EXPERIMENTAL STUDIES ON RUMENO-RECTAL FISTULA IN CALVES

BY
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THESIS

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DECLARATION

I hereby declare that this thesis entitled "EXPERIMENTAL STUDIES ON RUMENO-RECTAL FISTULA IN CALVES" is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship, or other similar title, of any other University or Society.

Mannuthy,
11-7-1980.

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CERTIFICATE

Certified that this thesis, entitled "EXPERIMENTAL STUDIES ON RUMENO-RECTAL FISTULA IN CALVES" is a record of research work done independently by Kumari. M. Sumangala under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship, or associateship to her.

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INTRODUCTION

INTRODUCTION

Bacterial fermentation is a normal phenomenon in the rumen. The gases produced in the rumen, namely, methane, carbon dioxide and oxygen are eliminated by eructation, absorption, or along with dung. Ruminal tympany is an over-distension of the rumen and reticulum with gases of fermentation either free or mixed with fluid or solid ingesta. The gases rapidly accumulate in the rumen producing an emergency which will endanger the life of the animal.

Treatment for bloat includes, administration of Turpentine, Polaxalene and pure mineral or vegetable oils. But frequent administration of turpentine makes the animal off feed.

Rumenocentesis is of little value in

relieving frothy bloat, where free gas will be comparatively very little and the cannula may get easily blocked.

Inconsistant results of conservative treatments for chronic bloat, necessitated the adoption of surgical procedures for its correction. A rumen fistula or rumenostomy has been reported to be of value, in some cases of bloat. The rumen fistula on the upper region of the left paralumbar fossa prevents accumulation of gases in rumen. But when the fistula is kept open, contents from rumen will escape through the fistula and consequently soil the skin around the fistula. Because of this defect in external fistulation, the possibility of establishing an internal fistula between the rumen and the rectum has been thought of.

The present study is undertaken with the object of establishing an internal fistula, in experimental calves, connecting the rumen to the rectum and studying its viability, maintenance and effects on the general health of the animals.

REVIEW OF LITERATURE

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Fistulation of the rumen was first attempted by Colin (1886). Wester (1926) and Schalk and Amadon (1928) adopted this technique for nutritional studies.

Phillipson and Innes (1939) reviewed the various modifications of external rumen fistulation techniques and described two methods for adoption. One method was to fix the rumen to the body wall by sutures, and then to excise the rumen wall to prepare the fistula. In the other method, a clamp was applied to the exteriorized portion of the rumen and left in situ for adhesion to take place. The clamped portion of rumen sloughed off later effecting the formation of fistula.

Nicholas (1947) adopted the insertion of

of a large hypodermic needle into the rumen through the upper third of the left paralumbar fossa for relieving gas from the rumen.

Dougherty et al. (1955) employed the exteriorization of a large portion of the rumen and fixing it to the skin on the left flank. The exteriorized portion of the rumen was surgically excised, four to five days later, to convert it into a fistula. Continuous escape of rumen contents was reported in this method.

Schnautz (1957) used through and through sutures, in addition to the sutures fixing rumen wound to the skin of the flank, in the external fistulation of rumen to the left side.

Komarek and Leffel (1961) recommended

an air tight polyethylene cannula for rumen fistulation. Since the fistula was kept closed, the internal environment of rumen was not altered.

Mendel (1961) preferred incising the rumen, simultaneously, after exteriorising and fixing it to the abdominal wall.

Balch and Cowie (1962) used pneumatic rubber cannula and bung for rumen fistulation in cattle. The dorsal sac of rumen was exteriorized through a laparotomy incision and a clamp was applied on the pouch of rumen. The clamped fold of the rumen sloughed off in 7 to 10 days leaving a direct opening into the rumen. A permanent cannula with bung was inserted to keep the fistula patent. There was seepage of rumen fluid through the inter-space between the fistula and the cannula.

Finna et al. (1962) evolved an artificial rumen vivar technique. It closely simulated rumen functions. A rumen fistula was made on the left flank and the apparatus was suspended into the rumen. The porcelain test tube of the apparatus permitted escape of gas from the rumen.

Jordon (1962) advised a change in the ration and administration of antibiotics and yeast cultures into the rumen as treatment for persistant bloat in young bovines. He had also reported that a permanent rumen fistula could be of value in cases where it did not respond to medicinal treatment. When the fistula was small, spontaneous closure by healing was noticed in six months. The site chosen for inserting the cannula was midway between the last rib and the tuber coxae on the left flank.

Yarns and Putnam (1962) recommended an economical rumen cannula made of plastisol for nutritional studies.

Johnson (1966) pointed out that the normal pH of rumen ranged from 6.7 to 7.0. When ammonia was produced in large quantities, the pH was above 7.0 and was deleterious to the rumen bacteria.

Jarrett procedure (Johnson, loc. cit) described a modified rumen fistula technique, where a pouch of rumen was made to herniate through a flank incision. The surface of the herniated rumen was scarified, and the skin was sutured over the rumen pouch. The cannula was inserted, 10 to 12 days after the initial operation, through a 2.5 cm long incision on the hernia.

In Schalk and Amadon procedure, (Johnson, loc. cit), a pouch of rumen was exteriorized and clamped. The clamped part of the rumen was excised seven to nine days later. A cannula was inserted to close the fistula when the wound healed. Leakage of rumen fluids was noticed in this technique.

Driedger et al. (1970) used rigid as well as flexible cannulae for rumen fistulation. Undue stress resulting in necrosis, infection and leakage of the ingesta were reported in his experiments.

Hinkson (1970) used a syringe type rumen fistula. A disposable plastic syringe was modified to serve as the cannula. Inside and outside washers were made of vinyl plastic. Braided nylon was used to adjust for tissue pressure and keep the fistula mechanism intact in the body. The fistula was fixed on the left flank.

Perez et al. (1971) modified the technique adopted by Dougherty et al. The cannula in this technique was introduced into the rumen and the stem of the cannula was forced through the wall of the rumen at a point away from the rumenotomy incision. Escape of rumen contents into the abdomen was not noticed with the modified procedure.

Rumsey et al. (1972) studied the changes in the rumen in fistulated animals. Changes in ammonia content, pH, and total volatile fatty acid levels were noticed after rumen fistulation.

Harlan et al. (1975) described the use of a frozen cannula for preparing permanent fistulae in ruminants. Rumen was inflated with air through a stomach tube to produce tympany. Laparotomy was performed and the rumen was exposed.

Through an incision on the rumen, the frozen cannula was introduced. The cannula was left in position until the ice had melted and a rubber stopper was used to close the cannula. In some animals necrosis of tissue around the cannula was noticed. Tone of the muscles was poor around the fistula but the adhesion between the rumen and abdominal wall was satisfactory.

Anderson and Frederiksen (1976) reported that medicinal treatment of chronic bloat resulted in poor weight gain and at times death. Devices like self-retaining trocars, plastic or metal fistulae and pop off valves were used. These mechanical devices became blocked either by local infection or by ingesta. They adopted rumen fistulation technique for treating chronic bloat. The percentage of success in the treatment of

chronic bloat ranged between 20 and 50 when surgical methods were not adopted to evacuate gases. With the adoption of the surgical techniques the results were greatly improved.

Priego and Sutherland (1977) used purse string sutures for fixing the rumen cannulae in position.

Filipov and Lock (1979) reported that stenosis, physical obstruction of the oesophagus or cardia, abnormal growths in oesophagus, dysfunction of vagus, spasm of oesophageal musculature etc. caused chronic bloat. Insertion of a plastic tube into the rumen through the flank was recommended, to relieve bloat.

Mogha and Bhargava (1979) reported that rumen fistula could be made by a single stage operation. The skin, muscles, and parietal

peritoneum were sutured to the rumen wall at the same time, in a single stage, after laparotomy and incising the rumen.

Samanta and Mukherjee (1979) described a simple surgical technique for permanent rumen fistula. The rumen was sutured to the peritoneum, muscles and skin by a single row of sutures. The fistula functioned without any complication for two years after surgery.

Wakankar et al. (1980) studied four different modifications of rumen fistulation techniques in bovines. They obtained better results by fixing a pouch of rumen to the subcutaneous tissue and simultaneously removing the exposed part of rumen.

Data pertaining to techniques of internal

fistulation between the rumen and other parts of the gastro-intestinal tract could not be found on screening the available literature.

SURGICAL ANATOMY

SURGICAL ANATOMY

Rumen

Rumen occupies most of the left half of the abdominal cavity and extends over the median line to occupy a part of the right half. It inclines obliquely downwards from the left to the right, elongated from before backwards and is slightly compressed from side to side. It extends from the inferior part of the 7th or 8th intercostal space to the pelvic inlet. The left surface is smooth, convex and is marked by the left longitudinal groove. This groove indicates the division of the rumen to the dorsal and ventral sacs. The right surface is concave and irregular. The dorsal curvature is convex, rounded and is attached to the left sublumbar muscles and the crura of the diaphragm by peritoneum and connective tissue. The anterior extremity lies

near the diaphragm and is divided by a transverse groove into dorsal and ventral blind sacs. The posterior extremity reaches the pelvic brim. It is divided by a deep posterior transverse groove into superior and inferior, posterior blind sacs, which are marked off from the remainder of the rumen by dorsal and ventral coronary grooves. Interior of the rumen is divided into dorsal and ventral sacs by muscular folds called pillars. The wall of the rumen is composed of serous, muscular and mucous coats. The serous coat covers the rumen except at its attachment to the lumbar structures. The muscular coat and the corium of the mucuous membrane are very thick.

Rectum

Large intestine extends from the termination of the ileum to the anus. In adult animals, it is

about 11.4 m long and 12 to 15 cm in diameter, at the initial part and about 5 cm in diameter, at the terminal part where it joins the rectum. The rectum is the terminal section of the alimentary tract and it extends almost in a straight line from the level of the pelvic inlet to the posterior opening of the digestive tube, the anus. Its walls are thicker and more dilatable than the preceding portions of the intestine. It is less than 30 cms in length, attached to the pelvic roof by the mesorectum which is a continuation of the mesenteric fold of colon. The anterior part has the same calibre as that of the terminal part of the colon. Behind this, it gradually dilates to form a reservoir for the faecal matter. The rectum passes backwards either straight or in an oblique direction. It is related superiorly

and laterally to the pelvic walls and on the ventral surface to the bladder, vasa deferentia, vesiculae seminalis, prostate, pelvic part of the urethra and Cowper's glands in the male animals and uterus and vagina in the female animals.

The serous coat covers the large intestine except at the adherent portion of the spiral part. The rectum behind the level of the first coccygeal vertebra does not have a serous outer coat. The retroperitoneal part is very short and is surrounded by fat and connective tissue. The muscular coat has longitudinal and circular layers with plexus of Auerbach between them. Ramification of vessels, nerves and plexus of Meissner are noticed in the submucosal tissue. The mucous membrane does not present any villi or the Brunner's glands as in

the small intestine. The intestinal glands - Liberkuhn and solitary glands are large and numerous. Peyer's patches are absent in the rectal wall.

Blood Supply

1) Rumen.

Three arterial trunks for rumen originate from the coeliac artery viz. hepatic, spleenic and left gastric arteries. The right ruminal artery originates from the spleenic artery and is the largest. It passes around the rumen in the right longitudinal and caudal grooves giving off many collateral branches, including right and left, dorsal and ventral coronary arteries. The left ruminal artery arises from the left gastric artery or the spleenic artery. It passes from the cranial groove to the left longitudinal groove. The left gastroepiploic

artery originates from the left gastric artery between the rumen and the omasum. It runs ventrally on the visceral side of the neck of the omasum and follows the greater curvature of the abomasum and anastomoses with the right gastroepiploic artery.

ii) Rectum.

The rectum is supplied by the cranial rectal branch of the caudal mesenteric artery and by several short middle rectal branches from the caudal branch of the urogenital artery. The anus is supplied by the terminal branches of the cranial and middle rectal arteries and by caudal rectal artery from the terminal bifurcation of the caudal branch of the urogenital artery.

Nerve Supply

i) Rumen.

Rumen is supplied by parasympathetic

fibres from the ventral and dorsal oesophageal trunks of vagus. Sympathetic nerves to the stomach originate from the coeliac plexus and accompany the branches of the coeliac artery.

ii) Rectum.

Sympathetic nerves reach the rectum from the caudal mesenteric plexus via the cranial rectal plexus. Main para-sympathetic nerve supply to the rectum arises from the caudal rectal nerves. The deep perineal nerves from the pudental nerve also gives a branch to the sphincter ani externus.

MATERIALS AND METHODS

MATERIALS AND METHODS

The studies were conducted on twelve apparently healthy, male calves. They were divided into two groups, each group consisting of six calves. The animals of group-I were numbered serially from I/1 to I/6 and that of group-II from II/1 to II/6. The animals were examined for endoparasites and infested animals were treated. Blood samples were collected and estimation of haemoglobin, packed cell volume, total erythrocyte count, total and differential leucocyte count were done.

In the animals of group-I laparotomy was performed on the right flank and fistula was established between the right dorsal sac of rumen and the anterior part of the rectum.

In the animals of group-II, laparotomy was

performed on the left flank and the left dorsal sac of rumen was anastomosed to the anterior part of the rectum to establish a fistula.

Site

Laparotomy was performed at the posterior portion of the flank, commencing 2 cm below the external angle of ilium.

Group-I

Pre-operative preparations.

Food and water were withheld for 24 hrs. prior to surgery. The flank was shaved, washed, and cleaned and the prepared site was painted with Liq. iodi mitis. The animal was cast and controlled in a position of left lateral recumbency.

Anaesthesia.

Narcosis was induced by slow intravenous

administration of chloral hydrate 10% solution at a calculated dose of 1 ml/kg body weight. Supportive local analgesia at the site of incision was induced by subcutaneous infiltration of xylocaine * (2%) solution.

Technique.

The skin over the right flank was incised for about 10 cm, starting from 2 cm below the external angle of ilium, vertically downwards just in front of the muscle tensor facia lata. The abdominal facia was incised and the incision was extended through the abdominal muscles viz., m. obliques abdominis externus, m. obliques abdominis internus and m. transverse abdominis, separating them by blunt dissection along the direction of muscle fibres. The peritoneum was exposed and incised. The posterior part of the dorsal sac of

* Lidocaine hydrochloride (Astra)

the rumen was exteriorised and a pouch of rumen, about 4 cm in diameter, was clamped using a Doyen's intestinal clamp. The anterior part of the rectum was exteriorized and about 4 cm length of the rectum was clamped, using a Doyen's clamp. The clamped portions of the rumen and rectum were brought side by side. Cushings sutures using, No. '0' silk, were inserted uniting the rumen wall and rectum to a length of about 3 cm. While suturing, about 12 cm of suture thread was left free at either end. A circular incision, 2 cm in diameter was made on the clamped pouch of rumen. A similar incision, 2 cm in diameter, was made on the rectum corresponding to the incision on rumen. The cut edges of rumen and rectum were apposed by continuous lock stitch and the clamps were released. The Cushing's sutures were completed around the lock stitch, using the strands left in

excess earlier. The patency of the fistula was tested by inserting a rubber tube through the anus and rectum to the rumen. The peritoneum and muscle layers were sutured by simple continuous sutures using No.1/0 braided silk. The skin edges were brought into apposition by vertical mattress sutures using No.1/0 braided silk.

Group-II

The animal was cast and controlled in a position of right lateral recumbency. Laparotomy incision was made on the left flank in a similar pattern as in group-I. Fistulation was effected by anastomosing the left dorsal sac of rumen to the rectum.

Surgical closure of the fistula

Surgical closure of the fistula was

performed in 2 calves.

Laparotomy was performed on the flank under chloral hydrate narcosis and local anaesthesia as described earlier. The fistula was identified, exteriorised, and clamped on either side of the site of anastomosis, on the rumen and the rectum. The part of the rumen between the clamp and fistula was severed. The rumen and rectum were separately closed by Cushings sutures, reinforced with a layer of Lemberts suture using No. 1/0 silk. The incision on abdomen was sutured to complete the procedure.

Post-operative care

A Tr. benzoin seal was applied to the suture line. Dextrose (10%) solution ml was administered intravenously after the operation. Steptopenicillin (1 gm : 8 lakhs/dose) administered

for the first four post-operative days. The wound was cleaned with 70% alcohol and was dressed with Spectrocin* ointment. Healing was uneventful and sutures were removed between 8th and 12th post-operative days. After surgery, the animals were kept under observation upto 100 days.

Observations

Rumen contents and rectal washings were collected at the time of operation for the estimation of pH and examination for the presence of protozoans (Table 1, 2 & 3). Blood samples were collected for the estimation of haemoglobin, packed cell volume and for cell counts, on the 3rd, 7th, 30th, 60th and 90th post-operative days (Table 4). The pH of the rectal contents was estimated on 2nd and 4th days and at weekly intervals till the animals were sacrificed or died (Table-2). Screening of rectal contents

* Spectrocin ointment (Sarabhai Chemicals)

following the method of Moir (1951) was conducted for the presence of protozoa on the 2nd and 4th days and at weekly intervals till the animals were sacrificed or died (Table 3). The apetite and consistancy of the dung before and after surgery were noted (Table 5). Body weight of the animals were recorded on the 7th, 15th, 30th, 60th and 90th post-operative days (Table-6). The autopsy findings are recorded in Table 7. The data, on the observations made on similar lines in the animals where closure of the fistula was done, are presented in tables 8 to 12.

RESULTS

RESULTS

The experiments were conducted in two groups, consisting of six calves in each group. The animals of group-I are numbered serially from I/1 to I/6 and of group-II from II/1 to II/6. The details of the observations are presented in Tables 1 to 12.

Group-I

Calf No.I/1.

The pH of rumen contents was 6.8 and that of rectal contents was 7.3 at the time of operation. The post-operative pH of rectal contents ranged between 7.0 and 7.2 from the second day after surgery. The erythrocyte count (5.83 million/cmm) was reduced to 5.45 million/cmm by the 30th day, but increased to 5.46 million/cmm by the 60th day and to 5.93 million/cmm by the 90th day. The haemoglobin content (10gm%) did not show any variation by the seventh day but

reduced to 7.2 gm% by the 30th day and increased subsequently to 8.0 gm% by the 60th day and to 9.2 gm% by the 90th day. The packed cell volume (32%) was reduced to 28% by the seventh day, to 24% by the 30th day, remained at the same level till the 60th day and improved to 26% by the 90th day. Variations observed in total and differential leukocyte counts were within normal limits. The body weight of 69.0 kg was reduced to 65.0 kg by the 30th day, to 64.0 kg by the 60th day and increased to 72.0 kg by the 90th day.

The animal was taking food and water in normal quantities. The consistency of the dung was loose and contained coarse undigested materials. Dung voided out immediately after drinking water was more fluidic. Rumen protozoans were present in the rectal contents from the second day onwards.

The animal was kept under observation for 100 days. At autopsy, the fistula was found to be patent

and had a diameter of about 2 cm. The site of anastomosis was hard to touch and no other abnormalities could be detected in the rumen and rectum. The sutures at the site of anastomosis were not fully encapsulated. Rumen contents were present in the rectum. Histological examination revealed complete healing at the site of anastomosis of the rumen wall to the rectum.

Calf No.I/2.

The pH of rumen contents was 6.9 and that of rectal contents was 7.5 at the time of operation. The post-operative pH of rectal contents ranged between 7.0 and 7.1 from the second day after surgery. The erythrocyte count (6.07 millions/cmm) was reduced to 4.26 millions/cmm by the 30th day and to 3.46 millions by the 45th day. The haemoglobin content (10.0 gm%) was reduced to 9.4 gm% by the seventh day, to 5.2 gm% by the 30th day and to 4.6 gm% by the 45th day. The

packed cell volume (25.0%) was reduced to 24.0% by the seventh day, to 18.0% by the 30th day and to 15.0% by the 45th day. Variations observed in total and differential leukocyte counts were within normal limits. The body weight of 52.5 kg was reduced to 49.0 kg by the 30th day and to 46.0 kg by the 40th post-operative day.

The animal was taking food and water in normal quantities. The consistency of the dung was loose and contained coarse undigested materials. Dung voided out immediately after drinking water was more fluidic. Rumen protozoans were present in the rectal contents from the second day onwards. There was reduction in the intake of feed and water by the 40th post-operative day. The animal became debilitated and recumbent by the 42nd post-operative day and died on the 46th day.

At autopsy, omental adhesions were noticed at the site of anastomosis. The fistula was patent and had a diameter of about 2.0 cm. The site of anastomosis was hard to touch and no other abnormalities could be detected in the rumen and rectum. The sutures at the site of anastomosis were not fully encapsulated. Rumen contents were present in the rectum. The bladder was distended and petechial haemorrhages were noticed at the neck of the bladder. A large quantity of fluid was noticed in the pericardial sac and the heart was flabby. Histological examination revealed complete healing at the site of anastomosis of the rumen wall to the rectum.

Calf No.I/3.

The pH of rumen contents was 6.8 and that of rectal contents was 7.4 at the time of operation. The post-operative pH of rectal contents ranged

between 7.0 and 7.2 from the second day after surgery. The erythrocyte count (4.86 million/cmm) was reduced to 4.36 millions/cmm by the 30th day, to 4.13 millions/cmm by the 60th day and to 3.92 millions/cmm by the 85th day. The haemoglobin content (9.8 gm%) did not show any variation by the seventh day, but reduced to 6.2 gm% by the 30th day, to 6.0 gm% by the 60th day and to 5.4 gm% by the 85th day. The packed cell volume (28%) was reduced to 23% by the seventh day, to 18% by the 30th day, to 16% by the 60th day and to 15% by the 85th day. Variations observed in total and differential leukocyte counts were within normal limits. The body weight of 63.0 kg was reduced to 53.0 kg by the 30th day, remained the same by the 60th day and reduced to 52.0 kg by the 80th post-operative day.

The animal was taking food and water in normal quantities. The consistency of the dung was loose

and contained coarse undigested materials. Dung voided out immediately after drinking water was more fluidic. Rumen protozoans were present in the rectal contents from the second day onwards. There was reduction in the intake of feed and water by the 80th post-operative day. The animal was found to be very weak by the 82nd day and was totally recumbent by the 84th day.

The animal was sacrificed on the 86th post-operative day. At autopsy, collection of pus was noticed between the muscle layers at the site of surgery. Omental adhesions were observed at the site of anastomosis. The fistula was patent and had a diameter of about 2.0 cm. The site of anastomosis was hard to touch and no other abnormalities could be detected in the rumen and rectum. The sutures at the site of anastomosis were not fully

encapsulated. Rumen contents were present in the rectum. There was consolidation of lungs and degeneration of the liver. The heart was flabby. Histological examination revealed complete healing at the site of anastomosis of the rumen wall to the rectum.

Calf No.I/4.

The pH of rumen contents was 6.9 and that of rectal contents 7.4 at the time of operation. The post-operative pH of rectal contents ranged between 7.1 and 7.2 from the second day after surgery. The erythrocyte count (6.89 million/cmm) was reduced to 6.12 millions/cmm by the 30th day, to 5.82 millions/cmm by the 60th day and to 4.32 millions/cmm by the 90th day. The haemoglobin content (10.4 gm%) was reduced to 9.6 gm% by the seventh day, to 6.3 gm% by the 30th day, to 6.2 gm% by the 60th day and to 5.6 gm% by the 90th day. The packed cell volume

(32%) was reduced to 25% by the seventh day, to 22% by the 30th day, to 20% by the 60th day and to 14% by the 90th day. Variations observed in total and differential leukocyte counts were within normal limits. The body weight of 52.0 kg was reduced to 46.0 kg by the 30th day, to 43.0 kg by the 60th day and to 42.0 kg by the 90th day.

The animal was taking food and water in normal quantities. The consistency of the dung was loose and contained coarse undigested materials. Dung voided out immediately after drinking water was more fluidic. Rumen protozoans were present in the rectal contents from the second day onwards.

The animal was kept under observation for 92 days. At autopsy, the fistula was patent and had a diameter of about 2 cm. The site of anastomosis was hard to touch and no other abnormalities could be

detected in the rumen and rectum. The sutures at the site of anastomosis were not fully encapsulated. Rumen contents were present in the rectum. Histological examination revealed complete healing at the site of anastomosis of the rumen wall to the rectum.

Calf No.I/5.

The pH of rumen contents was 6.7 and that of rectal contents 7.4 at the time of operation. The post-operative pH of rectal contents ranged between 7.0 and 7.2 from the second day after surgery. The erythrocyte count (4.83 million/cmm) did not show any variation by the 30th day, but reduced to 4.76 million/cmm by the 60th day and increased to 5.13 million/cmm by the 90th day. The haemoglobin content (12.6 gm%) was reduced to 10.6 gm% by the seventh day, 9.8 gm% by the 30th day, to 9.6 gm% by the 60th day and increased to 9.8 gm% by the 90th day. The

packed cell volume (28%) was reduced to 21% by the seventh day and remained at the same level by the 30th day, reduced to 20% by the 60th day and increased to 22% by the 90th day. Variations observed in total and differential leukocyte counts were within normal limits. The body weight of 65.0 kg was reduced to 59.0 kg by the 30th day, increased to 61.0 kg by the 60th day and to 66.0 kg by the 90th day.

The animal was taking food and water in normal quantities. The consistency of the dung was loose and contained coarse undigested materials. Dung voided out soon after drinking water was more fluidic. Rumen protozoans were present in the rectal contents from the second day onwards.

Surgical closure of the fistula was performed in this animal on the 95th post-operative day. Omental adhesions were observed at the site of anastomosis.

The fistula was patent and had a diameter of about 2 cm. The site of anastomosis was hard to touch and no other abnormalities could be detected in the rumen and rectum. Complete encapsulation of the sutures had taken place at the site of anastomosis. Rumen contents were present in the rectum.

After closure of the fistula, the pH of rectal contents ranged between 7.3 and 7.5 from the second day after surgery. The erythrocyte count (5.13 million/cmm) was increased to 5.26 millions/cmm by the 30th day and to 5.89 millions/cmm by the 60th day after surgery. The haemoglobin content (9.8 gm%) remained the same by the seventh day, increased to 10.2 gm% by the 30th day and to 10.8 gm% by the 60th day after surgery. The packed cell volume (22%) was increased to 23% by the seventh day and remained the same by the 30th day and increased to 24% by the 60th post-operative day.

Variations observed in total and differential leukocyte counts were within normal limits. The body weight of 66.0 kg at the time of closure of the fistula was increased to 83.0 kg by the 30th day and to 100.0 kg by the 60th day.

The animal was taking food and water in normal quantities. The consistency of the dung was normal. Rumen protozoans were absent in the rectal contents from the second day onwards.

The animal was kept under observation for 60 days. Adhesion of rumen with omentum was observed at autopsy. Complete encapsulation of the sutures had taken place.

Calf No.I/6.

The pH of rumen contents was 6.8 and that of rectal contents 7.3 at the time of operation. The

post-operative pH of rectal contents ranged between 7.1 and 7.2 from the second day after surgery. The erythrocyte count (5.16 millions/cmm) was reduced to 4.94 millions/cmm by the 30th day and to 3.53 millions/cmm by the 53rd day. The packed cell volume (24%) was reduced to 22% by the seventh day, to 20% by the 30th day and to 16% by the 53rd day. Variations observed in total and differential leukocyte counts were within normal limits. The body weight of 49.0 kg was reduced to 46.0 kg by the 30th day and to 45.0 kg by the 50th day.

The animal was taking food and water in normal quantities. The consistency of the dung was loose and contained coarse undigested materials. Dung voided out immediately after drinking water was more fluidic. Rumen protozoans were present in the rectal contents from the second day onwards. There was reduction in the intake of feed and water by the 45th post-operative day. The

animal was very weak and was totally recumbent by the 53rd day.

The animal was sacrificed on the 53rd day. At autopsy, the fistula was patent and had a diameter of about 2 cm. The site of anastomosis was hard to touch and no other abnormalities could be detected in the rumen and rectum. The sutures at the site of anastomosis were not fully encapsulated. Rumen contents were present in the rectum. Histological examination revealed complete healing at the site of anastomosis of the rumen wall to the rectum.

The observations on individual animals of Group-I could be summarized as follows:

1. The pH of rumen contents at the time of operation ranged between 6.7 and 6.9 (Table 1) and the pH of rectal contents ranged between 7.3 and 7.5 (Table 2). The pH of rectal contents varied from

7.0 and 7.2 from the second day after surgery.

2. There was a progressive reduction in the erythrocyte count in four animals, whereas in two animals, after an initial reduction it showed an increase.

3. The haemoglobin content showed a gradual reduction in four animals (Nos. I/2, I/3, I/4 and I/6) and in the other two animals (Nos. I/1 and I/5) after an initial reduction in value, it showed an increase.

4. The packed cell volume showed a gradual reduction in all the animals.

5. There was a slight increase in total leukocyte count during the first post-operative week in all the six animals, but the values became normal by the 30th day. However the variation in the total and differential leukocyte counts remained

within normal limits (Table 4).

6. Gradual loss of body weight was noticed in all the six animals during the first 60 days after surgery (Table 6).

7. The animals were taking food and water in normal quantities. The consistency of the dung was loose and contained coarse undigested materials. Dung voided out immediately after drinking water was more fluidic. Rumen protozoans were present in the rectal contents from the second day onwards (Table 3). Reduction in the intake of feed and water was observed in calf No.I/2 by the 40th post-operative day, in calf No.I/3 by the 80th post-operative day and in calf No.I/6 by the 45th post-operative day. Calf No. I/2 died on the 46th post-operative day. Calf No.I/3 had to be sacrificed on the 86th post-operative day and calf No.I/6 on the 53rd post-operative

day, because of progressive deterioration in the general health of these calves. Surgical closure of the fistula was performed in calf No.I/5 on the 95th post-operative day. The remaining two calves were sacrificed on the 92nd and 100th day after surgery.

8. At autopsy, omental adhesions were observed at the site of anastomosis in calves Nos.I/2, I/3, and I/5 (Table 7). The fistula was patent in all the animals and had a diameter of about 2 cm. The site of anastomosis was hard to touch and no other abnormalities could be detected in the rumen and rectum. Complete encapsulation of sutures had taken place at the site of anastomosis only in one calf (No.I/5). Rumen contents were present in the rectum. Histological examination revealed complete healing at the site of anastomosis of the rumen wall to the rectum in all the calves.

Group-II

Calf No.II/1.

The pH of rumen contents was 6.7 and that of rectal contents 7.4 at the time of operation. The post-operative pH of rectal contents ranged between 7.0 and 7.2 from the second day after surgery. The erythrocyte count (4.25 millions/cmm) was reduced to 4.13 millions/cmm by the 30th day and increased to 4.16 millions/cmm by the 60th day. The haemoglobin content (9.8 gm%) increased to 10.0 gm% by the seventh day, reduced to 9.4 gm% by the 30th day and to 9.2 gm% by the 60th day. The packed cell volume (22%) was reduced to 21% by the 30th day and to 20% by the 60th day. Variations observed in the total and differential leukocyte counts were within normal limits. The body weight of 57.0 kg was reduced to 52.0 kg by the 30th day and to 50.0 kg by the 60th day.

The animal was taking food and water in normal quantities. The consistency of the dung was loose and contained coarse undigested materials. Dung voided out immediately after drinking water was more fluidic. Rumen protozoans were present in the rectal contents from the second day onwards.

The animal was kept under observation for 60 days. Omental adhesions were observed at the site of anastomosis. The fistula was patent and had a diameter of about 2 cm. The site of anastomosis was hard to touch and no other abnormalities could be detected in the rumen and rectum. The sutures at the site of anastomosis were not fully encapsulated. Rumen contents were present in the rectum. Histological examination revealed complete healing at the site of anastomosis of the rumen wall to the rectum.

Calf No.II/2.

The pH of rumen contents was 6.8 and that of rectal contents 7.3 at the time of operation. The post-operative pH of rectal contents ranged between 7.0 and 7.2 from the second day after surgery. The erythrocyte count (3.79 millions/cmm) was reduced to 3.54 millions/cmm by the 30th day and increased to 3.60 millions/cmm by the 60th day. The haemoglobin content (4.6 gm%) was increased to 4.8 gm% by the seventh day, to 5.0 gm% by the 30th day and reduced to 4.8 gm% by the 60th day. The packed cell volume (18%) increased to 20% by the seventh day, reduced to 19% by the 30th day and increased to 20% by the 60th day. Variations observed in the total and differential leukocyte counts were within normal limits. The body weight of 43.0 kg was reduced to 38.0 kg by the 30th day and increased to 41.0 kg by the 60th day.

The animal was taking food and water in normal quantities. The consistency of the dung was loose and contained coarse undigested materials. Dung voided out immediately after drinking water was more fluidic. Rumen protozoans were present in the rectal contents from the second day onwards.

The animal was kept under observation for 60 days. At autopsy, omental adhesions were observed at the site of anastomosis. The fistula was patent and had a diameter of about 2 cm. The site of anastomosis was hard to touch and no other abnormalities could be detected in the rumen and rectum. The sutures at the site of anastomosis were not fully encapsulated. Rumen contents were present in the rectum. Histological examination revealed complete healing at the site of anastomosis of the rumen wall to the rectum.

Calf No.II/3.

The pH of rumen contents was 6.7 and that of rectal contents 7.3 at the time of operation. The post-operative pH of rectal contents ranged between 7.0 and 7.1 from the second day after surgery. The erythrocyte count (6.73 millions/cmm) was reduced to 5.78 millions/cmm by the 30th day and increased to 5.92 millions/cmm by the 60th day. The haemoglobin content (10.2 gm%) was reduced to 7.0 gm% by the seventh day, to 6.8 gm% by the 30th day and increased to 7.2 gm% by the 60th day. The packed cell volume (18%) was reduced to 16% by the seventh day, to 15% by the 30th day and increased to 21% by the 60th day. Variations observed in the total and differential leukocyte counts were within normal limits. The body weight of 53.0 kg was reduced to 46.0 kg by the 30th day and increased to 56.0 kg by the 60th day.

The animal was taking food and water in normal

quantities. The consistency of the dung was loose and contained coarse undigested materials. Dung voided out immediately after drinking water was more fluidic. Rumen protozoans were present in the rectal contents from the second day onwards.

Surgical closure of the fistula was performed in this animal on the 60th post-operative day. Omental adhesions were observed at the site of anastomosis. The fistula was patent and had a diameter of about 2 cm. The site of anastomosis was hard to touch and no other abnormalities could be detected in the rumen and rectum. Complete encapsulation of the sutures had taken place at the site of anastomosis. Rumen contents were present in the rectum.

After closure of the fistula, the pH of rectal contents ranged between 7.3 and 7.4 from the

second day after surgery. The erythrocyte count (5.92 millions/cmm) was reduced to 5.90 millions/cmm by the seventh day, increased to 5.98 millions/cmm by the 30th day and to 6.12 millions/cmm by the 60th day. The haemoglobin content (7.2 gm%) was reduced to 7.0 gm% by the seventh day, increased to 7.4 gm% by the 30th day and to 7.6 gm% by the 60th day. The packed cell volume (20%) was increased to 21% by the seventh day, to 22% by the 30th day and remained same on the 60th day. Variations observed in total and differential leukocyte counts were within normal limits. The body weight at the time of closure of the fistula (56.0 kg) was increased to 65.0 kg by the 30th day and to 75.0 kg by the 60th day.

The animal was taking food and water in normal quantities. The consistency of the dung was normal.

Rumen protozoans were absent in the rectal contents from the second day onwards.

The animal was kept under observation for 62 days. Adhesion of rumen with omentum was observed at autopsy. Complete encapsulation of the sutures had taken place.

Calf No.II/4.

The pH of rumen contents was 6.7 and that of rectal contents 7.3 at the time of operation. The post-operative pH of rectal contents ranged between 7.0 and 7.2 from the second day after surgery. The erythrocyte count (4.12 millions/cmm) was reduced to 3.92 millions/cmm by the 30th day and increased to 3.98 millions/cmm by the 60th day. The haemoglobin content (6.4 gm%) was reduced to 5.4 gm% by the seventh day, to 5.2 gm% by the 30th day and increased to 6.0 gm% by the 60th day. The packed cell volume

(18%) was reduced to 16% by the seventh day, to 15% by the 30th day and increased to 21% by the 60th day. Variations observed in total and differential leukocyte counts were within normal limits. The body weight of 53.0 kg remained to be same on 30th day and increased to 54.0 kg by the 60th day.

The animal was taking food and water in normal quantities. The consistency of the dung was loose and contained coarse undigested materials. Dung voided out immediately after drinking water was more fluidic. Rumen protozoans were present in the rectal contents from the second day onwards.

The animal was kept under observation for 60 days. At autopsy, omental adhesions were observed at the site of anastomosis. The fistula was patent and had a diameter of about 2 cm. The site of anastomosis was hard to touch and no other abnormalities

could be detected in the rumen and rectum. The sutures at the site of anastomosis were not fully encapsulated. Rumen contents were present in the rectum. Histological examination revealed complete healing at the site of anastomosis of the rumen wall to the rectum.

Calf No.II/5.

The pH of rumen contents was 6.7 and that of rectal contents 7.4 at the time of operation. The post-operative pH of rectal contents ranged from 7.1 to 7.2 from the second day after surgery. The erythrocyte count (6.36 millions/cmm) was reduced to 6.21 millions/cmm by the 30th day and increased to 6.23 millions/cmm by the 60th day. The haemoglobin content (10.4 gm%) was reduced to 9.6 gm% by the seventh day, to 9.4 gm% by the 30th day and increased to 9.6 gm% by the 60th day. The packed cell volume

(26%) was reduced to 24% by the seventh day, to 22% by the 30th day and increased to 23% by the 60th day. Variations observed in total and differential leukocyte counts were within normal limits. The body weight of 80.0 kg was increased to 88.0 kg by the 30th day and to 106.0 kg by the 60th day.

The animal was taking food and water in normal quantities. The consistency of the dung was loose and contained coarse undigested materials. Dung voided out immediately after drinking water was more fluidic. Rumen protozoans were present in the rectal contents from the second day onwards.

The animal was kept under observation for 60 days. At autopsy, the fistula was patent and had a diameter of about 2 cm. The site of anastomosis was hard to touch and no other abnormalities could be detected in the rumen and rectum. The sutures

at the site of anastomosis were not fully encapsulated. Rumen contents were present in the rectum. Histological examination revealed complete healing at the site of anastomosis of the rumen wall to the rectum.

Calf No.II/6.

The pH of rumen contents was 6.8 and that of rectal contents 7.3 at the time of operation. The post-operative pH of rectal contents ranged from 7.0 and 7.2 from the second day after surgery. The erythrocyte count (5.23 millions/cmm) did not show any variation by the 30th day, but increased to 5.32 millions/cmm by the 60th day. The haemoglobin content (8.6 gm%) was reduced to 7.6 gm% by the seventh day, to 7.2 gm% by the 30th day and increased to 7.4 gm% by the 60th day. The packed cell volume (22%) was reduced to 18% by the seventh day but did

not show any variation by the 30th day and increased to 20% by the 60th day. Variations observed in total and differential leukocyte counts were within normal limits. The body weight (65.0 kg) was increased to 72.0 kg by the 30th day and to 80.0 kg by the 60th day.

The animal was taking food and water in normal quantities. The consistency of the dung was loose and contained coarse undigested materials. Dung voided out immediately after drinking water was more fluidic. Rumen protozoans were present in the rectal contents from the second day onwards.

The animal was kept under observation for 60 days. At autopsy, the fistula was patent and had a diameter of about 1 cm. The site of anastomosis was hard to touch and no other abnormalities could be detected in the rumen and rectum. Complete encapsulation of the sutures had taken place at the site of

anastomosis. Rumen contents were present in the rectum. Histological examination revealed complete healing at the site of anastomosis of the rumen wall to the rectum.

The observations on individual animals of Group-II could be summarized as follows:

1. The pH of rumen contents at the time of operation ranged between 6.7 and 6.8 (Table 1) and the pH of rectal contents ranged between 7.3 and 7.4 (Table 2). The pH of rectal contents varied from 7.0 to 7.2 from the second day after surgery.

2. There was a progressive reduction in erythrocyte count in four animals whereas in two animals (Nos. II/3 and II/6), after an initial reduction, it showed an increase.

3. The haemoglobin content showed an initial

reduction in four animals in which it increased subsequently. In one calf (No.II/1), the initial increase was followed by a reduction in the value. In calf No.II/2, the initial increase was followed by a reduction, but it increased subsequently.

4. The packed cell volume showed a gradual reduction in four animals. In calf No.II/2, the initial increase was followed by a reduction in value. In calf No.II/4, the initial increase was followed by a reduction which subsequently increased.

5. There was a slight increase in the total leukocyte count in four animals (Nos.II/1, II/2, II/5 and II/6) and in the other two calves (Nos.II/3 and II/4), reduction in total leukocyte count was observed during the first post-operative week. However the variations in the total and differential leukocyte counts remained within normal limits (Table 4).

6. Gradual increase in body weight was observed in four calves (Nos.II/3, II/4, II/5 and II/6) whereas a gradual reduction in body weight was observed in calves numbered II/1 and II/2 by the 60th post-operative day (Table 6).

7. The animals were taking food and water in normal quantities. The consistency of the dung was loose and contained coarse undigested materials. Dung voided out immediately after drinking water was more fluidic. Rumen protozoans were present in the dung from the second day onwards (Table 3).

8. All the animals except calf No.II/3 were sacrificed on the 60th post-operative day. Surgical closure of the fistula was performed in calf No.II/3 on the 60th post-operative day. Omental adhesions were noticed at the site of anastomosis in calves Nos. II/1 and II/2 at the time of autopsy and in calf

No.II/3 at the time of surgical closure of the fistula (Table 7). The fistula was patent and had a diameter of about 2 cm in all the calves except in calf No.II/6 where it was only about 1 cm. The site of anastomosis was hard to touch and no other abnormalities could be detected in the rumen and rectum. Complete encapsulation of the sutures had taken place at the site of anastomosis in calves Nos. II/3, II/5 and II/6. Rumen contents were present in the rectum. Histological examination revealed complete healing at the site of anastomosis of the rumen wall to the rectum, in all these calves.

Surgical closure of the rumeno-rectal fistula was performed in two calves viz., I/5 and II/3, one from each group, and the observations after closure of fistula could be summarised as follows:

1. The pH of the rectal contents in calf No.I/5

and II/3 at the time of closure was 7.2 and 7.1 respectively. From the second day of closure of the fistula, the pH of rectal contents varied from 7.3 to 7.5 in calf No.I/5 and from 7.3 to 7.4 in calf No.II/3.

2. The erythrocyte count, haemoglobin content and packed cell volume showed a gradual increase in these two animals.

3. There was slight increase in the total leukocyte count during the first post-operative week. However the variations in the total and differential leukocyte counts were within normal limits. Gradual increase in the body weight could be noticed.

4. The animals were taking food and water in normal quantities.

5. The dung was normal in consistency from the second day of surgery. Rumen protozoans were not seen in the rectal contents from the second day onwards.

6. The calf No.I/5 was sacrificed on the 60th post-operative day and calf No.II/3 was sacrificed on the 62nd post-operative day. Adhesions of rumen with the omentum were observed at autopsy. Complete encapsulation of the sutures had taken place at the site of closure of wounds on the rumen and rectum. The healing of rumen and rectum was complete.

DISCUSSION

DISCUSSION

The present experimental study was conducted on 12 calves. In six calves, fistulation of the right dorsal sac of rumen to the anterior part of the rectum was performed by right side laparotomy. Similarly, fistulation of the left doreal sac of rumen to the anterior part of rectum was performed by left side laparotomy in the other six calves. Access to the organs was satisfactory in both the techniques.

In the conventional methods of rumen fistulation wherein the rumen wall was fixed to the left flank, with or without cannulae, one of the complications was continuous seepage of rumen contents and soiling of the surgical site and flank. (Dougherty *et al.* 1955; Balch and Cowie, 1962; Driedger *et al.* 1970 and Perez *et al.* 1971). In the present study, since the fistula was internal, this was not noticeable.

The alteration in the nature of rectal contents indicated escape of rumen contents into the rectum through the fistula. The normal pH of rectal contents vary from 7.3 to 7.5. In the present study, it was found that the pH varied from 7.0 to 7.2 after fistulation. Rumen protozoans are not normally seen in the rectal contents. But in the present study, rumen protozoans could be seen in the rectal contents after fistulation. These observations are suggestive of the continuous escape of rumen contents to the rectum.

The diameter of the fistula was about 2 cm throughout. Hence the escape of rumen contents to the rectum might have been continuous. The increase in fluidity of the rectal contents voided soon after the animal drank water, could be due to the escape of more water at that time from the rumen to the rectum.

The animals after the experiments were kept under observation for a period upto 100 days. During this period, the feeding habits of the animals were apparently normal.

There was a progressive reduction in the erythrocyte count and haemoglobin content in eight animals and reduction in packed cell volume in 10 animals, of which the reduction was acute in two animals. No significant variation could be observed in the total and differential leukocyte count. Gradual reduction in the body weight was seen in eight animals whereas in four animals, there was progressive increase in the body weight. Eventhough the feeding habits of these animals were apparently normal after fistulation, yet the fall in haemogram values and decrease in body weight in majority of animals would indicate that there was a progressive deterioration in the general health of the animals.

This may be due to the continuous escape of ingesta from the rumen directly through the rectum.

In external fistulation, the opening might close if the fistula was small (Jordon, 1962). But in the present study, eventhough the fistula was only two cm in diameter, closure of the fistula was not noticed in any of these experimental animals. At autopsy, no narrowing of the diameter of the fistula could be observed. This may be because of the low fibrous tissue proliferation encountered in the organs anastomosed (vide photomicrograph No. 14).

Regurgitation was one of the complications encountered in internal fistulation such as gastro-duodenostomy (Marcowitz et al. 1964). Regurgitated rectal contents was not seen in the rumen in the experimental animals, at autopsy.

Adhesion of the rumen to the abdominal wall is common in external fistulation techniques (Harlan et al. 1975). In the present study on internal fistulation, adhesions of omentum were noticed at the site of anastomosis in six animals. However no functional disturbances were found to occur due to these adhesions.

Closure of the fistula was performed in two experimental animals and the recovery was uneventful. There was progressive improvement in the haemogram values and the body weight.

SUMMARY

SUMMARY

Experimental studies on rumeno-rectal fistula were conducted in 12 bull calves, in two groups of six calves each.

In the animals of group-I, through a right flank laparotomy, the posterior part of the right dorsal sac of the rumen was anastomosed to the anterior part of the rectum. In the animals of group-II, laparotomy was performed on the left flank and the left dorsal sac of the rumen was anastomosed to the anterior part of the rectum. The animals were kept under observation for a period upto 100 days.

The pH of the rectal contents was reduced after the fistulation and rumen protozoa were present in the rectal contents. A gradual fall in the erythrocyte count, packed cell volume and haemoglobin content was observed in four animals in each group. The variations in the total and differential

leukocyte counts were within normal limits. A gradual loss of body weight was noticed in all the animals of group-I whereas an increase in body weight was observed in four animals of group-II. The animals were normal in their feeding habits, but the dung was loose and became more fluidic soon after drinking water.

At autopsy, adhesion at the site of anastomosis was observed in three animals of each group. The fistula was patent in all the animals. Rumen contents were present in the rectum.

In two calves, one from each group, surgical closure of the fistula was performed.

It was concluded that functional rumeno-rectal fistula could be established experimentally in calves and that these fistulae permitted escape of rumen contents to the rectum. The fistula could be closed surgically afterwards.

TABLES

Table 1. pH of Rumen contents at the time of operation.

Sl. No.	Animal No.	pH of Rumen contents.
1.	I/1	6.8
2.	I/2	6.9
3.	I/3	6.8
4.	I/4	6.9
5.	I/5	6.7
6.	I/6	6.8
7.	II/1	6.7
8.	II/2	6.8
9.	II/3	6.7
10.	II/4	6.7
11.	II/5	6.7
12.	II/6	6.8

Note: Beckman pH meter was used for estimation of pH.

Table 2. pH of rectal contents before and after rumeno-rectal anastomosis.

Sl. No.	Animal No.	pH before anastomosis	pH after anastomosis													Sacrificed/ died on
			2nd day	4th day	1st week	2nd week	3rd week	4th week	5th week	6th week	7th week	8th week	9th week	10th week	11th week	12th week	
1.	I/1	7.3	7.1	7.1	7.2	7.1	7.1	7.1	7.0	7.0	7.0	7.1	7.1	7.1	7.1	7.1	100th day
2.	I/2	7.5	7.0	7.0	7.1	7.1	7.0	7.0	7.0	7.1	..	..	..	..	..	..	46 "
3.	I/3	7.4	7.1	7.1	7.1	7.0	7.1	7.0	7.1	7.1	7.1	7.0	7.2	7.1	7.1	7.1	86 "
4.	I/4	7.4	7.2	7.2	7.2	7.1	7.1	7.2	7.1	7.1	7.1	7.1	7.2	7.2	7.2	7.2	92 "
5.	I/5	7.4	7.2	7.2	7.1	7.1	7.2	7.2	7.0	7.1	7.2	7.2	7.1	7.1	7.1	7.2	95 "
6.	I/6	7.3	7.2	7.2	7.2	7.2	7.1	7.1	7.1	7.1	7.2	..	..	..	..	..	53 "
7.	II/1	7.4	7.0	7.1	7.1	7.0	7.0	7.0	7.1	7.1	7.1	7.2	..	..	..	..	60 "
8.	II/2	7.3	7.1	7.1	7.1	7.1	7.2	7.2	7.1	7.1	7.1	7.0	..	..	..	..	60 "
9.	II/3	7.3	7.1	7.1	7.1	7.0	7.0	7.0	7.0	7.1	7.1	7.1	..	..	..	..	60 "
10.	II/4	7.3	7.1	7.1	7.1	7.1	7.0	7.2	7.0	7.1	7.1	7.1	..	..	..	..	60 "
11.	II/5	7.4	7.2	7.2	7.2	7.1	7.1	7.1	7.1	7.1	7.1	7.1	..	..	..	..	60 "
12.	II/6	7.3	7.1	7.2	7.2	7.1	7.1	7.1	7.0	7.1	7.1	7.1	..	..	..	..	60 "

Table 3. Presence of protozoa in rectal contents before and after rumeno-rectal anastomosis.

Sl. No.	Animal No.	Before anastomosis	After anastomosis													Sacrificed/ died on
			2nd day	4th day	1st week	2nd week	3rd week	4th week	5th week	6th week	7th week	8th week	9th week	10th week	11th week	12th week	
1.	I/1	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	100th day
2.	I/2	-	+	+	+	+	+	+	+	+	..	..	..	..	..	..	46 "
3.	I/3	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	86 "
4.	I/4	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	92 "
5.	I/5	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	95 "
6.	I/6	-	+	+	+	+	+	+	+	+	+	..	..	..	..	..	53 "
7.	II/1	-	+	+	+	+	+	+	+	+	+	+	..	..	..	..	60 "
8.	II/2	-	+	+	+	+	+	+	+	+	+	+	..	..	..	..	60 "
9.	II/3	-	+	+	+	+	+	+	+	+	+	+	..	..	..	..	60 "
10.	II/4	-	+	+	+	+	+	+	+	+	+	+	..	..	..	..	60 "
11.	II/5	-	+	+	+	+	+	+	+	+	+	+	..	..	..	..	60 "
12.	II/6	-	+	+	+	+	+	+	+	+	+	+	..	..	..	..	60 "

Note: Presence of protozoa was studied following the technique described by Moir (1951).
'+' denotes presence of protozoa.
'-' denotes absence of protozoa.

Table 4. Haemogram of the experimental animals during the pre-operative and post-operative period.

Sl. No.	Animal No.	Day of Examination	RBC millions/ cmm	WBC thousands/ cmm	Differential count N %	L %	E %	M %	B %	PCV %	Hb gm %
1.	I/1	Pre-operative	5.83	8500	31	66	3	0	0	32	10.0
		3rd day Post-operative	5.36	9500	35	62	3	0	0	28	10.0
		7th day "	5.42	9000	28	69	3	0	0	28	10.0
		30th day "	5.45	9000	24	72	3	1	0	24	7.2
		60th day "	5.46	8800	25	71	2	2	0	24	8.0
		90th day "	5.93	7000	20	78	2	0	0	26	9.2
2.	I/2	Pre-operative	6.07	8850	28	70	1	1	0	25	10.0
		3rd day Post-operative	5.62	9800	28	66	4	2	0	23	9.6
		7th day "	5.23	8500	32	64	4	0	0	24	9.4
		30th day "	4.26	9000	32	64	3	1	0	18	5.2
		45th day "	3.46	9000	34	64	2	0	0	15	4.6
3.	I/3	Pre-operative	4.86	8900	28	64	6	2	0	28	9.8
		3rd day Post-operative	4.57	9250	32	66	2	0	0	25	9.8
		7th day "	4.72	9150	26	68	4	2	0	23	9.8
		30th day "	4.36	9000	30	68	2	0	0	18	6.2
		60th day "	4.13	8800	26	70	3	1	0	16	6.0
		85th day "	3.92	8600	24	74	2	0	0	15	5.4
4.	I/4	Pre-operative	6.89	9500	23	71	4	2	0	32	10.4
		3rd day Post-operative	6.42	11250	29	66	4	1	0	27	10.2
		7th day "	6.44	10250	27	68	4	1	0	25	9.6
		30th day "	6.12	9250	26	70	3	1	0	22	6.3
		60th day "	5.82	8500	25	72	2	1	0	20	6.2
		90th day "	4.32	8000	24	74	2	0	0	14	5.6

Note: Animals in Group-I, are numbered I/1 to I/6 and animals in Group-II, are numbered II/1 to II/6

(contd.....2)

Table 4 (contd.)

Sl. No.	Animal No.	Day of Examination	RBC millions/ cmm	WBC thousands/ cmm	Differential count N %	L %	E %	M %	B %	PCV %	Hb gm %
5.	I/5	Pre-operative	4.83	6900	20	78	2	0	0	28	12.6
		3rd day Post-operative	4.75	7500	26	72	2	0	0	26	12.2
		7th day "	5.23	5150	23	73	3	1	0	21	10.6
		30th day "	4.83	5000	24	72	2	2	0	21	9.8
		60th day "	4.76	5000	24	72	3	1	0	20	9.6
		90th day "	5.13	5500	20	77	2	1	0	22	9.8
6.	I/6	Pre-operative	5.16	7000	27	71	1	1	0	24	10.0
		3rd day Post-operative	4.98	7100	28	68	3	1	0	22	10.0
		7th day "	4.96	6250	26	70	3	1	0	23	10.0
		30th day "	4.94	6000	26	72	2	0	0	20	8.0
		60th day "	3.53	6500	32	64	3	0	1	16	4.2
		90th day "	-	-	-	-	-	-	-	-	-
7.	II/1	Pre-operative	4.25	6000	24	70	5	1	0	22	9.8
		3rd day Post-operative	4.20	7200	28	68	4	0	0	22	10.0
		7th day "	4.23	6800	26	69	5	0	0	22	10.0
		30th day "	4.13	6500	24	72	3	1	0	21	9.4
		60th day "	4.16	6000	24	74	2	0	0	20	9.2
8.	II/2	Pre-operative	3.79	2700	21	78	1	0	0	18	4.6
		3rd day Post-operative	3.53	3250	26	72	2	0	0	16	5.0
		7th day "	3.64	3000	24	74	2	0	0	20	4.8
		30th day "	3.54	3200	26	70	3	1	0	19	5.0
		60th day "	3.60	3000	26	73	1	0	0	20	4.8

(contd.....)

Table 4 (concluded)

Sl. No.	Animal No.	Day of Examination	RBC millions/ cmm	WBC thousands/ cmm	Differential count N %	L %	E %	M %	B %	PCV %	Hb gm %
9.	II/3	Pre-operative	6.73	6100	15	80	4	1	0	28	10.2
		3rd day Post-operative	5.86	6150	21	77	2	0	0	26	9.6
		7th day "	5.98	5500	21	74	3	2	0	21	7.0
		30th day "	5.78	5000	22	74	3	1	0	20	6.8
		60th day "	5.92	5000	22	74	3	1	0	20	7.2
10.	II/4	Pre-operative	4.12	6750	14	83	3	0	0	18	6.8
		3rd day Post-operative	6.22	7400	24	73	3	0	0	24	6.4
		7th day "	3.74	6400	22	75	3	0	0	16	5.4
		30th day "	3.92	6000	24	74	2	0	0	15	5.2
		60th day "	3.98	5000	23	75	2	0	0	21	6.0
11.	II/5	Pre-operative	6.36	7100	16	80	3	1	0	26	10.4
		3rd day Post-operative	6.22	7400	28	69	2	1	0	24	9.8
		7th day "	6.18	7250	22	75	3	0	0	24	9.6
		30th day "	6.21	7000	22	74	3	1	0	22	9.4
		60th day "	6.23	7000	20	76	3	1	0	22	9.6
12.	II/6	Pre-operative	5.23	6000	18	80	2	0	0	22	8.6
		3rd day Post-operative	4.96	7200	28	70	2	0	0	20	7.8
		7th day "	5.13	7000	24	74	2	0	0	18	7.6
		30th day "	5.23	6800	23	74	2	1	0	18	7.2
		60th day "	5.32	6500	24	74	1	1	0	20	7.4

Table 5. Pre-operative and post-operative observations on appetite and nature of dung in the experimental animals.

Sl. No.	Animal No.	Pre-operative observations		Post-operative observations			
				Appetite		Nature of dung after 48 hrs.	
		Appetite	Nature of dung	Within 30 days	After 30 days	soon after drinking water	At other times
1.	I/1	Normal	Semisolid	Normal	Normal	Fluidic	Loose in consistency
2.	I/2	"	"	"	Reduced	"	"
3.	I/3	"	"	"	"	"	"
4.	I/4	"	"	"	Normal	"	"
5.	I/5	"	"	"	"	"	"
6.	I/6	"	"	"	Reduced	"	"
7.	II/1	"	"	"	Normal	"	"
8.	II/2	"	"	"	"	"	"
9.	II/3	"	"	"	"	"	"
10.	II/4	"	"	"	"	"	"
11.	II/5	"	"	"	"	"	"
12.	II/6	"	"	"	"	"	"

Table 6. Body weight of experimental animals (in kgs) during the pre-operative and post-operative period.

Sl. No.	Animal No.	Pre-operative	Post-operative					Sacrificed/ Died on
			7th day	15th day	30th day	60th day	90th day	
1.	I/1	69.0	67.0	66.0	65.0	64.0	72.0	100th day
2. *	I/2	52.5	51.5	50.0	49.0	..	..	46 ..
3. **	I/3	63.0	58.0	55.0	53.0	53.0	..	86 ..
4.	I/4	52.0	51.0	50.0	46.0	43.0	42.0	92 ..
5.	I/5	65.0	63.0	59.0	59.0	61.0	66.0	95 ..
6. ***	I/6	49.0	48.0	46.0	46.0	..	..	53 ..
7.	II/1	57.0	54.0	53.0	52.0	50.0	..	60 ..
8.	II/2	43.0	40.0	39.0	38.0	41.0	..	60 ..
9.	II/3	53.0	47.0	46.0	46.0	56.0	..	60 ..
10.	II/4	53.0	52.0	52.0	53.0	54.0	..	60 ..
11.	II/5	80.0	77.0	76.0	88.0	106.0	..	60 ..
12.	II/6	65.0	69.0	68.0	72.0	80.0	..	60 ..

* 46.0 on the 40th day after surgery.
** 52.0 on the 80th day after surgery.
*** 45.0 on the 50th day after surgery.

Table 7. Autopsy findings of animals after rumen-rectal anastomosis.

Sl. No.	Animal No.	Date of operation	Date of sacrifice/death	No.of days the animals were kept under observation	Autopsy Findings
1.	I/1	24-9-79	2-1-80	100	The fistula was patent and had a diameter of about 2 cm. Complete encapsulation of the sutures were not observed at the site of anastomosis. Rumen contents were present in the rectum.
2.	I/2	12-10-79	27-11-79	46	Omental adhesions were observed at the site of anastomosis. The fistula was patent and had a diameter of about 2 cm. Complete encapsulation of the sutures were not observed at the site of anastomosis. Rumen contents were present in the rectum.
3.	I/3	2-11-79	5-2-80	86	Omental adhesions were observed at the site of anastomosis. Collection of pus was noticed between the muscle layers at the site of surgery. The fistula was patent and had a diameter of about 2 cm. Complete encapsulation of the sutures were not observed at the site of anastomosis. Rectum contained contents from rumen.
4.	I/4	22-11-79	22-2-80	92	The fistula was patent and was about 2 cm in diameter. Complete encapsulation of the sutures were not observed at the site of anastomosis. Rumen contents were present in the rectum.

(contd.....)

Table 7 (contd....)

Sl. No.	Animal No.	Date of operation	Date of sacrifice/ death	No. of days the animals were kept under observation	Autopsy Findings
5.	I/5	4-1-80	9-4-80	95	While performing laparotomy for closure of the fistula, adhesion between the omentum and the rumen were noticed. The fistula was patent and had a diameter of about 2 cm. Complete encapsulation of the sutures were observed at the site of anastomosis. Rumen contents were present in the rectum.
6.	I/6	11-1-80	5-3-80	53	The fistula was patent and was about 2 cm in diameter. Complete encapsulation of sutures were not observed at the site of anastomosis. Rectum contained contents from rumen.
7.	II/1	18-1-80	19-3-80	60	Omental adhesions were observed at the site of anastomosis. The fistula was patent and had a diameter of about 2 cm. Complete encapsulation of sutures were not observed at the site of anastomosis. Rumen contents were present in the rectum.
8.	II/2	11-2-80	12-4-80	60	Omental adhesions were observed at the site of anastomosis. The fistula was patent and had a diameter of about 2 cm. Complete encapsulation of sutures were not observed at the site of anastomosis. Rumen contents were present in the rectum.

(contd....)

Table 7 (concluded)

Sl. No.	Animal No.	Date of operation	Date of sacrifice/ death	No. of days the animals were kept under observation	Autopsy Findings
9.	II/3	28-2-80	29-4-80	60	While performing closure of the fistula on the 60th day adhesion between the rumen and omentum was observed at the site of anastomosis. The fistula was patent and had a diameter of about 2 cm. Complete encapsulation of the sutures were observed at the site of anastomosis. Rumen contents were present in the rectum.
10.	II/4	21-3-80	20-5-80	60	The fistula was patent and had a diameter of about 2 cm. Complete encapsulation of the sutures were not observed at the site of anastomosis. Rumen contents were present in the rectum.
11.	II/5	11-4-80	11-6-80	60	The fistula was patent and had a diameter of about 2 cm. The sutures were completely encapsulated at the site of anastomosis. Rumen contents were present in the rectum.
12.	II/6	30-4-80	30-6-80	60	The fistula was patent and was about 1 cm in diameter. Complete encapsulation of the sutures were observed at the site of anastomosis. Rumen contents were present in the rectum.

Table 8. pH of rectal contents before and after closure of fistula.

Sl. No.	Animal No.	pH of rectal contents										
		Before closure of fistula	After closure of fistula									
			2nd day	4th day	1st week	2nd week	3rd week	4th week	5th week	6th week	7th week	8th week
1.	I/5	7.2	7.3	7.4	7.4	7.5	7.4	7.4	7.4	7.5	7.4	7.4
2.	II/3	7.1	7.3	7.4	7.4	7.3	7.3	7.3	7.3	7.4	7.4	7.3

Table 9. Presence of protozoa in rectal contents before and after closure of fistula.

Sl. No.	Animal No.	Presence of protozoa in rectal contents: Before closure of fistula	After closure of fistula: 2nd day	4th day	1st week	2nd week	3rd week	4th week	5th week	6th week	7th week	8th week
1.	I/5	+	-	-	-	-	-	-	-	-	-	-
2.	II/3	+	-	-	-	-	-	-	-	-	-	-

'+' denotes presence of protozoa.
'-' denotes absence of protozoa.

Table 10. Haemogram of the experimental animals after closure of the fistula.

Sl. No.	Animal No.	Day of Examination	RBC million/ cmm	WBC thousands/ cmm	Differential count N %	L %	E %	M %	B %	PCV %	Hb gm %
1.	I/5	Before closure	5.13	5500	20	77	2	1	0	22	9.8
		3rd day after closure	5.13	6000	28	69	2	1	0	22	9.6
		7th day "	5.20	5800	27	69	3	1	0	23	9.8
		30th day "	5.26	5400	24	73	2	1	0	23	10.2
		60th day "	5.89	5300	24	72	3	1	0	24	10.8
2.	II/3	Before closure	5.92	5000	22	74	3	1	0	20	7.2
		3rd day after closure	5.86	6400	32	65	2	1	0	20	7.2
		7th day "	5.90	6200	30	67	2	1	0	21	7.0
		30th day "	5.98	5600	26	71	2	1	0	22	7.4
		60th day "	6.12	5400	26	70	3	1	0	22	7.6

Table 11. Post-operative observations after closure of the fistula.

Sl. No.	Animal No.	Before closure of the fistula			After closure of the fistula		
		Nature of dung		Body weight (kgs)	Nature of dung after 48 hrs.	Body weight	
		Soon after drinking water	At other times			30 days (kgs)	60 days
1.	I/5	Fluidy	Loose in consistency	66	Semisolid	83	100
2.	II/3	Fluidy	Loose in consistency	56	Semisolid	65	75

Table 12. Autopsy findings of the experimental animals after closure of the fistula.

Sl. No.	Animal No.	Date of closure of fistula	Date of sacrifice	No. of days the animals were kept under observation	Autopsy Findings
1.	I/5	9-4-80	9-6-80	60	Adhesion of the omentum was observed at the site of anastomosis. Complete encapsulation of the sutures were observed.
2.	II/3	29-4-80	1-7-80	62	Adhesion of the omentum was observed at the site of anastomosis. Complete encapsulation of the sutures were observed.

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FIGURES

Fig. 1. Diagram of bovine pelvis and abdomen (Lateral view - Right side)

1. Rumen.
2. Rectum

Fig. 2. Diagram of bovine pelvis and abdomen (Lateral view - Left side)

1. Rumen.
2. Rectum.

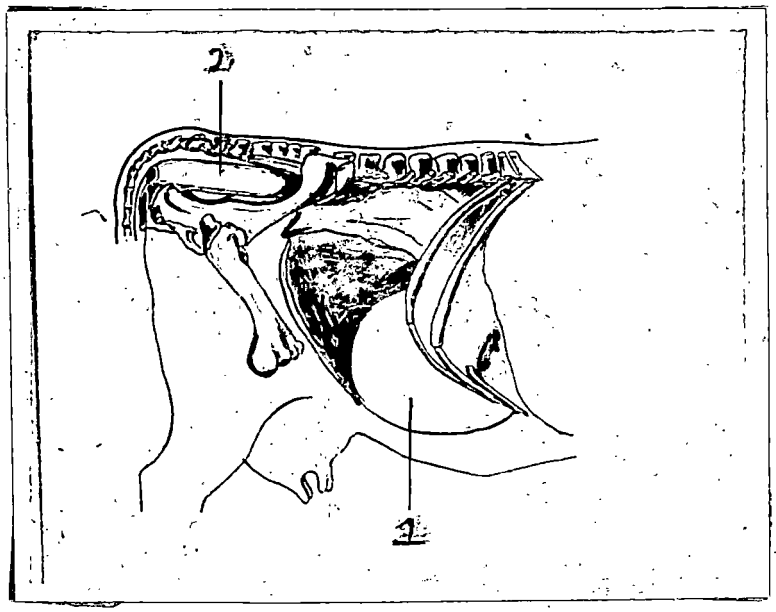

Fig.1

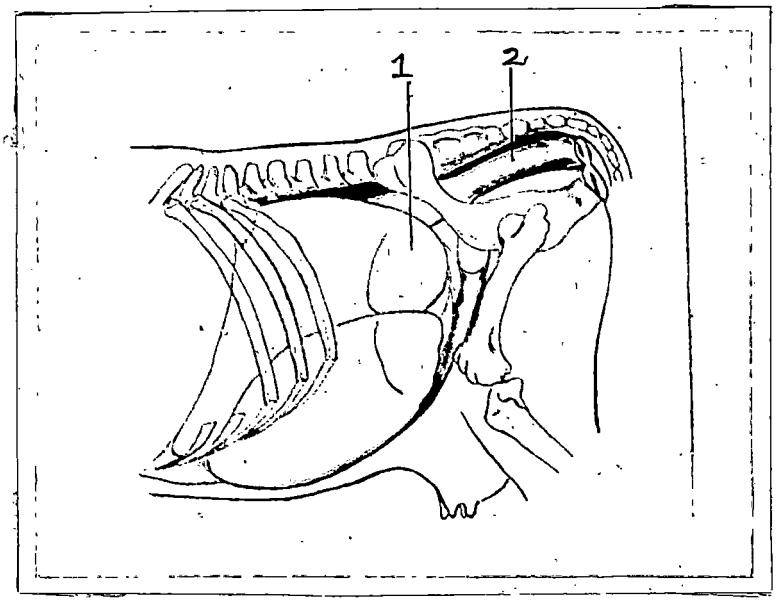

Fig.2

Fig.3. Diagram of the cross section of abdomen of cow at the level of the fourth lumbar vertebra.

1. Mesorectum
2. Colon
3. Uterus
4. Urinary bladder

Fig.4. Parts of rumen and rectum exposed and clamped for anastomosis.

1. Rumen.
2. Rectum.

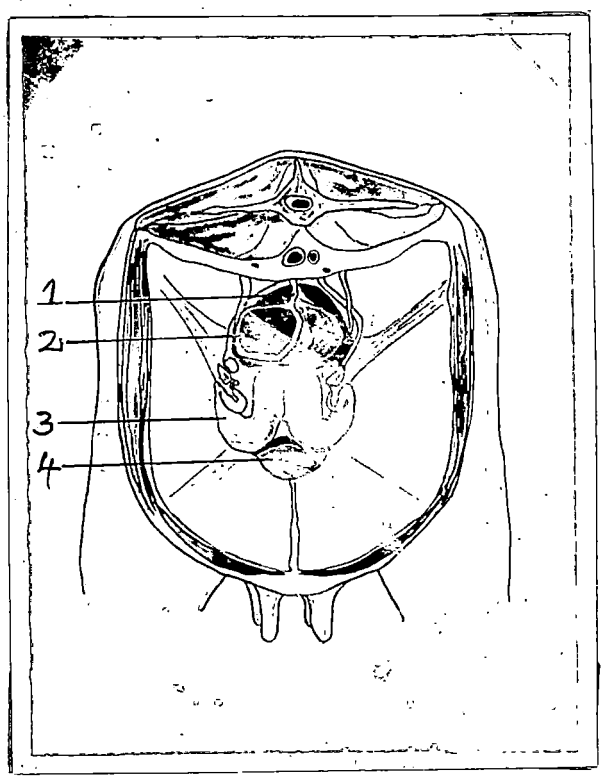

Fig.3

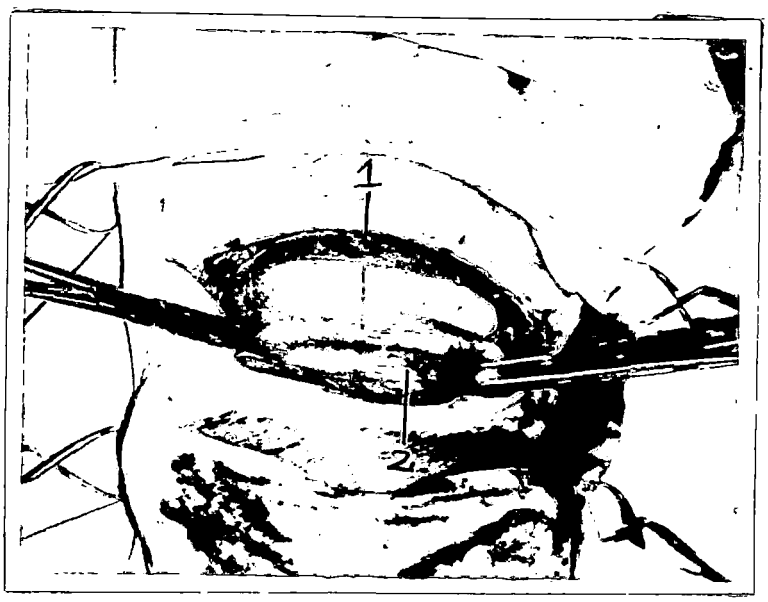

Fig.4

Fig.5. Parts of rumen and rectum with Cushing's sutures completed.

1. Rumen.

2. Rectum.

Fig.6. Parts of rumen and rectum after circular incision.

1. Rumen.

2. Rectum.

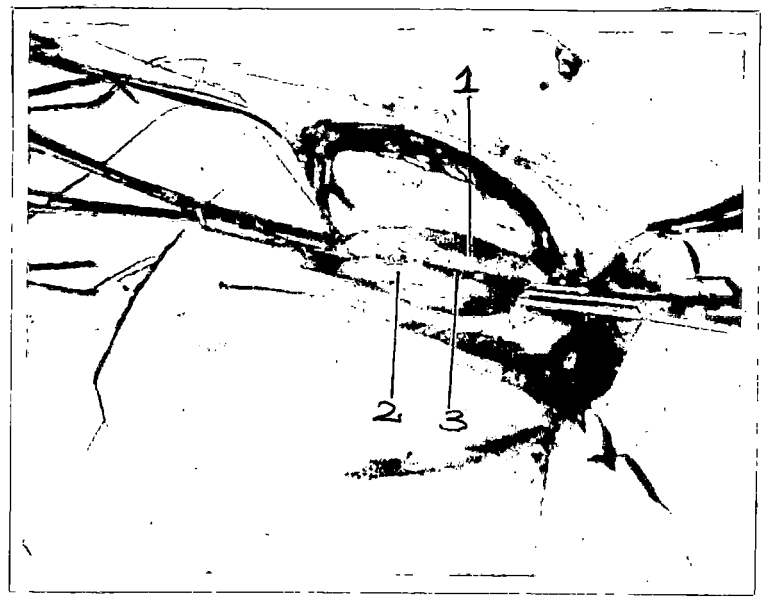

Fig.5

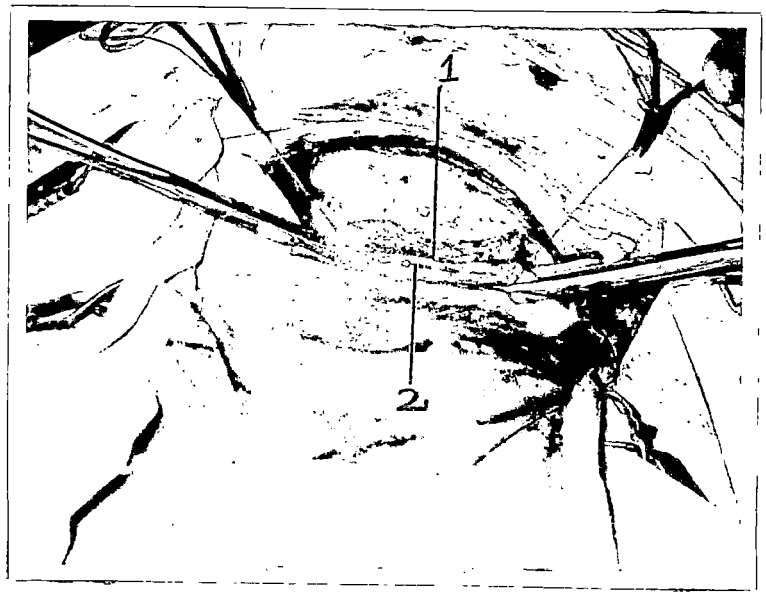

Fig.6

Fig.7(a & b). Lock stitches for anastomosis of wound edges of rumen and rectum - Part completed.

Fig.7(a)

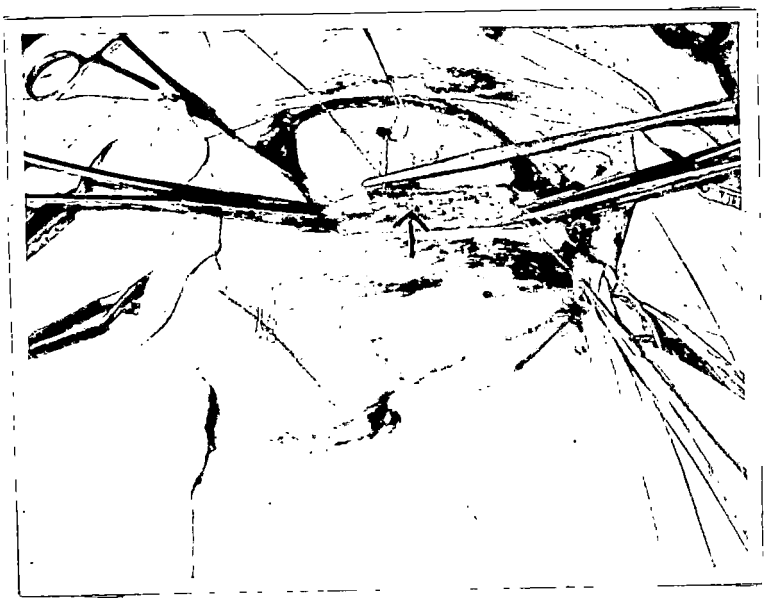

Fig.7(b)

Fig.7(c). Lock stitches for anastomosis of wound edges of rumen and rectum - Part completed.

Fig.7(d). Lock stitches completed.

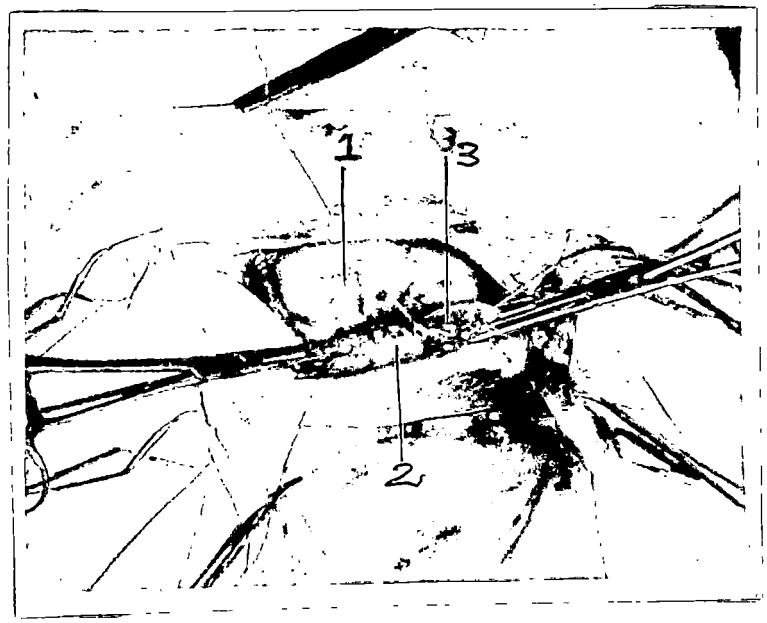

Fig.7(c)

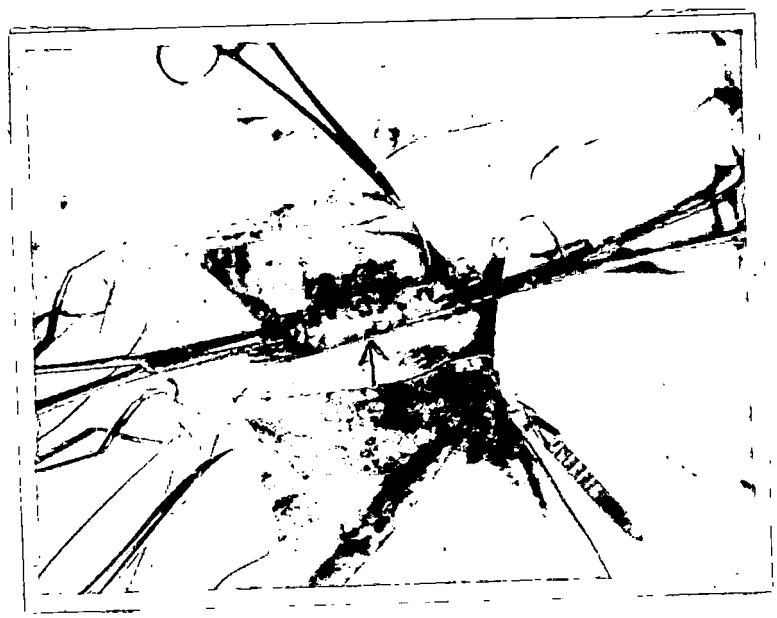

Fig.7(d)

Fig.8. Cushing's sutures completed.

1. Rumen.
2. Rectum.
3. Line of anastomosis.

Fig.9. Postmortem specimen : Rumeno-rectal fistula, viewed from rumen, a rubber tube positioned in the fistula to indicate the site.

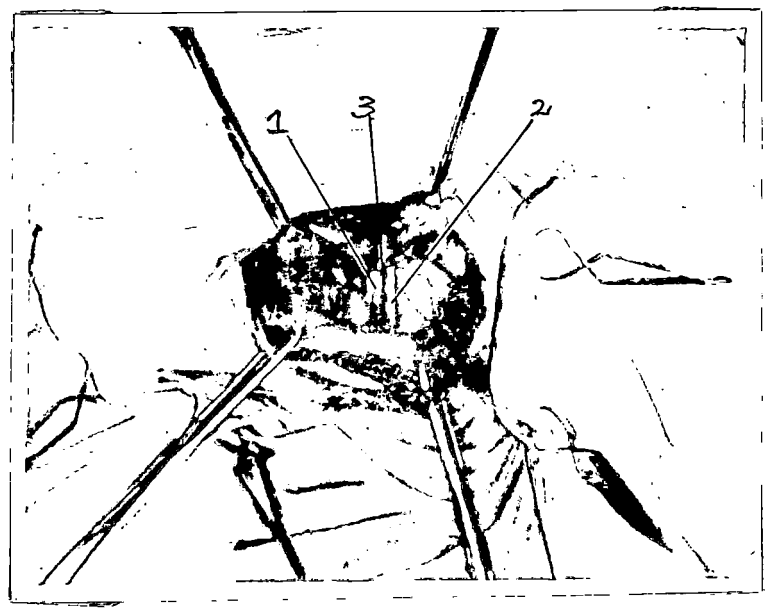

Fig.8

Fig.9

Fig.10. Postmortem specimen : view from the rumen side showing the size of fistula.

Fig.11. Postmortem specimen : showing the site of anastomosis.

a) Gross view from the serous surface.

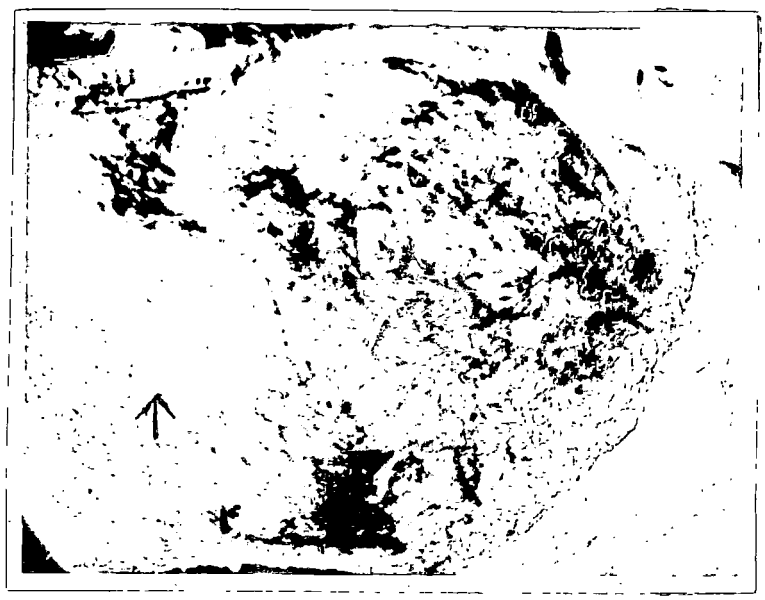

Fig.10

Fig.11(a)

Fig.11. Postmortem specimen : showing the site of anastomosis.

b) Gross view from the serous surface - specimens separated and spread.

Fig.11.(c) View from the rumen side.

Fig.11(b)

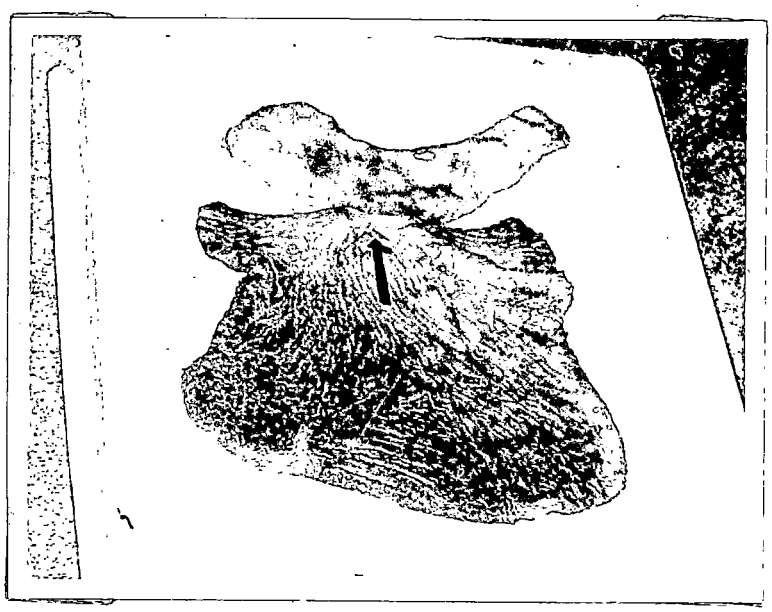

Fig.11(c)

Fig.12. Postmortem specimen : showing the suture line in rumen after surgical closure of the fistula.

Fig.13. Skiagram - showing the communication between rumen and rectum after filling it with Micropaque.

1. Rumen.
2. Rectum.
3. Site of communication.

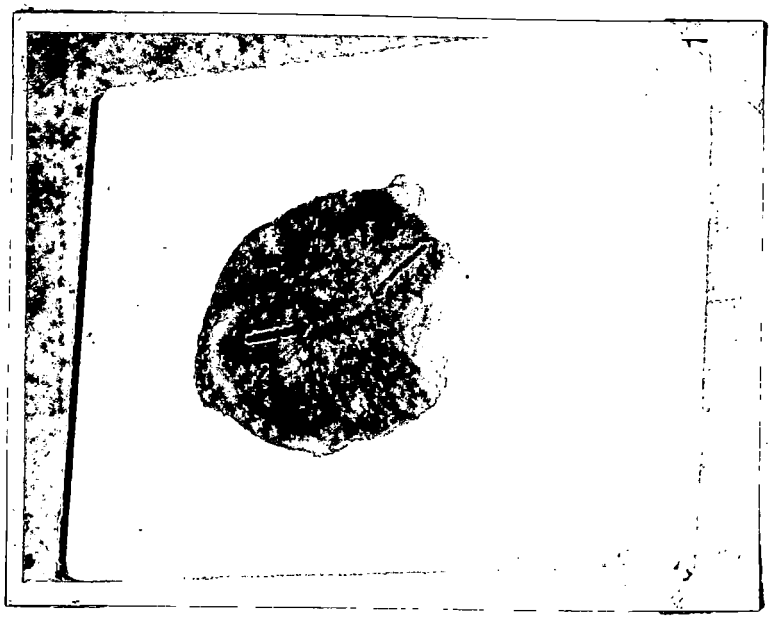

Fig. 12

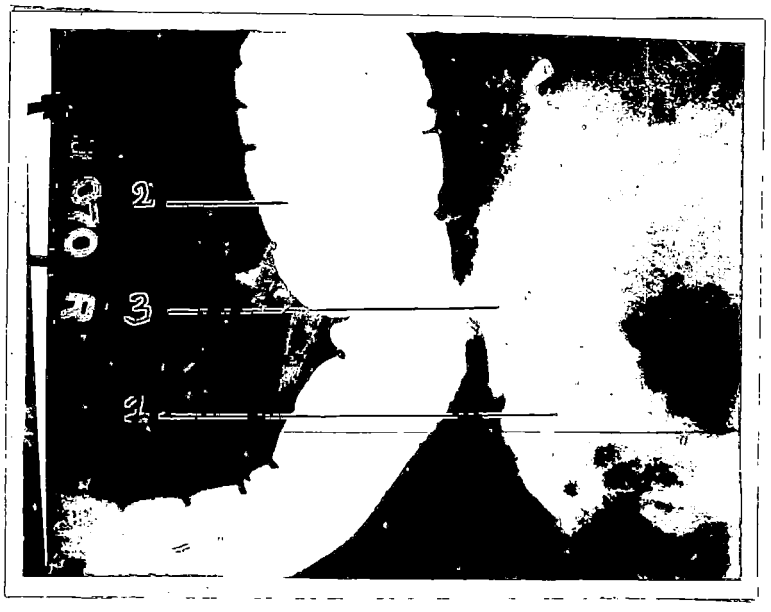

Fig. 13

Fig. 14 (a) & (b). Photomicrographs - site of anastomosis.

1. Rumen.
2. Rectum.
3. Junction of the mucous membrane of rumen and rectum.

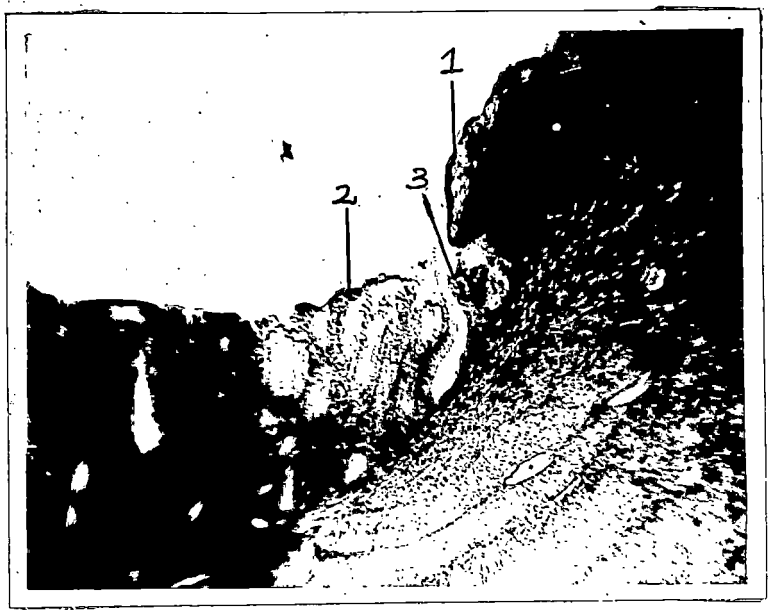

Fig. 14(a)

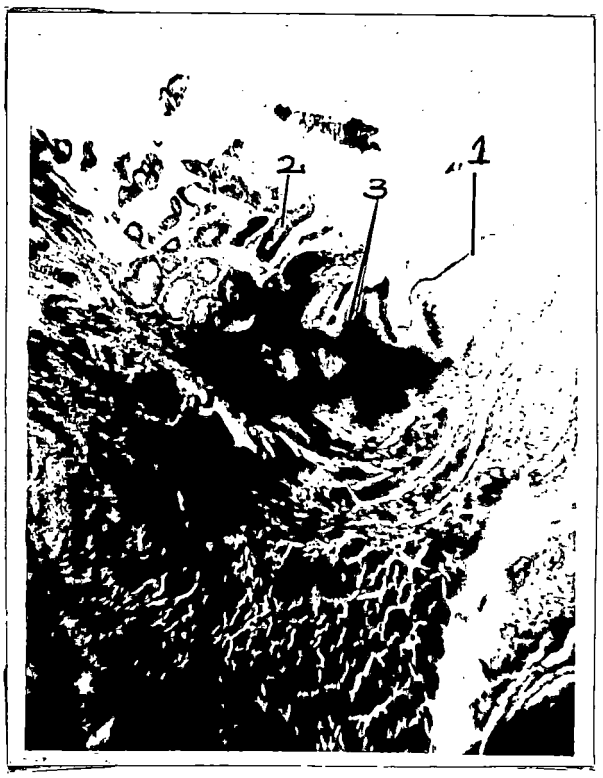

Fig. 14(b)

Fig.14(c). Photomicrographs - site of anastomosis.

1. Rumen.
2. Rectum.
3. Junction of the mucous membrane of rumen and rectum.

Fig.14(c)

EXPERIMENTAL STUDIES ON RUMENO-RECTAL FISTULA IN CALVES

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ABSTRACT OF A THESIS

Submitted in partial fulfilment of the
requirement for the degree

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ABSTRACT

Chronic tympany of the rumen is common in cattle. Rumen fistulation has been reported to be successful in the treatment of chronic tympany. Left side external fistulation of rumen has been adopted by many workers. But this was accompanied by seepage of rumen contents and soiling of the flank. While screening the available literature, no reports on an internal rumen fistulation could be found.

The effects of rumeno-rectal fistula in experimental calves were studied in the present work.

The study was conducted on 12 male calves in two groups, each group consisting of six calves. In the animals of Group-I, laparotomy was performed on the right flank and the right dorsal sac of

rumen was anastomosed to the anterior part of the rectum. In the animals of Group-II, laparotomy was performed on the left flank and the left dorsal sac of rumen was anastomosed to the anterior part of the rectum.

The pH of the rumen contents and the rectal washings, presence of rumen protozoa in the rectal contents, haemoglobin content, packed cell volume, total and differential leucocyte count, nature of dung and the body weight were noted before fistulation and at regular intervals after fistulation.

The animals were kept under observation for a period upto 100 days.

Closure of the fistula was performed 60 days after fistulation, in two calves, one from each group. The details as described above were noted in these animals also after closure of the fistula.

The pH of rectal contents before surgery ranged from 7.3 to 7.5. From the second day after surgery, it ranged between 7.0 and 7.2 in both the groups. The erythrocyte count and haemoglobin content showed a progressive reduction in eight animals and packed cell volume showed a reduction in 10 animals. The variations in the total and differential leukocyte counts were within normal limits. Rumen protozoans were present in the rectal contents from the second day after surgery.

Loss of body weight was noticed in all the six animals of Group-I, whereas an increase in body weight was noticed in four animals of Group-II.

The feeding habits of the calves were normal. Dung was loose in consistency from the second day after surgery and it contained more fluid soon after drinking water.

One animal of Group-I died on the 46th post-operative day, and another one was sacrificed on the 53rd post-operative day. Surgical closure of the fistula was performed in two animals, one from each group. All other animals were sacrificed between 60th and 100th post-operative day.

At autopsy omental adhesions were noticed at the site of anastomosis in six calves. The fistula was patent and had a diameter of about 2 cm in 11 animals. Rumen contents were present in the rectum. The site of anastomosis was hard to touch and no other abnormalities could be detected in the rumen and rectum. Complete encapsulation of sutures at the site of anastomosis was noticed in four calves. The healing at the site of anastomosis was complete in all the animals.

In the two calves in which closure of the

fistula was performed, the healing was uneventful and there was progressive improvement in haemogram values and body weight.

It is concluded that functional rumeno-rectal fistula could be established in calves and that it did not cause any untoward clinical manifestations. There was escape of rumen contents through the fistula to the rectum. Surgical closure of the fistula could also be done successfully.