formation did not occur in any case in which pericardial grafts were employed.

Archibald and Reed (1964) have stated that there is no ideal suture material for canine oesophageal surgery. Non-absorbable sutures (wire and cotton) are likely to tear through the tissue or result in granulomas. Catgut may be absorbed before healing is complete or cause excessive cicatrization. Marlex, a synthetic suture material according to the above authors appears though promising, finds 5-0 silk for the mucosa and 3-0 or 4-0 chromic catgut for the muscularis as the standard material.

Gage and Lyons (1949) state that the experimentation on the problem of comparative evaluation of different suture materials is always complicated by the presence of multiple variables such as the amount of tissue trauma, degree of bacterial contamination, integrity of haemostasis, and the amount of tension.

Catgut sutures constantly give rise to an inflammatory reaction resulting in the absorption of catgut, the method of absorption being the same as in the devitalized tissue.

According to Whipple as cited by Gage and Lyons (1949), meticulous handling of tissues, lowered the incidence of both trivial and serious wound infection, regardless of the suture material used. However, the incidence of wound infection was always considerably less with silk than catgut. Further, according to Shambangh and Dunphey, as cited by the above authors, silk causes less productive suppuration in the contaminated wound than catgut. Cotton incites less inflammatory response than silk. It may be stated here that adaptability of commercially produced cotton thread for surgical purposes, represents an economic advantage.

The use of nylon has gained the popularity

because of the high tensile strength. They believe that nylon tends to stretch and therefore the integrity of the ligature and security of the knot are questionable. Further tissue sensitivity to the plastic material is another handicap.

Gage and Lyon (1949) state that the greatest usefulness of catgut is for the apposition of the mucous surfaces within the gastrointestinal tract. Catgut avoids the formation of pendulous loop in the lumen. It is also believed that suturing mucosal layer with catgut and seromuscular layer with non-absorbable suture material, ensures intraluminal evacuation of perianastomotic abscess, if formed, between the two layers of sutures.

Guseva (1957) made histo-pathological study on the process of healing in oesophago-intestinal and oesophagogastric anastomosis from thirty specimens of anastomosis obtained from cadavers died at different intervals after the operation. After twenty four hour of operation, marginal necrosis of the mucosa of oesophagus or stomach is observed. There is oedema of the tissue. A granulation ridge begins to form which is most marked by the 4th day after surgery. Tissue oedema decreases significantly. Mucosa covers the newly formed connective tissue after three months. In the course of six months

after surgery, and in some cases even later, destructive manifestation in the nerve tissues are observed in the region of anastomosis even if some part of nerve cells and fibers near the anastomosis remains uninjured.

Inoue and Toyoji (1960) studied the healing process in experimental oesophageal anastomosis in dogs after gastrectomy and re-established the continuity by the methods i.e., esophago-duodenostomy, end-to-side esophago-jejunistomy with Braun's entero-enterostomy and Roux's Y-form anastomosis with artificial stomach like jejunal pouch.

No significant difference was evidenced among the three types of operation. In thirty days after operation regeneration and growth of nerve fibers were evidenced in the proliferated connective tissue at the anastomosis line. Regeneration of these nerve fibers was completed in 60 days after operation, when these fibers were shown to penetrate across the anastomosis line, and to re-establish the continuity between the oesophagus and intestine.

Schultz, Rodriques and Clatworthy (1962) in their study of tissue response to suture material in oesophageal anastomosis in puppies, have shown that it is maximum in chromic catgut, less in silk

and cotton, and minimum in Dacron and wire.

There is no dearth of literature on Oesophagotomies in bovines and canines and other domesticated animals, and enough material is available on the subject. Few of the records on oesophagotomy for the relief of obstruction and chocking in bovines has the been attempted successfully and recorded by Hoban (1923), Ross (1944), Blackwell (1935) and Dashinkar (1953) and others. In canine intra-thoracic and trans-thoracic oesophagotomies are reported by Wright (1933) and Knight (1951 and 1963) and others. As such no emphasis has been laid on the oesophagotomy operations.

Before concluding the review on the subject, it is imperative to mention here the different conditions involving bovine oesophagus requiring surgical interference, for the relief of which the present study has been taken up.

Mettam (1907) from a specimen recorded a case of intussuception and papillomata of the oesophagus in cow. The specimen was 6" long and flattened. The mucous membranes were adhered and upon the invaginated portion lied a papillomatous growth. This growth caused a kinking

of the lumen resulting in the invagination.

Hazelton (1922) reports a case of Emphysema due to a bone in the oesophagus of a heifer about 6" below the pharynx. The case was suspected to be suffering from indigestion but the postmortem examination revealed the presence of shank bone of sheep, firmly impacted in the oesophagus. There was a lacerated hole through the wall of the oesophagus, through which food material had escaped and gravitated downwards into the thorax and heart, causing septic pericarditis. Escaping gas from the rumen caused extensive emphysema.

Dunning (1931) recorded a case of obstruction due to a piece of glass in cow's oesophagus, which was confirmed on autopsy. The glass piece had sharp edges and points, measuring 3" x 1 $\frac{1}{2}$ ", accompanied by a large abscess in the chest cavity, where lot of food material had collected.

Menon (1931) reported a case of obstruction due to an iron sewing needle 2" long, bent and rusty, in the oesophagus of a country bred heifer. Since the needle was extracted with the help of dressing forceps, no further surgical interference was indicated.

Jones (1951) describes an unusual case of obstruction of oesophagus in the lower third of the

neck, due to a large potato firmly wedged in the oesophagus causing little damage to the oesophageal wall.

No surgical interference was possible as the animal died within half an hour after an injection of Carbamylcholine and trocharisation to relieve the tympany. A piece of wire about 3" was transfixed in left auricle, with extensive haemorrhage into the pericardium.

Morgan and Williams (1951) describe another unusual case of oesophageal obstruction in a dairy cow due to placenta and potato. The obstruction was in the lower third of oesophagus, about 6"-9" above ruminal opening. The obstruction was however, removed through ruminal opening and the patient recovered satisfactorily.

Lomberd (1962) gave an account of a case of oesophageal papillomata in a slaughtered cow.

CHAPTER - III

ANATOMY OF THE CERVICAL OESOPHAGYS.

PART-I.

GENERAL:-

Oesophagus is a musculo membranous cylindrical tube extending from the pharynx upto the stomach, having two main parts; cervical and thoracic (Anatomy of Ox- I. C. A. R. Publication, 1964). The average length of the medium sized animal is about 3-3½ feet (ca. 90 to 105 cms) with a diameter of about 2" (ca. 5 cms) (The Anatomy of the Domestic Animals by Sisson). According to Mcleod the length is 40" - 45" with an average diameter of 1½" to 2" at rest.

The cervical part takes its origin in the median plane from the ~~auditus~~ oesophagus of the pharynx, above the anterior border of crecoid cartilage of the larynx. It runs backwards and downwards till about the level of 3rd or 4th cervical vertebra. Thereafter it crosses the trachea and runs laterally along the left side, upto the thoracic inlet. This relation is maintained in the thoracic part well upto the 2nd or 3rd thoracic vertebra, after which it runs into the thoracic cavity. It does not have any abdominal part, as in horse.

According to Zigler and Hauser (1939), the

oesophagus in cattle forms a distinct curve bringing it on a level with the trachea in the lower third of the neck. Its power of contractibility is very great and there appears to be a contraction centre situated at the lowest point of this curve which assists in the process of regurgitation.

Wilkins and Rosenberger (1957) in their topographical study concluded that when a cow in normal posture, had three curves in the oesophagus. These are of practical importance in the treatment of oesophageal obstruction. The anterior most of these, is eliminated by holding the head in usual position as required for insertion of a probang. Second and third curves are eliminated when the head is held low.

RELATED STRUCTURES:-

(i) At its origin:- Superiorly Rectus Capitis ventralis major, and inferiorly the cricoid cartilage.

(ii) At its crossing at the level of lower third of the neck over the Trachea, on the left side it has longus colli superiorly and the trachea inferiorly.

(iii) At the level of 3rd Cervical Vertebra, Superiorly the left longus colli, common cord of vagus and

sympathetic nerve; common carotid artery externally; and trachea internally.

(iv) Infront of the thoracic inlet-External jugular vein externally.

Relations of the cervical oesophagus according to Mcleod are the Larynx ventrally and ventral straight muscles of the head dorsally, and the common carotid artery and vagosympathetic trunk laterally. From the 3rd cervical vertebra to the thoracic inlet, trachea is medial and the common carotid artery, vagosympathetic trunk, the selenous and Bracheocephalicus are lateral while thymus gland is ventral.

Blood Supply:- By the branches of the left common carotid artery for the cervical part of the oesophagus.

Nerve Supply:- Autonomic nerves.

HISTOLOGY:-

According to Trautman, oesophagus consists of cutaneous mucous membrane, and a muscular trunk, which in the cervical region is replaced by a loose fibrous adventetia. The latter is replaced by a serous membrane in the thoracic region.

In the Anatomy of Ox (I. C. A. R. Publication 1964) four distinct layers of the oesophageal wall have been described, namely, the mucous membrane, submucous coat, muscular coat and fibrous coat from within outward. Histologically it can be described in five different layers.

(i) Mucous Membrane:- It is the innermost layer and is directly facing the lumen. When the lumen is empty, it is thrown into numerous longitudinal folds. These folds obliterate the lumen of the tube, except during deglutition.

This layer is made up of striated squamous epithelium of cornified type and rests over the base-tunica propria. The tunica propria has got closely woven collagenous fibers and some elastic fibres (Plate- 1 and 2).

(ii) Muscularis Mucosae:- It is made up of longitudinal muscular fibers which are complete in man, but in bovines and some other animals they are seen only in few isolated bundles.

(iii) Submucosa:- This is the layer which attaches the mucous membrane to the muscular coat very loosely. This loose nature of the submucosa allows the formation of numerous mucosal folds and thereby completely separates the mucosal and the muscular coats.

(iv) Tunica Muscularis:- Is made up of two main layers, the inner layer being of circular muscle fibers and



Plate No. 1. Oesophagus showing normal Mucous Membrane. H. E. x 100



Plate No. 2. Oesophagus showing normal Mucous Membrane. H. E. x 400



Plate No. 1. Oesophagus showing normal Mucous Membrane. H. E. x 100



Plate No. 2. Oesophagus showing normal Mucous Membrane. H. E. x 400



Plate No. 3. Oesophagus, Tunica Muscularis
H.E. x 100

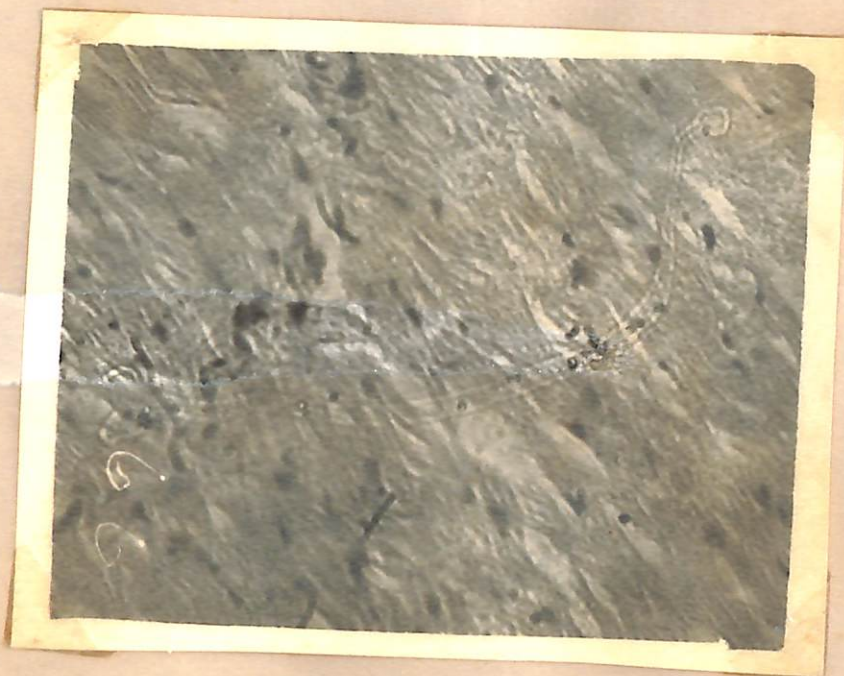


Plate No. 4. Oesophagus, Tunica Muscularis
H.E. x 400



Plate No. 3. Oesophagus, Tunica Muscularis
H.E. x 100



Plate No. 4. Oesophagus, Tunica Muscularis
H.E. x 400

with the help of the fingers, and is cleared by blunt dissection to go deeper into the groove. Oesophagus embedded in loose connective tissue, is readily felt. It is separated from its bed and lifted out to the level of the skin. Here one should be careful not to damage the Recurrent Laryngeal Nerve which runs in close association and is almost adhered with the oesophagus in the adventitious tissue. This is very tortuous in course and must be carefully separated by blunt dissection, before proceeding with the operation under study.

outer of longitudinal muscle fibers. These muscular fibers are mostly of striated nature (Plate 3 and 4).

(v) Tunica Adventetia:- Is the outer most connective tissue layer covering the muscular layer and is made up of loose fibrous connective tissue.

VESSELS AND NERVES:-

Vessels:- They run longitudinally in the sub mucosal layer, with the ramification of these branches in all the layers. Large venous plexus may be found in the cervical end of the oesophagus.

Nerves:- They are present in the submucosa and their branches penetrating all the layers. They may be seen as plexuses in the submucosal layers and between the muscular layers.

PART-II.

SURGICAL ANATOMY:-

The oesophagus, as described earlier lies most laterally and nearer to the skin in the lower third region of the left side of the neck. Ziegler and Hauser (1939) also agree that oesophagus describes a definite curve in the lower third of the neck, which brings it on a level with the trachea.

The operative site selected for the present

project was the juncture of middle and the lower third of the neck. The area on the left side of the neck is examined and an incision made superiorly to the jugular furrow. Immediately below the skin lies the fascia-superficial and deep. Underlying the fascia is the jugular groove which is covered and bounded by a layer of muscles. Superiorly forming the dorsal margin of the oesophagus is the Brachio Cephalicus Muscle. Inferiorly lies the Sternocephalicus muscle, which has got the superficial part known as Sterno mandibularis, and the deep branch known as Sternomastoideus. The Sternomastoideus part is placed deeper than the Sternomandibularis.

By blunt dissection, the Brachiocephalicus and the Sternomandibularis division of Sternocephalicus are separated to expose the deeper structures, embedded in the jugular groove. The first and the foremost structure to be encountered is the jugular vein which is easily recognised by its characteristic large size and dark colour. Below this, is the carotid artery, vagosympathetic trunk and the internal jugular vein. All these structures are bounded by loose connective tissue and lie on the dorso-lateral aspect of the trachea. Little difficulty is encountered in recognizing these three structures.

To reach the oesophagus, the carotid sheath along with its structures, is pressed slightly downwards

with the help of the fingers, and is cleared by blunt dissection to go deeper into the groove. Oesophagus embedded in loose connective tissue, is readily felt. It is separated from its bed and lifted out to the level of the skin. Here one should be careful not to damage the Recurrent Laryngeal Nerve which runs in close association and is almost adhered with the oesophagus in the adventitious tissue. This is very tortuous in course and must be carefully separated by blunt dissection, before proceeding with the operation under study.

C H A P T E R - I V
M A T E R I A L S A N D M E T H O D S .

P A R T - I

O P E R A T I V E S U R G E R Y .

MATERIALS:-

(1) Selection of Animals:-Buffalo calves, representing the bovine species, which could be easily available, were selected for the present study. Animals were procured at different intervals and soon after their receipt, a preliminary examination was done and temperature, pulse and respiration were recorded. This was done to ensure that they are reasonably healthy so that the results of the present work may not be materially affected. All the selected animals, thus, were apparently healthy.

When purchasing the animals, care was taken to have them of the same age and live body weight. Approximate age varied between one and half to two years, while the body weight varied rather widely from 184 Lbs. to 285 Lbs. The body weight was calculated by measuring the length and girth in inches, according to the standard formula—

$$\frac{L \times G^2}{300} = \text{Body weight (Lbs).}$$

(2) Design of the Experiment:- Before proceeding with the actual operation, the selected animals were divided at random into different groups. In total, twentyfive buffalo calves were used, and they were divided into four groups. Of

these, first three groups had six animals in each, and in the last group, which constituted a miscellaneous group, had seven animals. In the first three groups, silk and chromic catgut alone were used as suturing materials, while in the miscellaneous group different suturing materials were used, other than/ silk and chromic catgut.

(3) Suturing Material:- The different sutures studied in the present study were:--

- (i) Silk- 2/0
- (ii) Chromic Catgut- 3/0
- (iii) Cotton- mercerised commercial.
- (iv) Nylon- dermal coarse.
- (v) Vetafil.
- (vi) Linen.

Of the above sutures, silk and chromic catgut were used in larger number of animals than the other sutures.

METHODS:-

PREOPERATIVE PREPARATIONS:-

(A) Clinical Examination:-The following clinical examinations were made before finally proceeding with the operations:-

(i) Temperature, pulse and respiration:- As already stated above, temperature, pulse and respiration were daily recorded at rest. (Table No.3). The average findings are shown

in Table No.4.

(ii) Faecal sample examination and treatment:-The faecal samples were examined as per the usual procedures for any parasitic or protozoan infestation. All the buffalo calves, in general, harboured stomach and intestinal worms, belonging to the species of Haemonchus, Bunostomum (very common) strongyles. A few suffered from Coccidiosis. They were treated suitably (Phenothiazine, Carbontetrachloride, Sulphamezathin 5 gm. Tablets - ICI) in the prescribed doses. After the administration of the drug an interval of seven days was allowed, before taking up the operation.

(iii) Ectoparasites:- Ticks and lice infestation, if found were treated suitably with Gammexene lotion.

(iv) Haematological studies:- Was done primarily for anaemia and blood borne protozoan infection. Nothing significant was found (Table No.5 and 6).

(v) Recording of body weight:- The body weight of individual animal was again calculated and recorded (Table No.8).

(B) Preparations Twentyfour Hours Prior to Operation Day:- The buffalo-calf to be operated upon the next morning was selected at random. It was given a bath and the skin of the left side of the neck was scrubbed thoroughly, shaved and cleaned with soap and

water.

Only light feed was allowed in the morning consisting of small amount of straw and green grass. It was then separated from others to a clean dry stall. Water was given ~~and~~ libidum for the whole day.

(C) Preparations on the Operation day:-

(i) Preparation of Animal:- Operation was always done in the forenoon.

Before proceeding with the actual preparation of the operative site, temperature, pulse and respiration were recorded.

The left side of the neck was scrubbed with soap and water, and finally with Savlon lotion.

(ii) Sterilisation:- Sterilisation of instruments, drapes, gauze, cotton, and other necessary appliances including the disinfection of the Surgeon's hands, was carried out properly.

Suturing materials such as silk, cotton, nylon and linen were sterilised by boiling along with other instruments. B. P. Blade and Dovan's clamps were sterilised with conc. Savelon solution.

(iii) Antisilagogue:- To check excessive salivation 1/8 grain of Atropine Sulphate was given subcutaneously approximately fifteen minutes before the

operation.

(D) Anaesthesia:-

(i) Narcosis:-Chloral hydras in the doses of 4 ^{drachms} ~~oz.~~ was used as sedative. The animal was drenched atleast half an hour prior to the operation.

(ii) Local infiltration:-Procain Hydrochloride 2¹/₂% solution was used as local anaesthetic and 20 c.c. of the drug was infiltrated subcutaneously in a linear fashion along the line of incision in the left jugular furrow.

(E) Positioning of the Animal:-The animal was cast on its right side and properly secured. The head and neck regions were kept over a Makintosh sheeting. The head was extended little forward and backward, to keep the region of jugular furrow well exposed.

OPERATION:-

The site of operation was finally painted with Tr. of Iodine, and the drapes applied, leaving the operative site completely exposed. Drapes were also applied over the part of shoulder and thorax region, to avoid contamination.

(i) Incision:- Length of the exposed part of neck was measured and a point at the juncture of the

middle and the lower part of the neck was marked. An incision nearly 2" extending on each side of the said point was made. Allis forceps applied to expose the underlying tissue (Plate No.5).

(ii) Exposure:- The exposed superficial and deep fascia was cut through, by blunt dissection with the help of small artery forceps. The area was mopped with sterilised gauze and the bleeding points checked, if any, by artery forceps and sometimes by ligation. Then the muscles-Brachiocephalicus and Sternocephalicus, were as far as possible, separated by blunt dissection. Mayo's dissecting scissors were used to cut the fascia to facilitate the separating of the above muscles in order to have a good exposure of the deeper structures. Bleeding points from the muscular tissue were checked, and the site mopped with sterilized gauze.

Just below the muscular tissue, external jugular vein became visible. It was separated gently further in the groove. Carotid sheath containing the common carotid artery, internal jugular vein, and vagosympathetic nerve, was located and gently separated.

Just below the carotid sheath, laterally to the trachea lied the oesophagus. All possible care

STAGES OF OESOPHAGEAL END - TO - END ANASTOMOSIS

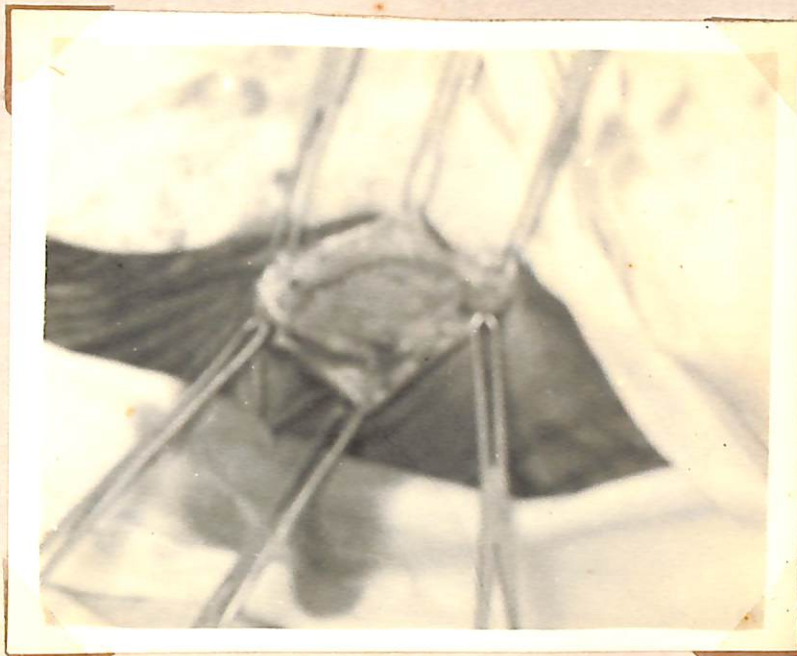


Plate No. 5. Skin incised to expose the fascia and muscles.

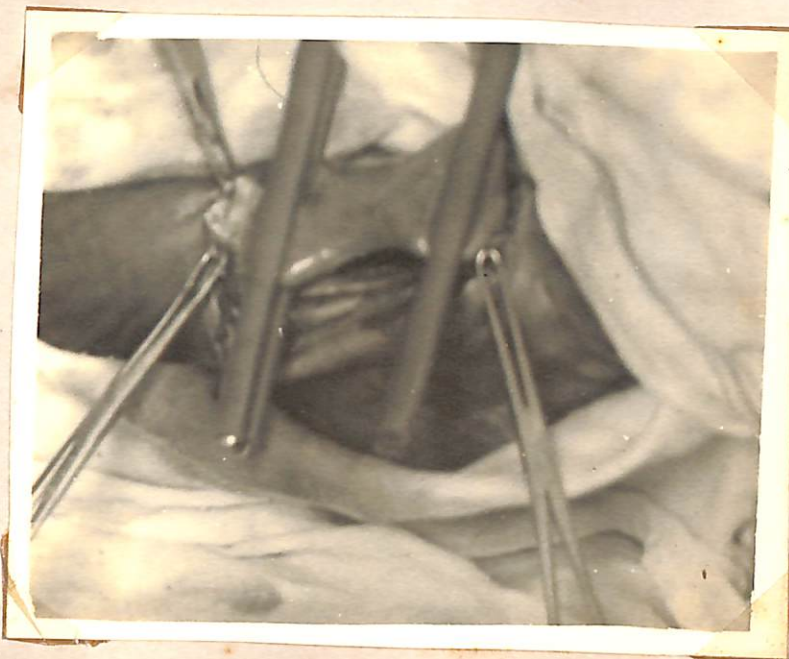


Plate No. 6. Oesophagus exposed, Clamps in position.

was taken to avoid any injury to the vessels and nerves in the vicinity. This part of the procedure was accomplished by blunt dissection with fingers alone.

(iii) Exposure of Oesophagus:-It was freed from its fascial bed by blunt dissection and was brought upto the surface. It was kept resting over long straight artery forceps. Recurrent laryngeal nerve was also separated along with the fascia, and making the oesophagus completely free for the resection (Plate No.6 and Fig.1).

(iv) Recording of the Oesophageal Diameter:-First the circumference was noted by passing sterilised nylon thread round the oesophagus at one point and then measuring the length of the thread in centimeters.

After the completion of the operation, the diameter of the oesophagus was calculated on the basis of circumference already noted(Table No.8).

$$2 \pi r^2 = \text{Circumference.}$$

While taking the measurement of the oesophageal circumference, it is necessary to keep the oesophagus empty of the ruminal contents. The bulging of the oesophagus with the contents will surely affect the circumference.

(v) Oesophagectomy:-Sterilised piece of gauze was placed below the exposed part of oesophagus. Doyan's Clamps were applied about 1" apart. Help from an assistant

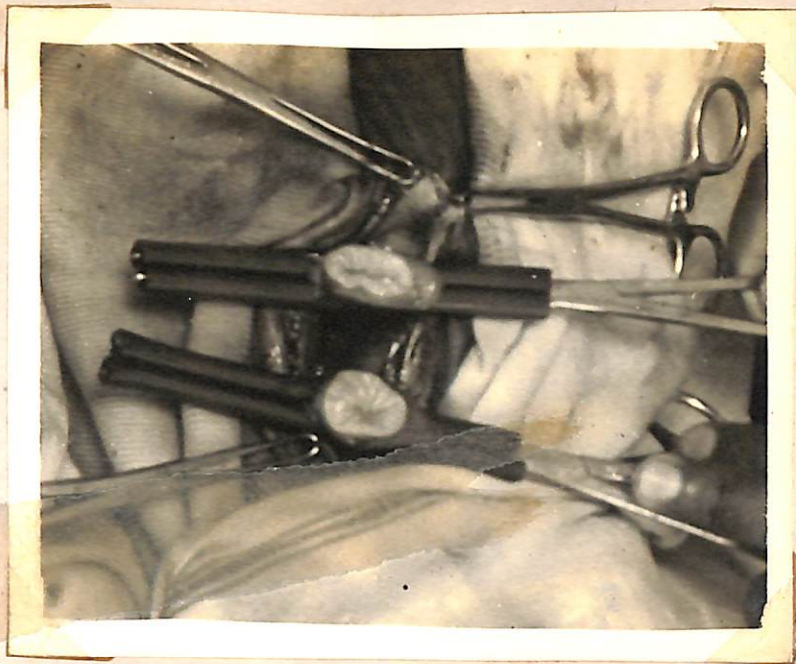


Photo No. 7 : Stomach isolated and separated.

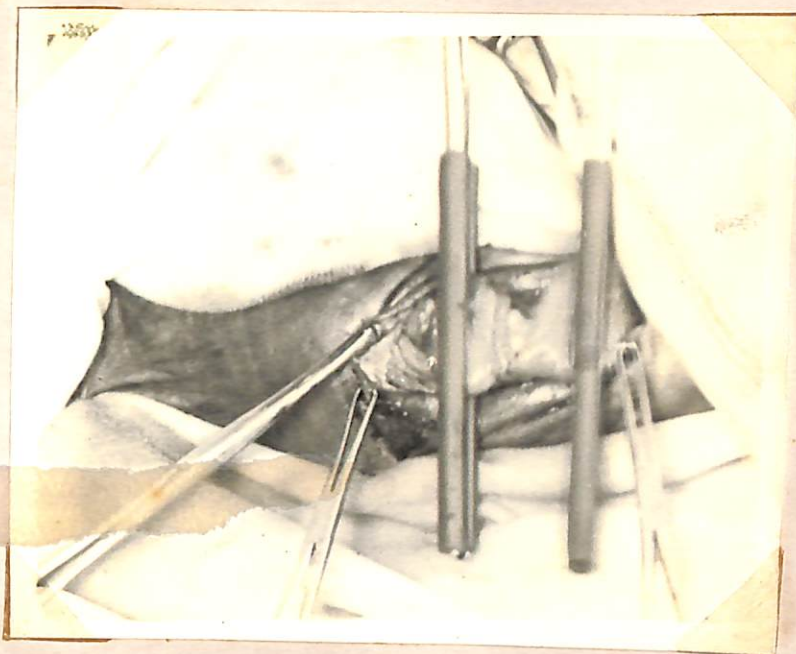


Photo No. 8 : Fixation of the stomach in position.

was required to hold the oesophagus. Before pressing the jaws of the clamps, it was ensured that ruminal contents were not present in the oesophagus anteriorly to the clamps, to avoid regurgitation or aspiratation into the trachea, during the operation.

The oesophagus was then incised in the middle of the clamped portion with scalpel. Immediately the cut ends of the oesophagus were mopped with sterilised gauze, to remove the contents if any, sticking to the mucosa (Plate No.7, Fig. 2). The piece of gauze placed under the oesophagus, before incising, was also removed and the site mopped again with sterilised gauze. These precautionary measures, are necessary to avoid contamination from ingesta.

The exposed oesophagus was kept all along moistened with warm normal saline, to avoid necrosis or dehydration of the part.

(vi) Resection of the Oesophagus:-This step was included in the IVth group (Miscellaneous one) only. In all other groups direct end-to-end anastomosis was done after the resection. A portion of 2" and 3" were removed from two groups of three animals each.

END-TO END-ANASTOMOSIS:-

Two techniques were adopted; one as

described by Archibald and Reed (1964) for canine oesophageal anastomosis (two layers of sutures-Mucosa and muscularis sutured separately), and the other being slightly different in the present study (only one layer of suture- Mucosa and muscularis sutured together).

The said standard technique was applied in sixteen animals, while modified one was adopted in the remaining animals.

ARCHIBALD AND REED TECHNIQUE:-

The cut ends of the oesophagus were brought close together for the anastomosis. Atraumatic half circle curved needle with the type of suturing material as laid down in the experiment, was held in the needle holder. The mucosa along with the submucosa was held with rat tooth forceps in the one hand, and suturing done by the other hand. The suturing was started from the inner face of the mucosa, directly coming in contact with the reminant portion of food material in the lumen. The needle pierced the mucosa from inside to the outside of one end of the cut oesophagus and continued to the other side of cut end, piercing and coming through the mucosa from outside to the inside, thus reaching into the lumen of opposite cut end. A simple knot was placed after drawing the

SCHEMATIC FIGURES TO SHOW THE TECHNIQUE OF
OESOPHAGEAL ANASTOMOSIS . (FIGURES 1 TO 6)
ARCHIBALD AND REED TECHNIQUE (1964)

Fig. 1 : Oesophagus clamped

Fig. 2 : Oesophagus incised and separated. Mucous
& Muscular layers can be distinctly marked.

Fig. 3 : Distal row of mucosa sutured. Note the
position of knots.

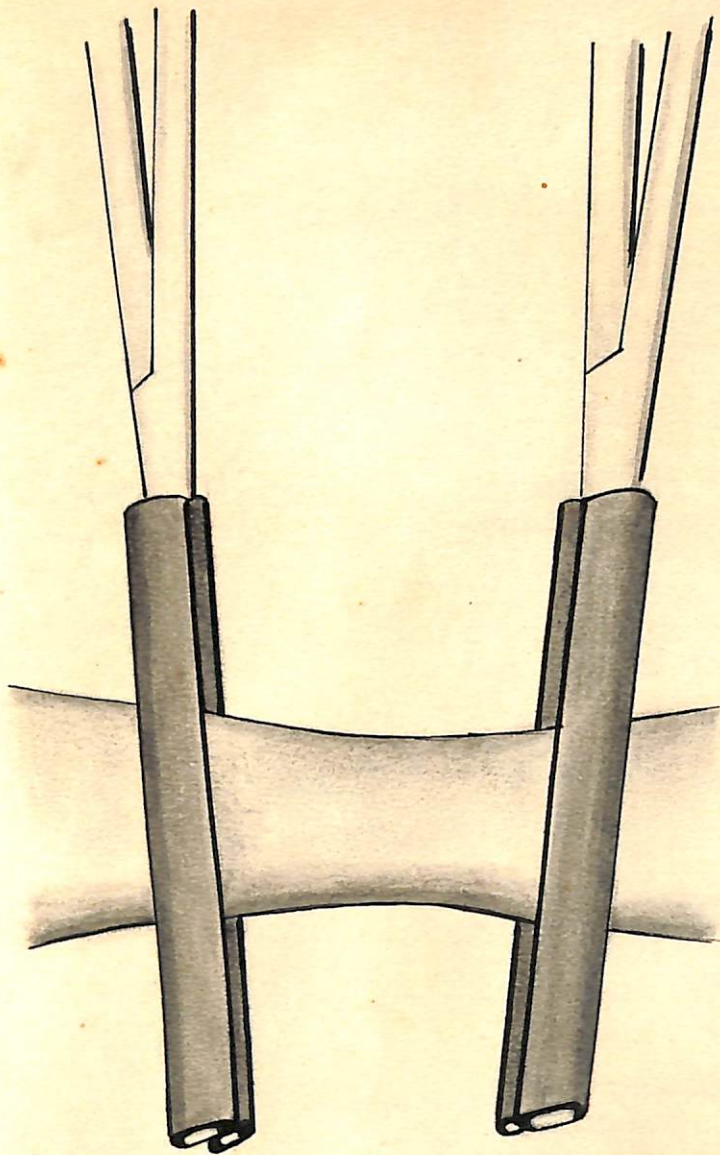


Fig.-1

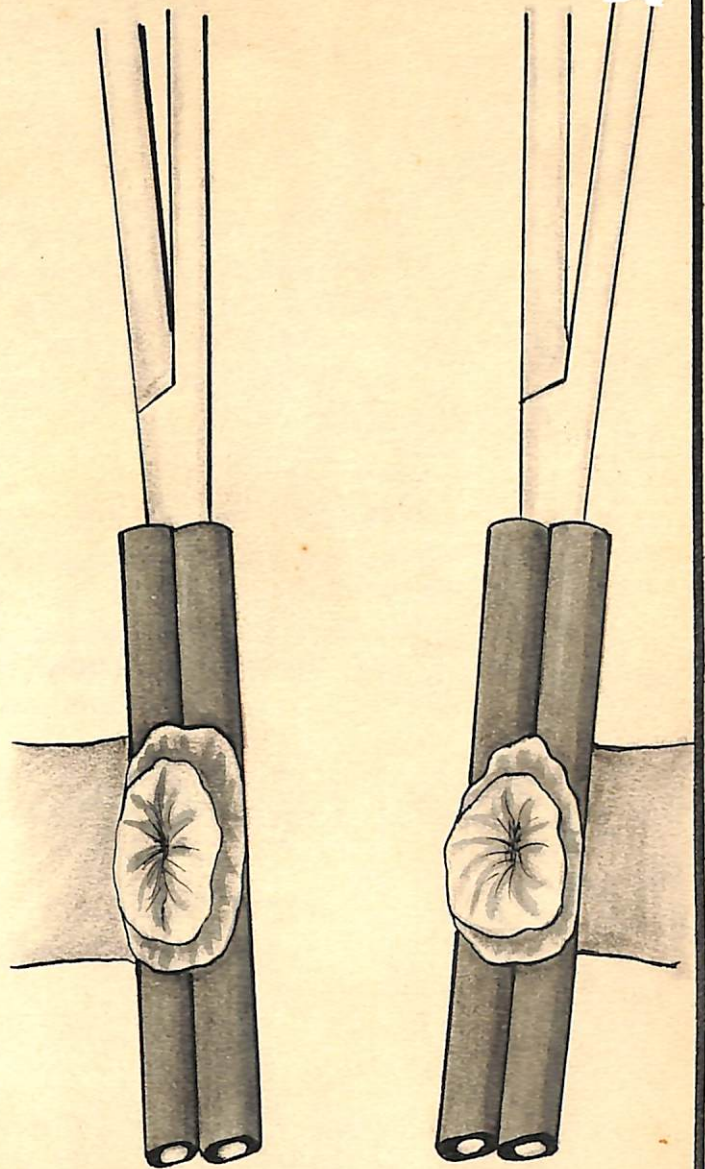


Fig.-2

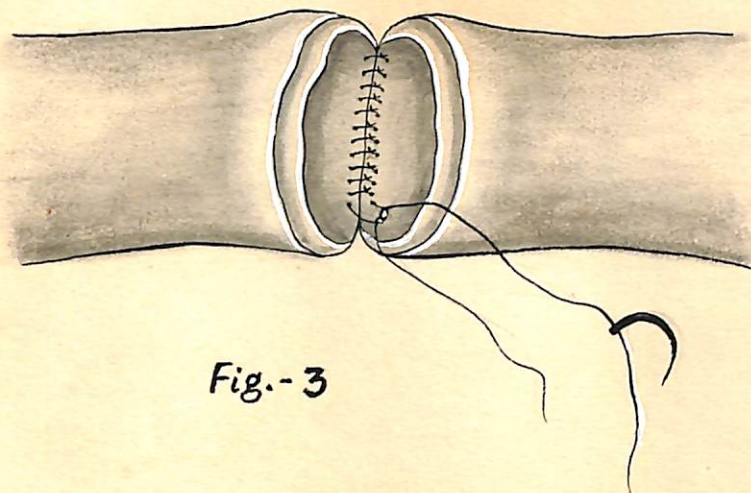


Fig.-3

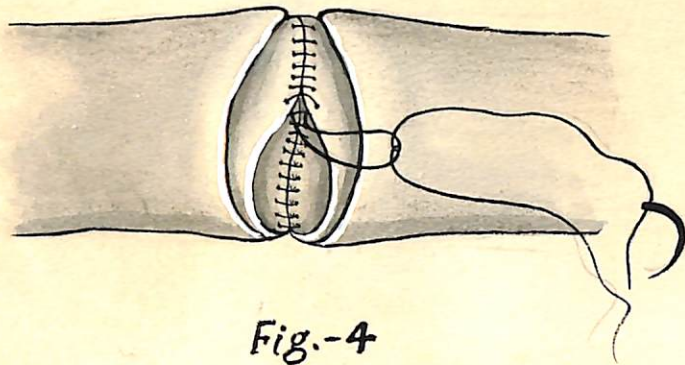


Fig.-4

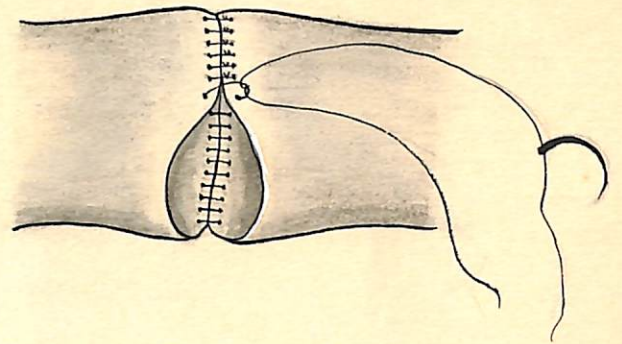


Fig.-5

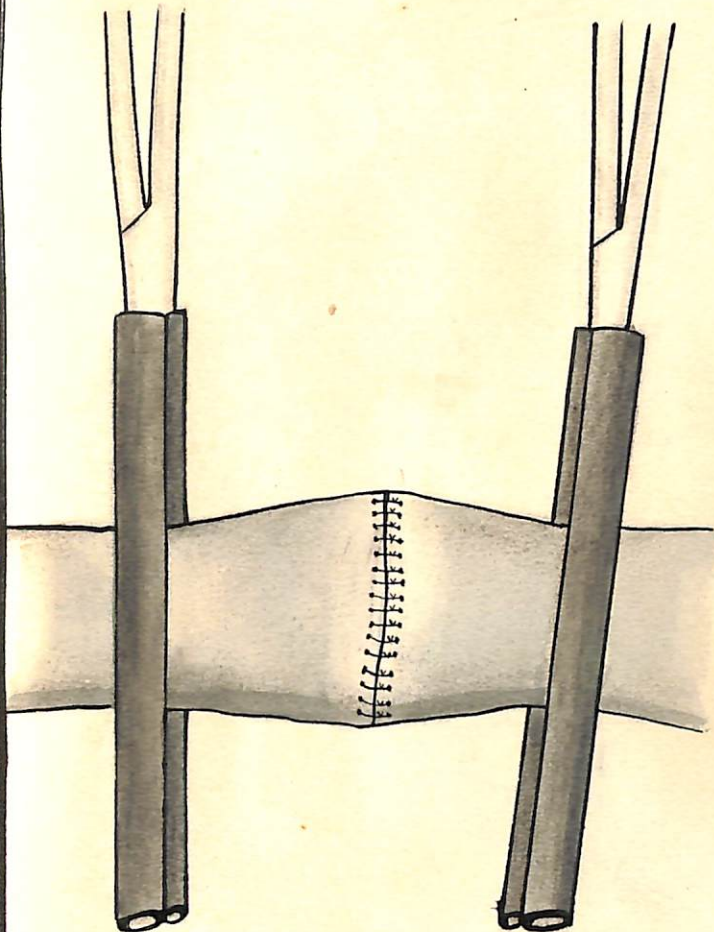


Fig.-6

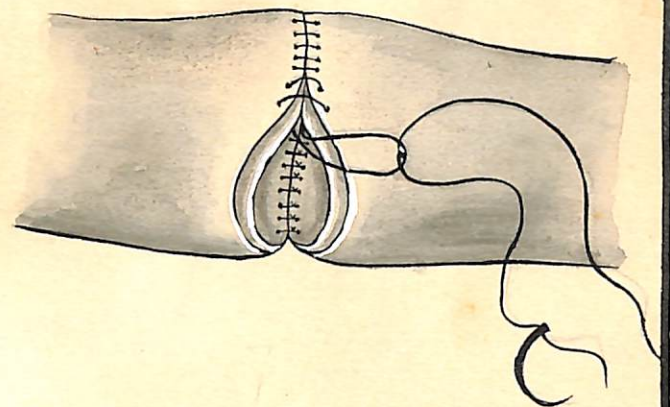


Fig.-7



Plate No. 9 : Anastomosis of the mucosa completed and suturing of the muscular layer in progress.

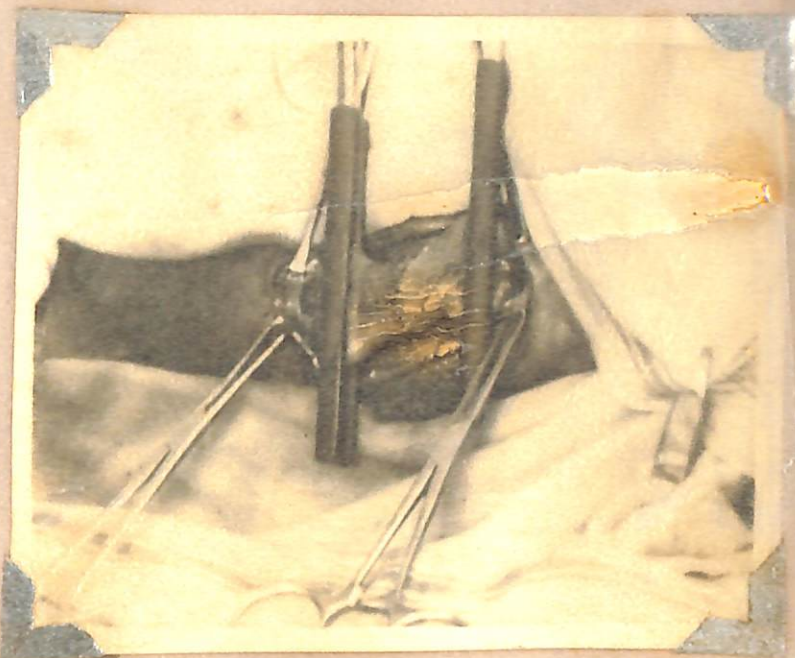


Plate No. 10. : Oesophageal Anastomosis completed.



Plate No. 9 : Anastomosis of the mucosa completed
and suturing of the muscular layer in
progress.

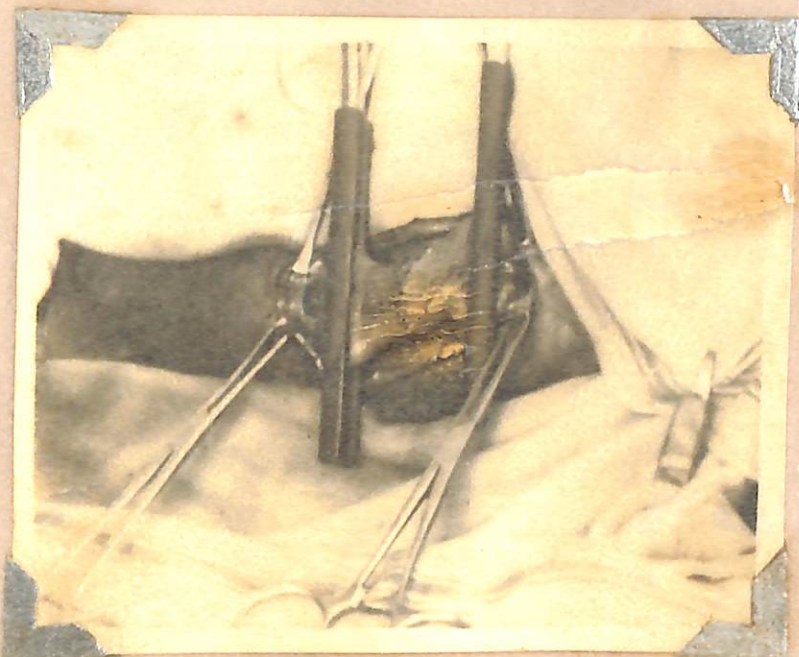


Plate No. 10. : Oesophageal Anastomosis completed.

two cyt ends together, on one side of the lumen (Plate No.8, Fig.3 and 4). Such simple interrupted sutures were continued and the knots placed within the lumen of the oesophagus, till the two cut ends of the oesophagus were reunited. Suturing was done atleast 2-3 mm.from the cut end and so were the knots placed 2-3 mm.apart. The cut edges were inverted while tying the knots.

Before proceeding with the muscular layer, the mucosa was again examined and ensured that no such opening was left, which may result in leakage with subsequent fistula formation.

Muscular layer was sutured in the similar way, with the difference that the knots this time, being placed outside, as done in normal interrupted sutures(Plate No.9, Fig.5).

In this way anastomosis was completed (Plate No.10, Fig.6). It may be noted that no knots were placed in between the two layers of the oesophagus.

MODIFIED TECHNIQUE:-

The technique being basically the same, as described by Archibald and Reed (1964), with the difference, that while suturing, both the layers (mucosa and the muscularis) were included thus accomplishing anastomosis with only one layer of suture. The suturing material was introduced from the inner face of the mucosa piercing the submucosa

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during the post operative period.

Finally the skin was placed into apposition with the help of Allis forceps and suturing was done with Nylon sutures, in the horizontal Halsted fashion.

After completing the closure of the wound, the incision site was cleaned with Rectified spirit and then sealed with collodian pad.

POST OPERATIVE CARE AND MANAGEMENT:-

Recovery after the operation:- Recovery was quite normal in most of the animals, and were able to stand and walk within one to two hours of the operation. In a few cases, recovery period extended upto four hours.

Recording of Temperature, Pulse and Respiration:-After the completion of the operation, temperature, pulse and respiration were recorded. Daily recording was done every morning and evening till the 8th day of the operation, when the sutures were removed. (Table 10.3).

Post Operative Treatment:-

1) Antibiotics:-Antibiotics treatment was started from the operation day. A daily dose of Combiotic $\frac{1}{2}$ gm. formula, large dose vial- was injected intramuscularly for three consecutive days in the dose of 4 c.c. on the 1st day, and 3 c.c. on each of the following 2 days.

Use of Combiotic was only limited to 1st three groups, and Buff. Calf No.1A of the last group. In the

miscellaneous group, except the Bull Calf No.1A Dicrystacin (half gram- formula- large dose vial-Squibb) was tried, which has the same efficacy as that of Combiotics. The vial of Dicrystacin was dissolved in 7 c.c. of distilled water, of which 3 c.c. was injected on the 1st day, and 2 c.c. on each of the following successive two days.

2) Local Treatment:- The surgical wound was examined daily for any post-operative complication, and dressed with spirit Ractificatus alone. In the first two groups, application of Terramycin liquid was locally applied, to check secondary infection.

3) Glucose Therapy:-Was necessary as the animals had to be fasted for atleast fortyeight hours after the operation. Dextrose solution 10% 200 c.c. was injected daily I/V for three consecutive days.

Besides the above usual therapeutic measures special treatment, when indicated, as a result of some post-operative complications, was suitably done. Animal No.9 became very weak, and was unable to get on its feet. The temperature was however, normal. Glucose 20% 200 c.c. was given intra-venously for further three days. In Buff. Calf No. 10, the operative site was found to have become septic with few maggots. It was treated

with Oil Turpentine for first two days, followed by daily cleansing of the wound with rectified spirit and application of dressing oil. The wound healed up in ten days time.

Removal of Sutures:- Stitches were removed on the 8th day of operation, with pre-sterilised scissors and forceps. After their removal the site was cleaned with rectified spirit.

In Buff. Calf No.3, the wound gaped after few hours of the removal of sutures, while in Buff. Calf No.20 also, the wound got opened on the 11th day. However, in both cases, they were attended to, and were resutured with Nylon in Halsted pattern. These stitches were subsequently removed on 8th day. There were not further post-operative complications.

Management and Feeding:- The animals after the operation were maintained for a period of thirty days after which they were destroyed and the tissue of the anastomosed site were collected for the study of Surgical Pathology.

Each animal after the operation was kept under complete fast for fortyeight hours, but water only was allowed ad libidum. However, dextrose was given

parenterally as already discussed above. For the first twentyfour hours the animal were very dull and depressed, but gradually started grazing and showing signs of appetite.

After fortyeight hours, green grass (Berseem or Elephant grass according to the availability) was given. If the animal took it without showing any signs of difficulty in swallowing, the quantity being increased gradually. From the sixth day, paddy straw in addition to green grass was also given. Grazing was allowed for a limited period, both in the morning and evening.

Those animals which showed any difficulty in swallowing, were offered green grass only.

A close watch on all the experimental animals was maintained until they were destroyed.

PART -II.

S U R G I C A L P A T H O L O G Y .

DESTRUCTION OF ANIMALS AND COLLECTION OF TISSUE MATERIAL:-

Animals were destroyed on the thirtieth day of operation by euthanasia giving saturated solution of Magnesium Sulphate. Oesophagus was exposed, and portion of 4" piece along with anastomosed part in the middle, was

removed and preserved in 10% formal- saline.

When the experimental animals died before the due date (six animals), their tissues were also collected for the above study.

Preparation of the slides for study of Surgical Pathology was done by standard technique under proper guidance. Microphotographs showing the Pathological Changes undergone in the course of operative process till the final healing (30th Post-operative day), are affixed herein. Special features as seen are mentioned against each such microphotographs in the Chapter of Observation and Results.

CHAPTER - V

OBSERVATIONS & RESULTS

Suturing materials used in the present plan were black braded silk 2-0, chromic catgut 3-0, braded silk and chromic catgut combined, commercial mercerised cotton, Nylon - dermal coarse, Vetafil, and Linen. Emphasis was however laid upon the first three types only.

The technique in this study was same as advocated by Archibald and Reed (1964) for canine oesophageal anastomosis. In nine of the twentyfive buffalo calves operated upon, slightly **different** technique, was employed.

G R O U P - I

Buffalo calf No. 1. The animal weighed 211 lbs. approximately. The R.B.C. and the differintial count was normal. For anastomosis, chromic catgut was used for the muscular layer and black braded silk, for the mucosa.

(The animal was sacrificed on the 30th post-operative day). No untoward symptoms were noticed during the period of recovery. On necropsy of the anastomosed part, an extensive area of adhesions and fibrosis was marked around the adjoining muscles. Catgut was still not fully absorbed and could be seen on the muscular layer. Silk employed for mucosal layer was however not visible.

Buffalo Calf No. 2. Animal weighed about 250 lbs. Total R.B.C? and Differential ^{count} revealed no abnormality. Anastomosis was completed, using chromic catgut (3-0) and Silk (2b) for the mucosal and the muscular layer respectively. The oesophageal diameter recorded after destruction, was 2.4 cms.

During the post operative period of thirty days, no untoward symptoms were noticed. Only slight difficulty was marked on the third post-operative day in swallowing green grass.

The animal was sacrificed on the 30th day. Fair degree of adhesions were noticed. Silk suture material on the muscular layer was found to be intact while catgut was not visible.

Buffalo - Calf No.3:- Approximate body weight 204 lbs. Total count and Differential leucocytic count was within the normal range. Diameter of the oesophagus prior to oesophagectomy was 2.64 cms.

Silk
The muscularis and the mucosa were sutured together by single layer technique for anastomosis using silk only.

When skin stitches were removed on the 8th post-operative day, the disruption of wound took place. The skin had to be resutured after debriding the wound margin, and the wound then healed up normally.

The animal was destroyed on 30th day. On examination extensive adhesions and fibrosis were noticed around the anastomosed part. Pronounced inflammatory changes around few knots were visible (Plate No. 12 A).

Microscopical examination revealed marked leucocytic infiltration around them, (Plate No. 12B & C).

Buffalo Calf No.4 :- Approximate body weight 243 lbs.

Haematological picture was normal. Oesophageal diameter prior to operation and after destruction was found to be 2.1 cm. and 2.3 cm. respectively.

Anastomosis was done with chromic catgut by placing only one row of sutures through both the layers. No post operative complication was noticed and the animal was destroyed on 30th day.

Fibrosis was marked and around few points on the mucosa incomplete absorption of catgut plus marked fibrosis were noticed. Microscopical examination showed oedematous changes in the submucosa and small areas of leucocytic infiltration.

Buffalo Calf No.5 :- Approximate body weight 285 lbs. Total and differential blood picture normal. The oesophageal diameter, prior to operation was 2 cms.

With silk two separate rows of sutures were placed. Slight difficulty in swallowing was noticed on the 8th day when fed on straw but did not evince any difficulty when offered greens. The animal was destroyed on 30th day.

Chromic catgut

Gross examination of the anastomosed part showed few silk knots on the muscular layer, while mucosal layer was completely free.

Buffalo Calf No.6 :-Approximate body weight 251 lbs. Total and differential count were within the normal limit. Prior to operation, and on autopsy the oesophageal diameter was 3.1 cm. and 2.4 cm. respectively.

Chromic catgut was used by placing two rows of sutures for anastomosis. No complication was noticed during the post operative period. The animal was destroyed on 30th day.

Catgut was visible in the muscular layer while mucosa appeared perfectly anastomosed. Microscopical examination showed epithelial layer slightly thickened. Congestion of blood vessels and oedematous changes were also marked in the submucosa. Some infiltration of the mucosa with round cells were noted.

G R O U P - II.

Buffalo Calf No.7 :-Approximately body weight 240 lbs. Total and Differential count was within normal range. Oesophageal diameter prior to oesophagectomy and after destruction were 2.1 cms. and 2.7 cms. respectively.

Two layer technique using silk was employed for anastomosis. The animal showed no post operative complications and was destroyed on 30th day.

On gross examination, fibrosis was found comparatively less, than in Buff. Calf No. 5. Traces of silk were seen on the muscular layer only and in mucosa scar was evident. Inflammatory reaction was comparatively mild.

Histological examination revealed normal reparative changes.

Buffalo Calf No.9:-Approximate weight 274 lbs.

Oesophageal diameter prior to operation was 1.9 cms.

In this case two layer technique was employed using chromic catgut for mucosa and silk for the muscular layer. No complication at the site of operation was noted though the animal showed signs of unthriftiness. As such the animal was suitably treated and then destroyed on 30th day.

On examination of the anastomosed part showed fibrosis and adhesions. Catgut had completely absorbed (Plate No.18) while the silk was visible on the muscular layer. Nothing significant was revealed on microscopical examination.

Buffalo Calf No.10:-Approximately weight 220 lbs.

Blood picture normal. Oesophageal diameter prior to operation was 1.7 cms. For anastomosis using silk, one layer technique was employed. On the 10th post operative day slight wound infection was noticed and treated suitably.

The animal was destroyed on 30th day. Marked adhesions and fibrosis were noticed. Histological examination showed usual inflammatory changes.

Buffalo Calf No.11:- Approximate weight 192 lbs. Blood picture was normal. Preoperative oesophageal diameter was 2.2 cm.

For anastomosis two-layer technique using catgut was employed, but the animal suddenly died on the 16th post operative day. On autopsy oesophageal stricture was noticed. There was also excessive fibrosis, and induration of the anastomosed part. Inflammatory changes were pronounced.

Buffalo Calf No.13:- Approximate weight 206 lbs. Haematological picture was within normal range. Preoperative oesophageal diameter was 2.4 cms.

For anastomosis one layer technique using catgut was employed. Animal showed no post operative complications and was destroyed on 30th day.

Anastomosed portion showed marked fibrosis. Histopathological examination of tissue revealed extensive inflammatory changes. (Plat No.16 A to D).

Buffalo Calf No.15:- Approximate weight 184 lbs. Blood picture was normal. Oesophageal diameter preoperative and after destruction of the animal was 2.7 and 2.9 respectively.

To anastomose two-layer technique using silk for mucosa and catgut for muscularis was employed. The animal made uneventful recovery and destroyed on 30th day. Gross examination of the lesion showed extensive fibrosis and adhesions. Suturing materials were not visible on any of the two layers. Histopathological examination revealed inflammatory changes and few giant cells.

G R O U P III.

Buffalo Calf No.14:-Approximate body weight 222 Lbs. Haematological picture was normal. Prior to oesophagectomy diameter of oesophagus was 1.9 cms.

For oesophageal anastomosis, two layer technique with only chromic catgut was employed. The animal suddenly died on 26th day, and on autopsy the anastomosed region showed considerable oesophageal dilatation with accumulation of food material (Plate No. 15).

Buffalo Calf No.12:-Approximately weight 233 Lbs. Blood picture normal. Oesophageal diameter prior to oesophagectomy and after destruction were 2.6 and 2 cms. respectively.

Oesophageal anastomosis was performed by single layer technique using silk.

The animal showed no post operative complication and destroyed on 30th day. Slight degree of fibrosis was noticed around the anastomosed part. Microscopical examination of slides revealed usual inflammatory changes (Plates Nos.14 A & B).

Buffalo Calf No. 19 :- Approximate weight 203 lbs. Blood picture was within normal range. Oesophageal diameter prior to operation and after destruction was 2.5 cms. and 1.8 cms. respectively.

For anastomosis two layer technique was employed, using silk for the mucosal and catgut for the muscular layers. The animal showed no post operative complication and destroyed on 30th day. Fibrosis was much less marked. Catgut was still unabsorbed while silk was not visible. Nothing significant was noted on microscopic examination, (Plate Nos. 17 A to D).

Buffalo Calf No. 16 :- Approximate weight 191 lbs. Total and Differential count was normal.

For anastomosis, two layer technique using silk only was employed. The animal survived till 30th day when it was destroyed. Gross examination of the operated part showed that the healing has been quite satisfactory. Histopathological examination revealed mild degree of fibroplasia with usual inflammatory changes.

Buffalo Calf No. 18 :- Approximate weight was 265 lbs. Haemogram was normal. Preoperative and post-destructive oesophageal diameters were 2.1 cm. and 2.9 cm. respectively.

Anastomosis was established by suturing the mucosa with catgut and muscularis with silk. During the

post operative period symptoms of dysphagia followed by regurgitation were noticed, which lasted upto three weeks and then the animal destroyed on 30th day. Gross examination showed adhesions. Clean and well marked scar line was seen around the mucosa, along the suture line. Due to excessive cicatrisation, the area had become hard. Anastomosed zone showed inflammatory area.

Buffalo Calf No. 8 :- Approximate weight 243 lbs. Total and Differential count was normal. Preoperative oesophageal diameter was 2.1 cms.

Anastomosis was done by employing one layer with chromic catgut. Animal showed no post operative complication and was destroyed on 30th day. Varied degree of adhesions were noticed all around the site of anastomosis. On exposing the lumen, prominent scar mark was seen on the mucosal wall. Inflammatory changes were less marked.

G R O U P IV.

The main distinguishing feature of this group compared with the other three, is this, that instead of silk and catgut, other suturing materials like cotton, nylon, vetafil and linen have been studied. Oesophageal resection of 2 and 3 inches long has also been included.

Buffalo Calf No.17:- Approximate body weight 240 Lbs. Total and Differential count was within normal range. Pre and post operative oesophageal diameters were 1.7 cms. and 2 cms. respectively.

One layer technique was employed for anastomosis with fine cotton. After resecting 2 inches of oesophagus, two ends were anastomosed. The animal showed intermittent symptoms of dysphagia and regurgitation from 10th day of the operation.

Buff Calf No.1A:- Two layer technique was employed using cotton thread. No post operative complications were observed through out the observation period. On autopsy marked adhesions were noticed. Suturing material was clearly visible on the muscular layer. Prominent scar around the suturing line was noticed. Histopathological examination revealed inflammatory changes.

Buffalo Calf No.21:- Approximate weight 206 lbs. Haemogram was normal. Oesophageal diameter prior and after resection was 2.1 cms. and 2.3 cms. respectively.

After resecting 3 inches long oesophagus, the two ends were anastomosed employing single layer technique with Nylon.

The animal exhibited symptoms of dysphagia and regurgitation from 15th day of operation.

The animal was destroyed on 30th day. Gross examination of the anastomosed part showed suturing material. Partial stenosis had also developed.

Buffalo Calf No.22:-The approximate weight was 218 lbs. Blood picture was normal. Preoperative oesophageal diameter was 2.5 cms.

After resecting a piece of 3 inches long oesophagus, the ends were anastomosed, employing two layer technique with Nylon. The animal developed complication from 3rd day and showed symptoms of dysphagia and finally died on 25th day of operation. Considerable quantity of food material was seen accumulated in the pouch which has escaped from the oesophageal lumen forming extensive adhesions of the surrounding muscles. Gangrenous changes had also set in. In this case it was not considered necessary to make any histopathological study.

Buffalo Calf No. 23 :-

The body weight approximately was 221 lbs. Total and differential count was normal. Preoperative oesophageal diameter was 2.2 cms.

Oesophageal resection was performed by removing a 3 inches piece of oesophagus and anastomosis was completed with Vetafil employing two layer technique.

The animal started showing symptoms of dysphagia on 3rd day and finally succumbed on the 11th day of operation. Autopsy revealed marked diverticulum with stricture at the site of anastomosed part. Since healing process was incomplete, histological examination of the tissue was not considered necessary.

Buffalo Calf No.24:- Approximate weight 201 lbs. Total and Differential count was within normal range. Preoperative oesophageal diameter was 2.3 cms.

After resecting 2 inches long oesophagus, ^{was} anastomosis done employing one layer technique with Vetafil. Symptoms of post operative complications were observed from 4th day and the animal died on 12th day. Food material had escaped and accumulated into a pouch formed by the surrounding muscles. The entire adjacent tissue had become gangrenous. No histopathological examination was done in this case.

Buffalo Calf No.20:- Approximate weight of the animal 187 lbs. Blood picture was normal. Preoperative oesophageal diameter was 2 cms.

In this case only two inches long oesophagus was resected, then anastomosed with linen applying two layer technique. The cutaneous wound gaped on 11th day which was resutured.

ANASTOMOSED OESOPHAGUS (BUFF. CALF NO. 7)

(Plate Nos. 11 A to C)



Plate No. 11 A :
Muscular layer,
Healed up zone is
not well marked.



Plate No. 11 B :
Mucosa, the scar
can be seen

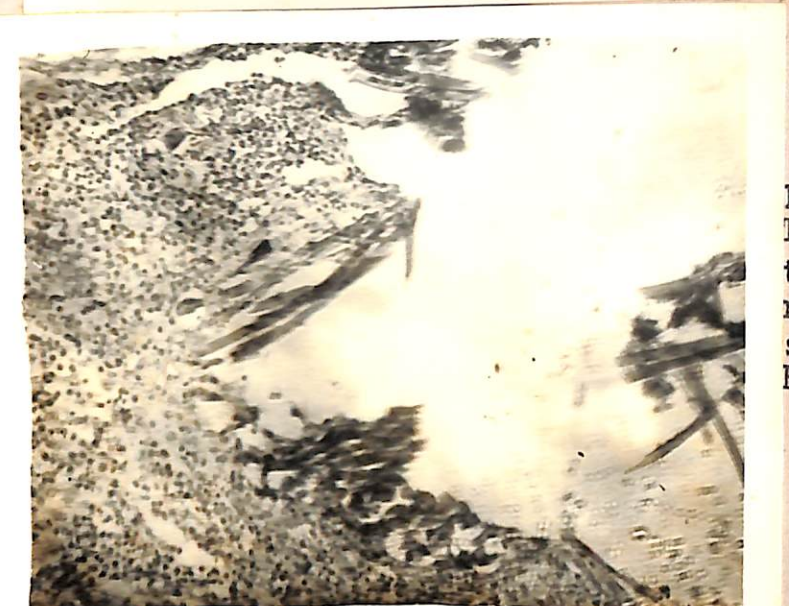


Plate No. 11 C :
Tunica Muscularis, Note
the leucocytic infil-
tration and presence of
suturing material.
H. E. x 100.

ANASTOMOSED PART OF OESOPHAGUS (BUFF. CALF. NO - 3)

(Plate Nos. 12 A to C)



Plate No 12 A : Mucosa, Note slight swelling around the knots with inflammatory reaction around two.



Plate No 12 B : Mucosa, Note leucocytic infiltration and improper healing . H. E. x 150.

ANASTOMOSED PART OF OESOPHAGUS (BUFF. CALF. NO - 3)

(Plate Nos. 22 A to C)



Plate No 12 A : Mucosa, Note slight swelling around the knots with inflammatory reaction around two.



Plate No 12 B : Mucosa, Note leucocytic infiltration and improper healing . H. E. x 150.

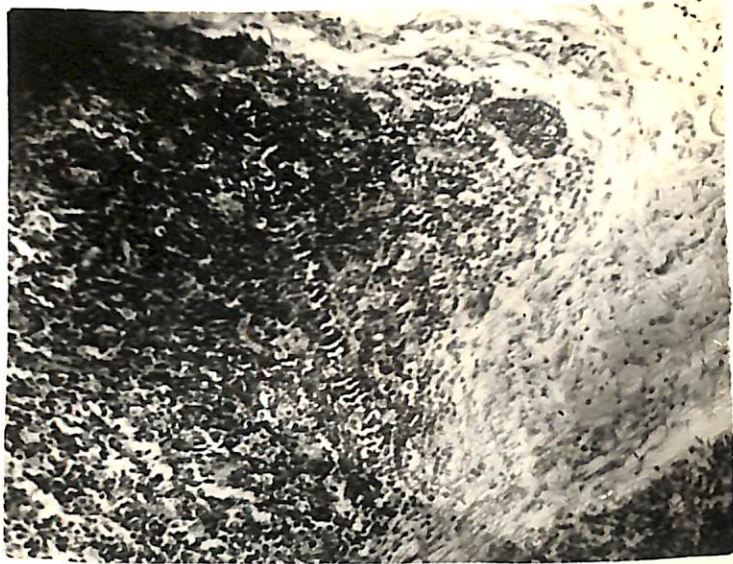


Plate No. 12 C : Muscular layer showing ~~remarkable~~ leucocytic infiltration in the zone of reaction. H.E. X 150

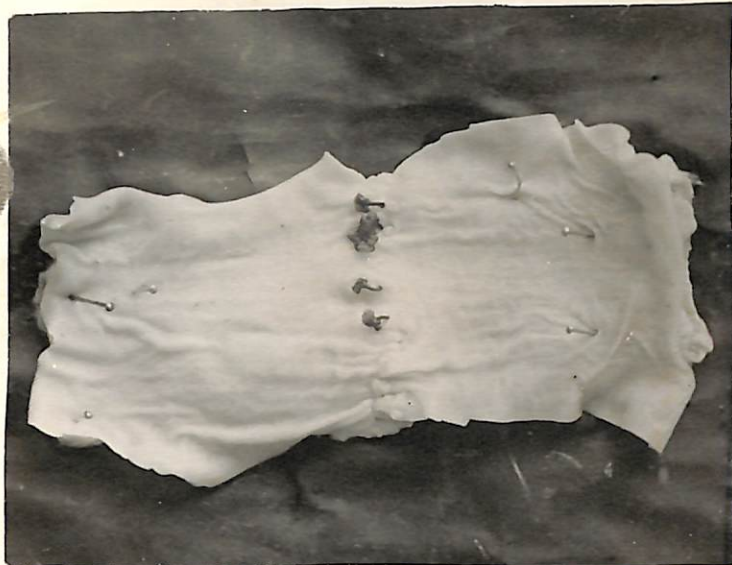


Plate No 13 : Anastomosed Oesophagus (Buff. Calif No. 10)
Note less Number of knots in comparision to Plate No. 12 A.

The animal started showing symptoms of dysphagia on 4th day and died on 12th day. Autopsy revealed a small diverticulum. Oesophageal wound had also gaped through which food material had escaped. Gangrenous changes in the adjacent tissues had set in. No microscopic examination of the tissue was done (Plate No.21).

COMPARATIVE EVALUATION OF DIFFERENT SUTURING MATERIALS:-

SILK :-Black braded 2.0 silk, was used in six buffalo calves of which in three (No.5,7 and 16) two layer technique, and in the remaining three,(No.3,10 and 12) one layer technique was employed.

All the six animals in this group under study showed no post operative complications and had clinically recovered.

On autopsy after the observation period, gross examination of the anastomosed part revealed no complications except a very mild degree of adhesions around the operation site. It was observed that when two layer technique was employed, the suturing material in the mucosal layer had completely disappeared where as it was retained when one layer technique was employed. The anastomosed wound in all the animals showed normal healing. No leakage could be detected from the site of anastomosis in any of the animals under this group of study.

Histopathological study also revealed normal reparative changes.

CATGUT :-

Anastomoses were done in six cases employing one layer and two layer technique with chromic Catgut 3-0. In the first group (No. 6, 11, & 14) where two layer suturing technique was adopted, case No. 6 made clinical recovery while the remaining two died of stricture and oesophageal dilatation before expiry of the observation period.

In the second group (case No. 4, 8, and 13) where only one layer suturing technique was employed, all the three animals made clinical recovery. Gross examination on autopsy showed incomplete absorption of the suturing material in both the groups. Microscopic study revealed better healing changes when one layer technique was employed.

SILK AND CATGUT COMBINED :-

In six anastomoses combination of both silk and catgut combined employing two layer technique was employed for anastomosis. In case no. 1, 15 and 19, braided silk 2/0 was used for the mucosal layer and chromic catgut 3/0 for the muscular layer. Similarly in case No. 2, 18, and 9, chromic catgut 3/0, and silk 2/0,



Plate No. 15 : Oesophageal dilatation (Buff-Calf No.14)



Plate No. 16 A : Oesophagus (Buff - Calf No. 13)
Muscular layer. Healed up zone is
not well marked.

ANASTOMOSES PART OF OESOPHAGUS (BUFF. CALF NO. 12)

(Plate Nos. 14 A & B)



Plate No 14 A : Mucosa, Note the regenerated epithelia around the space containing some traces of suturing material. H. E. x 100 .

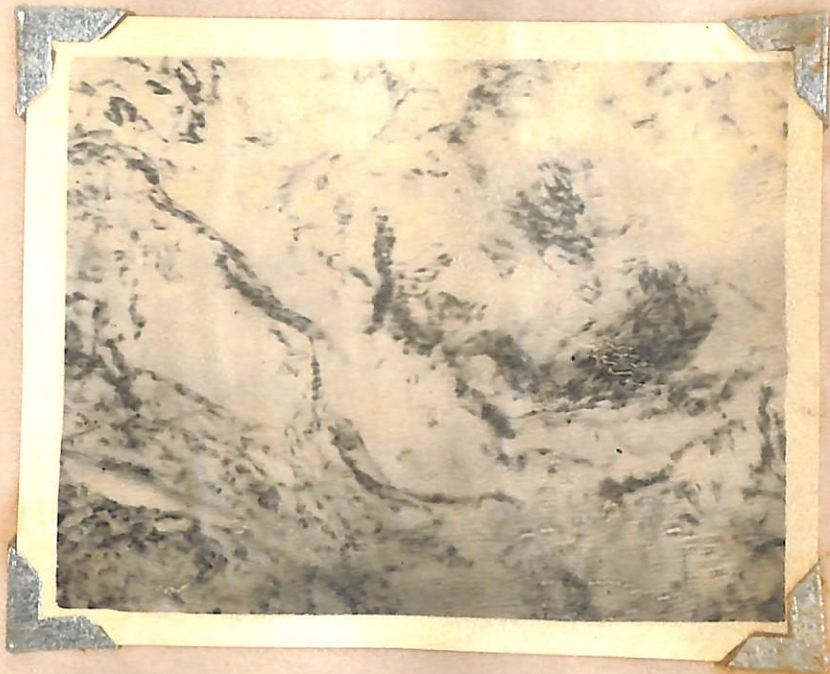


Plate No 14 B : Tunica Muscularis, proliferating fibroblast cells with few leucocytes may be seen H.E.x 100.



Plate No. 15 : Oesophageal dilatation (Buff-Calf No.14)



Plate No. 16 A : Oesophagus (Buff - Calf No. 13)
Muscular layer. Healed up zone is
not well marked.

ANASTOMOSED PART OF OESOPHAGUS (BUFF.-CALF No.13)

(Plate Nos. 16 A to D)



Plate No. 16 B : Mucosa-Anastomotic scar is not well marked.



Plate No. 16 C. : Mucosa-regenerated epithelium along with suturing material can be seen.

was used for the mucosal and muscular layer respectively.

The results obtained in the first group of three animals were quite satisfactory, while in the other group, mild symptoms of dysphagia were observed. Gross examination on autopsy showed complete disappearance of silk material from the mucosal layer, so also complete absorption of catgut in those three animals used for suturing mucosal layer. Slight degree of stricture formation was noticed in Buff Calf No. 18.

COTTON:-

Only two animals were taken up for study, in one employing two layer technique and in other one layer technique (No. 17) using mercerised cotton.

The first case made normal clinical recovery but the other animal developed partial stenosis. On gross examination suturing materials were not visible on the mucosal layer in both the cases. Microscopical study of the slide prepared from the tissue of case No. 1A, revealed presence of suturing materials in both the layers.

NYLON :-

This material was used in two animals No. 21 and 22. Case No. 21 in which single layer technique was employed of dysphagia from 15th day of the operation.



Plate No. 16 D : (Buff. Calf No. 13)
Tunica Muscularis, Note a huge
collection of Leucocytes H. E. x 100

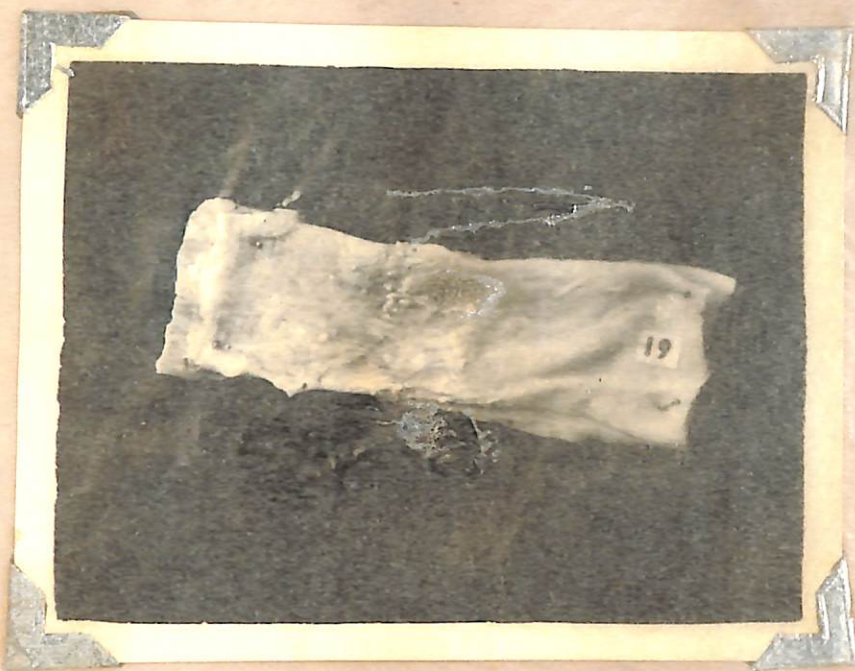


Plate No. 17 A : (Buff Calf No. 19),
Muscular layer - Zone of anastomosis
is hardly visible.

In other case where two layer technique was adopted, the animal started showing symptoms of dysphagia from 3rd day and finally succumbed on 25th day of the operation. This animal also developed oesophageal fistula.

Results obtained with Nylon in the two animals were unsatisfactory.

VETAFIL :-

Oesophageal anastomosis was done with this material in calves No. 23 and 24 only, employing two layer and one layer technique respectively. Both the animals showed marked symptoms of dysphagia from 3rd and 4th day onwards and finally died on 11th and 12th day respectively. Case No. 23 developed oesophageal stenosis with diverticulum and No. 24 developed oesophageal fistula. Since both these animals died of complications during the observation period, no histopathological examination was done.

LINEN :-

This material was used in only one case (No. 20) employing two layer technique, but the animal developed complications with both oesophageal stenosis and fistula and died on the 12th day of operation.



Plate No. 16 D : (Buff. Calf No. 13)
Tunica Muscularis, Note a huge
collection of Leucocytes H. E. x 100



Plate No. 17 A : (Buff Calf No. 19),
Muscular Layer - Zone of anastomosis
is hardly visible.

ANASTOMOSED PART OESOPHAGUS (BUFF CALF NO. 19)



Plate No. 17 B : Mucosa-Anastomotic scar can be seen.



Plate No. 17 C. : Mucosa showing regenerated Epth.
and leucocytic infiltration.
H. E. x 100.

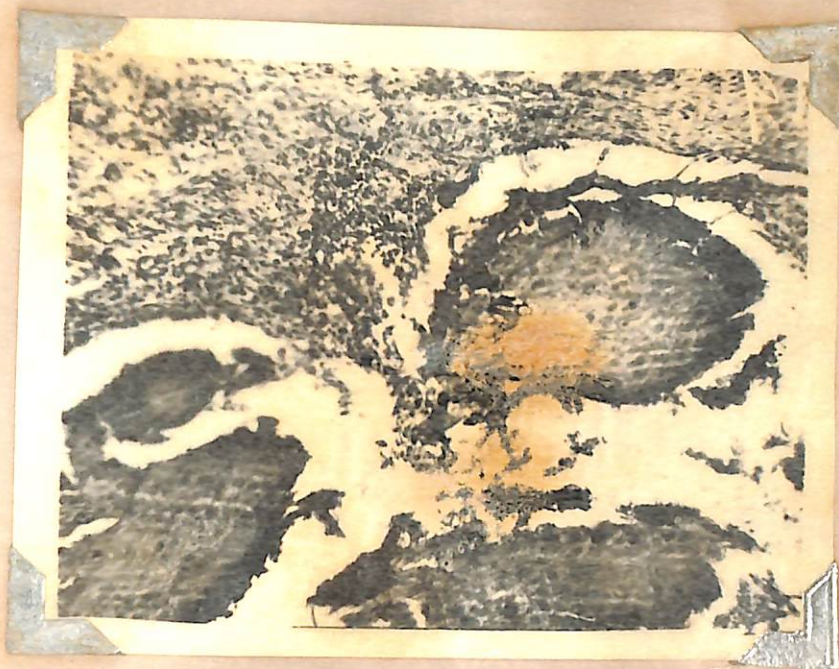


Plate No. 17 D. : Tunica Muscularis showing Catgut
along with inflammatory cells.
H. E. x 100.

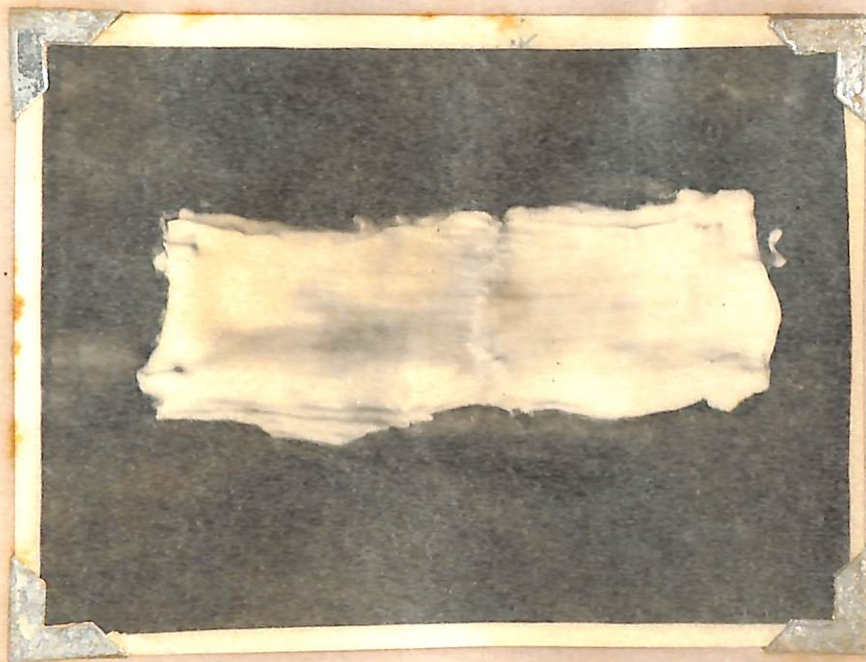


Plate No. 18 : (Buff Calf No. 9) Mucosa-the
healed up Zone can be marked.



Plate No. 19 : (Buff Calf No. 18)
Tunica Muscularis- Note the mass of inflammatory
cells along with few fibers of the suturing
material. H. E. x 100



Plate No. 20 : (Buff ~~2185~~ Calf No 1 A)
Mucosa - The Zone of anastomosis can be
seen.



Plate No. 20 B. : (Buff Calf No. 1 A)
Tunica Muscularis - Leucocytic
infiltration may be seen.
H. E. x 100.



Plate ~~H~~ No. 21 : (Buff Calf No. 20)
Oesophageal fistula.

CHAPTER - VI

DISCUSSION

As already stated in the chapter for "Review of Literatures" that no specific record is available on the bovine oesophageal anastomosis as such. In this study the discussion is therefore mainly based upon the researches and experiences on human and canine oesophageal surgery.

Progress in the Oesophageal resection in canines has been slow due to various factors, as cited by Saint (1929). The common post operative complications that make the resectional operation difficult are :-

- (i) partial or complete disruption of the anastomosis resulting into fistula ;
- (ii) excessive cicatrization resulting into Stenosis, occasionally complete occlusion of the lumen; and
- (iii) occasional necrosis and releasing of the oesophagus free from its bed.

In the present series of twentyfive operations, sixteen anastomoses were conducted by placing two layers of sutures as described by Archibald and Reed (1964), and in the rest nine, only one layer of sutures with the knots placed inside the lumen, was employed. Of the first sixteen animals, five died before the expiry of the observation period and two developed partial stricture, thus success being achieved in 56.2 per cent only. In the remaining nine, only one died and

two developed partial stricture showing a successful recovery in 66 per cent cases.

Adam (1938) states the incidence of strictures, infection and leakage is definitely related to the method of suturing in the anastomosis. Silk when used in single or double layer technique, clinically it did not manifest any post operative complication. Use of silk in two layers for oesophageal anastomosis has been described by Dobermysslow (1901), Carrington (1927), Saint and Mann (1929), Swenson and Clatworthy (1949), Hertzler ^{et al} (1952), and Dorsey et al (1958). It would be worth mentioning here that actual technique of giving the double layer of sutures in the present study simulating Archibald and Reed (1964), differs with the technique adopted by the above workers in respect of placing of the knots only.

The knots of the first layer of sutures ~~interruptedly~~, were placed inside the lumen and that of the second layer outside the lumen. No knots were placed in between the two layers of anastomosis, the method which is also advocated by Grove (1961). The advantage is that there will be minimum amount of foreign material between the layers of the anastomosed oesophagus, thereby causing minimum interference in the healing process.

Saint and Mann (1929) employed two layers of silk sutures, of which the inner one consisted of

interrupted horizontal mattress sutures passing through the whole thickness of the wall, and outer row of continuous Lambert sutures, passing through the muscular coat only. Only 33 percent cases survived. The main complications were sloughing of the suture lines, with strictures.

Swenson and Megruder (1944) concluded that by placing interrupted non-inverting type of sutures in two separate layers with silk, stricture formation is avoided to a great extent.

Swenson and Clatworthy (1949) claimed twenty survivals out of thirty cases of thoracic oesophageal resection. Hertzler and Tuttle (1952) placed two layer of through and through everted mattress sutures with 3.0 or 4.0 silk and claim success in eight cases. Boyd (1964) also advocates the application of two rows of sutures with fine silk or catgut. Schultz et al (1962) employed two layer technique of anastomoses in puppies using silk only, and reported stricture development in one out of four cases. The tissue reaction was moderate. Results were no better when anastomosis with one layer technique of suturing was employed. The suturing material was invariably found retained upto the 30th day. The suturing material has been seen retained even upto 90 days in dogs as reported by Schultz et al. (1962) in two layer technique. Therefore

its presence in the present study up to 30 days is quite understandable.

Chromic catgut has been more extensively used in this experiment, but the results obtained are discouraging. Two layer technique of suturing employed in three animals, only one survived and the other two died before the due date of destruction. Whereas, when only one layer technique of suturing was employed, results were ~~far~~ much better; All the three animals in this group survived, without showing any post-operative complications.

Mennon (1953) has described the closure of the muscular wall of the oesophagus in one dog with 21-day 1/0 chromic catgut, for the removal of spirocerca tumour. Gage and Lyons (1949) state that catgut sutures give rise to persistent inflammatory reaction, and consequent absorption. In the study of Schultz et al. (1962), where four anastomoses were done with two rows of sutures, showed normal tissue reaction and stricture development. They concluded that chromic catgut is not a satisfactory material for oesophageal anastomosis in growing animals.

Death in two animals in this group under study was due to marked tissue reaction as a result of employing two layer technique of suturing. It has also been observed when one layer technique of suturing was employed, tissue reaction was much less marked and thus obtaining better end results.

When two rows of sutures, using silk for the mucosa, and the chromic catgut for the muscularis, were employed in three cases none showed any post operative complications and all survived. Archibald and Reed (1964) advocate use of fine 5/0 silk for the mucosa and 3/0 or 4/0 chromic catgut for the muscularis, which is still a standard procedure for the canine oesophageal anastomosis. The mucosa being strong and squamous in character, can hold the sutures well. This explains why the application of silk suture on the mucosal layer proved more satisfactory.

When chromic catgut was employed, for the mucosa, and silk for the muscularis, the results were unsatisfactory. Two developed stricture probably due to the marked tissue reaction probably by catgut. However, Hopper et al. (1963) in their study on anastomosis with and without pericardial grafts, and using catgut for the mucosa and silk for the muscularis, found that no stricture formation took place in those cases in which pericardial grafts were employed. This technique probably helped in reducing the healing process.

Parker and Brockington (1944) had employed the use of cotton sutures in two layers for thoracic oesophagus in twenty one dogs. Out of the fourteen survi-

survivals, only one developed stricture. Kleinsassar et al (1950) in their experimental evaluation of peritoneal grafts in eighteen dogs conducted, fourteen had anastomosis with two rows of sutures using No.70 cotton. Inner row of interrupted sutures passed through the entire thickness of the wall with the knots tied within the lumen, while the second layer of interrupted sutures including the muscularis was placed outside. In the above study emphasis is laid to follow the technique of suturing in two separate layers. The similar technique was adopted for study in this experiment. The result obtained was not satisfactory when one layer technique using cotton was employed. Cotton sutures when employed in two layers did not show any post operative complication. This observation is corroborated on the study of Schultz (1962) , who employed two layer technique with cotton. Out of his six cases, one showed stricture and two developed fistula.

Under the miscellaneous study in five cases with Nylon, Vetafil, and Linen (Nylon- 2: Vetafil-2: and Linen-1), employing both one and two layer techniques only one survived. On autopsy this animal showed stricture formation. In this case one layer technique with Nylon was employed. The remaining four animals died due to post-operative complications showing fistula and diverticulum formation.

The poor result in the above group was mainly due to disruption of the wound when Nylon, Vetafil and poor quality linen were used as suturing materials.

Since the number of animals in the above group employing four different sutures, Cotton, Nylon, Vetafil and Linen, is much too small, it is difficult to arrive at any definite conclusion.

It has already been stated that practically no literature is available on esophageal resection in bovine which forms the next important part of the study. This experiment was taken up in two batches of 3 animals each. Oesophageal resection was performed after removing 2 inches and 3 inches long piece oesophagus in each batch. In each batch only one survived showing stricture formation. In the first batch two layer technique with cotton was employed where as in the 2nd, one layer technique with Nylon was employed. Poor survival in the above two groups is probably due to excessive tension on the suture line with consequent disruption.

The data obtained from the limited material, it would not be safe to come to any definite conclusion. It would be advisable to state here that there is definite

scope for further investigation particularly to
establish the maximum length of oesophagus, which
can be resected and anastomosed safely without causing
excessive tension and disruption of sutures.

S U M M A R Y.

In the present study an attempt has been made to evaluate the value of different suturing materials for Oesophageal anastomosis in bovines, taking buffalo calves as the type species.

The success of the anastomoses was assessed from the clinical observations made post-operatively upto a period of thirty days, after which the animals were sacrificed, and the Surgical pathology in respect to the healing process was studied.

The plan of the suturing materials used and the anastomosis technique employed in the first three groups is shown in Table - I.

TABLE - I.

Sl. No.	Group No.	No. of animals.	Suturing Material	Suturing technique employed.
1.	I	One	Silk	Mucosa and Muscular layers sutured separately in interrupted fashion. (Two rows of sutured).
2.		One	Catgut	-do-
3.		One	Silk & Catgut	Mucosa - sutured with Z z silk. Muscular- -do-Catgut
4.	III	One	-do-	Mucosa- sutured with I catgut. Muscular- -do-silk
5.		One	Silk	Both the mucosa and Mus., layers sutured together. (Only one of sutures).
6.		One	Catgut	-do-

The plan adopted in the last group (Group-IV Miscellaneous) is shown in Table - II.

TABLE - II.

Sl. No.	Group No.	No. of animals	Suturing material	Suturing technique employed.
1.		One	Cotton	Two rows of sutures.
2.		One	Nylon	-do-
3.		One	Vetafil	-do-
4.	IV	One	Linen	-do-
5.	(Misce-llane-ous)	One	Cotton	One row of sutures.
6.		One	Nylon	-do-
7.		One	Vetafil	-do-

Preoperative preparations of the animals were as usual. Total R.B.C. and W.B.C. count and the Differential Leucocytic count of all the experimental animals were done except in Buff. calf No 1A. Routine Treatment of the ectoparasites and endoparasites including protozoan were duly taken up.

Animals were narcotised by Chloral Hydras followed by local infiltration with procaine Hydrochloride. To check excessive salivation Atropine Sulphate subcutaneously was injected.

Post-operative antibiotic treatment consisted of Terramycin Liquid locally and Combiotic (Pfizer) parenterally in the first three groups, while in the last group (except No. IA), Dicrystacin (Squibb) was included in place of combiotic, which has the same efficacy as the later.

As regards the efficacy of the suture materials used, black braded silk 2-0, used in six animals, was found to be quite satisfactory. Out of these, three had one row of sutures, and the rest three had two rows of sutures. Chromic catgut 3.0, which was also employed in six animals, two died before the expiry of the observation period of thirty days, out of which one had oesophageal dilatation (Buff. Calf No. 14) and the other developed stricture (Buff. Calf No. 11). Both of them had their mucous and muscular layers sutured separately. However, no mortality was there when only one row of sutures was employed. The combination of silk and chromic catgut was employed in six animals, of which only two (Buff. Calf No. 2, and 18) showed signs of developing stenosis, though none died before the expiry of the observation period. These two animals had their mucous layer sutured with chromic catgut, and muscular layer with silk.

Little emphasis was laid on the use of mercerised cotton, Nylon, Vetafil and Linen. Two trials were given

for each of these materials, giving one-row and two-row of sutures, except the last one, where only one operation, placing two rows of sutures was performed. The number of animals studied in this group has been very low, as such it is difficult to conclude any significant result. Out of the animals in which cotton was used, only one showed satisfactory result, while in other, marked stricture formation tookplace. In two animals nylon was employed, but both died, one due to oesophageal stricture and the other as a result of fistula formation. Anastomosis with vetafil also proved failure since both the animals died, one forming fistula and the other forming diverticulum with stricture. Similarly, when Linen was used the case died after formation of fistula.

In general, on the basis of microscopical study of the above observations on oesophageal anastomosis, utilizing different suturing materials and technique, the silk has been found to give a better healing response than chromic catgut. The healing process, when chromic catgut was used, showed varied degree of oedema and infiltration of leucocytes than the other group, where silk alone was used.

In brief, on the basis of clinical observations, macroscopic and microscopic findings, the plan can be summarised as follows - (Table No. 9).

(1) Cervical oesophageal anastomosis in twentyfive buffalo calves using braded silk, chromic catgut, combination of the two, cotton, nylon, vetafil and linen, laying particular emphasis on the application of the first three suturing material was studied in the present plan.

(2) End-to-end anastomosis was adopted as described by Archibald and Reed (1964) in sixteen animals, while in nine others, the technique employed slightly differed, in as much that the mucosa and the muscular layers were sutured together, placing the knots inside the lumen.

(3) The number of anastomoses with different suturing materials were :- Silk - six; Chromic Catgut - six; Silk and Chromic Catgut-combined - six; Cotton - two; Nylon - two ; Vetafil - two; and Linen - one.

(4) Silk has been found to be a suitable material for oesophageal anastomosis, specially, when two rows of sutures were applied.

(5) Chromic catgut was found to be unsuitable as the healing was poorer than when silk was used. However, when only one row of sutures (mucosa and muscular layers being sutured together) was employed, it was found to be better than when two rows of sutures were applied. In later cases complications such as stricture formation and oesophageal dilatation, were more common.

(6) When chromic catgut and silk were combined the results were satisfactory. Silk was used for the mucosa and catgut for the muscular layer. Formation of stricture was noted in two out of the three animals when anastomosis was done using catgut for the mucosa and silk for the muscular layer.

(7) Cotton was used in two animals, and proved satisfactory in one in which two layer technique was employed.

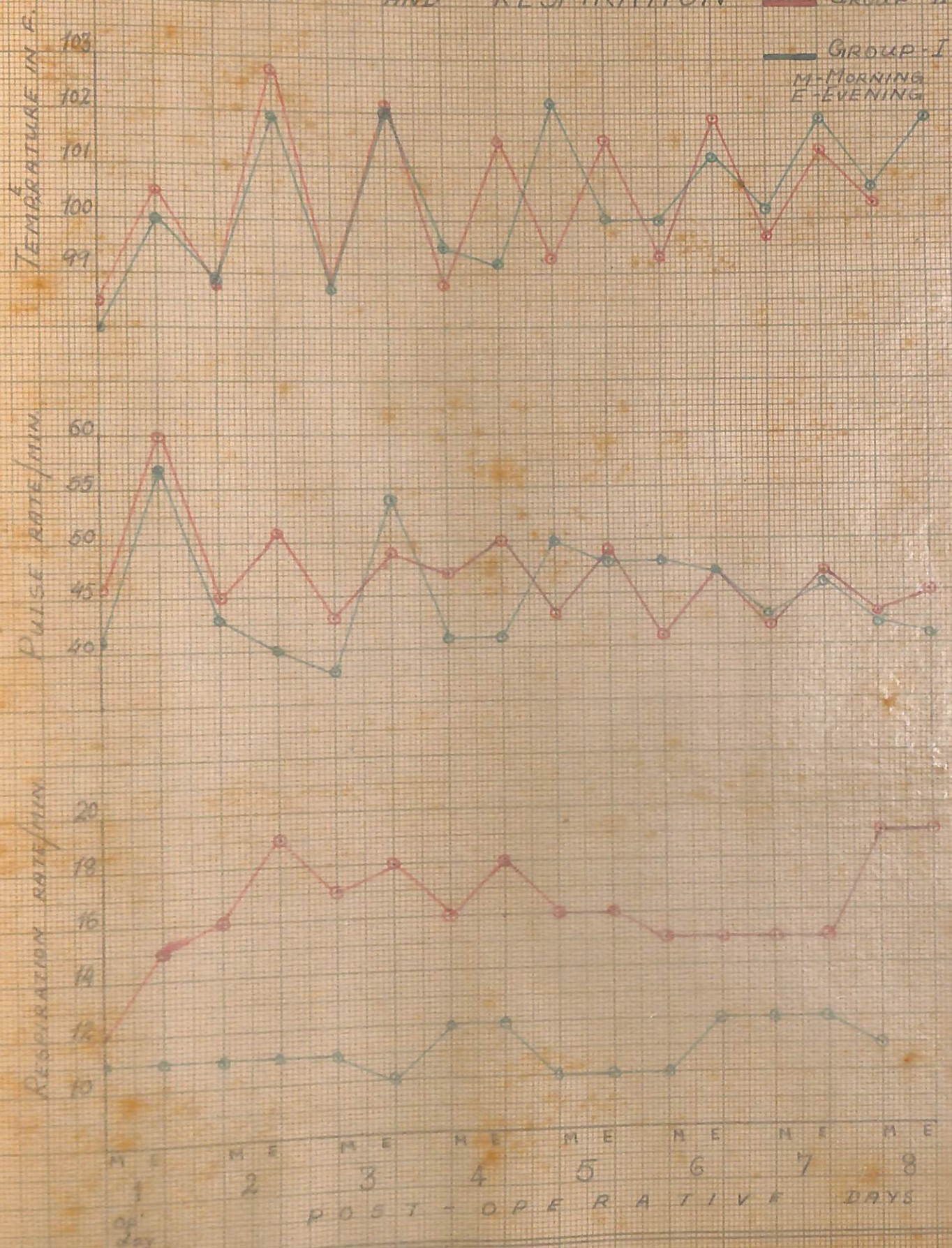
(8) Nylon (dermal coarse) proved unsuitable material, as out of the two cases studied, one developed stricture, and other died due to leakage with subsequent fistula, formation.

(9) Vetafil also proved unsatisfactory material since both the cases died, one due to formation of diverticulum with stricture, and the other due to fistula.

(10) Linen was tried in only one case and that too proved unsatisfactory. The animal died after fistula formation (Plate No.21).

(11) No conclusion can be drawn in respect to the value of cotton, nylon, vetafil and linen, as suturing materials, in view of the limited observations.

AVERAGE TEMPERATURE, PULSE AND RESPIRATION



(12) Resection of 2" of oesophagus was studied in three animals (No.17, 20 and 24) and 3" resection in another three buffalo calves (No.21, 22 and 23). Only one animal survived in each group (No.17 and 21) till the date of destruction.

(13) Out of the twentyfive anastomoses, nineteen animals stood the operation successfully and were kept under observation for thirty days, while the rest six died before the due date of destruction.

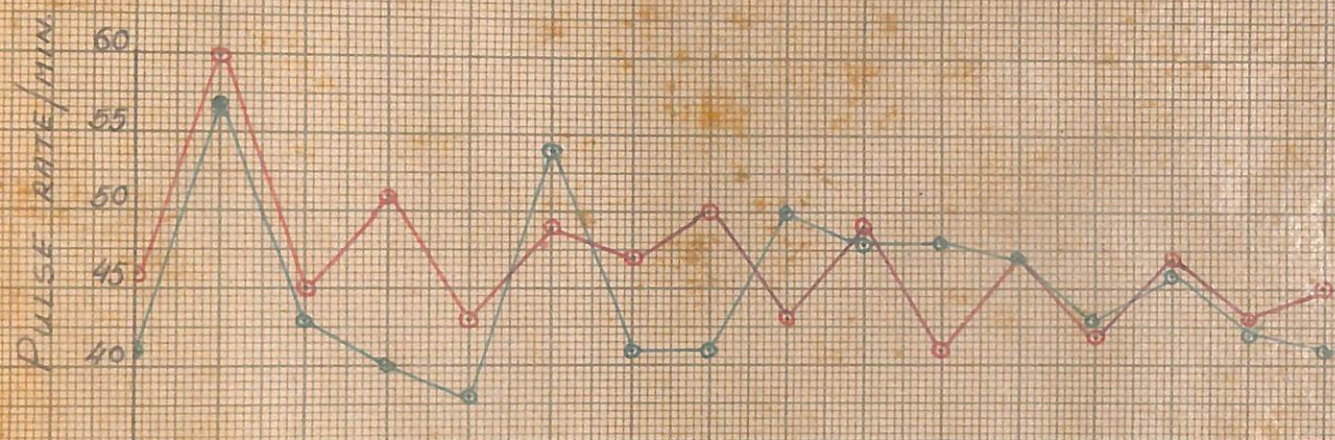
(14) Out of nineteen survivals, fifteen animals showed clinical recovery without any complication, while four animals developed stenosis and fistula.

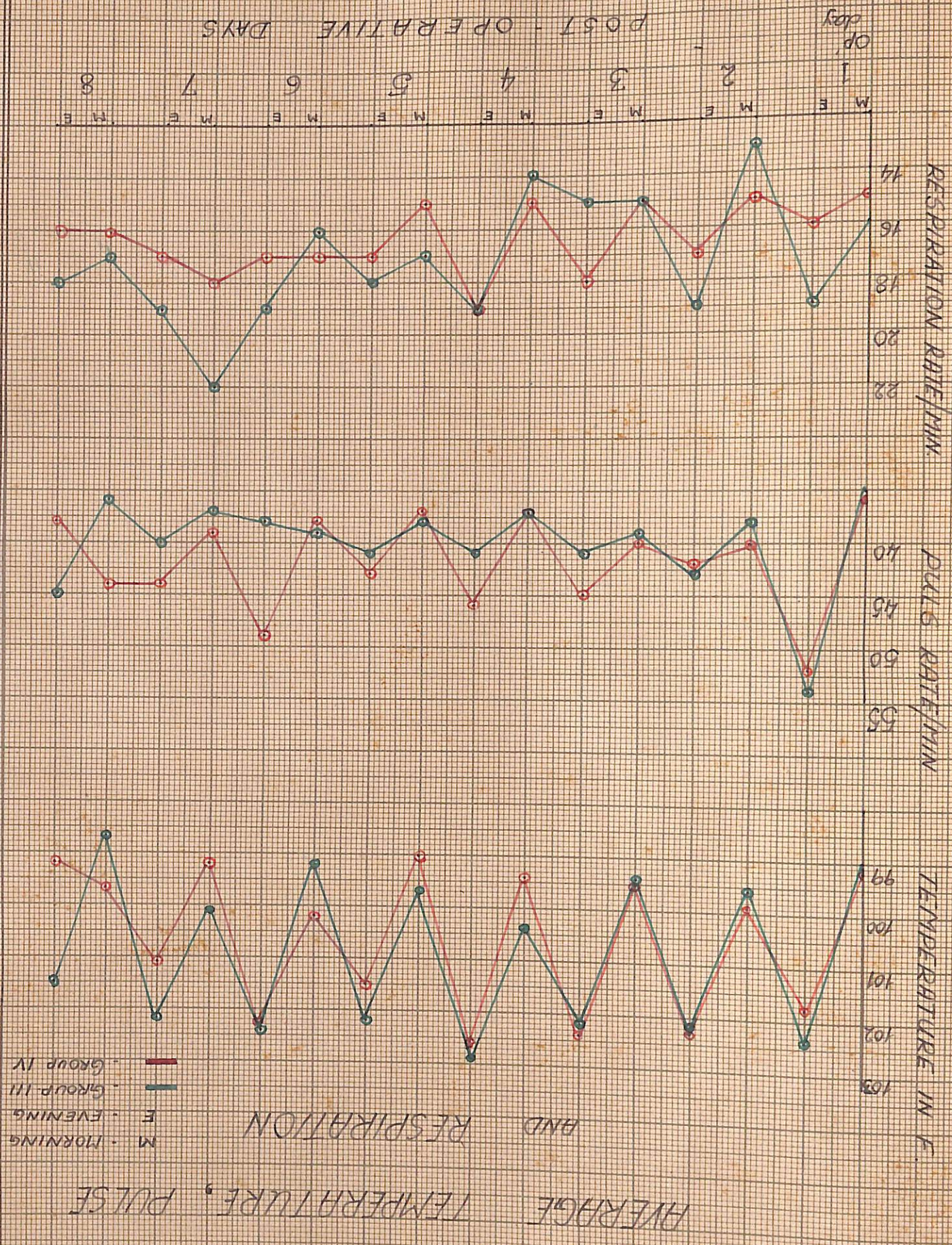
(15) The remaining six animals died of post operative complications before expiry of the observation period.

A new approach on bovine oesophageal resection and anastomosis, using different suturing materials has been tried in this experiment and a fair degree of success achieved.

Perhaps this will now encourage the Veterinary Surgeons to under take this new line of Surgical treatment in bovines with fair degree of success.

AVERAGE TEMPERATURE, PULSE AND RESPIRATION





COMPARATIVE EVALUATION OF DIFFERENT SUTURING MATERIALS

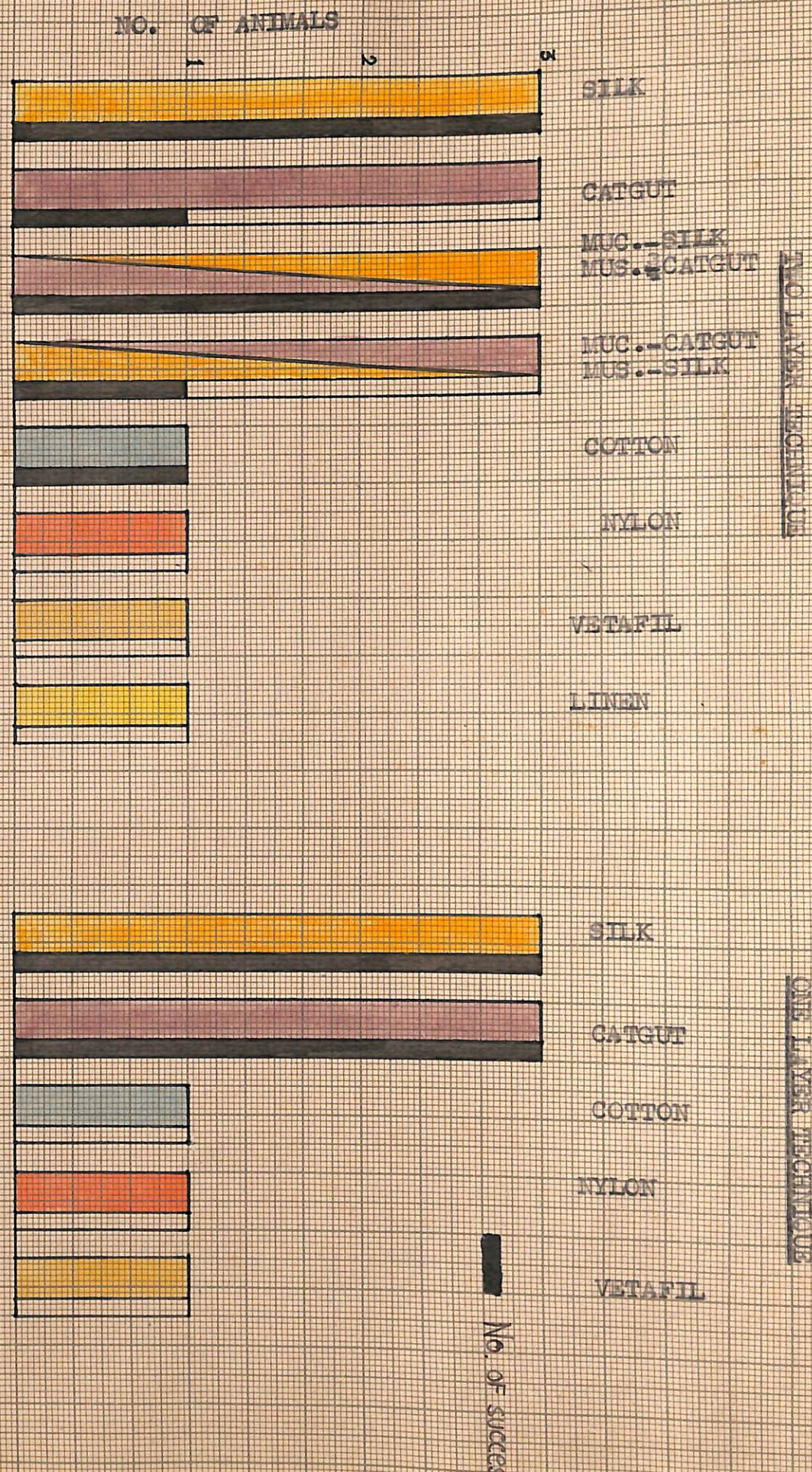


TABLE NO:4

AVERAGE TEMPERATURE, PULSE AND RESPIRATION OF DIFFERENT GROUPS (PREOPERATIVE AND POSTOPERATIVE RECORD).

DAYS	T I M E	Group-I			Group-II			Group-III			Group-IV		
		Temp. in F.	Pulse per min.	Resp. per min.	Temp. in F.	Pulse per min.	Resp. per min.	Temp. in F.	Pulse per min.	Resp. per min.	Temp. in F.	Pulse per min.	Resp. per min.
1st	M	98.0	41	11	98.5	46	12	99.1	35	16	99.2	36	15
	E	100.0	57	11	100.5	60	15	102.4	54	19	101.8	52	16
2nd	M	98.9	43	11	98.8	45	16	99.6	38	13	99.9	40	15
	E	101.9	40	11	102.8	51	19	102.2	43	19	102.3	42	17
3rd	M	98.7	38	11	98.7	43	17	99.4	39	15	99.5	40	15
	E	102.0	54	10	102.1	49	18	102.2	41	15	102.4	45	18
4th	M	99.5	41	12	98.8	47	16	100.4	37	14	99.4	37	15
	E	99.2	41	12	101.5	50	18	102.9	41	19	102.6	46	19
5th	M	102.2	50	10	99.3	43	16	99.7	38	17	99.0	37	15
	E	100.0	48	10	101.5	49	16	102.2	41	18	101.5	43	17
6th	M	100.0	48	10	99.3	41	15	99.2	39	16	100.2	38	17
	E	101.2	47	12	101.9	47	15	102.4	38	19	102.3	49	17
7th	M	100.2	43	12	99.7	42	15	100.1	37	22	99.2	39	18
	E	101.9	46	12	101.3	47	15	102.2	40	19	101.9	44	15
8th	M	100.6	42	11	100.3	43	19	98.7	36	17	99.7	44	14
	E	101.9	41			45	19	101.5	45	18	99.2	38	14

M-Morning.
E-Evening.

1st day M -Pre-operative record

The above figures are obtained from the daily recordings noted pre and post operatively till the 8th day.

TABLE NO: 5

TOTAL AND DIFFERENTIAL LEUCOCYTIC COUNT OF THE EXPERIMENTAL ANIMALS.

Group No.	Buff. Calf. No.	Total Count.		Differential Count.				
		R.B.C. in million	W.B.C. in thousand	Lympho %	Mono %	Neutro %	Eosino %	Baso %
I	1	5.2	-	68	4	25	3	Nil.
	2	5.8	-	66	3	30	1	Nil
	3	4.6	9523	60	4	33	3	-do-
	4	5.2	9520	52	4	43	1	-do-
	5	5.2	10000	49	5	44	2	-do-
	6	4.9	10230	73	6	20	1	-do-
II	7	5.52	6600	69	5	24	2	-do-
	9	5.00	9120	66	3	29	2	-do-
	10	4.00	8600	56	3	39	2	-do-
	11	5.20	9520	60	3	35	2	-do-
	13	3.5	10200	62	3	34	1	-do-
	15	5.0	10200	67	3	30	Nil	-do-
III	14	4.6	9520	59	4	36	Nil	1
	12	7.38	7800	72	4	20	4	Nil
	19	7.02	6600	82	6	11	1	-do-
	16	-	-	67	2	31	Nil	-do-
	18	7.8	10100	66	8	25	-do-	1
	8	6.48	15800	69	4	22	4	1
IV	17	8.93	10400	65	6	29	Nil	Nil
	21	8.63	6500	67	6	26	1	-do-
	22	7.79	18100	65	2	33	Nil	-do-
	23	6.11	9000	62	3	32	3	-do-
	24	2.78	5600	71	5	22	2	-do-
	20	6.9	13500	57	2	38	3	-do-

TABLE NO. 6.

SUMMARY OF HAEMATOLOGICAL STUDIES

Group No.	Average of Total Count		Average of Differential Count				
	R.B.C. in million/ cmm.	W.B.C. in thousand/ cmm.	Lympho %	Mono %	Neutro %	Eosino %	Baso. %
I	5.1	9818	61	4	32	1	-
II	5.28	9040	63	3	31	1	-
III	6.65	9964	69	4	24	3	1
IV	6.85	10576	64	4	30	2	-

SUMMARY OF GROSS AND HISTOPATHOLOGICAL CHANGES.

TABLE No. 7.

Suture	Suturing Technique	Case Observation		Gross Examination	Microscopic Examination
		No. of operation	period		
1	2	3	4	5	6
S	One layer	3	30	Extensive fibrosis. Silk visible on the mucosa.	Leucocytic infiltration, Silk in thread like form marked.
		10	30	Silk visible on the mucosa.	Inflammatory changes, Thickening of the epithelium noted
		12	30	Same as above.	Oedematous changes in the mucosa.
I					
L	Two layers	5	30	Fibrosis comparatively less Silk visible on the muscularis only.	-
		7	30	Nothing significant.	Suture material visible fibroblast seen in these own reaction. Leucocytic infiltration marked.
		16	30	As above.	AS ABOVE. Inflammatory reaction marked.
K					

(TABLE NO. 7 CONTINUED-I)

1	2	3	4	5	6
Q	4	30	Fibrosis present. Catgut visible on the Mucosa.		Oedematous changes in the submucosa, small areas of leucocytic infiltration noted.
N					
D	8	30	Moderately fibrosis. Catgut not visible on the mucosa.		Nothing significant.
L					
A					
Y					
E	13	30	Extensive fibrosis. Catgut not visible on the mucosa.		Disquamated epithelium Catgut visible in the submucosa.
R					
Z					
G					
U	6	30	Fibrosis. Catgut visible on the muscular layer only.		Epithelia slightly thickened, inflammatory changes present.
T					
W					
O	11	16	Extensive fibrosis and anastomosed part very hard on manipulation (Stricture).		Not studied.
L					
M					
X					
Y					
E	14	26	Oesophageal dilatation noted. Oesophageal wall very thin.		-do-
R					
S					

(TABLE NO. 7 CONTINUED-II)

1	2	3	4	5	6
S	Mucosa-Silk	1	30	Catgut visible. Silk disappeared. Fibrosis present.	-
I		15	30	Extensive fibrosis suture material not visible in any layer.	Leucocytic infiltration chiefly neutrophils, catgut visible in the muscular layer.
L	Muscularis-Catgut.	19	30	Fibrosis comparatively less, catgut visible.	Fibroblasts along with catgut and inflammatory cells noted.
K					
&		2	13	Silk visible Mucosa showed better healing.	-
C	Muscularis-Silk	9	30	Extensive fibrosis silk visible.	Infiltrative Oedematous changes silk threads visible.
A					
T	Mucosa-Catgut.	18	30	Nothing significant.	As above.
G					
U					
T					

(TABLE NO. 7 CONTINUED-III)

1	2	3	4	5	6
N Y L O N	One layer	21	30	Nothing significant. Nylon seen on the mucous layer.	Suture visible on the mucosa.
	Two layers	22	25	Oesophageal fistula noted.	Not studied.
V E T A F I L	One layer	24	12	Disruption of sutures	Not studied.
	Two layers	23	11	Diverticulum.	-do-
C O T T O N	One layer	17	30	Sutures not visible on the mucosa. Nothing significant.	-
	Two layers	1A	30	Cotton visible on the muscularis only fibrosis present.	Suturing material visible along with inflammatory cells.
L I N E N	Two layers	20	12	Fistula with necrotic & gangrenous changes.	Not studied.

Group NCas
No

1

2

I.

II.

11

10

9

Geographical
distinction.

Destroyed.

-50-

-50-

-50-

-50-

Destroyed.

2nd Geographical
distinction

Destroyed.

3rd distiction

3rd distiction

3rd distiction

Destroyed.

Inc. - Incos.

Inc. - Incos.

together.

separately.

TABLE No. 9

SUMMARY OF THE RESULTS OF EXPERIMENTAL STUDY

Suture	Suturing technique	No. of Animals	Individual case Nos.	Stricture	Fistula	Dilation	Diver-ticulum	No. of failures	No. of success
Silk	*Two-layers **One-layer	3 3	5, 7, 16 3, 10, 12	- -	- -	- -	- -	- -	3 3
Chronic Catgut	Two-layers One-layer	3 3	6, 11, 14 4, 8, 13	1 -	- -	1 -	- -	2 -	1 3
Silk & Catgut	Muc.-silk Mus.-Catgut	3	1, 15, 19	-	-	-	-	-	3
	Muc.-Catgut Mus.-silk	3	2, 9, 18	2	-	-	-	2	1
Cotton	Two-layers One-layer	1 1	1A, 17	- 1	- -	- -	- -	- 1	1 -
Nylon	Two-layers One-layer	1 1	22 21	- 1	1 -	- -	- -	1 1	- -
Vetafil	Two-layers One-layer	1 1	23 24	- -	- 1	- -	1 -	1 1	- -
Linen	Two-layers	1	20	-	1	-	-	1	-
Total :-		25	-	5	3	1	1	10	15

*Two-layers - Mucosa and Muscularis sutured separately. Muc. - Mucosa.
 **One-layer - Both Mucosa and Muscularis sutured together. Mus. - Muscularis.

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