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Closure of Laparotomy Incision by
Comparative Study of Techniques For
Comparative Study of Techniques For Closure of Laparotomy Incision by Different Suturing Materials in Bovines.

Thesis
SUBMITTED TO THE FACULTY OF VETERINARY SCIENCE
RAJENDRA AGRICULTURAL UNIVERSITY
IN PARTIAL FULFILMENT OF THE REQUIREMENTS
FOR THE DEGREE OF
MASTER OF SCIENCE (Veterinary)

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authorities for giving this unique opportunity for the Degree of Master of Science (Veterinary Surgery) at the Bihar Veterinary College, Patna.

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INTRODUCTION
CHAPTER I

INTRODUCTION

In veterinary practice a great majority of cases are particularly met with in bovine, which require abdominal surgery. On various sites of the abdominal wall laparotomy is performed. It is well known that the greater bulk of abdominal viscera in large animals necessitate special and cautious steps for closure of the abdominal wound. So, effective closure of the abdominal wall is one of the important aspect of it; otherwise possibility of disruption cannot be ruled out. In such condition it may cause severe consequences. A satisfactory technique for closure of the abdominal wall in large animals needs further elaboration. At first one might think that the techniques of closure of laparotomy incision is relatively simple surgical problem. But till date, very little works have been done for comparative evaluation of different techniques of closure of laparotomy incision by different types of suture materials in bovine. Without any distinguished effort in this direction, the problem cannot be solved. If patients survive by a given procedure, it is performed again and again without giving any thought of improving the technique to lower the incidence of post operative complications, then refined surgery cannot come out to meet the challenge of more complicated cases under adverse circumstances. The advancement of animal surgery have been very
well marked during the past twenty years.

The various types of closure of laparotomy incision with two, three and four tier techniques at various sites, namely right or left flank area, midline, para median, para rectal and para costal have been advocated by different workers for abdominal surgery. But still there is not much evidence regarding closure of laparotomy wound by one tier technique with different suture materials and this paucity of literature has stimulated the author to undertake this particular study in bovine.

The present work is an attempt to simplify the technique of closure of laparotomy incision in bovine, so young male buffalo calves have been utilized for experimentation and entire surgical plan has been outlined accordingly. Experimental work is discussed against the background of past and present experiences.

In the present study, three different techniques of closure of laparotomy incision namely one tier, two tier and three tier have been followed using silk no. 4/0, cotton no. 3 and vetafil no. 0.2 mm. as suture material (non-absorbable).

Eighteen young male buffalo calves have been taken and divided in three different groups by random selection. Again by random selection two animals within the particular group have been taken for adopting each technique of closure of laparotomy incision using one type of suture material and
post operative observations were made for 14 and 21 days respectively. Clinical observation, mode of healing, gross and histopathological changes of the repaired tissues in different techniques were studied, which finally formed the basis of this study.

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REVIEW OF LITERATURE
CHAPTER II

REVIEW OF LITERATURE

While going through the literature a very little evidence is found about one tier technique of suturing the laparotomy wound. On the other hand there are many literatures available both in human and veterinary surgery dealing with the closure of the laparotomy wound by means of two and three tier techniques. In one tier technique the skin, muscles and peritoneum are sutured together with one strand of thread like the figure of "8". In two tier technique the peritoneum and muscles are sutured together and the skin separately, whereas in three tier technique the three layers of the abdominal wall are sutured separately by employing conventional method.

The era of a perfect suture material is not yet at hand, veterinary and human surgeons will no doubt, continue to have differences of opinion as to the merits of available suture materials. In all the category of surgical details, there is nothing so effective or indeed indispensable, as the properly applied suture material for the retention of breaches of continuity.

The main purpose of suture is to hold the wound edges in contact, until fibroblastic proliferation is so firmly established to take over the suture (Dhablonia, 1970).

Frederic and Preston (1947) stated that figure of
"S" suture was essentially a pair of simple interrupted sutures. They were placed diagonally across each other, like the letter X, beneath the fascia and the two corresponding legs of the letter X were tied together above the fascia. The suture was of course by one thread. It approximated a wider strip of tissue than the simple interrupted suture and permitted free circulation to the edges of the fascia. There was no disturbance of circulation to the fascia between figure of "S" sutures. One thread would effect as much closure as two simple interrupted sutures, which made it slightly more economical and time saving. The integrity of the wound would not be disturbed when one figure of eight suture break. Besides, when properly tied, the figure of "S" suture would be less rigid and slightly more yielding to an increased tension than the simple interrupted suture.

Bonney (1947) reported the closure of the abdominal wall, where the peritoneum was united by continuous suture using No. 1, 20 day catgut. The fascia and muscles were sutured together by the same suture material. The skin incision was closed either by suture or by means of Michel's clips.

Talawalkar (1952) while performing the caesarian section in a goat a six inches long incision was made on the right flank. The skin, muscles and peritoneum were incised in the same direction and after operation, the peritoneum, muscles and finally the skin were sutured after dusting sulfonamide powder. Except skin sutures, which were interrupted
all other were continuous.

Molmoud and Hafiz (1954) performed an ovariectomy operation in buffalo by laparotomy incision. After operation the peritoneum and muscles were sutured together and soaked with a twenty percent suphpanilamide solution. The skin was sutured in interrupted fashion.

Hawaldar and Khambete (1956) did cesarian section in a goat and mentioned about the closure of the abdominal wall. In this case, the peritoneum and transverse abdominis muscles were sutured together, whereas oblique abdominis internus and externus and the skin were sutured separately by employing silk as suturing material in interrupted pattern.

Menon (1956) closed the laparotomy wound in 4 layers after using eight lakh units of procain penicillin in the peritoneal cavity. For internal sutures on the peritoneum and musculature twenty day chronic catgut size two was used, continuous suture for the former and interrupted sutures for the two layer of the muscles and their sheaths were applied, and the skin wound was closed with a set of interrupted stitches with silk. The suture line was sealed off with a strip of elastoplast and a many tailed suspensory bandage was applied for supporting the abdominal wall and protecting the wound.

George (1958) stated that fine sutures of silk, cotton and nylon were usually satisfactory for skin closure. It was particularly important that wounds should be closed carefully
after placing fine sutures.

Singh and Kholi (1959) performed laparotomy in a goat. After operation the peritoneum and muscles were sutured with 20 days chromic catgut. Skin was sutured separately in Lockstitch pattern with S.S. wire and the line of sutures was painted with weak tincture of iodine.

Singh et al (1960) operated a case of abomasal fistula in a bullock. He mentioned about the closure of the laparotomy wound. The peritoneum and transversalis were sutured together, while the other abdominal muscles were sutured separately in continuous fashion with the same catgut. Interrupted silk sutures were applied to close the skin wound.

Shuttleworth and Smythe (1960) described about the suturing of the laparotomy wound in large animals. They observed during the course of operation that there was retraction of the severed muscle sheets in the varied direction of their fibers. As such the muscles sheets were searched and for accurate suturing. The transversalis muscle and the peritoneum were sutured in one layer. The internal and external oblique muscles whether aponeurotic or muscular were gathered into another suture line, the deep subcutaneous tissue was drawn together with another suture and finally the skin was closed in halsted fashion.

Rathor (1962) performed caesarian section on a camel. After operation the peritoneum was approximated with
simple continuous sutures, whereas interrupted sutures were applied in the muscles. The skin was closed with mattress stitches and carbonised vaseline was applied on the closed incision. Skin sutures were removed after 10 days.

Shuttleworth and Smythe (1960) were described that the abdominal wall should be sutured with No. 3 chromic catgut in three layers. The deep layers of the muscle should be sutured with peritoneum the transversalis and the internal oblique muscles with the external oblique should be sutured together. The skin is sutured with nylon in a mattress fashion.

Alexander (1966) recommended to use continuous suture for peritoneal closure. But in cases, where the peritoneum becomes feeble and can not hold the sutures it must be incorporated with the internal rectus muscles or its sheath. Skin may suitably be closed with monofilament nylon.

Leonard (1968) mentioned about the closure of laparotomy wound in cats and described that the peritoneum was closed with a continuous running stitch. The fascial layers were approximated with interrupted stitches.

According to Frank (1969) the laparotomy wounds may be closed in the following manner. The peritoneum is sutured separately with continuous suture using catgut or linen. The muscles are sutured with No. 2 or 3, 20 days chromic catgut using continuous suture. All sutures must be closely placed so that the edges of the muscles are in close apposition thus
preventing the formation of air pockets. The sutures should be so placed that they grasp more of the fascia than muscle tissue. Fascia will withstand suture tension while muscle tissue has a tendency to develop suture necrosis. The skin incision may be closed with mattress or interrupted sutures of silk, linen, umbilical tape or other suture materials.

Tyagi and Nigam (1971) performed laparotomy for the repair of diaphragmatic hernia in bovine. After operation, the peritoneum, muscles and skin were sutured separately with black braided silk No. 2 or 3 in all animals.

Deore and Johnagirdor (1971) reported repair of diaphragmatic hernias in cattle and buffaloes after performing laparotomy and suturing the muscles and peritoneum with No. 1 or 2 chromic catgut together. The skin was sutured alone with coarse nylon (thick and smooth) in halsted fashion manner.

Masoni (1971) mentioned about the closure of the abdominal wall wound and accordingly the peritoneum was closed continuously by using chromic catgut No. 0. The recti muscles were approximated together by interrupted catgut sutures whereas, rectus sheath was sutured transversely by continuous No. 1 chromic catgut. The subcutaneous tissues were approximated by interrupted sutures using plain catgut No. 0, Interrupted stitches were used to approximate the skin edges.

Jespersen (1940) has successfully removed a foetus using a high left flank incision. He closed the abdominal
wound by two layers of sutures. The first layer, which included the peritoneum, muscles and aponeurosis was achieved up by three short continuous sutures. The skin was closed by series of mattress interrupted sutures about 1½ inches apart, and they were inserted ½ inch from the cut edges. The suture was removed after 8th post operative day.

McConn (1953) mentioned about the closure of the abdominal wall after laparotomy. The peritoneum was sutured with fine silk or catgut. The muscles likewise and the skin with silk wound gut. Great care was taken to obliterate the dead space between the tissues.

Berge and Westhuys (1966) preferred the closure of laparotomy incision by opposing peritoneum, fascia transversalis together in a continuous manner using catgut as suture materials. Then the obliquus abdominis internus and externus were sutured again continuously with catgut. Finally the skin incision was stitched with interrupted U-sutures of silk.

Guard (1953) mentioned about the closure of laparotomy wound in bovine. A continuous suture using (chronic catgut No. 3) was used to appose the peritoneal and transversalis muscle together. A second line of suture brought the remaining layers of fascia and muscles together. The skin was sutured using either umbilical tape or linen suture. A small piece of gauze saturated with dettol B.I.P. was held in place by inferior suture to provide for drainage of serum. A heavy
coat of vaseline was applied over the sutured wound and this was replenished daily until the stitches were removed usually between five to seven days.

Anscombe and Hunt (1970) studied the use of a new absorbable suture material (polyglycolic acid or dexon) in general surgery. According to them, the discovery of this material was credited in the name of Davis and Geck. It was the first synthetic absorbable material in the world which could replace both absorbable and non-absorbable sutures. It was said to be a suitable suture material in animals.

They further observed that Dexon was the first suture material ever designed and created in the laboratory to be used as synthetic absorbable suture material. So, it was most suited for suturing both cuticular and deep tissues.

Postlethwait (1970) made comparative study on non absorbable suture materials, like silk, cotton, dacron, nylon and poly-prophylene. These sutures were implanted in the abdominal muscles of rabbits. The determination of the tensile strength and tissue reactions were graded at intervals of 2 years. Silk and cotton gradually lost their tensile strength. Silk was absorbed at a variable rate. Nylon showed a moderate decrease in tensile strength but caused the least tissue reaction. Poly-prophylene maintained its tensile strength and showed low tissue reaction until the late interval, whereas, dacron maintained its tensile strength and caused a moderate
tissue reaction.

Zydeck (1965) studied various new synthetic suture materials. He listed them in order of decreasing tissue reactions as follows, cotton, silk, merseline, orlon, dacron, vitafil, nylon, marlex and taflon.

Lascelles and Claringbold (1960), found the absence of significant difference between the variant suture techniques on the healing of wounds in the skin of sheep.

Walker, R.G. (1966) cited by Alexander, published a clinical study which compared the incidence of infection between silk and catgut suturing materials both in clean and potentially infected cases. Infection occurred considerably more frequently in the catgut group than in the silk group in both categories.

Kovacs and Somagyvori (1969) reported the comparative study of tissue reaction to various suture materials namely catgut, silk and polyester. Sterilized polyester catgut and milk sutures of various sizes were implanted subcutaneously in the muscle tissue of horses and dogs and were removed after interval of 120 days. Polyester fibre sutures provoked the least tissue reaction and absorption of this material was rapid and un complicated.

Salthouse and Williams (1969) reported the histochemical observations of enzyme activity at suture implant
sites. Accordingly, evidence was obtained to demonstrate that acid hydrolytic and proteolytic enzymes constituted the principal type of activity which was present at the site of tissue reaction to sutures. Such activity was higher with collagenous suture and might be responsible for suture absorption. On the other hand, less hydrolytic activity was found with the nylon and polyester fibre sutures. It was believed that further histochemical studies of suture reaction would lead to a better understanding of the dynamics of cellular response and suture absorption.

Kumar and Singh (1969) studied the effect of simple interrupted through and through sutures, continuous through and through and interrupted mattress sutures in buffaloes and made comparative evaluation of these suturing techniques in regards to wound healing. They further concluded that the wound healing was more or less the same with no appreciable differences.

Myers (1969) carried out an experiment on "augmentation of wound tensile strength by early removal of suture". He found more tensile strength in wound when the sutures were removed earlier than those sutures which were left in place for seven days. The use of suture materials with different reactivity did not affect the result, when the tension was decreased in one wound and increased in another in the same animal. The wound with higher tension was consistently stronger. Early removal of skin sutures not only relieved much of the discomfort
of a wound but also added to its tensile strength.

Kumar et al. (1969) made comparative evaluation of absorbable and non-absorbable suture materials in buffalo calves. They concluded on histologic evaluation of suture materials that there was not much difference between absorbable (Plain and chromic catgut) and non-absorbable (vitafil, silk) suture materials. Chromic catgut acted like non-absorbable suture material until chromium concentration suddenly disappeared. Plain catgut produced severe edema up to 72 hours where as it was moderate in other suture specimens.

Kumar and Singh (1969) reported the use of wool and cotton thread as suture material in veterinary surgery. They concluded that ordinary wool and cotton thread allowed satisfactory healing when used to close experimental hip wounds in eight buffalo calves. No infections were noticed, but the tissue reaction was greater than that seen after using normal suture materials.

Alexander and Kaplan (1967) studied the role of suture material in the development of wound infection. A comparison was made on several commonly used suture materials and their ability to resist the development of infection in wounds which were contaminated with single strain of virulent staphylococcus aureus. There was no significant difference in the degree of infection which occurred any of the non absorbable multifilament suture materials.
According to James (1965) an accurate apposition of the severed edges of the peritoneum is essential to ensure rapid healing and prevent wound dehiscence or evisceration. Each suture must penetrate the peritoneum on both sides of the wound. If the peritoneum is grasped with Allis forceps on either edge and elevated, the sutures are easily inserted. The internal lamina of the rectus sheath and the peritoneum are usually sutured as a single layer. Muscle and fascia has little holding power for sutures, and it is unnecessary to suture this tissue separately. Opposition of muscle is achieved by inserting sutures into its fascial cover. Skin has great holding power for sutures and contributes greatly to total wound strength. It is necessary that it be accurately apposed and completely closed.

Rodger et al. (1962) studied on surgical suture by testing and checking the tensile strength of sterile suture and ligature. They observed that the tensile strength of a suturing material gradually decreased after prolong storage. It was also found a 20 percent decrease in tensile strength after sterilization of non-absorbable suture materials.

Gorth and Major (1957) studied the tissue responses to orlon and dacron sutures. A comparison with nylon, cotton and silk were given as follows:

(i) The characteristic which the ideal suture should possess including availability, tensile strength, ease of sterilization, manageability, non-carcinogenesis and non-
carcinogenesis and nonreactivity had been investigated.

(ii) The physiochemical properties of the synthetic fibres which made them appear to be ideally suited as suture material had been discussed.

(iii) The results of experimental study of a tissue response to silk, cotton, nylon, orlon, and dacron had been presented.

(iv) This comparative study had shown the synthetic fibres, orlon, dacron and monofilament nylon to be far less irritating to tissues than cotton or silk. Although there was little difference among the plastic fibres as to their stimulation of tissue, dacron was proved to be a decided improvement over the present commonly employed sutures and a clinical evaluation of its usefulness appeared distinctly worthwhile.

Williams et al (1955) reported a new method of comparing sutures of ovine catgut with that of bovine in three species of animals namely, rat, rabbit and dog as regards the rate of absorption and tissue reaction.

They found that the plain catgut was almost always absorbed more rapidly than chromicised gut and produced slightly greater inflammatory responses. The inflammatory reaction to implanted catgut in the rat consisted at an initial stage intensely neutrophilic response followed by a lymphocytic and
phagocytic reaction persisting until absorption was complete.

Madsen (1953) evaluated the surgical suture material experimentally and clinically. He concluded that the histologic method gave only limited information about the qualities of the various suture materials even when a standard technique was used. It was, hereby possible to ascertain that the same suture materials constantly produced a very marked and prolonged exudation and therefore, they were liable to cause suppuration in the wound, knot extrusion and intraperitoneal adhesion. It was justifiable to assume that such reactions caused weakening of the surrounding tissues so that even solid fascia became soft as cheese. With same exactness it could be reduced from the microscopic appearance, that certain suture materials were so rapidly absorbed that the threads broke as soon as they were exposed to increased tension. Exact information, however could not be obtained solely by means of microscopic examinations. It was necessary to use more direct methods in order to find out their function of holding the edges of the wounds together during healing.

According to Whipple as cited by Gage and Lyons (1949) the meticulous handling of tissue 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.

According to Shambough and Dunphys as cited by the
above author silk caused less productive suppuration in the contaminated wound than catgut. Cotton incited less inflammatory response than silk. It might be stated here that adaptability of commercially produced cotton thread for surgical purposes represented an economic advantage.

The use of nylon thread gained the popularity because of the high tensile strength. They believed that nylon tended to stretch and therefore, the integrity of the ligature and security of the knot were questionable. Further, tissue sensitivity to the plastic material was another handicap.

Frederic and Pr-estona (1947) described that the non-absorbable sutures had relatively less local reaction and did not lose their tensile strength. Once they were implanted in tissues they remained as permanent foreign bodies.

Gage and Lyons (1940) stated that the experimentation on the problem of comparative evaluation of different suture materials were always complicated by the presence of multiple variable factors, such as the amount of tissue trauma, degree of bacterial contamination, integrity of haemostatics and the amount of tension which sutures constantly gave rise.

Shambough (1940) found that the strength of a stitch was much greater than the tensile strength of a single strand. He found that the holding power of the tissue and the strength of the stitches were affected directly by the number of stitches placed in a given area. Thus the frequency of stitches
depended upon the number required for accurate approximation and upon the required strength of the suture line which could be increased only by increasing the number of stitches and not by employing heavier suture material.

Further he mentioned that a continuous row of suture was stronger than a corresponding suture line with interrupted stitches because the tension was evenly distributed and only two knots were present. On the other hand the strength of the wound was jeopardized when a break occurred anywhere on the continuous suture line in the event of suppuration. A continuous row gave more trouble than a wound sutured with interrupted stitches. In a continuous suture line more material was utilized which produced greater tissue response.

Iocalio et al (1943) made an experimental and statistical study of suture material in relation to bacteriological and pathological effects.

They observed very little difference in wound sutured with non-absorbable materials. Serum was not seen in large amount in cotton, silk, wire and nylon sutures.

Further more, it was unusual to find serum in the subcutaneous tissues after 3rd to 4th day in animals whose wounds were sutured with non-absorbable material.

Joseph (1940) studied the influence of sutures upon operative wounds. A new principle was offered which
distinguished between reacting and non-reacting foreign bodies. Catgut, silk and other suture materials of animal origin are of protein in nature and as such behaved as reacting foreign bodies more or less.

Fast et al (1947) estimated the strength at varying periods of the healing wounds and found that in rabbits the strength of the freshly closed abdominal wall wounds with silk, allowed healing for about 80 percent at two weeks.

Carleton (1951) studied the healing factors of the abdominal wound in rabbit and concluded that the strength of the healed wound followed a definite time pattern and the increase in the size of the suture material did not add strength to the healing wound. It only added strength during long period because the wound had to depend on suture material during the early part of the proliferative phase of the wound healing.

Further he observed that the role of suture material was only a contributory factor to the tensile strength to the wound which might be completed within 14 days.

He further apprised that the tightly tied suture and presence of infection materially delayed the gain in the tensile strength of healing of abdominal wound.

Sandblom (1954) made an analysis of the method to assess the healing of a wound by measuring the tensile strength
and as such special efforts were made to detect factors that might disturb the result of the method in a systematic way.

Billingham and Russel (1956) studied on wound healing with special reference to the phenomenon of contracture in experimental wounds in rabbit skin and concluded that the repair of full thickness cutaneous wound in rabbit was the outcome of contracture, a forced inward movement of the margins of the wound in response to tensile forces generated within the wound. The wound in very young animals contracted faster than those in adults. An evidence had been obtained suggesting that even during adult life there was a slight progressive decline of the specific rate of contracture.

Orr's (1958) stated that the type of incision might definitely influence the rate of wound healing. Clean cut wounds heal smoothly. Accurate approximation of sutured structures deserves special attention. When closing the peritoneum, fascia or skin portions of fat, muscles or other tissue should not be permitted to protrude between the sutures, dead spaces should not be left in wound to fill blood and serum. In mechanics of a good wound closure, tension on the tissues is of prime importance. When closing the wound the wound margins should be accurately approximated without any more tension than is necessary. A suture that is too tight squeezes out the blood supply causing necrosis, which not only weakens the wound, but also predisposes to infection and adds an unnecessary load by compelling the body
to remove dead material before normal cicatization can take place.

Postlethwait et al (1961) performed an experimental study on polyester fibre sutures. They inferred that the polyester fibre as a surgical suture exhibited good handling properties and the ability to hold a knot. No untoward effect on the healing of wound and the maintenance of tensile strength in tissue was observed.

Peacock (1962) studied the detail aspects of fibrogenesis during the healing of primary and secondary wounds. The production and polymerization of collagen in primary and secondary wound healing of rats were studied by measuring saline extractable collagen, total collagen and the tensile strength of the scar tissue. In primary wounds saline extractable collagen decreased for 3 days after wounding and did not reappear in normal amounts before the 7th post operative day. Maximum levels of extractable collagen were not seen before twentyfirst day. In secondary wounds, saline extractable collagen was decreased during the first 3 days of rapid gain in tensile strength. Total collagen including soluble and insoluble collagen was decreased in secondary wounds in comparison with primary wounds of the same edge.

Adomsons and Enquist (1963) mentioned the relative importance of sutures to the strength of healing wounds under normal conditions as follows:
(i) The tensile strength of incised abdominal wall wound was tested with sutures in situ, and after the sutures removed in normal and scorbutic guinea pigs.

(ii) Normally the incised abdominal wall wounds were closed and tested with non-absorbable sutures in situ which regained the strength of the original un-injured tissue by the ninth day after wounding and exceeded it significantly by fortyfifth day.

(iii) Normally healing of incised abdominal wall wound closed by non-absorbable sutures and tested after the sutures were removed, regained 80 percent of strength of the original un-injured tissue by the ninth day after wounding and 114 percent by fortyfifth day.

Adomsons et al (1964) conducted an experiment on the relationship of collagen content to wound strength in normal and scorbutic animals. The collagen concentration of abdominal wounds and unwounded abdominal wall and their relationship to tensile strength were studied in normal and scorbutic guinea pigs. Evidences were found in favour of collagen difference between the wounded and unwounded tissues. The wound collagen was found in excess rather than absolute collagen concentration. While studying the collagen and tensile strength relationship the following conclusion were drawn; (i) the wound collagen in excess showed a direct quantitative relationship to the tensile strength (ii) the collagen
content of a wound was less than that of unwounded muscle and (iii) the wound remained always associated with negligible tensile strength in both normal and scurbutic animals.

Brunius and Zederfeldt (1965) studied the effect of anti inflammatory treatment with təndril on wound healing and tensile strength of sutured skin incision in rabbits. It was found that təndril when given either during the entire healing period or during the first two days of the healing produced anti inflammatory effect in the tissues effected.

Williams and Harrison (1967) studied the healing of soft tissue in experimental animals. They said that the soft tissue healing by primary intention progressed under idial circumstances when the wound margins were accurately apposed without tension and without reduction in their vascularity to achieve this. The tissues were approximated with sutures which maintained the wound margins in opposition until they gained sufficient tensile strength.

Udupa and Chansouria (1969) studied the role of suture materials in healing of skin wounds. Effect of various suture materials like cotton, silk, copper wire and stainless steel wire were studied in the cutaneous wounds of guinea pigs for a period of 7th and 12th post operative days. They found maximum deposition of mature collagen in the wound area with stronger union when the stainless steel wire was used as suture material.
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Peterbloom and Hermes (1970) studied the influence of tetracycline and chloromphenicol on the healing of cutaneous wound. The implications were that these drugs might be used in treating surgical patients without the danger of adversely affecting the healing of their wounds and that fibroblasts system was less sensitive to these drugs than the other types of tissues.
Surgical Anatomy
CHAPTER III

SURGICAL ANATOMY OF THE ABDOMINAL WALL.

THE ABDOMINAL WALL:

The ventral and much of the lateral abdominal wall are formed by muscles and fascia. The muscles are named according to the direction of their fibres. Hence it is known as external and internal obliquus, transverse abdominis and rectus abdominis muscles. The two structures concerned with the insertion of the abdominal muscles are the linea alba and prepubic tendon. The linea alba is formed when the embryonic tissues fold inward to enclose the body cavity. It is a distinct median line extending from the sternum to the prepubic tendon. Slightly behind its middle is the umbilicus. When the linea alba was formed the fusion of the right and left sides were interrupted by the presence of the umbilical vessels, urachus and yolk stalk. When the cord breaks at birth the umbilicus severed.

The prepubic tendon is the medium of insertion for the abdominal muscles with the exception of the transversus. It is a short, strong rather broad structure, attaching to the anterior border of the pubis and separates the medial angles of the inguinal canals. Since the abdominal muscles, particularly the rectus are important in maintaining the arch of the back, this tendon is of prime importance and rupture
of this not only modifies the contour of the tap line, but also interferes with the support of the abdominal viscera. The fascia is both superficial and deep. The superficial fascia is areolar in structure and more abundant than on the other parts of the body. The portion of the cutaneous muscle of this region is in this fascia as well as fats in amounts varying with the condition of the animal. Superficial fascia is very abundant above and anterior to the stifle. The deep fascia is known as the abdominal tunic. It is elastic and therefore of a yellowish colour, muscular in structure to accommodate changes in size of the abdomen and is said to be capable of supporting the weight of the viscera without the aid of the abdominal muscles. Since its chief function is to support it is confined to the ventral and adjacent part of the lateral wall. It does not extend into the upper part of the flank.

The external oblique is the most extensive of the abdominal muscles. Its fibers are directed downward and backward and are rather short about 8 to 10 inches and the extensive aponeurosis attaches to the prepubic tendon and linea alba.

The internal oblique arises from the tuber Coxae and is directed downward and forward to the last rib and linea alba. It forms the second muscular layer in the flank.

The transverse abdominis is a thin muscle forming
the third muscular layer of the flank and in this region its fibers are vertical. In the abdominal floor the fleshy part is succeeded by aponeurosis which crosses the rectus to reach the linea alba. The rectus abdominis extends from the sternum to the prepubic tendon and is therefore entirely confined to the abdominal floor.

It is the strongest of the abdominal muscles and is of prime importance in maintaining the arch of the back as well as supporting the viscera.

**HISTOLOGY**

**Histological structure of the abdominal wall:**

For this description of the histological structure of the abdominal wall will be dealt with under the following headings:

(A) **SKIN**:

The skin is composed of two distinct layers the epidermis and dermis.

(1) **Epidermis**: The epidermis which is the superficial layer is a non-vascular stratified epithelial structure. It is composed of a deep and superficial layer of cells. The cells of the deep layer are soft and form the stratum malpighii, while the cells of the superficial layer are hard and horny. The cells of the deep layers are columnar. The cells
of the superficial layer are flattened and constitute the stratum grunulosum. Next to it is stratum lucidum in which the cell outlines are not distinct. Superficial to the stratum lucidum and stratum corneum which is composed of a number of layers of epithelial cells.

(2) Dermis: - The dermis (corium) is made up of dense fibrous tissue, a few elastic fibers and numerous blood vessels, lymphatics, and nerves which consists of a superficial papillary layer and a deep reticular layer. The papillary layer has a number of conical eminences - the papillae which are received into corresponding depressions on the deep face of the epidermis. This layer is composed of dense connective tissue.

The reticular layer is also composed of strong fiber bundles consisting mostly of white fibrous tissue. It contains a few elastic fibers (Fig. No. 1).

(3) MUSCLE:

There are three types of muscles found in the body namely - smooth, skeletal and cardiac muscles, out of which in the abdominal wall, only the skeletal muscle is found. The smallest independent units of muscle cells are called fibers. The fibers are grouped together into the bundles called fasciculi.

Fibres: - The fibers are cylindrical or prismatic
structures which vary greatly in length.

Each muscle fiber (or cell) is closed by a membrane known as sarcolemma. The term sarcolemma is used for the plasmalemma. It looks like the united membrane of other cells and it is composed of an outer and inner layer of protein and an intermediate layer of lipid material. Inside the sarcolemma are the nuclei and a cross striated substance composed principally of myofibrillae (Fig. No. 2).

(c) PERITONEUM:

Peritoneum is the serous membrane which lines the abdominal cavity and part of the pelvic cavity and the organs contained in them and is composed of two layers—parietal and visceral.

The parietal layer lines the boundaries and is then reflected over the contained organs forming the visceral layer. The double folds of peritoneum thus passing from the wall to the viscera constitute a pathway for vessels and nerves (Fig. No. 3).

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Figure 4: Section of the abdominal wall showing the circular muscle bundles. H.E. 10x40.

Figure 5: Longitudinal section of the normal abdominal wall showing the muscle bundles. H.E. 10x40.
Fig. 5: Section of the normal abdominal peritoneum showing its structure. H.E. 10x100.
MATERIALS AND METHODS
CHAPTER IV
MATERIALS AND METHODS

PART I
OPERATIVE SURGERY

MATERIALS:

I. Selection of animals:

Buffalo calves (Bos bubalis) representing the bovine species, which were easily available, selected for the present study.

A preliminary clinical examination was done. The temperature, pulse and respiration were recorded. This was done to ensure that they were reasonably healthy, so that the results of the present work may not be materially affected. Approximate age of the animals taken for study, varied between one and half to two years, while the body weight was ranging from 190 to 200 lbs.

II. Design of the experiment:

In the present study three different techniques of closure of laparotomy incision namely one tier, two tier and three tier have been followed using silk, cotton and vitafil as suture material (non absorbable), and entire surgical plan
was outlined accordingly.

Eighteen young male buffalo calves have been taken and divided in three different groups by random selection. Again by random selection two animals within the particular group have been taken for adopting each technique of closure of laparotomy incision using one type of suture material.

**DESIGN OF THE EXPERIMENT**

<table>
<thead>
<tr>
<th>Group No.</th>
<th>Types of Suture Material</th>
<th>Technique of Closure of Laparotomy</th>
<th>Period of Observation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group - I.</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Animal No.1</td>
<td>Silk No. 4/0</td>
<td>One tier.</td>
<td>21 days.</td>
</tr>
<tr>
<td>Animal No.2</td>
<td>-do-</td>
<td>-do-</td>
<td>14 days.</td>
</tr>
<tr>
<td>Animal No.3</td>
<td>Cotton No. 8</td>
<td>-do-</td>
<td>21 days.</td>
</tr>
<tr>
<td>Animal No.4</td>
<td>-do-</td>
<td>-do-</td>
<td>14 days.</td>
</tr>
<tr>
<td>Animal No.5</td>
<td>Vitafil No. 0.2 mm.</td>
<td>-do-</td>
<td>21 days.</td>
</tr>
<tr>
<td>Animal No.6</td>
<td>-do-</td>
<td>-do-</td>
<td>14 days.</td>
</tr>
</tbody>
</table>

<p>| <strong>Group - II.</strong> | | | |
| Animal No.7 | Silk No. 4/0 | Two tier. | 21 days. |
| Animal No.8 | -do- | -do- | 14 days. |
| Animal No.9 | Cotton No. 8 | -do- | 21 days. |
| Animal No.10 | -do- | -do- | 14 days. |
| Animal No.11 | Vitafil No. 0.2 mm. | -do- | 21 days. |
| Animal No.12 | -do- | -do- | 14 days. |</p>
<table>
<thead>
<tr>
<th>Group No.</th>
<th>Types of suture material</th>
<th>Technique of closure of laparotomy</th>
<th>Period of observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group - III.</td>
<td>Silk No. 4/0</td>
<td>Three tier.</td>
<td>21 days.</td>
</tr>
<tr>
<td>Animal No. 13</td>
<td>-do-</td>
<td>-do-</td>
<td>14 days.</td>
</tr>
<tr>
<td>Animal No. 14</td>
<td>-do-</td>
<td>-do-</td>
<td>21 days.</td>
</tr>
<tr>
<td>Animal No. 15</td>
<td>Cotton No. 8</td>
<td>-do-</td>
<td>14 days.</td>
</tr>
<tr>
<td>Animal No. 16</td>
<td>-do-</td>
<td>-do-</td>
<td>21 days.</td>
</tr>
<tr>
<td>Animal No. 17</td>
<td>Vitafil No. 0.2 mm.</td>
<td>-do-</td>
<td>14 days.</td>
</tr>
<tr>
<td>Animal No. 18</td>
<td>-do-</td>
<td>-do-</td>
<td></td>
</tr>
</tbody>
</table>

### III. Suturing materials:

The main purpose of suture was to hold the wound edges in contact, until fibroblastic proliferation was so firmly established to take over the suture. In the present investigation the following non-absorbable suture materials have been used:

Silk No. 4/0, cotton No. 8, and vitafil No. 0.2 mm. (Fig. No. 4).

### METHODS:

**Preoperative preparation:**

(A) **Clinical examination:**

The following clinical examinations were made before
Fig. 6: Suturing materials used in the present experiment.
finally proceeding with operation:

(i) Temperature, pulse and respiration were daily recorded (Table No. 3).

(ii) Faecal sample examination and treatment:—Faecal samples were examined for any endoparasites and protozoan infection. The faecal sample of eighteen buffalo calves were examined and found them free from any parasitic infestation except in one case, the faecal sample showed the presence of strongyloides which was treated accordingly.

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

(iv) Haematological studies:—Haematological studies of the experimental animals were carried out for haemoglobin estimation, total R.B.C., W.B.C. and differential count pre and post operatively (Table No. 4).

(v) Recording of body weight:—The body weight of individual animal was calculated and recorded (Table No. 1).

(b) Preparation of experimental animal a day before operations:

The buffalo calf to be operated upon, the next morning was selected at random. The left flank of the animal was clipped, shaved and washed thoroughly with carbolic soap 5% and water. The shaved area was disinfected with savlon lotion (I.C.I.) sponge-dried and swabbed with spt. mercurochrome.
Fig. 7: Preparation of the operative site.

Fig. 8: The site of operation.
and peritoneum with a 2% solution of procaine hydrochloride. For this, the needle was inserted almost parallel to the skin surface and pushed along the subcutaneous tissues on the proposed line of incision, from one puncture site in either direction. After that (the subcutaneous tissue) the needle was further advanced in succession and then musculature, intervening connective tissue and so on to the full depth up to the parietal peritoneum was infiltrated. To achieve this deep infiltration anaesthesia a ten (10 cm.) long needle was used and nearly 10 ml. solution was necessary for an incision of 10 cm. long and on the whole about 20 to 30 ml. of local anaesthesia was required (Fig. No. 7).

OPERATION

METHOD:

The operation was carried out in the standing position of the animal which was tied short with its right side against the wall and was held in position by a pole alone its left side to prevent its moving laterally. A good light source was essential. The skin of left flank was shaved and scrubbed well with soap and water and again painted with 1% mercuricchrome solution. The operative area was draped with sterile towels. Three fingers breadth behind and parallel to the last rib, a 15 cm. long incision was made beginning 3-4 cm. below the transverse process of the lumbar vertebrae through the skin and fascia with a Bard-parker scalpel. Then
The obliquus abdominis externus and internus muscles were opened bluntly and then the transverse abdominal muscle along with peritoneum was picked up by forceps and punctured with blunt pointed scissors carefully on the same direction of the skin incision. At the time of giving incision on peritoneum, the peritoneal fat which varies in the thickness from 1 - 10 cm. depending on the condition of the animal was also incised. The peritoneal opening was enlarged to allow the hand to be introduced into the abdominal cavity without displacing the viscera. The peritoneum and the muscles were grasped together by Allis forceps at four corners. After performing the operation the laparotomy wound was closed by different techniques - using different suturing materials (Fig. No. 8, 9, 10, 11, and 12).

**TECHNIQUES OF CLOSING THE LAPAROTOMY WOUND**

Three techniques of closure of laparotomy wound with three different kinds of suture material was taken up for this study.

I. **ONE TIER TECHNIQUE:**

In this technique skin, fascia, muscles and peritoneum were sutured together with figure of "8" suture on six buffalo calves of one and half to two years old employing three kind of suturing materials namely, silk, simple cotton and vitafil. For every two animals one kind of suture material was used (Fig. No. 13, 14, 15, and 16).
Fig. 9: While giving infiltration anaesthesia.

Fig. 10: The skin is incised.
Fig. 11: Muscles incised to expose the peritoneum with scissors.

Fig. 11: Muscles incised to expose the peritoneum.
Fig. 12: The peritoneum is incised with scissors.

Fig. 12: The peritoneum is incised.
METHOD:

The muscles and peritoneum were grasped together and skin separately with Allis forceps. The needle was passed through the skin on one side of the lip of the wound, crossed over to the other side and pierced through the fascia, muscles and peritoneum. Again crossed over to the first side and pierced the needle through the peritoneum, muscles and fascia. Then crossed the needle again to the second side and pierced the skin and brought back to a distance of 0.5 to 1 cm. to the lip of the same side of the skin, pierced the needle on that point and was taken out. Crossed again to first side and pierced the skin from inside to out side. Two cm. apart another suture same as above was given and the ends of suture were held with artery forceps. In this way, the entire abdominal laparotomy incision was closed, and thus all the layers were approximated with each other, like peritoneum to peritoneum, muscles to muscles, fascia to fascia and skin to skin. After that the suture ends were tied in Halsted pattern (Fig. No. 17). The laparotomy wound healed up uneventfully and the sutures were removed after eight post operative days.

II. TWO TIER TECHNIQUE:

In this technique, muscles and peritoneum were sutured together in simple continuous fashion and skin separately with Halsted pattern, using silk, cotton and vitafil as a suturing materials. Six buffalo calves were utilised
Fig. No. 15

Cross section of a flank laparotomy wound in the buffalo-calf. It illustrates the "figure-eight suture through the wall of the flank. Skin, Fascia, Muscles, Peritoneum. Sutured together by one layer technic. With Halsted suture.

**Fig. No. 16**

**Illustrates closure of laparotomy wound with two layer technique.**

1. **Peritoneum and muscles sutured together with simple continuous suture.**

2. **Halsted suture.**

   A. **Showing the suturing of peritoneum and muscles together.**

   B. **Showing the suturing of skin.**
ILLUSTRATES CLOSURE OF LAPAROTOMY WOUND WITH THREE LAYER TECHNIQUE.

1. PERITONEUM SIMPLE CONTINUOUS SUTURE.
2. MUSCLES SIMPLE CONTINUOUS SUTURE.
3. SKIN HALSTED SUTURE.

A. SHOWING THE SUTURING OF PERITONEUM.
B. SHOWING THE SUTURING OF MUSCLES.
C. SHOWING THE SUTURING OF SKIN
for this experimental study. Skin sutures were removed on eighth post operative days (Fig. No. 18).

III. THREE TIER TECHNIQUE:

In this technique, skin, muscles and peritoneum were sutured separately with silk, cotton and vitafil in six buffalo calves. The peritoneum and muscles were approximated separately in simple continuous pattern and finally the skin was closed with Halsted suture (Fig No. 19).

Post operative care and management:

Recovery after operation: Recovery was quite normal in most of the animals and they were able to walk after operation.

Recording of temperature, pulse and respiration before and after operation were done every morning and evening till the removal of sutures.

Post operative treatment:

1. **Antibiotic treatment**: A daily dose of 10 lakhs of seclopen was injected intramuscularly for four days.

2. **Local treatment**: The surgical wound was examined daily for any post operative complication and dressed with terramycin ointment in order to check the probable development of topical secondary infection.
Fig. 16: The skin, muscles and peritoneum are sutured together in figure of "g" fashion.

Fig. 17: Before tying knots all the sutures are pulled and burned to the opposite side.
Fig. 18: Tying the knots in one tier technique.

Fig. 19: The protective bandage is placed in position after closing the abdominal wall.
(3) **Glucose therapy**: Dextrose saline 5% solution was administered in animals where its necessity was felt.

**Removal of sutures:**

The stitches were removed on eighth post operative day with pre-sterilised scissors and forceps. After their removal the site was cleaned with rectified spirit.

**PART - II**

**SURGICAL PATHOLOGY**

**DESTRUCTION OF ANIMALS AND COLLECTION OF TISSUE MATERIAL**

All the experimental buffalo calves were sacrificed on 14th and 21st post operative days by intravenous administration of saturated solution of Magnesium sulphate. The tissues of the healed up area (skin, fascia, muscles and peritoneum) were taken for gross and histopathological studies. They were preserved in 10% formalin solution. This helped both fixing and hardening of the tissues for the desired studies.

Preparation of the slides for the study of surgical pathology was done by standard technique under proper guidance.

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OBSERVATIONS & RESULTS
CHAPTER V

OBSERVATION AND RESULTS

PART I

OBSERVATION

The closure of abdominal wall after laparotomy with three different techniques was carried out in three groups of animals, consisting of six buffalo calves in each group, using cotton, silk and vetafil as a suturing materials. These animals were kept on observation for 14 and 21 days post-operatively, and the results obtained during the course were recorded under the following headings:

1. Clinical observation from the date of operation to the day of euthanasia.
2. Gross changes at the site of operation.
3. Histopathological changes of the repaired tissue.

The clinical observation included inflammatory swelling, post-operative complication, sture line disruption and mortality. Gross changes were confined to adhesion, abscess formation and growth of fibrous tissues. The histopathological observations included the changes that took place during the time of healing.
GROUP I

In this group, six young apparently healthy male buffalo calves, weighing about 100 to 150 lbs. were used. Only one tier technique was tried in these animals using the above mentioned three varieties of suture materials. In animal No. 1 and 2, silk; in animal No. 3 and 4, cotton; and in animal No. 5 and 6, vetafil were used for closing abdominal wall. The temperature, pulse and respiration were recorded until the date of removal of sutures. The sutures were removed on eight post-operative day.

Buffalo calf No. 1:

In this particular experimental animal no other complications except a slight inflammatory swelling was observed on the sutured line, which gradually subsided within a week. During that period slight elevation of temperature was noticed. The wound healed up by first intention and thus the animal made uneventful recovery. The animal was sacrificed on 21st days after operation. On gross examination the skin, muscles and peritoneum showed complete healing without any adhesion.

Microscopical examination of the tissue revealed the depression over the epidermis which was sufficiently reduced and the different layers of epidermis cells were re-organised. The sign of inflammation had almost subside except
a few inflammatory cells here and there. There were many newly formed blood vessels. The collagen tissues were laid down in bundles. The deep blue staining property of these fibers indicated maturing of collagen muscle bundles and complete degeneration of fibroses from top to the bottom was found.

**Buffalo calf No. 2:**

Very little inflammatory swelling was observed on the site of operation. The temperature, pulse and respiration were almost normal during the observation period. The wound healed up by first intention without any untravers complication. The animal was sacrificed on 14th post-operative days. Necropsy material showed complete healing of the tissues.

Histopathological examination showed rich vascularity in the muscular layer along with proliferation of the fibroblast, specially in the lower part of the muscular zone. The fibroses was seen to ascend through the dermis where there was characteristic depression of the epidermis at the line of union. Inflammatory cells and newly formed blood vessels were as in animal No. 1. Adjacent muscle bundles were fibrosed following degeneration. There was more deposition of young collagen tissue throughout the scar. More collagen was seen around the blood vessels.

**Buffalo calf No. 3:**

In this case inflammatory swelling was observed
from the 2nd post-operative day and it gradually subsided after 5th day.

The wound healed up satisfactorily and the animal was destroyed on 21st post-operative day and on gross examination no abnormalities were seen.

Microscopically the depressions over the epidermis were reduced. The different layers of the epidermis cells were reorganised. The sign of inflammation was found to be subsided. Some inflammatory cells were seen in some parts. Matured collagen muscle bundles showed complete degeneration in the healed portion.

**Buffalo calf No. 4:**

No other complications were seen except a slight inflammatory swelling of the operated site which subsided after a few days. Temperature, pulse and respiration did not show any marked variation from the normal. The animal was sacrificed on 14th post-operative day. On autopsy satisfactorily healing process of the tissues were marked in the abdominal wound.

On microscopical examination the fibrosis was seen to ascend through the dermis. Much of the inflammation had already subsided in this case. Rich vasculatory in the muscular layer along with proliferation of the fibroblast was seen.
Buffalo calf No. 5:

The recovery was uneventful without even the slightest systemic complications, though slight variation of temperature, pulse and respiration were observed for 3 to 4 days after operation. The wound was found to be healed up satisfactorily. The animal was destroyed on 21st post-operative day. Grossly, the skin, muscles and peritoneum were found to be completely healed up.

Microscopical examination of the repaired tissues showed that the sign of inflammation was subsided, but some inflammatory cells were seen here and there. The collagen muscles bundle showed complete degeneration.

Buffalo calf No. 6:

The animal recovered without showing any major post-operative complications. Only a slight inflammatory reactions was marked during the period of observation which subsided by 5th day after surgery. A slight rise in temperature was recorded which had dropped to normal level by the 3rd day.

The wound healed up normally and the animal was sacrificed on 14th day after operation. The repaired tissues showed normal healing on gross examination.

Microscopic examination revealed the sign of inflammation but in a mild form. There was no tissue oedema but
inflammatory cells were numerous. Young capillaries were noticed here and there. The adjacent muscular bundles showed sign of degeneration.

GROUP - II

In this group, two tier technique was tried using the same suture material used in group I. In two tier technique the peritoneum and muscles were sutured in continuous fashion and the skin was closed by Halsted method. Body weight of the animals of this group varied between 120 to 180 lbs.

Buffalo calf No. 7:

Moderate inflammatory swelling was observed from the 2nd day of operation which lasted for 5 days and after that it subsided gradually. No other post-operative complications were noticed. Temperature was slight elevated which came down to normal by 5th post-operative day. Pulse and respiration remained normal.

The wound almost healed up completely and satisfactorily and the animal was killed on 21st post-operative day. On autopsy the repaired tissue was found normal except there was slight adhesion with the peritoneum.

Microscopically the reactionary zone around the suture material showed comparatively less leucocytic infil-
-tration. The epidermal cells were differentiated throughout the line of apposition. The healing of the cutaneous tissue was similar to that of one tier technique already described.

**Buffalo calf No. 8**:

There was no inflammatory swelling in this animal and all the cutaneous sutures remained intact till they were removed on 8th post-operative day. A slight variation in temperature, pulse and respiration was observed on the 2nd and 3rd post-operative day. The animal recovered satisfactorily and was sacrificed on 4th day of surgery. Grossly, the skin was found to be completely healed up but the muscles and peritoneum could not healed up as skin. There was slight adhesion of peritoneum also.

Microscopic examination revealed heavy leuocytic infiltration in the area around the suture material in the second layer. The replacement of the tissue was seen by connective tissue fibers.

**Buffalo calf No. 9**:

No appreciable changes were found up to 4th day around the wound except a mild inflammatory swelling, but by the 5th day seepage of serum exudate was observed from one stitch. The particular offending stitch was removed and the wound was dressed as an open wound. It was found that the
wound had healed by the 10th day after surgery. The animal was destroyed on 21st day after operation. On gross examination the tissues showed complete healing except a slight omental adhesion with the adjacent peritoneum. On microscopical examination the line of union showed epidermal depression only to a little extent of the dermis. Some of the depressions around the cells were much more marked. The epidermal pegs were seen in the process of formation in this zone. The fibrosis was less marked. The sebaceous glands and hair follicles were seen around the depressed area of epidermis.

**Buffalo calf No. 10:**

A mild type of inflammation was noticed at the site of operation. There was no seepage of serous exudate from the wound. Temperature, pulse and respiration were almost normal.

The wound healed up by first intention without any complication. The animal was sacrificed on 14th day. Gross examination revealed slight peritoneal adhesion with the wounds. A uniform growth of fibrous tissue was also noticed in this case.

Microscopical examination showed fibrosis throughout the dermis. Although, much of the inflammation had subsided, yet some inflammatory cells were present. The proliferation of the fibroblast was seen in the histopathological study.
Buffalo calf No. 11:

Excessive inflammatory swelling was observed from the second day of operation which subsequently subsided by the 5th post-operative day. Seepage of inflammatory exudate was noticed from two of the stitches which were removed and dressed with terramycin liquid till the wound healed up. The animal was destroyed for gross examination. Peritoneal adhesion was found around the suture line. It was noticed that the wound did not heal completely because of suture necrosis, and dehiscence was also found at two or three places.

Microscopical examination showed the line of union still incomplete. However, epidermal cells differentiation was marked around the cleft. A great number of fibroblast cells were noticed.

Buffalo calf No. 12:

Inflammation was not so much marked as in case No. 11. No seepage of inflammatory exudate was found. The animal recovered uneventfully and was sacrificed on the usual date. Gross examination showed satisfactory healing of the wound in question.

On microscopical examination, the line of union showed depression in the epidermis extending upto the whole extent of the dermis with marked fibrosis and leucocytic infiltration around it. Heavy leucocytic infiltration and large
amount of fibrosis were also seen in the second layer of the suture.

GROUP - III

In this group, three tier technique was followed using the same suture materials as in group I and II. Here the peritoneum and muscles were sutured separately by continuous suture and lastly the skin was closed by Halsted fashion. The weight of the animals ranged between 150 to 200 lbs.

Buffalo calf No. 13:

Heavy inflammation was noticed at the site of operation from the 2nd post-operative day which lasted for 5 days. Subsequently at diminished in size and there was no sign of inflammation by the 7th day.

The animal recovered uneventfully and was sacrificed on 21st day after operation. On postmortem examination, repair of wound was found uniform. Omental adhesion was also found around the suture line of the peritoneum.

Microscopically, the line of union showed very little extension of the epidermal pit into the dermis. The area around the pit showed little fibrosis and the epidermal cells differentiation were however nearing the normal. But the reactionary zone around the suture material showed well marked fibrosis and leucocytic infiltration.
Buffalo calf No. 14

Inflammatory swelling was not so huge as in buffalo calf No. 13. It subsided gradually and it became almost normal by 6th post-operative day. The animal was euthanised as routinely. Gross examination of the tissue showed that the healing of the wound was not complete, though the skin showed complete healing externally.

Microscopic examination showed fibrosis throughout the dermis. The area around the suturing material in the second layer was marked with heavy leucocytic infiltration. The replacement of the tissue by connective tissue was also seen. Much of the inflammation was subsided but some inflammatory cells were seen here and there.

Buffalo calf No. 15

Clinical manifestations of the operative area observed were similar to buffalo calf No. 13. The temperature, pulse and respiration remained slightly elevated for a couple of days and gradually became normal by 6th post-operative day. Gross examination showed some fibrous tissues infiltration in and around the suture line.

Microscopical examination revealed the epidermal cells differentiation at the line of union. The epidermal peg was seen in the process of formation in this zone. The stratum corneum and stratum germinativum were also clearly
distinguished even in the epidermal pit and mild degeneration of muscle fibers was present.

Buffalo calf No. 16:

Diffuse inflammatory swelling was noticed after second day on the site of abdominal wound. The temperature became very high and rose upto 104 and 105°F. The condition of the animal deteriorated badly and it progressively became weak and emaciated, as such, antibiotic intramuscularly and 5% Dextros solution intravenously were given to tone up the animal health. Suture disruption took place in this case and necessitate the secondary closure after debriding the wound. The animal succumbed after 10th post-operative day. On autopsy, it was found that the animal died due to acute peritonitis. In this case, only gross examination was done and microscopical examination was deferred.

Buffalo calf No. 17:

Inflammatory swelling was not so marked. But little swelling was seen from 2nd to 4th post-operative days. The temperature was found somewhat elevated on 3rd and 5th days and then gradually became normal. The animal was killed on 21st post-operative day. On gross examination the skin was found to be healed up completely where as muscles layer became thickened and adherent with peritoneum.

On microscopical examination, the line of union
showed the epidermal cells - differentiation, but on second and third layers heavy leucocytic infiltration was observed.

Buffalo calf No. 18:

The recovery of the animal was uneventful. No post-operative complications were marked in this case, only a slight rise of temperature was recorded on 2nd and 3rd days post-operatively. The animal was sacrificed on 14th day of surgery. On gross examination no other abnormalities were detected except an uniform growth of fibrous tissue in and around the suture line.

On microscopical examination, the degeneration of muscle fibers was found. Oedema was not seen. Much of the inflammation had subsided but some inflammatory cells were seen. Fibroblastic proliferation was a characteristic feature of granulation tissue.
PART - II

RESULT OF THE EXPERIMENT

The results of the present experiment revealed the histological reaction of the tissues around the suture materials, which depended mostly on gross and microscopic changes in connection with the simplified technique for closure of laparotomy wounds.

GROUP - I

One tier technique:

In this group, all the wounds healed satisfactorily without showing any microscopical differences between the three different suture materials, except with vetafil which had slight adhesion and comparatively more swelling than cotton and silk. These studies were based on six experimental animals sacrificed at different intervals, which showed normal and complete healing.

The microscopical changes in relation to silk, cotton and vetafil employed each for two animals showed rich vascularity in the muscular layer along with proliferation of the fibroblasts, specially in the lower part of the muscular zone. The fibrosis was seen to ascend through the dermis with characteristic depression on the epidermis at the
line of union. Much of the inflammation had already subsided by 21st post-operative day. The inflammatory cells were found less in number. Numerous new blood vessels were seen here and there. There was more deposition of young collagen tissues throughout the line of incision. It was also seen aggregated to orient itself in the perpendicular direction to the abdominal wound with more collagen around the blood vessels. The depression over the epidermis was sufficiently reduced, and the different layers of the epidermal cells were reorganized. In cotton rich vascularity with proliferation of fibroblast was seen. The depression over the epidermis was reduced. The sign of inflammation to some extent had subsided but not as in the case of silk. The collagen bundles showed complete degeneration and gave inferior result than silk, whereas, in case of vetafil there was slight sign of inflammation with least tissue oedema, and young capillaries were noticed here and there. The inflammatory changes observed at the line of junction were well marked in vetafil in comparison to silk and cotton. While comparing these three suture materials in this group (using one tier technique) best result were obtained with silk, cotton and vetafil respectively.

GROUP II

Two tier technique:

In this group, two tier technique was used on six
Experimental animals employing same suture materials as in group I.

Microscopically, some adhesion was seen between muscles and peritoneum on the line of suture. The suture materials were found partly encapsulated both in muscles and peritoneum. In case of silk, the microscopical examination revealed the differentiation at the line of junction similar to group I, specially at the zone of skin. The reaction zone around the suture material showed comparatively more leucocytic infiltration than that of one tier technique. The line of union showed epidermal depression only to a little extent of the dermis. The epidermal pegs were seen in the process of formation. In case of cotton the fibrosis was less marked in this zone and remained as usual as in the second layer of the suture. The sebaceous glands and hair follicules were seen around the depressed area of the epidermis. With vetafil the line of union showed appreciable depression in the epidermis extending up to the whole extend of the dermis which marked fibrosis and leucocytic infiltration around the suture. Heavy leucocytic infiltration and large amount of fibrosis were seen in the second layer of the suture. The line of union revealed incomplete healing which extended almost to the whole length of the skin. However, epidermal cells differentiation was more marked around the cleft. Marked reduction in the number of fibroblast cells were noticed on the second line of the suture. Over all result obtained in this group was inferior than the
GROUP - III

Three tier technique:

In this group three tier technique was employed on six experimental animals while keeping the suture materials constant as in group I and II.

On gross examination, peritoneal adhesion was found in two, out of six animals. On the other hand, the healing of the second and third layers of the abdominal wounds were not complete. The suture materials were visible on the line of repaired tissues with inflammatory exudate.

On microscopical examination in case of silk heavy leucocytic infiltration was marked around the suture material on the second layer. Edema was not seen and much of the inflammation was subsided, whereas in case of cotton the line of union had showed an appreciable amount of cells differentiation. The epidermal peg was seen in the process of formation in this zone and also the stratum corneum and stratum germinativeum were clearly distinguished even in the epidermal pit. In case of vetafil the line of union showed depression in the epidermis extending upto the whole extent of the dermis and heavy leucocytic infiltration was seen with edema to a little extent. The result obtained in this group was not so much satisfactory as found in Group I and II.
Chapter VI

Discussion

...
CHAPTER VI

DISCUSSION

Suturing of the wound is considered to be an art as well as skill of surgeons. It is one of the most important part in the field of surgery. Because there is every chance and possibility to occur complications if the wound of the abdominal wall is not properly sutured. Moreover, suturing plays an important role in surgery. It is known fact that several workers employed various techniques to close the abdominal wall wounds. Generally in deep wounds each layer of the tissue is sutured separately using absorbable and non-absorbable suture materials. The abdominal wall is closed in layers using buried suture or figure of "8" suture. It should be kept in mind that peritoneum should lie against peritoneum during the suturing of the abdominal wall wounds.

This project was undertaken to study the different techniques for closure of laparotomy wounds with the application of different suture materials in buffalo calves. The work was carried out on 18 apparently healthy male buffalo calves between the age group of one and half to two years. Following laparotomy, the abdominal wall was sutured with silk, cotton and vetafil employing different suturing techniques namely continuous, halsted and figure of "8" fashion.
even if one stitch of figure of "S" breaks. The figure of "S" suture will be less rigid and slightly yielding to an increased tension than the simple interrupted suture. In this present technique the knots were not tied much tightly while opposing the abdominal wall wounds in figure of "S" fashion. Tight suturing might result some swelling on the sutured line due to undue pressure leading to suture necrosis and disruption. This was really an agreement with the finding of Carleton (1951), who apprised that the tightly tied suture and presence of infection materially delayed the gain in the tensile strength of healing of abdominal wounds.

The figure of "S" suture which was adopted in six buffalo calves in the present experiment, proved to be the stronger and easier suturing technique for closure of laparotomy wounds. This finding supported the view point of Shambough (1940), who mentioned that figure of "S" stitch had approximately the same strength as that of two single stitches, and also the matress stitches were weaker than the figure of "S" stitches, because of the facts, that the holding power of the tissues and the strength of the stitches were directly affected by the number of stitches placed in a given area. Thus the frequency of the stitches depended upon the numbers of stitches required for accurate approximation. Besides, the required strength of the suture line could be increased only by increasing the number of stitches and not by employing heavier suture materials.
The animals were observed grossly for healing of abdominal wounds and other complications for a period of 14 and 21 days, and thereafter, sacrificed for histopathological examination so as to assess the percentage of healing rate.

Among the techniques used in closing abdominal wall, the author adopted three types of techniques namely one tier, two tier and three tier.

While going through the literatures a very little evidence was found about one tier technique of suturing the abdominal wall wound. On the other hand, there were many literatures available both in human and veterinary surgery dealing with the closure of laparotomy wounds by means of two, three and four tier techniques. The beginning of the discussion inaugurates with one tier technique. In this technique the skin, muscles and peritoneum were sutured together with one strand of thread like the figure of "8". This technique gave good result in closure of the abdominal wall wounds. This upheld the view of the Frederic and Prestona (1947) regarding the figure of "8" suture which is essentially a pair of interrupted sutures to approximating a wider strip of tissue than the interrupted suture which permits free circulation to the edges of the tissues without any disturbances. One of the preceding suture will effect as much closure as to simple interrupted sutures which makes it more economical and time saving.

The integrity of the wound will not be disturbed
even if one stitch of figure of "8" breaks. The figure of "8" suture will be less rigid and slightly yielding to an increased tension than the simple interrupted suture. In this present technique the knots were not tied much tightly while opposing the abdominal wall wounds in figure of "8" fashion. Tight suturing might result some swelling on the sutured line due to undue pressure leading to suture necrosis and disruption. This was really an agreement with the finding of Carletan (1951), who apprised that the tightly tied suture and presence of infection materially delayed the gain in the tensile strength of healing of abdominal wounds.

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Similarly in one tier technique, more stitches were present in the sutured line so it was inferred that the one tier technique was the quickest way of suturing abdominal wall wounds with less quantity of suture materials and could easily be removed on eight post-operative days without leaving any buried material inside, which might prove to be a potential source of trouble.

Therefore, suturing of the abdominal wall wound with one tier technique could only be achieved by means of figure of "8", which could provide accurate anatomical apposition of the tissues, but any variation in the suturing pattern might lead to failure of healing and unwanted peritoneal adhesion. In this case, the choice of proper suture materials was very important. No doubt both veterinary and human surgeons would continue to have differences of opinion as to the merits of available suture materials. In all category of the surgical details there was nothing so effective or indeed indispensable as the properly applied suture materials for the retention of breach of continuity. It nearly conferred the observation of Dhoblinia (1970), who mentioned that the main purpose of suture was to hold the wound edges in contact until fibroblastic proliferation was so firmly established to take over the sutures.

In the present experiment, the choice of suture materials remained confined to silk, simple cotton and vetafil. On eighteen experimental buffalo calves, the above
non absorbable suture materials were used. Since in veterinary practice economical consideration in relation to cost of suturing materials as well as its availability and pliability should be taken into account.


Closing of abdominal wall wound by one tier technique:

In this study, six apparently healthy male buffalo calves were used. Laparotomy was performed in these animals under local anaesthesia and chloral hydras sedation. The wound was closed with silk, cotton and vetafil thread respectively.

In this technique the peritoneum, muscles and skin were sutured together in figure of "8" Halsted fashion. The stitches were removed after eight post operative days from all parts of peritoneum, muscles and skin at one time without
difficulties. The knots were not finally tied till the completion of closure of wound, so as to facilitate the suturing of the abdominal wall structures.

In the author's opinion this technique was the best and quickest way for closure of laparotomy wounds. In this case comparatively lesser amount of suture materials will be required at the time of suturing. Out of six animals four recovered satisfactorily without showing any complications while swelling adhesion was noticed in two animals in which vetafil was used as a suturing materials.

Microscopic observation of the tissue revealed the depression over the epidermis. The sign of inflammation had almost subsided and collagen tissues were laid down in bundles, newly formed blood vessels were seen as well as the fibrosis from top to bottom was found.

Non absorbable suture material was found grossly and microscopically to be a suitable suture material for closing the abdominal wall wounds by one tier technique, because the animals in this group showed complete wound healing. It would not be an exaggeration to state that the problem of wound healing and repair is as old as the origin of the living organisms and the process of wound healing has attracted the attention of investigators for many centuries. Various workers have investigated the process of wound healing like, Fast (1947), Carleton (1951), Sandblom (1954), Billingham and Russel (1956), Orris (1958), Postlethwait (1961),

They studied the healing aspects of the abdominal as well as skin wounds in different animals and they found that the basic elements of wound healing were the collagen fibers, reticular fibers and elastic fibers.

In the author's opinion the closure of laparotomy wounds by employing one tier technique is an easy, economical and more satisfactory procedure to be adopted in the field condition.

**Closing of the abdominal wall wound by two tier technique:**

In this technique peritoneum and muscles were sutured together in continuous fashion and skin separately with Halsted pattern. The number of animals, suture materials and observation days remained the same as in group I.

Many workers like Talawalker (1952), Mohmoud and Hafiz (1954), Singh and Khali (1959), Muccunn (1953), Guard (1953), employed two tier technique for closing abdominal wall wound in different species of animals including human beings, using absorbable and non-absorbable suture materials. But most of them used absorbable suture materials. They reported that good results were obtained by this technique if the wound was closed with absorbable suture materials with
aseptic measures. But in present study, grossly the wound scars revealed satisfactory healing. In some cases peritoneal adhesion was seen, the suture material was visible on the second layer of the sutured portion and some inflammatory swelling was also observed. In one, animal out of six see-page of exudate was noticed.

Microscopical observation revealed less leucocytic infiltration in the area around the sutured line in second layer. The replacement of the tissue was seen with epithelization and connective tissue. Heavy leucocytic infiltration was seen on 14th post-operative day and thus this observation upheld the findings of Dhoblonia (1970) and Levenson et al (1965).

In this technique the non-absorbable suture materials gave inferior result grossly and microscopically than one tier technique.

**Closing of the abdominal wall wound by three tier technique:**

In this group three tier technique were followed using the same suture materials, animals and observation days as in group I and II. Here the peritoneum and muscles were sutured separately with continuous fashion and skin separately with Halsted pattern.

Several workers namely Bonney (1947), Hawaldor and Khambete (1956), Menon (1956), Singh (1960), Shuttleworth
(1960), Rattor (1962), Leonard (1968), Frank (1969), Masoni (1970), Berge and Westhues (1966) used three tier technique and employed absorbable suture materials for closing peritoneum and muscles and non-absorbable suturing material for skin. They reported that this technique was quite useful for closing abdominal wall wound. Instead, the author used the non-absorbable suture materials for closing the abdominal wounds. But it did not afford satisfactory result.

Because on gross examination, peritoneal and omental adhesion along with heavy inflammatory swelling at the site of operation was observed. Moreover, the suturing material were also visible on the sutured line. The animal No. 16 succumbed after 10th post-operative day and on autopsy it was found that the animal died due to acute peritonitis.

Microscopically, the line of union showed very little extension of the epidermal pit into the dermis. The area around the pit showed little fibrooses and leukocytic infiltration around the suture material. Some inflammatory cells were seen here and there and gave inferior result than group I and II. When the peritoneum was sutured separately it did not give good result due to its rupture and in cases it could not hold the sutures as it had become feeble. Therefore, it must be incorporated with the muscles and its sheath and the skin should be sutured separately.

This particular technique did not offer satisfactory healing result as seen in group I and II.
Fig. 20: Gross picture of the normal tissue of the abdominal wall.

Fig. 21: Gross picture of tissue in one tier technique with silk.
Figure 22: Gross picture of tissue in one piece with cotton.

Figure 23: Gross picture of tissue in one piece.
Fig. 24: Showing the union at the sutured line by one tier technique. W.V.G. 10x70.
Fig. 25: Section of abdominal skin sutured by one tier with silk showing union at the line of suture and newly formed blood vessels. W.V.G. 10x10.

Fig. 26: Abdominal muscles and peritoneum in one tier with silk showing complete healing at the line of the suture & newly formed blood vessels. W.V.G. 10x4.
Fig. 27: Section of the abdominal skin in one tier sutured with cotton showing complete healing at the sutured line. H&E. 10x10.

Fig. 28: Section of the skin and muscles with cotton showing the junction of the suture with complete healing. W.V.G. 10x10.
Section of peritoneum sutured with cotton in one tier technique showing to become normal. W.V.G. 10x10.

Fig. 29: Section of the lower portion of the skin, muscles and peritoneum in one tier with tefillin showing the junction of the sutured line with marked thickening of the tissue. H.A.P. 10x10.
Fig. 31: Gross picture of tissue in two tier technique with silk.

Fig. 32: Gross picture of tissue in two tier with cotton. The suture material is visible in the sutured line.
Fig. 33: Gross picture of tissue in two tier with vetafil. The suture material is visible with slight adhesion.
Fig. 34: Section of the skin, muscles and peritoneum showing heavy leucocytic infiltration and newly formed connective tissue. H.E. 8x4.
Fig. 35: Section of the abdominal skin sutured with silk by two tier showing complete healing at the line of the sutures and newly formed blood vessels. W.V.G. 10x40.

Fig. 36: Section of muscles and peritoneum sutured with silk by two tier showing union at the sutured line. W.V.G. 10x10.
Fig. 37: Section of the skin sutured with cotton showing the collagen bundles indicating the healing. H.A.P. 10x4.

Fig. 38: Section of muscles and peritoneum sutured with cotton in two tier showing the healing at the line of junction, which is marked by thickening of the tissue. W.V.G. 10x10.
Fig. 39: Section of the skin and muscles sutured with vetafil in two tier showing the healing in process. W.V.G. 10x10.

Fig. 39: Section of the muscles and peritoneum sutured with vetafil in two tier showing the sutured line in healing process. W.V.G. 10x10.
Fig. 41: Gross picture of tissue in three tier with silk which is visible on the sutured line.

Fig. 42: Gross picture of tissue in three tier with cotton showing the peritoneal adhesion.
Fig. 43: Section of the skin, muscles and peritoneum sutured with silk showing nerve plexes and blood vessels with heavy leukocytic infiltration. W.V.G. 10x10.
Fig. 44: Section of the skin and muscles sutured with silk in three tier. W.V.G. 10x10.

Fig. 45: Section of the muscles and peritoneum sutured with silk by three tier showing the heavy leucocytic infiltration.
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<th>GROUP NO.</th>
<th>Types of suture materials</th>
<th>Technique of closure</th>
<th>Period of observation</th>
<th>Body weight</th>
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<td>14</td>
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Table No. 2

Suture materials, observation days, average temperature, pulse and respiration in different groups of experimental animals.

**GROUP-I**
*(One tier technique)*

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<tr>
<th>No. of animal</th>
<th>Suture material</th>
<th>Observation days</th>
<th>Average temperature in °F</th>
<th>Average pulse/minute</th>
<th>Respiration/minute</th>
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<td></td>
<td>E</td>
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<td>51</td>
<td>21</td>
<td>M</td>
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</table>
**Cont'd Table No. 2.**

**Group-II**

(Two tier technique)

<table>
<thead>
<tr>
<th>No. of animal</th>
<th>Suture material</th>
<th>Observation days</th>
<th>Average temperature in F</th>
<th>Average pulse/minute</th>
<th>Respiration/minute</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
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<td>23</td>
<td>E</td>
</tr>
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<td>9</td>
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</table>
### CONT'D TABLE NO. 2

#### GROUP-III

(Three tier technique)

<table>
<thead>
<tr>
<th>No. of animal</th>
<th>Suture material</th>
<th>Observation days</th>
<th>Average temperature in F.</th>
<th>Average pulse per minute</th>
<th>Respiration per minute</th>
<th>Time</th>
</tr>
</thead>
<tbody>
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<td>50</td>
<td>20</td>
<td>M</td>
</tr>
</tbody>
</table>

M = Morning, E = Evening. Temperature in F. Pulse per minute. Respiration per minute. Recording of temperature, pulse and respiration were done every morning and evening till the removal of sutures.
TABLE No. 3
Average temperature, pulse, respiration in different groups of experimental animals for 8 post-operative days.

<table>
<thead>
<tr>
<th>Days</th>
<th>Group-I</th>
<th></th>
<th></th>
<th>Group-II</th>
<th></th>
<th></th>
<th>Group-III</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Fire</td>
<td>minute</td>
<td>Fire</td>
<td>minute</td>
<td>minute</td>
<td>Fire</td>
</tr>
<tr>
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<td>M</td>
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<td>50</td>
<td>20</td>
<td>100.0</td>
<td>51</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>E</td>
<td>100.4</td>
<td>53</td>
<td>22</td>
<td>101.0</td>
<td>52</td>
<td>22</td>
</tr>
<tr>
<td>2nd</td>
<td>M</td>
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<td>51</td>
<td>20</td>
<td>100.0</td>
<td>50</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>E</td>
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<td>3rd</td>
<td>M</td>
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<td>50</td>
<td>20</td>
<td>100.4</td>
<td>51</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>E</td>
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<td>53</td>
<td>25</td>
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</tr>
<tr>
<td>4th</td>
<td>M</td>
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<td>52</td>
<td>21</td>
<td>101.0</td>
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<td>21</td>
<td>100.4</td>
<td>51</td>
<td>20</td>
</tr>
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</table>

The pre-operative temperature of the animals was normal.
<table>
<thead>
<tr>
<th>Group No.</th>
<th>Buffalo calf no.</th>
<th>Total count</th>
<th>Differential count</th>
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</thead>
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<td>L.S.C.</td>
<td>W.B.C.</td>
</tr>
<tr>
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<td>million</td>
<td>thousand</td>
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<tr>
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<td>68</td>
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<tr>
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<tr>
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</table>

PAGE NO. 100.
<table>
<thead>
<tr>
<th>Group No.</th>
<th>Average of total count in million per cm³</th>
<th>Average of differential count in thousand per cm³</th>
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</thead>
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<td>Group</td>
<td>Case No.</td>
<td>Approximate body weight in lbs.</td>
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<td>---------------------------------</td>
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<td>130</td>
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<tr>
<td></td>
<td>12</td>
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<tr>
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<td>125</td>
</tr>
<tr>
<td></td>
<td>18</td>
<td>180</td>
</tr>
</tbody>
</table>

One tier - Skin, muscles and peritoneum sutured together.

Two tier - Peritoneum and muscles sutured together and skin separately.

Three tier - Peritoneum, muscles and skin were sutured separately.
<table>
<thead>
<tr>
<th></th>
<th>Gross examination</th>
<th>Microscopic examination</th>
<th>Summary of gross and histopathological changes of the experiment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Table 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Table 2</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Table 3</td>
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<td></td>
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<td>Table 4</td>
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<td></td>
</tr>
<tr>
<td>Table 6</td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
was not complete. Sinew was seen on site.

The site was seen around the surface, where there was no adhesion. The pit showed little threads. It was transsected. Opened into the dermis, the area around the section was seen at extension of the epidermal pit. The site of union showed very little heavy innumerable.

**Tissue**

There was slight tissue on muscles and petechial. The tissue was seen by connective second layer. The replacement of the skin around the surface in some abnormalities revealed gross examination revealed.

---

Contd. Table No. 7.
<table>
<thead>
<tr>
<th>Suture materials</th>
<th>Experimental technique</th>
<th>Observation period in days</th>
<th>Gross examination</th>
<th>Microscopic examination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>21</td>
<td>Microscopically slight inflammatory swelling was seen and gradually subsided. The wound healed up satisfactorily and the animal did not show any abnormalities.</td>
<td>Microscopically the depression over the epidermis was reduced. The different layers of the epidermis cells were re-organised. The sign of inflammation was subsided. Some inflammatory cells were seen in some parts. Maturated collagen muscle bundles showed complete degeneration in the healed portion.</td>
<td></td>
</tr>
<tr>
<td>COTTON. One tier</td>
<td></td>
<td>Adhesion was not seen.</td>
<td>In 14 days rich vasculatory in the muscular layer with proliferation of fibroblast was seen.</td>
<td></td>
</tr>
<tr>
<td>DAYS</td>
<td>Cotton thread was seen on sutures if used</td>
<td>Compression and the site of entry of the suture was seen</td>
<td>Heavy Inflammatory</td>
<td>Swelling was seen</td>
</tr>
<tr>
<td>------</td>
<td>------------------------------------------</td>
<td>--------------------------------------------------------</td>
<td>-------------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>14</td>
<td>Cotton thread was seen on sutures if used</td>
<td>Compression and the site of entry of the suture was seen</td>
<td>Heavy Inflammatory</td>
<td>Swelling was seen</td>
</tr>
<tr>
<td>15</td>
<td>Cotton thread was seen on sutures if used</td>
<td>Compression and the site of entry of the suture was seen</td>
<td>Heavy Inflammatory</td>
<td>Swelling was seen</td>
</tr>
<tr>
<td>16</td>
<td>Cotton thread was seen on sutures if used</td>
<td>Compression and the site of entry of the suture was seen</td>
<td>Heavy Inflammatory</td>
<td>Swelling was seen</td>
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Cont'd. Table No. 7.
<table>
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<tr>
<th>1</th>
<th>2</th>
<th>3</th>
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<tbody>
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<td>5</td>
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<td>8</td>
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</table>

<table>
<thead>
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<th>12</th>
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</thead>
<tbody>
<tr>
<td>13</td>
<td>14</td>
<td>15</td>
<td>16</td>
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</table>

**Table:**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Observation 1</th>
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<th>Observation 3</th>
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<td>22°C</td>
<td>23°C</td>
</tr>
<tr>
<td>Visibility</td>
<td>10°C</td>
<td>11°C</td>
<td>12°C</td>
</tr>
<tr>
<td>Moisture</td>
<td>50%</td>
<td>55%</td>
<td>60%</td>
</tr>
<tr>
<td>Date</td>
<td>Event</td>
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<tr>
<td>------</td>
<td>-------</td>
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</tr>
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</tr>
<tr>
<td>15</td>
<td>19</td>
<td></td>
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</tr>
</tbody>
</table>

**General Observations:**
- Interstitial infiltration was seen in the third layer, but not in the second and first layers.
- The interstitial infiltration was observed to be more pronounced in the first and second layers.
- There was no significant infiltration in the third layer.
- The infiltration was observed in the interstitial space between the muscle fibers.
- The infiltration was more pronounced in the region of the muscle fibers.
AVERAGE TEMPERATURE, PULSE AND RESPIRATION.

GROUP I
GROUP II
GROUP III

M MORNING
E EVENING

TEMPERATURE IN F.

104
103
102
101
100
99

PULSE/MIN.

54
53
52
51
50

RESPIRATION/MIN.

25
24
23
22
21
20

OF DAY
1 2 3 4 5 6 7 8
POST OPERATIVE DAYS.
COMPARATIVE EVALUATION OF DIFFERENT SUTURING MATERIALS SHOWING THE HEALING.

GROUP III
(THREE TIER)

PERCENTAGE OF HEALING

21 S,M,P
21 S,M,P
21 S,M,P

S - SKIN
M - MUSCLES
P - PERITONEUM

21 OBSERVATION DAY

SILK
COTTON
VETAFIL
SUMMARY & CONCLUSION
CHAPTER VII

SUMMARY AND CONCLUSION.

The present work was undertaken to investigate the different techniques for closure of laparotomy wounds by different suture materials.

In the present experiment, the three different suturing materials such as silk No. 4/0, cotton No. 8 and vetafil No. 0.20 mm. were used in eighteen young healthy male buffalo calves. The laparotomy was performed under chloral hydras sedation and procaine hydrochloride infiltration at the site of operation. About 15 cm. long incision was made 3 to 4 cm. below the transvers process of the lumbar vertebrae.

The wounds were closed with three different techniques, viz., one tier, two tier and three tier. In one tier technique peritoneum, muscles and skin were sutured together with the figure of "8" fashion. In two tier, peritoneum and muscles were closed together in continuous manner and skin separately with Halsted suture, where as in three tier technique, the peritoneum, muscles and skin were sutured separately.

The comparative study of these techniques for closure of laparotomy incision by employing different sutu-
-ring materials were evaluated as follows:

1. Non absorbable suture material was found grossly and microscopically to be a suitable suture material for closing the abdominal wall wounds by one tier technique.

2. The gross observation showed satisfactory healing without any complication and adhesion except in case of vetafil which showed slight adhesion with peritoneum.

3. Microscopic observation of the tissues revealed the depression over the epidermis. The sign of inflammation had almost subsided and collagen tissues were laid down in bundles as well as newly formed blood vessels were seen. The fibrosis was also found from top to bottom.

4. This technique furnished satisfactory healing result with silk, cotton and vetafil arranged in order of merit.

5. In two tier technique, the non-absorbable suture materials gave inferior result grossly and microscopically than one tier technique.

6. In the first layer, the healing was almost similar as in Group I, but in second layer (i.e. peritoneum and muscles), the sutures were visible with little
adhesion in and around the sutured line.

7. Microscopically it was the same as found in Group I, but some inflammatory cells were observed here and there. On the whole this technique gave inferior healing result than Group I.

8. In three tier technique some inflammatory swelling with peritoneal and omental adhesions were observed.

9. Microscopically, heavy infiltration of inflammatory cells were noticed on the line of union which showed very little extension of epidermal pit in to the dermis.

10. In this group more quantity of suture materials were used. This particular technique did not offer satisfactory healing as seen in Group I and II.

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