A RANDOMISED CONTROL TRIAL COMPARING THE EFFICACY OF POLYDIAXANONE II AND POLYPROPYLENE SUTURE MATERIAL FOR MIDLINE VERTICAL ABDOMINAL INCISION USING INTERRUPTED X SUTURES IN PREVENTION OF BURST ABDOMEN

Submitted by:

DR. GANESH.M.K

DISSERTATION

Submitted to the
KLE University, Belgaum, Karnataka.

In partial fulfillment
of the requirements for the award of the degree of

M.S. IN GENERAL SURGERY

Under the Guidance of :

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LIST OF ABBREVIATIONS

DC	:	Differential count
ESR	:	Erythrocyte sedimentation rate
Hb	:	Hemoglobin
HBsAg	:	Hepatitis-B surface antigen
HIV	:	Human immunodeficiency virus
IP No.	:	Inpatient number
RR	:	Relative risk
SL:WL	:	Suture length : Wound length
TC	:	Total count
W/v	:	Weight / volume

ABSTRACT

Background:

Abdominal wound dehiscence is a common complication of emergency laparotomy. Its prevention in important to reduce postoperative morbidity and mortality. The search for the optimal laparotomy technique has gone on for more than 100 years and will continue.

Research Hypothesis: The application of Polydiaxanone (PDS II) suture material in reducing the risk of burst abdomen in midline laparotomy wound.

Objectives:

To compare the incidence and risk of burst abdomen, wound infection and sinus formation with Polydiaxanone (PDS II) versus Polypropylene (PPL) in midline laparotomy wounds.

Design: Open randomized trial with two arms.

Setting: Surgical wards of K.L.E.Society's Dr Prabakar Kore Hospital & M.R.C., Belgaum.

Material and Methods:

60 patients undergoing laparotomy through a midline vertical incision were randomized after informed consent, to either a Polydiaxanone (PDS II) versus Polypropylene (PPL) suture material.

Outcome variable:- The incidence and risk of burst abdomen, wound infection and suture sinus formation.

Predictor variable:- Intraperitoneal sepsis, abdominal distension, cough, diabetes, malignancy and anemia.

Statistical analysis:- The incidence and relative risk (RR) of burst abdomen, wound infection and sinus formation using Polypropylene (PPL) group as the reference category were calculated.

Results:

There was 1 burst abdomen (out of 30 cases, 3.3%) in Polypropylene (PPL) group and none (out of 30) in Polydiaxanone (PDS II). The RR of burst could not be calculated because of 0 in one arm. The incidence of wound infection was 16.6% in Polypropylene (PPL) (5 out of 30 cases) compared to 10% (3 out of 30 cases) in Polydiaxanone (PDS II). The relative risk (RR) of wound infection was 0.60 .

The incidence of suture sinus was 10% (3 out of 30 cases) in Polypropylene (PPL) as compared to 3.3% in Polydiaxanone(PDSII) group.

Conclusion:

The risk of burst abdomen, wound infection& suture sinues is less with the use of Polydiaxanone (PDS II).

Keywords: Abdominal wound dehiscence; Burst abdomen; Emergency laparotomy; Midline vertical incisions; Suture technique; Suture sinus; Abdominal closure; Wound infection.

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INTRODUCTION

Every surgeon's dream is to close the abdominal incisions securely, so as to prevent complications, such as wound infection, dehiscence, incisional hernia, sinuses, scar hypertrophy and intraperitoneal adhesions[1].

Since the dawn of the history of surgery many different varieties of suture materials and techniques have been tried and advocated at different times. No one suture material or method has given a total satisfactory result as far as vertical abdominal incisions are concerned.

Every now and then, new suggestions and changes have been made from single layer closure to layered closure, advocating different suture materials like nylon, vicryl, prolene, steel wires, chromic catgut, PDS etc. This only shows that no single method has satisfied all ideal requirements. Any suture material for closure of the wound should satisfy at least some of the ideals of wound healing.

The ideal method of abdominal wound closure has not been discovered. It should be technically so simple that the results are as good in the hands of a trainee as in those of master surgeon, does not come in the way of pathophysiology of wound healing, with least possibility of post-operative complications as mentioned earlier.

Abdominal wound dehiscence is a common complication of emergency laparotomy in Indian setup. Wound dehiscence carries with it a substantial morbidity and mortality in addition to increase in cost of care. Its prevention is important to reduce post-operative morbidity and mortality. Many patients have a poor nutritional status and the presentation of patients is often delayed. This makes the problem of wound dehiscence more common and graver.

Wound dehiscence is related to the technique of closure of abdomen and the suture used.[2] Numerous studies have been conducted evaluating a bewildering variety of suture materials and closure technique.[3-5] The current opinion in the west centers around some form of running mass closure of abdomen in emergency and elective settings as there is no significant difference reported between the two, in most studies.[6-14] A new interrupted X technique was introduced to circumvent the problem of cutting out effect of continuous sutures which showed reduced incidence of wound dehiscence[38]

While the choice may not be so important in elective patients who are nutritionally adequate, do not have any risk factor for dehiscence and are well prepared for surgery, however it may prove crucial in emergency patients who often have multiple risk factors for developing dehiscence[15] and strangulation of sheath is the proverbial last straw in precipitating wound failure.

A new suture material Polydiaxanone (PDS II) was introduced to reduce the morbidity and mortality rate of laprotomies by its newer properties. Polydiaxanone (PDS) is monofilament. It absorbs slowly and there is minimal absorption until about 90 days. However, its in vivo tensile strength reduces more quickly to 70% at 2 weeks, 50% at four weeks and 25% at six weeks. So it is intended to study the closure of abdomen with Polypropylene (Prolene) versus Polydiaxanone II (PDS II) in cases operated in K.L.E. Society's Dr Prabakar Kore Hospital and M.R.C., Belgaum, regarding the effectiveness of two different suture material in our setup[16].

AIM AND OBJECTIVES

To compare the efficacy of Polydiaxanone (PDS II) versus Polypropylene (Prolene) suture material in midline abdominal incisions using interrupted X sutures –

1. Incidence and relative risk of burst abdomen.
2. Incidence and relative risk of post-operative wound infection and sinus formation.

REVIEW OF LITERATURE

ANTERIOR ABDOMINAL WALL:

Embryology:[17]

The abdominal wall begins to develop in the earliest stages of embryonic differentiation from the lateral plate of the intraembryonic mesoderm. At this stage, the embryo consists of three principal layers: an outer protective layer termed ectoderm, an inner nutritive layer termed endoderm, and the mesoderm. The intraembryonic mesoderm becomes segmented into mesodermal somites or myotomes from which proliferating cells grow into the developing abdominal wall or somatopleure. The developing mesoderm of the future anterolateral abdominal wall splits into three layers that ultimately give rise to the transversus abdominis and the internal and external oblique muscles.

At this early stage, the lining of the coelomic cavity communicates broadly with the lining outside the body cavity. As the embryo enlarges and the abdominal wall components grow towards one another, the ventral open area, bounded by the edge of the amnion, becomes smaller. This results in the structure containing the yolk stalk (omphalomesentric duct), allantois, and the fetal blood vessels, which pass to and from the placenta.

By the end of the third month of gestation the body walls have closed, except at the umbilical ring. Because the alimentary tract increases in length more rapidly than the coelomic cavity increases in volume, much of the developing gut protrudes through the umbilical ring to lie within the umbilical cord. As the coelomic cavity enlarges enough to accommodate the intestine, the latter returns to the developing peritoneal cavity such that only the omphalomesentric duct, the allantois, and the fetal blood vessels pass through the shrinking umbilical ring. Umbilical vessels and the omphalomesentric duct has been reduced to a fibrous cord and no longer communicates with the intestine. After division of the umbilical cord, the umbilical ring heals rapidly by scaring.

Anatomy:

There are nine layers to the abdominal wall: skin, subcutaneous tissue, superficial fascia, external oblique muscle, internal oblique muscle, transversus abdominis muscle, endoabdominal or transversalis fascia, extraperitoneal or preperitoneal adipose and areolar tissue, and peritoneum.

Surgical Anatomy of Anterior Abdominal Wall:

Incisions through anterior abdominal wall are based on anatomic principles. The intra-abdominal pressure is considerable and our aim is leaving the abdominal wall as strong as possible after operation, otherwise there exists a very real fear that portions of the abdominal contents may leave the abdominal cavity through the weak area caused by a badly placed incision resulting in incisional hernia. Hence, it is very essential to know the surgical anatomy of anterior abdominal wall.

Definitions and Boundaries:

The anterior abdominal wall is bounded above by flare of costal margins and xiphoid process of sternum, below by iliac crests, inguinal ligaments, pubic tubercles and symphysis pubis. Its lateral margins are vertical lines dropped from costal margins to the most elevated portion of iliac crests.

Surface Anatomy:

For clinical purpose the anterolateral abdominal wall is divided into nine regions by two vertical lines (mid inguinal point) bisecting the inguinal ligament, and two horizontal lines, the upper one between tips of 9^{th} costal cartilage – transpyloric line and the lower one transtubercular line at the level of two tubercles on the iliac crest, about 2” behind the anterior superior iliac spine. The areas are epigastric, right and left hypochondrium, umbilical, right and left lumbar, hypogastric, right and left iliac fossae. Umbilicus lies midway between xiphisternum and pubic symphysis. Recti form bulging bands on each side of midline. Across them are stretched linear, transverse, tendinous intersections producing depressions in muscular persons. The contour of abdomen is subject to considerable variations.

SUPERFICIAL STRUCTURES:

The skin of the abdomen is attached loosely to the subjacent structures except at umbilicus, where it adheres firmly. Bodylines of tension of the skin are produced by the coarse fibrous tissue bundles and disposition of elastic fibres in the corium. Attention to their direction is important in making surgical incisions made in the lines of skin cleavage and accurately approximated to leave a hairline scar. Incisions that cross the lines are apt to leave a broad scar, especially when wound infection develops. The subcutaneous tissue consist of Camper's and Scarpa's fascia, Camper's fascia is the superficial layer that contains the bulk of subcutaneous fat. Scarpa's fascia is a denser layer of fibrous connective tissue contiguous with the fascia lata of thigh. Approximation of Scarpa's fascia aids in the alignment of the skin after surgical incisions.

Abdominal Muscles:

The flat muscles of abdomen and recti are arranged to form an elastic contractile layer about the abdominal cavity protecting its contents. They function as a constricting mechanism, and the pressure they exert, helps to maintain the abdominal viscera in their position. The peristaltic contractions of hollow viscera are supplemented by uniform pressure of the abdominal wall muscles, which is very well demonstrated in the acts of micturition and defaecation.

Abdominal muscles also assist in ventilation and vomiting. Uncommon pressure exerted over the muscles can bring about their rupture as seen in muscular strain or parturition where recti can tear. Transversus abdominis acts only on abdominal contents, and has no effect on vertebral column.

Obliqus externus abdominis: (Fig.1)

This is the largest and most superficial of the three flat muscles. It arises by 8 slips from external surfaces and inferior borders of lower 8 ribs, which interdigitate with slips of origin of serratus, pass vertically downwards and are inserted into anterior half of the outer lip of iliac crest. Other fibres end in an aponeurosis. None of the fleshy fibres of the muscle extend downwards beyond a line drawn from anterior superior iliac spine to the umbilicus. In the median plane, the aponeurosis ends in linea alba which is a tendinous raphe extending from xiphoid process to symphysis pubis. The margin of this aponeurosis extending from pubic tubercle to anterior superior iliac spine is thick and folded backwards forming inguinal ligament, below which it is continuous with fascia lata.

Nerve supply:- Ventral rami of lower six thoracic nerves.

Obliqus internus abdominis: (Fig.2)

It is thinner and less bulky, lies under cover of external oblique. Arises by fleshy fibres from lateral 2/3rd of grooved upper surface of inguinal ligament, anterior 2/3rd of intermediate line of the ventral segment of iliac crest, and from thoraco lumbar fascia. They are inserted into the inferior borders of the lower 3 or 4 ribs. Fibres arising from inguinal ligament, run downwards and medially, becoming tendinous, are inserted conjointly with the aponeurosis of the transverses abdominis into the crest of pubis-pecten pubis, forming conjoint tendon. Rest of the fibres diverge and end in an aponeurosis. The aponeurosis splits at the lateral border of rectus into 2 lamellae

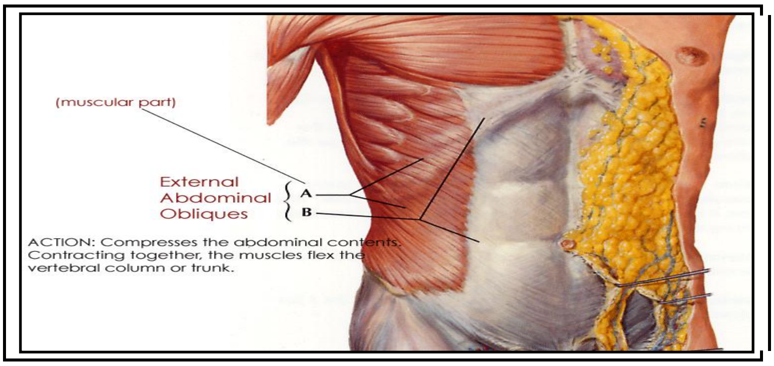


Fig.1: External Oblique Muscle

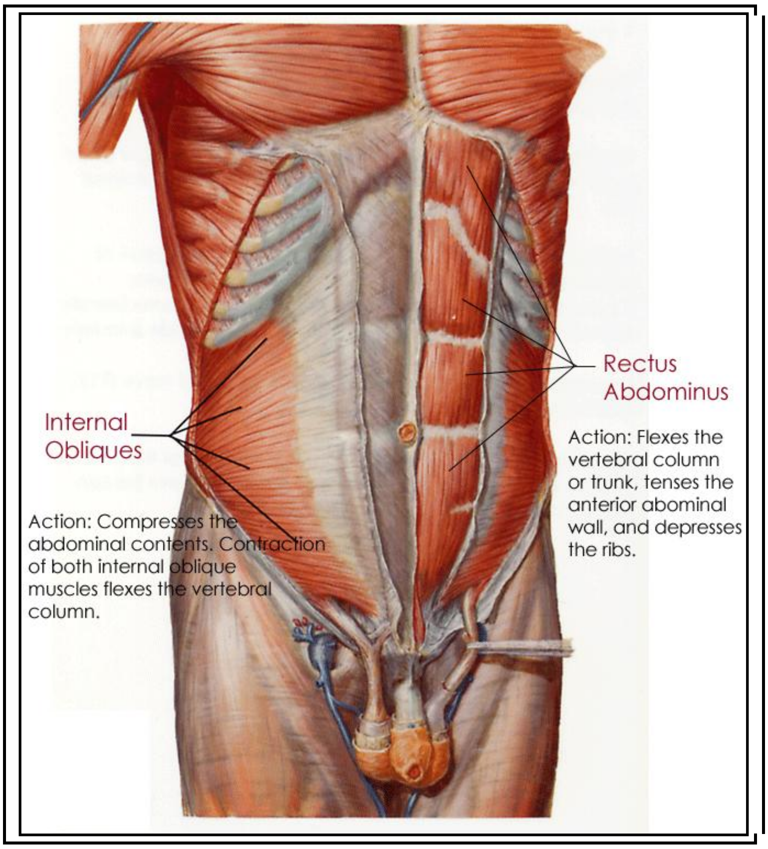


Fig.2: Internal Oblique and Rectus Abdominus Muscle

ensheathing the muscle and reunite at the linea alba. Anterior layer of this, blends with aponeurosis of external oblique and posterior layer blends with aponeurosis of transversus.

Nerve supply:- Ventral rami of lower six thoracic and first lumbar nerves.

Transversus abdominis:

It arises by fleshy fibres from lateral $1/3^{rd}$ of the inguinal ligament, anterior $2/3^{rd}$ of inner lip of ventral segment of iliac crest, thoraco lumbar fascia and inner surfaces of lower costal cartilages. It ends in an aponeurosis and are inserted together with aponeurosis of lower lamellae of internal oblique into linea alba in the median plane. Lower fibres form conjoint tendon with arched fibres of internal oblique.

Nerve supply:- Ventral rami of lower 6 thoracic and first lumbar nerves.

Pyramidalis:

Triangular muscle placed at the lower part of abdomen infront of rectus within the sheath of the muscle, arises by tendinous fibres from the front of the pubis, ascends upwards and ends in a pointed extremity and is inserted into lina alba midway between umbilicus and pubis. It is a tensor of linea alba.

Nerve supply: Subcostal, T12.

Rectus abdominis muscle and rectus sheath: (Fig.2)

Recti are long flat muscles, broader above than below, extending along the whole length of abdomen, and is separated from its counter part by linea alba. It arises by two tendons, lateral larger one arises from pubic crest, and medial one interlaces across the midline with the opposite one, it is inserted as three slips into cartilages of 5^{th}, 6^{th} and 7^{th} ribs. It has 3 tendinous intersections, upper one opposite the free end of the xiphoid process, 2^{nd} one at the level of umbilicus, 3^{rd} one midway between these two. They are intimately adherent to the anterior lamina of the sheath of the muscle. These recti are enclosed in a sheath formed by the aponeurosis of obliqui and transversus. At the lateral margin of the rectus, the aponeurosis of internal oblique divides into two lamellae, one passes infront of the rectus, blending with aponeurosis of external oblique, the other passes behind the recti and blend with aponeurosis of transversus and these joining again in the medial border of the rectus reaching linea alba. This arrangement exists from costal margin to a variable level, usually midway between umbilicus and symphysis pubis where posterior wall of the sheath ends in a curved margin – Arcuate line, concavity of which is directed downwards. Below the level of this, all the three muscles pass infront of the rectus. Hence the recti are separated from peritoneum only by transversalis fascia. The lateral margin of the recti are marked on the surface of the anterior abdominal wall by a curved groove termed linea semilunaris, which extends from the tip of the 9th costal cartilage to pubic tubercle.

Nerve supply: Ventral rami of lower 6 or 7 thoracic nerves.

Linea alba: (Fig.3)

It is a tendinous raphe stretching between the xiphoid process and symphysis pubis, placed between medial borders of recti formed by interplacement of fibres of aponeurosis of oblique and transversus. It is narrow below and broader above. Its supraumbilical portion can usually be recognized as a shallow groove. Its lower end has double attachment-superficial fibres passing infront of the medial heads of the recti to the front of symphysis pubis while its deeper fibres form a triangular lamella attached behind the recti to the posterior surface of the pubic crest called adminiculum linea albae.

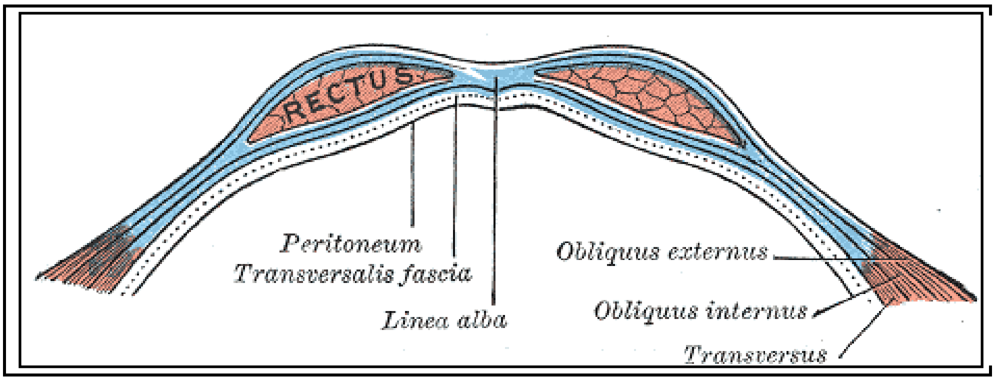


Fig.3: Rectus Sheath and Linea Alba

Transversalis fascia:

It is a thin membrane which lies between inner surface of the transverses and extra peritoneal fat and is continues with the iliac and pelvic fascia. In the inguinal region it receives fibres from aponeurosis of transversus. Above it blends with the fascia covering undersurface of the diaphragm. Behind it is lost on the surface of thoracolumbar fascia with which it blends.

Below it has following attachments – posteriorly to the whole length of iliac crest, between the origins of transversus and iliacus between anterior superior iliac spine and femoral vessels, and to the posterior margin of inguinal ligament and is continuous with iliac fascia. It is fixed to the pectin pubis medial to the femorals, it descends infront of femoral vessels to form the anterior wall of femoral sheath.

In well nourished patients, the peritoneum may be separated from the transversalis fascia with ease. It extends into the scrotum as internal spermatic fascia.

Extra Peritoneal Tissue:

There is considerable amount of fibroareolar tissue between transversalis fascia and peritoneum. It is scanty in the anterior abdominal wall, except in the pubic region and above iliac crest.

Blood supply of the anterior abdominal wall: (Fig.4)

Abdominal wall is supplied with arteries of various sources with free anastomosis. Above umbilicus arterial supply is by branches from superior epigastric, musculophrenic and lower intercostals arteries, below the umbilicus by few branches from femoral artery, superficial epigastric, superficial circumflex iliac, and superficial external pundendal artery. Veins below the umbilicus drain into femoral vein and above umbilicus drain in to internal mammary, intercostals and long thoracic vein.

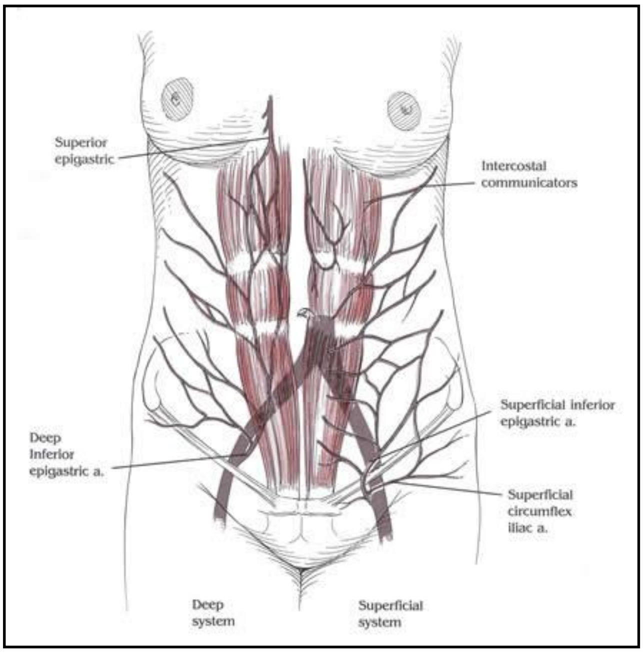


Fig.4: Blood Supply of the Anterior Abdominal Wall

Lymphatic drainage of anterior abdominal wall:

Lymphatics from the superficial fascia and skin above the umbilicus drain to axillary nodes; those from below the umbilicus drain to superficial inguinal nodes. Lymphatics from the abdominal wall muscles, the extraperitoneal connective tissue and parietal peritoneum drain along the arteries to nodes associated with parent vessels (lateral aortic parasternal, external iliac and inguinal lymph nodes).

THE PERITONEUM:

The peritoneum is the largest and most complexly arranged serous membrane in the body. In males it is a closed sac, a part of which lines the abdominal wall, while the remainder is reflected over contained viscera. In females, the free ends of fallopian tubes open into the peritoneal cavity. The part which lines the abdominal wall (or parieties) is called parietal portion of the peritoneum; the one which is reflected over contained viscera, constitutes the visceral portion of the peritoneum. The free surface of the membrane is smooth, covered with a layer of flattened mesothelium and kept moist by a small quantity of serous fluid. Hence, the viscera can glide on the wall of the cavity or on one another with a minimum friction and complete freedom within the limits dictated by their attachments to the wall of abdominal cavity or to other structures such as vascular structures.

The peritoneal cavity is of course a coelom, a discontinuity in the mesoderm with its own special surface epithelium which maintains the surface. Loss of these epithelium entails adherence of the underlying tissues and a consequent interference with function which may be serious and even lethal.

A considerable amount of areolar connective tissue intervenes between the parietal peritoneum and the abdominal walls with the fascial lining of which it blends. It is known as extra peritoneal tissue. It varies in quantity and contains varying amounts of fat in different regions. This tissue loosely connects the parietal peritoneum to the abdominal and pelvic walls in general, and so allows the peritoneum to be relatively easily stripped off these walls. It is dense in the undersurface of the diaphragm and behind linea alba, so that parietal peritoneum is more firmly adherent to these parts. It is especially loosely arranged in some places to allow for alterations in the size of certain organs e.g. in the front part of the pelvis and lower part of anterior abdominal wall, where it allows the urinary bladder to distend in an upward direction behind the anterior abdominal wall, from which it strips off the peritoneum at it ascends. It is usually laden with fat in relation to kidneys. The visceral peritoneum on the other hand is firmly united to the viscera which it covers and cannot be readily stripped off. Infact the connective tissue layer (tela subserosa) of visceral peritoneum is directly continuous with fibrous tissue stroma of the viscera. Thus from the point of view of pathological condition of an organ, the visceral peritoneum must be considered to be a part of the viscera itself.

The peritoneum consists of a single layer of flattened mesothelial cells which covers a layer of loose connective tissue. In most areas, the mesothelium forms a continuous surface. Adjacent mesothelial cells are joined by junctional complexes, which probably allow the passage of macrophages to and from underlying connective tissue in the same manner as endothelial cell junctions, which allow leucocytes to pass from blood stream. In other areas, however as in greater omentum, the peritoneum may be discontinuous presenting a series of fenestrations which may be visible to unaided eye. At such points mesothelial surface layers is continuous over trabecular connective tissue which interlace around the margin of fenestrations.

The submesothelial connective tissue carries cells usually found in loose connective tissues. It has been claimed that the mesothelial cells possess macrophages. They may also transform into fibroblasts and fusion between layer of fibroblasts of mesothelial origin may lead to macroscopic adhesions between the peritoneal surfaces of adjacent structures. If extensive, these may have serious clinical consequences interfering with intestinal motility or even leading to complete intestinal obstruction.

The mesothelium is similar in many respects to the endothelial lining of blood vessels and it forms a dialyzing membrane across which fluids and small molecules of various solutes may pass. Numerous pinocytotic vesicles are present near pinocytotic cell surfaces, the remaining cytoplasm being relatively poorly provided with organelles indicating a low level of metabolic activity. Normally small volumes of fluid are transferred across the peritoneal surfaces. Therapeutically however, considerable volumes of fluid may be administered via intraperitoneal route. Certain blood borne substances such as urea can be dialysed from the blood stream, when fluid is artificially circulated through peritoneal cavity.

PATHOGENESIS OF WOUND HEALING: [18-20]

Wound repair represents the main point of convergence of all the disciplines of surgery; it may therefore be viewed as the foundation of surgery. How to maximize the human body's capacity to heal disrupted tissue with the optimal restoration of form and function is the concern of all who perform surgery, regardless of the tissue on which one works.

Wound repair is one of the fundamental processes of life. The mysteries of wounds and the mechanisms of repair are slowly being unrevealed, but it appears that the more one gains knowledge about them, the more questions seem to arise. Understanding of the cellular and biochemical mechanism involved in wound healing is far from complete. Indeed, many individuals have spent their lifetimes exploring wound healing, and many careers, both academic and non-academic, have been based on exploration of this subject. Knowledge of the practical aspects of wound repair requires a continuous process of observation and learning throughout one's medical career, moving from the patient to the literature or laboratory and back to the patient.

Philosophically wound healing can be considered an extension of morphogenesis because it is more than merely the formation of new tissue and cells; it is an awakening of cellular states that existed at an earlier time ontogenetically. Cellular mitosis, formation of intercellular substances, and cellular migration are found both embryologically when tissue is first formed and in the reformation of tissue, which allows wound healing to proceed.

Tissue healing is a topic of intense importance in every branch of surgery. Without this remarkable living phenomenon, surgery as we know it would of course be impossible.

The factor that differentiates the carpenter from the surgeon is that the former relies entirely on his mortice joints and screws to hold his work together while the latter depends on an intimate knowledge of the healing of soft tissues in planning of treatment.

To the abdominal surgeon, wound healing is of enormous interest in two respects. First in safe healing of laparotomy wound, without either early rupture or late herniation, and second in sound healing of underlying alimentary canal anastomosis.

Wound healing can no longer be thought of as a generic term. Wound heals by various processes such as coagulation, inflammation, matrix synthesis and deposition, angiogenesis, fibroplasia, epithelialization, contraction, and remodeling. When wound proceeds through these processes in an orderly and timely manner and achieve sustained anatomic and functional integrity, they are considered acute wounds. When they either do not proceed in an orderly and timely fashion or do so without achieving sustained anatomic and function integrity, they are considered chronic. Repeated trauma, ischemia, and infection are leading causes of the pathobiology leading to wound chronicity.[20]

Laparotomy incisions heal by primary union/ intention, where they undergo different phases of healing viz. inflammation, fibroplasia, epithelialisation, remodeling.

Healing by Primary Intention:

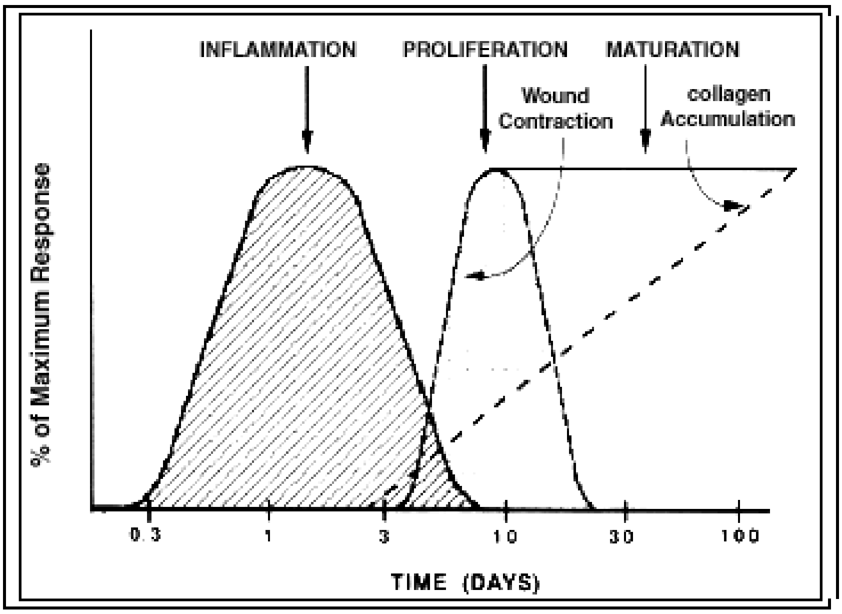


Fig.5: Phases of Wound Healing

Phases of Wound Healing:

Inflammatory Phase:

Immediately after a wound is created and blood vessels are cut, the first reaction is vascular. Initially there is vasoconstriction followed by vasodilatation. The dilation of venules allows escape of serum, plasma, proteins, and blood cells. Polymorphonuclear leukocytes (PMNLs), red blood cells, and blood migrate to fill the wound. A coagulum of fibrin is formed, which initially helps to hold the wound together. This is spoken of as the agglutination of a wound. The polymprphonuclear leukocytes preferentially increase in the wound for 1 to 2 days and then decrease in number. Concomitant with the decrease in PMNLs, lymphocytes and monocytes become the dominant cells, increasing in number from the second day to peak on the third or fourth day. The monocytes are transformed into macrophages engaged in phagocytosis. As we shall see, the macrophages are the dominant cells in early wound healing, directing the next phase (proliferative phase) and helping to terminate the inflammatory phase. The main inflammatory phase normally lasts up to 5 days.

During the inflammatory phase fibroblasts first appear at 24 to 48 hours; showing that collagen synthesis and the laying down of proteoglycans is beginning. Some new blood vessels formation also occurs.

During the inflammatory phase the epidermis begins to thicken and migrate into the wound, eventually crossing the surgical defect. This migration takes place in the midst of the clot that has formed in the surgical defect and is directed in a downward fashion into the wound. In a well-sutured wound, epithelial migration may be complete in as soon as 24 hours.

Proliferative Phase:

In the early proliferative phase, there is intense proliferation of fibroblasts and capillaries. The fibroblast at first migrates along fibrin strands, most of which are oriented vertically in the wound. Capillary endothelial budding occurs particularly in the subcutaneous tissue and papillary dermis. The epithelium from each side continues to grow and eventually unites in the upper dermis. Mitosis occurs not within the epidermal tongues moving under the scab but peripherally around the wound. Also the epidermis begins to thicken in the wound, a process that continues into the next phase.

Later in the proliferative phase, collagen is laid down by the fibroblasts, increasing the tensile strength of wound. The direction of fibroblastic migration and vascular proliferation into the wound is from the papillary dermis above and from the subcutaneous tissue below. Thus at first, the collagen laid down is vertical, but as the wound tension increases, the collagen becomes more horizontal. Mucopolysaccharides are also synthesized and secreted by fibroblasts. The wound is filled with granulation tissue and new collagen, which has poor tensile strength because the fibers lack orientation and extensive linkage. Therefore this phase represents a quantitative phase of collagen production. The duration of this phase is variable, lasting from 4 days to 2 weeks after creation. During the time after the scab is shed (usually 1 to 2 weeks), the surface of the wound appears as a depressed furrow. This gradually becomes level at about 3 weeks.

Early maturation phase:

During the early maturation phase, which lasts from 2 weeks to 3 months, the collagen is remodeled along the lines of tension. There is also a gradual gain in tensile strength of wounds as more cross-linking occurs and covalent bonds are formed between collagen fibrils. The number of cells in the wound decreases.

Late maturation phase:

All scars go through changes that continue for the lifetime of the individual. The vascular network of the scar decreases over 6 months to a year, and the redness of the scar gradually fades. With time the scar becomes white. Collagen is also continuously synthesized and broken down. If the scar is at first hypertrophic, it may flatten out on its own as breakdown becomes greater than synthesis of collagen. Other, less appreciated facts about this late maturation phase are the late appearance of elastic fibers (at about 2 months) and the ingrowth of nerve fibers. Regardless of all the remodeling that occurs, the collagen of a wound always appears abnormal and never looks exactly like unwounded tissue.

Every surgeon who has attempted to suture a wound in the abdomen of straining patient, knows that the strength of abdominal wall is chiefly vested in its aponeurotic layers. The case with which muscle and peritoneum tear off more when a very light strain is placed on them, is quite familiar and it is an annoying experience. Skin has no role in maintaining the integrity of abdominal wall. It is readily stretched. Once a gap in the aponeurotic layer has developed, it forms no bar to the progressive enlargement of a hernia. In most of the wounds, the aponeurosis showed measurable tensile strength by 8th day and rapid increase until the end of 2 months. Then the curve of healing begins to flatten out. Subsequently a slow increase of tensile strength was detectable which may continue for longer than one year. Only rarely did the tensile strength of wound reached that of control tissue. At the end of 2 weeks, the values were about 20% normal, at the end of one month 50%, 2 months 60%, and one year up to 90%. Occasionally some wounds showed the tensile strength greater than that of control tissue.

From the above thing, it is seen that aponeurosis seems to unite much more slowly than the skin. Skin is said to achieve maximal strength in 14-21 days. A consideration of histology and function of the two tissues make this quite understandable. Skin is composed of rapidly growing epithelium of dermis. The rich blood supply of which serves largely to control body temperature. Hence, it is admirably accomplished with rapid healing. Indeed the survival of organism depends in a considerable measure on its ability to quickly repair many small defects in the skin. When this facility is lost as in ischaemia of extremities, chronic ulcers develop. Aponeurosis on the other hand is one of the most avascular tissue in the body. Its function is to give attachment to muscle, and in the abdomen to give strong support to the viscera. Under normal conditions it is not subjected to injury. It would not therefore be expected to be capable of rapid healing, and once damaged, it might have poor regeneration power.

In a large majority of instances, the wounds were weaker than the parent tissues even at one year. In other words infection of a wound in aponeurosis under the conditions of experiments, left a weakness which was in all probability a permanent one. This is substantiated by the fact that post operative herniation in obese patient, is almost always through wounds and seldom through intact parieties.

PERITONEAL HEALING: [21,24]

The most important fundamental principle in the healing of peritoneum is the rapid reconstruction of the surface, following removal of injury. Regardless of the size of the defect, a mesothelial surface indistinguishable physically from that of normal peritoneum occurs within 3-5 days.

The mesothelial surface is restored rapidly in large or small defects, and covering the raw surface with polythene shield retards the restoration of continuity. This strongly suggests that desquamated or shed mesothelial cells from visceral or remaining parietal perotineum rain down upon denuded area and cover the defect. To some extent centripetal activity is also involved in the healing of the peritoneum. Stem cells in the base of the wound or defect also contribute to remesothelialisation process. Ascorbic acid depletion significantly retards the process, suggesting that fibroblasts may be actively involved. Some studies have also indicated that the macrophages are also involved in the healing process.

Wound contracture is not a problem in peritoneal healing and even large area heals rapidly provided that the mechanical interference is not present in normal healing process.

One of the certain way to interfere healing of peritoneum is by inserting foreign materials like sutures, drains, retained cotton from sponges, gauze. Sutures stimulate the formation of bands known to cause intraperitoneal adhesions.

Peritoneum regenerates denovo and not from cut edges of the defect. Hence, by not suturing an opened defect results in fewer adhesions than a closed one. Nevertheless attempts in reperitonising the defects as in cholecystectomy and in pelvis after antero-posterior resection leads to inevitable intraperitoneal adhesions.

FACTORS INFLUENCING WOUND HEALING:[1,19,20,23]

Adverse Factors:

General Factors	Local factors
Age	Tissue tension
Malnutrition	Hematoma formation
Vitamin deficiency	Necrotic tissue
Trace metal deficiency	Local infections
Anaemia	Foreign body
Malignant disease	Poor blood supply due to vascular disease
Uraemia	Trauma
Jaundice	Faulty technique of wound closure
Diabetes	Recurrent trauma
General infections	Local irradiation
Cytotoxic drugs and steroids	

Tension:-Tension of the tissues inhibits local blood supply and leads to wound failure. Local swelling and subsequent tension build up during first 48 hours increase the tension. Hematoma and infection increase the tension.

Age:-

Protein turnover reduces with age which is reflected by slow rate of healing. With aging, collagen undergoes qualitative and quantitative changes and also, there is a decrease in response to hypoxia. Dermal collagen content decreases with aging and aging collagen fibers show distorted architecture and organization. Elderly patients are more likely to have surgical wound ruptures and delayed healing, compared with younger patients.

Infection:-

Probably the mot common cause of healing delays is wound infection. Bacteria prolong the inflammatory phase and interfere with epithelialization, contraction and collagen deposition. Once infection is established the fibroblasts must compete with bacteria and inflammatory cells for oxygen and nutrients. Thus overall collagen synthesis is inevitably reduced and collagen breakdown is enhanced by collagenolytic enzyme activity.

Malnutrition:

This is associated with defective synthesis of both collagen and ground substance. Severe protein calorie malnutrition has long been implicated in the failure of wounds to heal, while similar lesser degrees of malnutrition, delays healing. Albumin must be below 2.0g/dl to have an effect on wound healing. Vitamin C is necessary for synthesis of ground substance and maturation of collagen. Vitamin A is essential for epithelialisation. Calcium, manganese and other trace elements also play some role. Zinc is a necessary cofactor for RNA polymerase and DNA polymerase, deficiency results in early wound healing delay. Vitamin K deficiency limits the synthesis of prothrombin and factors VII, IX ad X.

Hypoxia:

Ischemia can be caused by atherosclerosis, cardiac failure, or simple wound tension preventing localized perfusion. Molecular oxygen is critical for the post-translational hydroxylation of prolyl and lysyl residues required for triple-helix formation and cross-linking of collagen fibrils.

Uraemia:

Urea prevents growth of fibroblasts. Hence, uraemia is implicated in the retardation of wound healing in patients.

Jaundice:

It is associated with reduction in wound strength. Appearance of fibroblasts and formation of new blood vessels are both delayed. Biopsies of skin in jaundiced patients show a reduction of enzyme prolylhydroxylase involved in collagen maturation.

Steroids:

Inflammatory response is essential for healing to proceed normally, steroids depress wound healing by their anti-inflammatory action. New vessels formed are abnormal and sparse, as are fibroblasts. So if steroids are given after the inflammatory phase of wound healing, there is little overall effect on healing.

Radiation and Cytotoxic Drugs:

These causes cell death by both damaging DNA and disruption of intracellular metabolism. Most cytotoxic drugs show their greatest effect on mitotic cells. Local application also prevents healing.

Malignancy:

This has associated cachexia and is associated with delayed wound healing.

Diabetes:

Diabetes mellitus impairs wound healing. The diabetic patient with associated neuropathy and atherosclerosis is prone to tissue ischemia, repetitive trauma, and infection. Lymphocyte and leukocyte function is impaired, and there is increased collagen degradation and decreased collagen deposition.

CAUSES OF ACUTE WOUND FAILURE:

We, as surgeons, must be more heroic as the tragedy is much our fault.

- J.W. Kennedy, 1934. [1]

This is perhaps a universal experience of one who performs laparotomy and seems to illustrate the most common cause of wound disruption. The causes of acute wound failure may be reduced to four: a suture break, a slipped knot, a loose or an excessive stitch interval which allows protrusion of viscera, or suture tearing through the fascia. The last is the most common cause of wound dehiscence.

One might ascribe the cause of suture tearing through tissue to inadequate tissue strength, which implies that patient-related factors are responsible. This may be the explanation in some burst abdomens, as a number of patient risk factors have been elaborated that may compromise the closure. It has been observed in animals and cadavers, however, that greater tissue strength is obtained by taking a wider bite of fascia. All of these data, in light of the most common cause of dehiscence (tissue tearing), suggest that the predominant cause of acute wound failure is an inadequate tissue bite with the suture needle.

RISK FACTORS:

Opening the Abdomen:

Incision Type:

It has been suspected from retrospective data that the rate of dehiscence in midline incisions is higher than in transverse incisions. The explanation for this belief is that the midline incision is “non-anatomic”; that is, it cuts across the aponeurotic fibers, as opposed to the transverse incision, which cuts parallel to the fibers. Contraction of the abdominal wall muscles tends to pull the midline incision apart but brings the edges of the transverse incision together. Furthermore, it is thought that sutures in a midline incision tear out more easily than in a transverse wound because ripping in the former occurs parallel to the fibers.

The belief that transverse incisions suffer less dehiscence has not been substantiated by recent reviews and the available prospective controlled trials. The purporated advantage of the lateral paramedian incision is a buttress effect of the rectus muscle, which is claimed to make the incision inherently strong. No one as of yet has reported duplication of the above results with the lateral paramedian incision. It is not clear whether general surgeons should convert to this incision.

Incision Location:

An incision located in the upper abdomen has been thought to have a higher risk of disruption than an equivalent incision in the lower abdomen.

Incision Opening:

Vertical incisions made with the coagulation current of an electrocautery device had wound strength reduced by one third compared with incisions that were opened with a scalpel. A coagulation current is short bursts of electrical energy that allow the contacted and surrounding tissues to heat, dehydrate, and denature. Published clinical correlation to suggest that coagulation current predisposes to dehiscence is lacking, but it seems wise to avoid this current type when cutting the fascia.

Size of Tissue Bite and Suture Length-to-Wound Length Ratio:

The most important intervention the surgeon can make to prevent tissue tearing and wound dehiscence is to perform running mass closure with wide bites of fascia (2cm or more) and a short stitch interval (1 cm or less) so that the SL:WL ratio is well above 4 : 1.

Tension on the Suture:

The tissue strength gained with wide bites may be negated if the suture is pulled too tight. Suture tension that raises the interstitial pressure in the center of the incision above capillary pressure (30 to 40 mm Hg, but variable) may cause necrosis. Tight sutures also cut through fresh cadaver fascia at a wider distraction force than do loose sutures. Ideal suture tension should approximate the fascia yet allow perfusion of healing tissue.

Suture:

The use of catgut for fascial closure has been condemned because of associated dehiscence rates of 10% to 12%. Catgut usually is found dissolved during repair of fascial dehiscence in which catgut was the original closure material, a phenomenon not observed with other sutures.

The slowly absorbed monofilaments (polydioxanone and polyglyconate) are the strongest sutures in the fresh state, followed by the nonabsorbabl monofilaments (nylon and polypropylene), and then the braided sutures (polyglactin, polyglycolic acid, polyester) and gut. Silk, the weakest of the commonly used sutures, has about 15% of the strength of polydioxanone and has been associated with a 7.4% dehiscence rate.

A small controversy surrounding suture choice involves absorbable versus nonabsorbable suture. Randomized trials have not found a difference in dehiscence rates between absorbable and non-absorbable sutures. It may be wise, however, to use a absorbable monofilament in the patient who has an excessive number of risk factors for delayed healing as the wound infection rates will become less.

Peritoneal Closure:

Wound disruption was thought to originate from a peritoneal defect through which omentum and bowel insinuated itself; therefore, emphasis was placed on peritoneal closure. It has been demonstrated, however, that peritoneal defects heal by simultaneous regeneration of the layer over the entire defect, not in incremental advancement from the wound edge, as is seen with skin. Randomized trials comparing one-layer closure (peritoneum not sutured) with two-layer closure (peritoneum closed) in paramedian and midline incisions and found no difference in the wound disruption rate. Suturing the peritoneum is not vital to prevent wound dehiscence.

Mass Versus Layered Closure:

Closure of the abdominal wall in layers has been the traditional approach. Some non-randomized data have been published, however, that suggest that mass closure (all layers taken together) is equivalent to or better than layered closure in preventing dehiscence. Mass closure appears to be favored currently because of its safety, efficacy, and speed.

Interrupted Versus Running Closure:

Running closure was found to have a smaller (but not significant) burst abdomen rate than interrupted closure (1.6% versus 2.0%) in a multicenter randomized trial of 3135 midline incisions closed with polyglycolic acid.

Smaller randomized trials comparing running with interrupted closure also reveal no difference in the incidence of wound disruption. Running suture is a reasonable closure technique because of its safety, efficacy, and speed.

Knot Security:

Tied suture loops break at the knot 95% of the time when subjected to stress testing. Most knots lose some strength after 7 days in vivo. Generally speaking, the more throws, the more secure the knot; double throws are more secure than single throws; and square knots are more secure than non-square knots.

Retention Sutures:

The controlled and uncontrolled data regarding prophylactic placement of retention sutures conflict. Routine placement of retention sutures currently is not commonly done and is not recommended. It is difficult to know if prophylactic retention placement in the occasional high-risk patient would produce a more secure wound than running a mass closure with wide bites (2 to 3 cm).

Male Sex:

Most reviews of wound disruption report male sex as a risk factor on the basis that among patients men outnumber women by at least 2 for 1.

Age:

Advanced age (defined variably as over 50 to 65) has been proposed as a risk factor for dehiscence because the incidence in the “aged” is higher than in the “young”. The complicating issue in patients is that “advanced age” often is accompanied by medical problems that also may affect healing, so it is difficult to discern the importance of advanced age as a risk factor for dehiscence.

Emergency Operation:

Emergency operation is a risk factor for dehiscence in some case control studies. The risk for dehiscence from emergency operation may be related more to hemodynamic instability than to the unscheduled procedure.

Obesity:

Most studies that evaluate obesity as a risk factor for burst abdomen report no association. One recent case control study, however, did report obesity (defined as greater than 50% above ideal body weight) as a risk factor.

Diabetes:

Prior to the availability of insulin, incisions in insulin-deficient diabetics failed at a rate of 25%, usually secondary to wound sepsis. The introduction of insulin improved operative results. Clean wound infection rate, however, was still higher in diabetic patients (10.7%) than in the general patient population (1.8%). It is unclear whether the increased infection risk of diabetics places them at a higher risk for burst abdomen.

The clinical consensus, however, appears to be that well-controlled diabetes is not a risk factor for fascial dehiscence.

Renal Failure:

Anecdotal experience suggests that acute renal failure predisposes to wound dehiscence. The presence of an elevated risk for burst abdomen attributable to uremia in the well-compensated chronic renal failure patient is speculative. Hyperalimentation properly adjusted for the renal failure patient may counter the putative defect of healing associated with uremia.

Jaundice:

It is unclear whether the defect in wound healing associated with jaundice is secondary to hyperbilirubinemia, malnutrition associated with chronic biliary obstruction, both, or some other factor(s).

Bilirubin or retained bile has inhibitory effect on fibroplasia and angiogenesis. Hence, wound healing is delayed in jaundiced patients.

Anemia:

Hypovolumeia and shock, but not acute anemia alone, reduce wound strength. Chronic anemia secondary to iron deficiency may result in decreased wound strength, but the data are conflicting.

Low hemoglobin has been found to be a risk factor in some case control studies, but not in others. The animal data suggest that iron deficiency anemia, anemia associated with severe malnutrition, and hemorrhagic anemia with shock may predispose a patient to wound dehiscence.

Malnutrition:

Protein Deficiency:-

Low serum albumin often is associated with dehiscence, and, as a marker of malnutrition, hypoalbuminemia probably represents a real risk factor. The recommended dietary allowance for protein in normal adult men and women is about 1 gm/kg/day; this value should be increased to 1.5 to 2.0gm/kg/day with severe sepsis and burns.

Vitamin C Deficiency:

Subclinical vitamin C deficiency has been assumed to impair healing and predispose to wound failure. Vitamin C is critical for strength gain in healing wounds.

Routine vitamin C supplementation seems reasonable in malnourished (if not all) surgical patients. The recommended dosage is controversial but ranges from 30 to 75 mg/day.

Zinc Deficiency:

Zinc is required by more than 300 enzymes, many of which are vital to both would healing and life itself. A healing human wound sequesters zinc; a known complication of zinc deficiency is impaired wound healing. Zinc deficiency is uncommon but may be seen with burn injury, alcoholism, gastrointestinal fistula, and zinc-deficient parenteral nutrition. The recommended allowance of zinc is 12 to 15 mg/day.

Other Preoperative Diagnosis:

Operations for malignancy and operations on the stomach have been variably noted as risk factors for dehiscence. These conditions more appropriately would be called associations because no specific aspect of them has been shown to cause fascial disruption.

Postoperative Evaluation of Intra-abdominal Pressure:

Increased intra-abdominal pressure secondary to coughing, vomiting, or abdominal distention is frequently cited in retrospective reviews as an instigator, if not the source, of dehiscence. A properly sutured incision should withstand the intra-abdominal pressure generated postoperatively.

Wound Infection:

Wound infection also is a frequently cited risk for dehiscence. Infection certainly may be blamed for a dehiscence in which the fascia has disintegrated from a necrotizing infection, but this is an uncommon scenario. Dehiscence often occurs before wound infection becomes established, so the role of infection is not clear.

Corticosteroids:

Glucocorticoids are known to adversely affect healing, due to their anti-inflammatory action. Cortisone administration also prevents disrupted and resutured wounds from rapidly regaining tensile strength. The effect of cortisone on skin wound strength is negated if vitamin A is given concurrently. The recommended dose of vitamin A is about 1 mg/day.

Antineoplastic Agents:

A variety of cytotoxic drugs administered to wounded animals delays gain in wound tensile strength. It has been customary to delay administration of an antineoplastic agent in a postoperative cancer patient until the acute healing phase is over (usually 2 to 3 weeks) because of concern that the drug may have an adverse effect on wound healing.

Radiation Therapy:

Skin wounds in animals that receive a radiation dose of 18 Gy within 2 days after wounding have 50% of the strength of control incisions at 7 and 14 days. The effect of radiation on experimental healing when it is administered 1 week or more after wounding is equivocal and probably negligible. Although the data are incomplete, perioperative regional radiation therapy probably does not affect fascial healing if given 2 weeks or more before or after the operation.

TREATMENT OF WOUND DEHISCENCE:

Non-operative Treatment:

Non-operative treatment of dehiscence, or "tamponade", is performed with bedside gauze packing and binder application to the disrupted abdominal wound. The wound subsequently may contract to closure; or, if the patient's condition improves, delayed operative closure may be performed. Hernia is a common sequelae to this treatment.

Operative Treatment:

Retention Sutures:-

The prevalent technique for repairing fascial dehiscence is immediate resuture with placement of retention sutures (also known as stay or tension sutures). Retention sutures may be placed by a number of techniques, but the basic principles include heavy non-absorbable suture material, usually monofilament; wide interrupted bites (3 cm or more from the wound edge), either external (peritoneum through skin) or internal (all layers except skin); a stitch interval of 3cm or less; a buttress device to prevent suture erosion into the skin; and suture removal (if external) after 3 weeks or more.

Repair with Prosthetic Materials:

Closure of an abdominal wound in which an acute loss of abdominal wall has occurred can result in dehiscence in greater than 50% of cases. Non-elective mesh closure of an abdominal incision is usually indicated in cases of abdominal wall destruction and/or massive visceral edema in which primary closure would result in enough tension to make tissue tearing inevitable.

Emergency reconstruction of the abdominal wall with mesh may salvage an otherwise unmanageable closure, but subsequent complications of fecal fistula, mesh extrusion, and hernia have a combined incidence of about 50%.

The use of polytetrafluoroethylene (PTFE) in an animal model of abdominal wall reconstruction in the presence of contamination and peritonitis was associated with less bacterial adherence and fewer adhesions than the use of polypropylene mesh.

Absorbable mesh may also be used for closure of a difficult abdomen; this usually commits the patient to an elective ventral hernia repair later on. Recurrent dehiscence does not seem to be a problem with the use of absorbable mesh. Enterocutaneous fistula still occurs, perhaps with less frequency than with polypropylene mesh. Fistula associated with absorbable mesh may be easier to manage than fistula associated with non-absorbable mesh.

SEQUELAE:

Mortality:

The average mortality rate from recent reviews is 25%. The dehiscence-associated morality rate does not appear to be declining. Cardiorespiratory failure is the most common cause of death; peritonitis is the second most common cause. Advanced age (not quantified), female sex, and postdisruption mechanical ventilation were risk factors for death after dehiscence occurred.

Other Postoperative Complications:

Other surgical complications after wound disruption repair that have been described in a large series include wound infection (14%), fistula (6%) and intra-abdominal abscess (4%).

HISTORICAL REVIEW ON ABDOMINAL CLOSURES:

Abdominal surgery has progressed to a great extent over the period of years. Clinical experiments in laboratories, Lelpedin evaluating the suture materials and techniques in surgery, rather than mere hypothetical basis, and even theoretical evaluation based on mathematical understanding helped a lot in the evaluation of suture materials and surgical techniques.

Reports on the use of mass closure technique of laparotomy wounds have periodically appeared in surgical literature for the last 50 years.

A study reported burst abdomen rate of 11% when incisions were sutured with two layers of catgut, and 7% when sutured with catgut for peritoneum and interrupted steel wire for the anterior rectus sheath. However, only one burst abdomen occurred in 81 operations after steel-wire closure with interrupted mass far-and-near sutures incorporating all layers of the abdominal wall apart from skin. This technique is often referred as Smead-Jones method.[24]

Theoretical arguments have been supporting the value of a closure employing non-absorbable sutures that include all layers of the abdominal wall, apart from skin, and that also incorporate wide bites of tissue on either side of the line of incision.[24]

In a study it was observed that wound may lengthen by 30% if distension occurs. An adequate reserve of suture length in the wound is necessary to allow this lengthening to occur and to ensure a minimal resulting rise in tension between the sutures and the tissues. Deep wound disruption is associated with the use of an SL : WL ratio of 2 : 1 or less—the lower the ratio, the greater is the risk of a burst wound. Wound disruption because of cutting out of sutures can be prevented by the use of non-absorbable continuous sutures at 1 cm intervals and an SL: WL ratio of 4: 1 or more.[4]

It has been shown that the size of the bite and the diameter of the suture material bear an inverse relationship to the disruption of forces at the suture-tissue interface. Thus large bites with thick sutures should have less tendency to cut out than small bites with thin sutures.[3]

In an interesting study, it was opined that separate suture of peritoneum should be abandoned in closure of midline laparotomy incisions. Healing of peritoneal defects is different from the healing of epithelial surfaces; large peritoneal defects heal by differentiation of underlying connective tissue cells which become flattened mesothelial cells within a few days of production of defect. The single layer closure carried out was quicker, less costly and safer and healed better than those, where peritoneal suturing was carried out. Thus separate suturing of peritoneum should be abandoned.[22]

In a study conducted to evaluate factors influencing wound dehiscence it was observed that most important cause of wound dehiscence was bites cutting through tissues. Local wound infection was most important independent variable. Chronic lung disease, post-operative pulmonary complication, abdominal distension are important systemic factors.[23]

Medline and Embase databases were searched. All trials with a follow-up of at least 1 year that randomized patients with midline laparotomies to closure of the fascia by different suture techniques and/or suture materials were subjected to meta-analysis. To reduce the incidence of abdominal wound dehiscence without increasing wound pain or suture sinus frequency, slowly absorbable continuous sutures appear to be the optimal method of fascial closure[24]

A recent meta-analysis pooled data from randomized controlled studies primarily comparing absorbable to nonabsorbable sutures but there was no significant difference in infection or dehiscence rates .Continuous mass closure with absorbable monofilament suture material is the closure technique of choice. [25]

A new interrupted X technique was developed to circumvent the problem of cutting out effect of a continuous sutures .It was observed that acute wound dehiscence can be reduced in emergency setting using interrupted X sutures .[38]

A new suture material “Polydiaxanone II (PDS II)” was developed to circumvent the problem of wound infection and burst abdomen. It was observed revised version of Polydiaxanone i.e Polydiaxanone II (PDS II) which is loop suture material in nature has decreased the rates of acute wound dehiscence even in emergency setting. Continuous closure gives satisfactory results in elective and emergency settings.[26]

METHODOLOGY

The present study was carried out at K.L.E.S's Dr.Prabhakar. Kore Hospital and M.R.C., Belgaum, where 60 patients underwent both elective and emergency laparotomies through midline vertical incisions. Equal number of cases (30) were studied for closure with these two suture materials; Polydiaxanone (PDS II) and Polypropylene (Prolene) suture material. Patients were randomized to either procedure according to computer generated randomized list.

Inclusion Criteria:

All patients undergoing laparotomy requiring vertical midline abdominal incisions which includes clean, clean contaminated, contaminated cases.

Exclusion Criteria:

Patients who had undergone previous midline abdominal surgery for any condition (or had an incisional hernia or burst abdomen at presentation).

History:

A detailed history and clinical examination done as per the proforma attached (Annexure 1).

Investigations:

Following investigations were done in almost all cases:-

1) Hb, TC, DC, ESR
2) Urine Routine, bile salts and pigments in jaundiced patients
3) Blood sugar, urea, blood grouping
4) Chest x-ray, abdominal x-ray wherever indicated.

5) Ultrasonography wherever indicated
6) Gastroscopy, Ba-meal studies wherever indicated
7) Serum protein profiles in some cases
8) Serum bilirubin, HBs Ag and HIV wherever indicated.

Pre-operative preparation of the abdomen in the ward:

Routinely shaving of the abdomen from nipple to knee, washing with soap and water and cleaning with spirit in some cases, no other special measures were taken for the preparation of the part.

In operation theatre:

Part was prepared by 1% Povidone-Iodine (Betadine) 5% w/v and then cleaning with spirit, then the part was draped with sterile towels. Drains when used were inserted by separate stab wounds away from the main incision.

The cases were either elective or emergency laprotomy cases. The mode of anaesthesia was general anesthesia in majority of cases and epidural or spinal in few cases.

Closure of the abdominal incisions:

Group 'A' Polydiaxanone (PDS II)**:**

An Interrupted X sutures were Performed using No.1 Polydiaxanone (PDS II) suture. All layers of abdominal wall except skin and subcutaneous tissue were included in single layer .A bite was taken outside in 2 cm from cut edge of linea alba. The needle emerged on other side from inside out diagonally 2 cm from edge and 4 cm above or below first bite. This strand was crossed or looped around free end of suture and continued outside-in diagonally at 90^0 to first diagonal. A bite is taken inside out and the end is tied with free end of suture just tight enough to approximate linea alba. This creates two 'X' like crosses one on surface and another deep to linea alba. Next X suture is placed 1cm away from previous one.

POLYDIAXANONE II (PDS II)

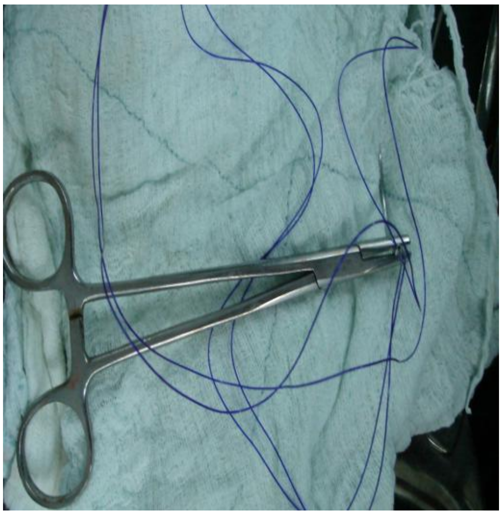


Fig.6a**:** PDS II suture material (Loop)

Fig.6b Bite is taken outside in 2cm from cut edge of linea alba

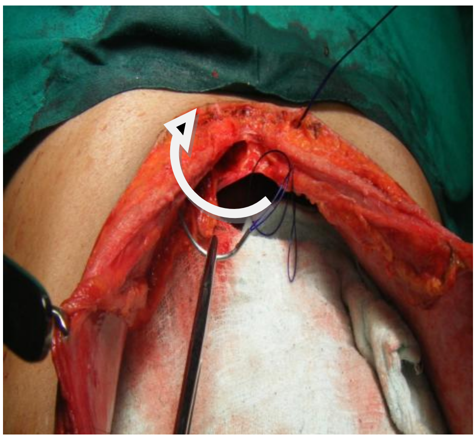


Fig.6c: Needle emerged on other side from inside out diagonally 2cm from the edge and 4cm below first bite the sutur

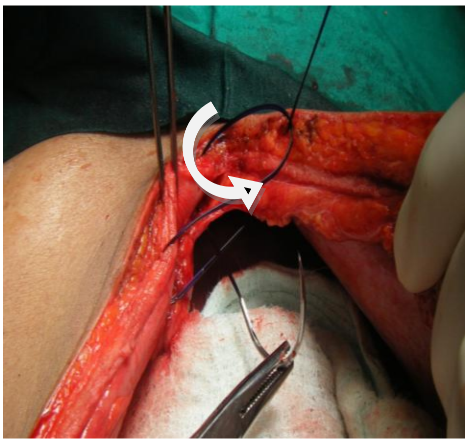


Fig 6d: 3rd bite is taken outside in diagonally at 90^0 to the first diagonal after looping it around the free end of

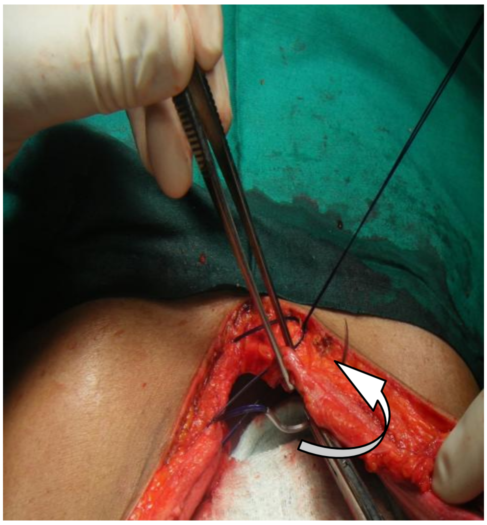


Fig 6d; Bite is taken 2 cm from cut edge
Of linea alba on the opposite side

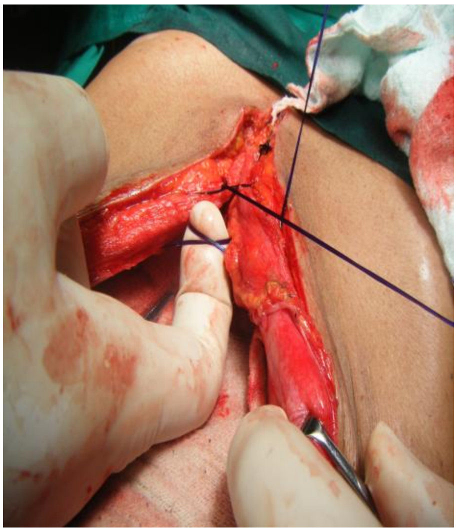


Fig 6e: Free ends are tied which creates
two X like crosses.

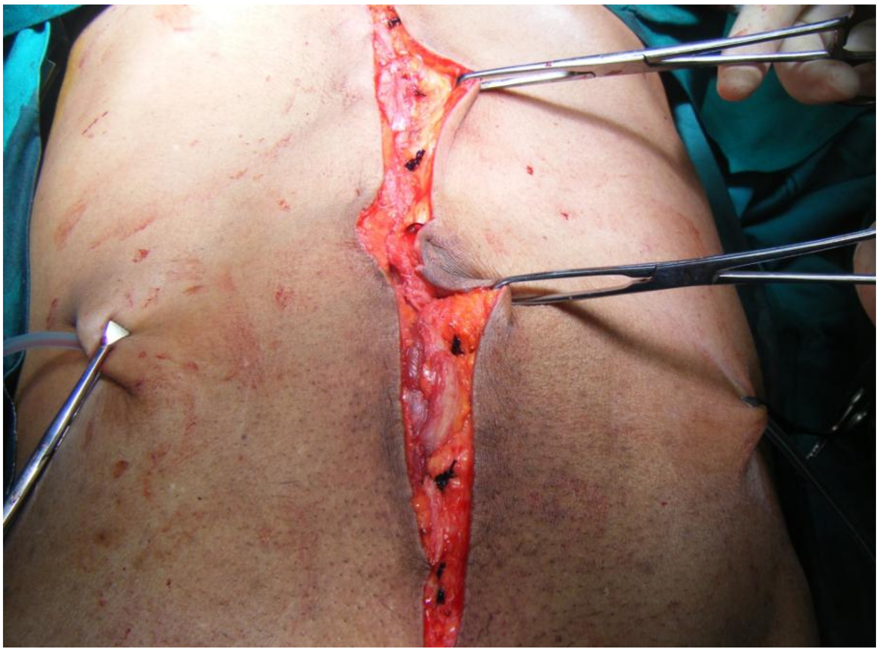


Fig 6f:Midline incision closed with interrupted X sututes

Group 'B' Polypropylene (Prolene)**:**

Similar interrupted X sutures were performed using No.1 Polypropylene (prolene) suture

Suture Technique:

Interrupted X suture mass closure technique was used for fascial closure in both the groups.

In both the groups, skin was sutured with subcuticular sutures with no.3-0 Ethilon. Sterile dressings were placed after completion of closure.

Post operatively all patients received IV fluids and antibiotics as required. Blood transfusions were done wherever indicated.

Postoperatively, the laparotomy suture line were checked after 48 hours and assessed for any early wound complications. Thereafter the wound was examined on 5^{th}, 7^{th} and 9^{th} post operative days.

Objectives:

Various parameters were assessed during the course of healing of the suture line like,

- Burst abdomen partial/ total
- Wound infections
- Stitch sinus/ abscess formation

All cases were followed up for a period of 6 weeks after surgery. Patients were called for their first visit after one month and then after 6 weeks postoperatively.

Abdominal wound dehiscence -

1) Partial dehiscence: When one or more layers have separated but either the skin or peritoneum remains intact.

2) Complete dehiscence: This was considered present, when intestine, omentum or other viscera were seen in abdominal wound.

Wound infection - Infection occurred within 30 days after the procedure and involved at least one of the following

1) Purulent discharge, with or without laboratory confirmation, from the incision.

2) Organisms isolated from an aseptically obtained culture of fluid or tissue from the incision.

Suture sinus was defined as presence of blind ending tract leading from skin into surrounding tissue with presence of suture material in it.

The skin sutures were removed on 9-11 days post-operatively in majority of cases, in cases where secondary suturing was done patients were called on outpatient basis for removal of sutures. All patients were discharged with a discharge card, narrative summary and advice regarding regular follow up. The record of all patients was kept as per the proforma attached (Annexure 1).

Statistical Analysis:

1. Incidence/ Risk of Burst: The risk (Cumulative incidence) of burst was calculated as number of burst abdomen patients in a group/ total number of patients in that group.
2. Relative Risk of Burst (RR): The relative risk (RR) of burst abdomen was calculated by the risk of burst in interrupted method group/ risk of burst in continuous suturing group.

Similarly incidence and relative risk for wound infection and sinus formation was calculated. The results are analyzed using Fisher exact test & chi-square test.

RESULTS

The following are the observations of the study represented in tabular form and graphs.

A total of 60 patients satisfying the selection criteria were included in the study, which was carried out at K.L.E.S's Dr Prabakar Kore Hospital & M.R.C., Belgaum.

Age:

In this series of 60 patients, PDS groups mean age was 45.7+/- 15.56(mean +/-SD) and in PPL group mean age was 43.4+/-18.82 Statistical analysis shows no significant difference in distribution of age between two groups.

Sex:

In this series of 60 patients, 38 were male and 22 were female. In the PDS II group 17 were male and 13 were female. In PPL group 21 were male and 9 were female. Statistical analysis shows no significant difference in distribution of sex between two groups (chi-square test=1.148, with p=0.284) which is shown in table 2.

Table No.1: Sex Distribution of Cases

Sex	Male	Female	Total
PDS II	17	13	**30**
PPL	21	9	**30**
Total	**38**	**22**	**60**

Emergency/ Elective Operations:

16 patients underwent elective surgery and 14 patients emergency surgery in the PDSII suture group. 14 patients underwent elective surgery and 16 patients emergency

surgery in the PPL group. Overall 50% of cases underwent elective laparotomy and 50% underwent emergency laparotomy as shown in table 3.

Table No.2: Distribution of Cases According to Nature of Operation and Closure Technique

Nature of Operation	Closure Technique		Total	%
	PPL	PDSII		
Elective	14	16	30	50.00
Emergency	16	14	30	50.00
Total	30	30	60	100.00

Burst abdomen:

In Polydiaxanone (PDSII) group there was no case of burst abdomen. In Polypropylene (PPL) group 1 patients developed burst abdomen which done on emergency basis. Incidence of burst abdomen was 3.3% in PPL group and 0 in PDS II group. When only emergency cases were considered the incidence was 6.2% in PPL group. Statistical analysis shows no significant difference in the incidence of burst abdomen between the two groups (Fisher exact test, p-value =1.0). Relative risk could not be calculated due to ZERO value in one arm.

Table No.3: Incidence of Burst Abdomen in Relation to suture material

Type of Closure	BA absent	BA present	Total
PDSII	30	0	30
PPL	29	1	30
Total	59	1	60

Wound infection in relation to nature of operation:

In the PDSII group there were 14 emergency cases out of which 3 got infected and 16 elective cases out of which none got infected (0%). In 30 cases of Polydiaxanone, the overall incidence of wound infection was 10%. The incidence was higher in emergency cases (21%) compared to elective cases (0%).

Table No.4A: Wound Infection in relation to suture material and nature of operation in Polydiaxanone II

Type of operation	No. of cases	Infected cases	%
Emergency	14	3	21.00
Elective	16	0	0.00
Total	30	3	10

In the Polypropylene, 16 were emergency cases out of which 4 got infected (25%) and 14 were elective cases out of which 1 got infected (7.1%). In 30 cases of Polypropylene (PPL) overall infection rate was 16.6%. The incidence was higher in emergency laparotomy cases compared to elective cases.

Table No.4B: Wound Infection in relation to suture material and nature of operation in Polypropylene (PPL)

Type of operation	No. of cases	Infected cases	%
Emergency	16	4	25
Elective	14	1	7.1
Total	30	5	16.6

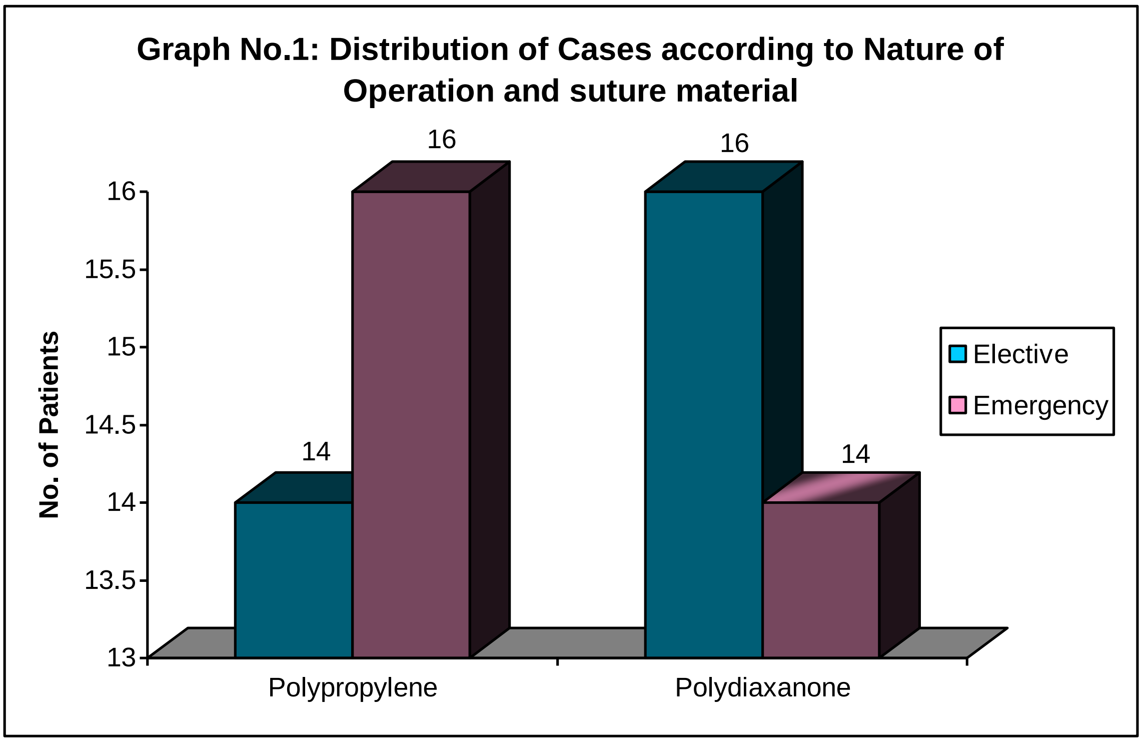
From the tables 5A and 5B it is seen that there was higher incidence of wound infection in emergency cases and amongst Polypropylene (PPL) and Polydiaxanone II(PDS), incidence of wound infection was higher in Polypropylene (PPL). However, there is no statistical significance in the incidence of wound infection between the two closure techniques (p=0.704, chi-square with tate's correction=0.144). Relative risk of wound infection was 0.6O.

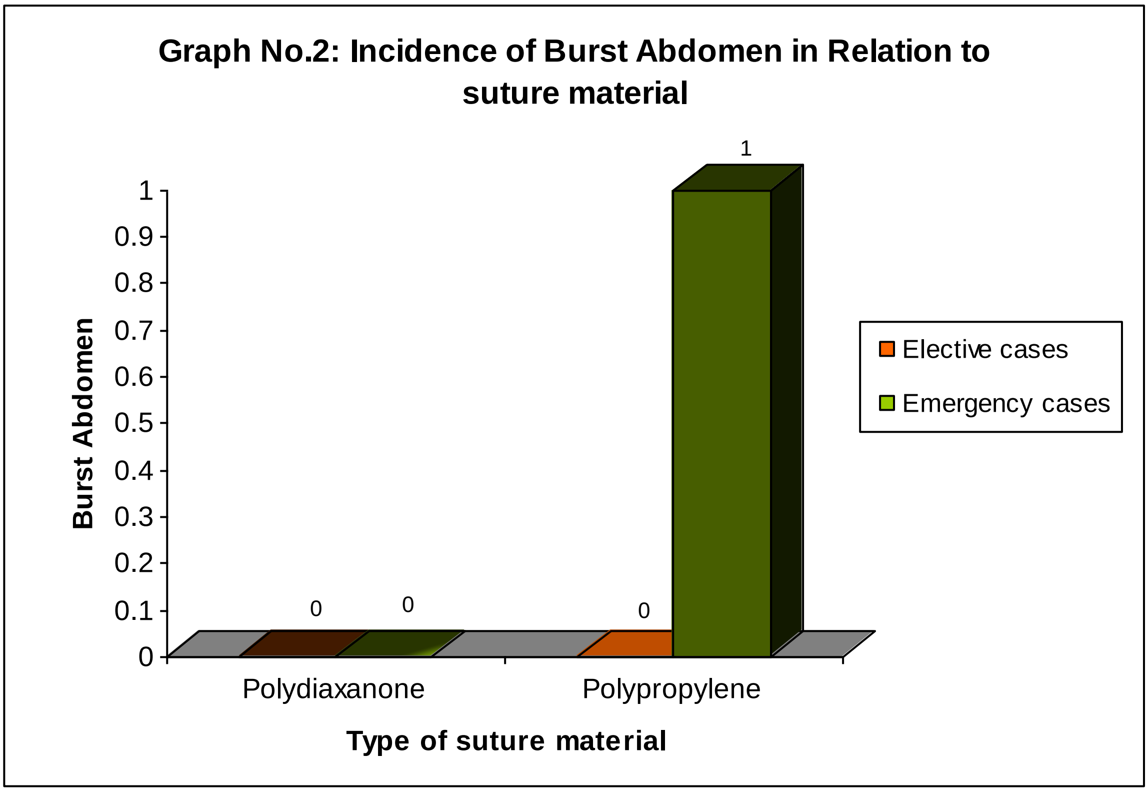
Suture Sinus:

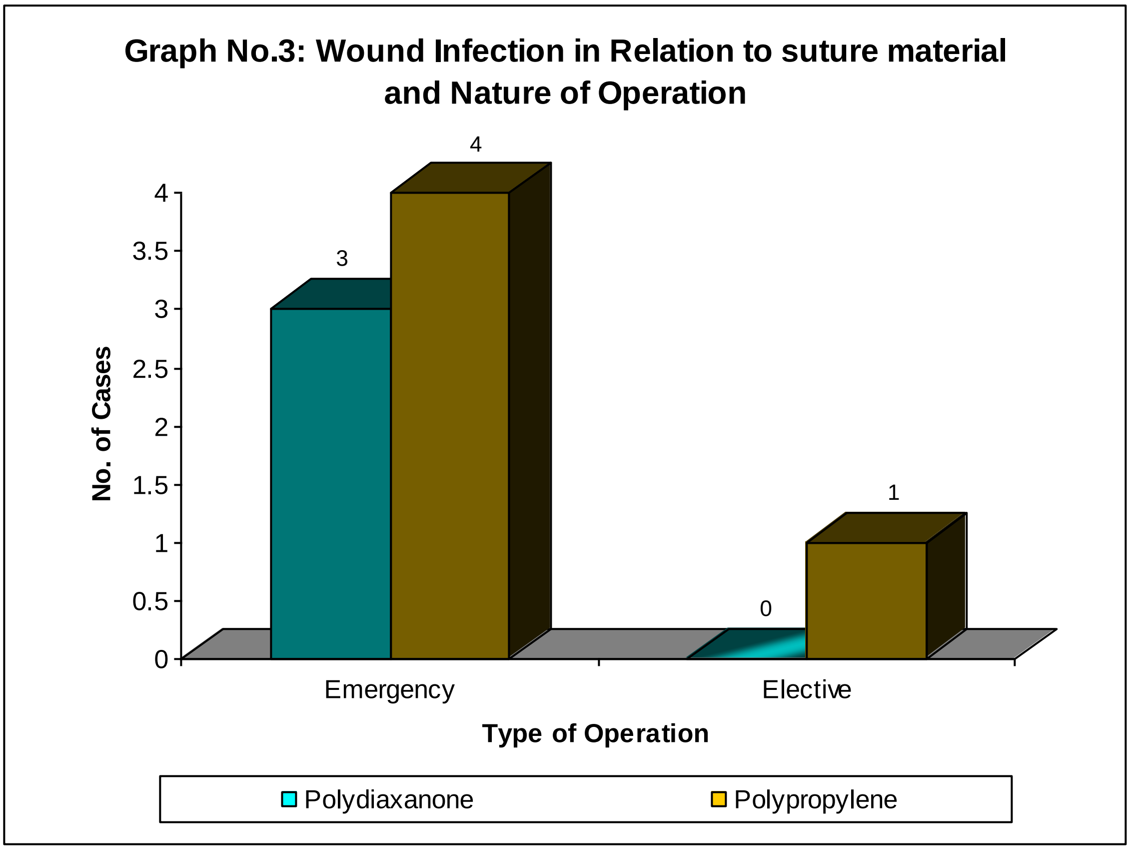
The incidence of suture sinus was as follows. In Polydiaxanone II group out of 30 cases, one developed suture sinus (3.3%) .In Polypropylene (PPL), 3 patients developed suture sinus (10.0%). Fisherexact t test was used. There is no statistical significance in the incidence of suture sinus between two groups as the p value < 0.612.

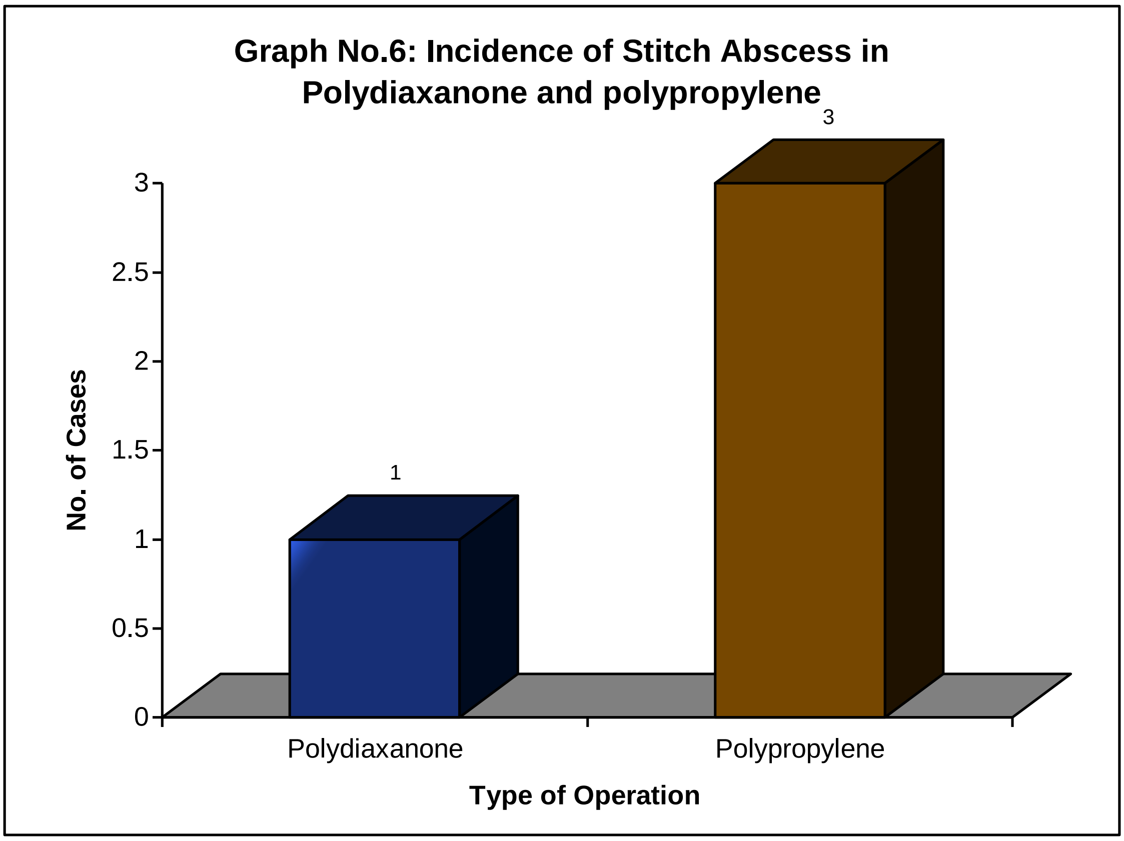
Table No.5: Incidence of stitch abscess in Polydiaxanone II and Polypropylene (PPL)

Type of closure	SS absent	SS present	%
Polydiaxanone II	29	1	30
Polypropylene (PPL)	27	3	30
Total	56	4	60


Graph No.1: Distribution of Cases according to Nature of Operation and suture material
No. of Patients
16
15.5
15
14.5
14
13.5
13
14
16
16
14
Polypropylene
Polydiaxanone
Elective
Emergency


Graph No.2: Incidence of Burst Abdomen in Relation to suture material
Burst Abdomen
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0
0
1
Polydiaxanone
Polypropylene
Type of suture material
Elective cases
Emergency cases


Graph No.3: Wound Infection in Relation to suture material and Nature of Operation
No. of Cases
0
0.5
1
1.5
2
2.5
3
3.5
4
3
4
0
1
Emergency
Elective
Type of Operation
Polydiaxanone
Polypropylene


Graph No.6: Incidence of Stitch Abscess in Polydiaxanone and polypropylene
No. of Cases
0
0.5
1
1.5
2
2.5
3
1
3
Polydiaxanone
Polypropylene
Type of Operation

DISCUSSION

Lord Moynnihan has said “Never judge a surgeon unless you have seen him close the wound”.

“I dressed the wound and God healed them” is the famous saying of Ambrose Parre (1510-1590) it could mean, “I suture the wounds and God heals them”. It is every surgeons desire that after suturing the wound, it should heal without any complications.

Majority of the operations performed by a general surgeon take place on the abdomen and consequently the incision and suturing of abdominal parieties is one of the commonest exercises in operative surgery. A considerable number of different suturing techniques exist for closure of the abdomen and each has its pros and cons.

Most surgeons believe that closing the abdominal wound in layers was most sacrosanct, since the layered closure brings about opposition and exact anatomical layers together once the abdomen was closed. It is now fully realised, both from clinical observation and laboratory animal studies that healing of the incision take place by formation of dense fibrous block of tissues however meticulously closed. This fact is quite evident when the abdomen is opened from the previous scar, it is not possible to identify separately the anatomical layers as closed in the previous surgery. Hence, the opposing faces of laparotomy wounds heal en-masse. Wide bites must be taken a minimum of 1 centimeter from wound edge and placed at 1 centimeter intervals. The suture length should measure at least 4 times the length of the wound.[1,4,24]

Proper healing of the abdominal incisions so as to restore the structural integrity and strength of the wound has always been the most important factor in surgeons mind.

Inspite of the modern surgical technology and skills the morbidity associated with abdominal wounds is high. There are many factors which delay wound healing such as systemic and local factors.[1,19,20] Systemic factors include obesity, jaundice, diabetes, malnutrition, protein deficiency, elderly patients, patients on steroids and immunosupressants. Local factors which delay wound healing after laparotomy are wound infection, hematoma, foreign body reaction. All these impose stress on the freshly sutured abdominal wound.

60 patients undergoing laparotomy were included in this study. 30 cases out of these were closed by Polydiaxanone (PDS II) suture material and 30 cases were closed by Polypropylene (PPL) so as to compare the two suture materials.

In both groups, the fascial closure technique used was interrupted X suteres. Polydiaxanone (PDS II) sutures are strong, delayed absorbable, retain their strength after implantation, are inert and cause minimal tissue reaction. The only disadvantage is their slipping quality in handling and in tying. This can be overcome by using minimum 5 knots and better handling technically during the closure.[27].

Wound complications:-

1. Burst abdomen
2. Wound infection
3. Suture sinus

1) Burst abdomen:

Burst abdomen is a grave and tragic complication that may follow any abdominal operation in either sex, at any age, and when it occurs, it permits many serious problems in management of case.

It is the complete or partial disruption of layers of abdomen at the incision site so as to expose the peritoneum and viscera.

Partial burst abdomen is when either skin or peritoneum is intact with disruption of all layers of abdominal wall and complete burst abdomen when all layers of abdominal wall are disrupted exposing the viscera.[24] Clinically it is diagnosed when postoperatively there is pink discharge from the suture line and when observed carefully after removal of a stitch and inspecting the layers of abdomen, all layers give way all of a sudden, which may or may not cause evisceration of the abdominal contents. This may occur any day from 7-10th postoperative day.

Burst abdomen being a mechanical process no single cause can be held responsible for its disruption. Following factors are the main local factors responsible for disruption.[28]

1. The knot may break or undo, a technical error that should be avoided but is still seen from time to time.
2. The suture material may rupture either because it is too weak for the tensions placed upon it or because it is destroyed rapidly in the tissues. This can be avoided by correct selection of suture material.
3. The sutures may cut through the tissues, either because they are placed too close from the wound edge or because of excessive weakening of the tissues from such systemic factors like jaundice, uremia, protein depletion, neoplastic conditions or most important, sepsis and this will be compounded if the tension placed on the healing wound is increased by abdominal distension, coughing or straining.

In the normal healing fascial wound, the intrinsic strength in first four days is practically zero, therefore it is advisable to follow a good suturing technique and use ideal suture material.

The ideal method of wound closure would be one that provides adequate tensile strength to the tissues until the wound has healed, approximates the tissue in such a way that normal healing takes place under optimum conditions, and remains secure in presence of local and systemic factors.[3]

Incidence of burst abdomen and associated mortality rate has not decreased during this century. Number of factors has been associated with dehiscence, most common cause being intraperitoneal sepsis.

The incidence of wound dehiscence has been reported to vary from 0.2% to 10% and mortality associated with dehiscence is considerably high at 10% to 44%. Indian authors have reported burst abdomen to occur in 10% to 30% of emergency cases.

In our study, incidence of wound dehiscence for Polypropylene (PPL) use was 3.3%(1 out of 30 cases).when only emergency cases were considered the incidence was 6.2%

The risk for dehiscence from emergency operation may be related more to hemodynamic instability then to unscheduled procedure.

In Polydiaxanone (PDS II) group, no case of burst abdomen occurred. The difference in both groups was not statistically significant, and p-value was 1.0.

The low dehiscence in the elective laprotomy group can be explained by the fact that patients do not have any intraperitoneal sepsis, have less abdominal distension, their malnutrition and anemia are corrected prior to surgery and they are operated in a more controlled setting where errors of technique are minimal.

Results indicate that our patients seem to do better with Polydiaxanone (PDS II) suture material.

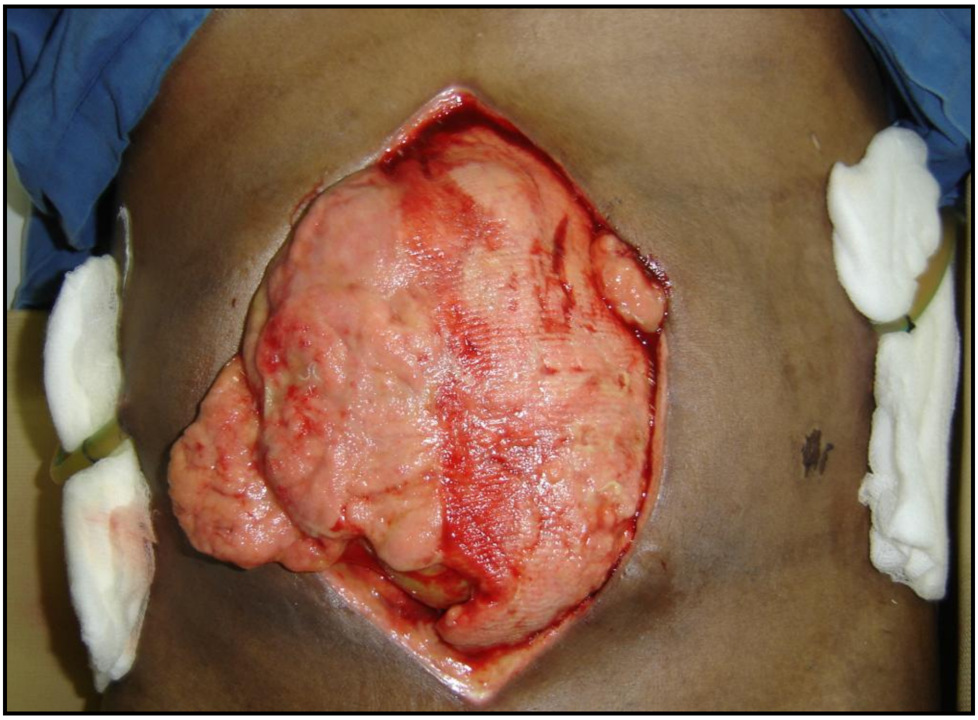


Fig.7: Burst Abdomen

Fig.8: Wound Infection

2) Wound Infection:

Postoperative wound infection was considered present when there was purulent discharge from wound. Superficial wound infection is the infection of superficial layers of abdomen like skin and subcutaneous tissue. Deep wound infection is the infection of deeper layers of abdomen, Linea alba and the peritoneum. In both cases, finding of seropurulent discharge from a stitch or from the incision, with signs of inflammation, with or without constitutional symptoms are present.[1,21,24]

Variety of factors are responsible for the wound infection to occur in a sutured incision like, closure technique, suture material, improper aseptic measures, tissue ischaemia, other factors which contribute to the wound infection are conditions of the viscera on opening the abdomen i.e. presence of peritonitis with collection, cases where infection due to breach in continuity of the bowel is present. Local factors like seroma, hematoma formation also increase the chances of wound infection. In the present study the overall wound infection incidence was 13.3% (8 cases out of 60 cases). The percentage in Polypropylene was 16.6% while in Polydiaxanone was 10%.

Polydiaxanone (PDS II) had a lower incidence of wound infection 10% (3 cases out of 30 cases) compared to Polypropylene (PPL) 16.6% (5 cases out of 30 cases).

In Polydiaxanone (PDS II) group, the incidence of wound infection was higher in emergency operations 21% (3 cases out of 14 cases) compared to elective operations in which there was no case of wound infection.

In Polypropylene (PPL), in emergency situation 4 cases out of 16 (25%) developed wound infection while 1 out of 14(7.1%) elective cases developed wound infection.

From above discussion it is evident that chances of wound infection in emergency operations (25%) and both emergency and elective operations (16.6%%) are higher in Polypropylene (PPL) suture material compared to Polydiaxanone (PDS II) and thus Polydiaxanone (PDS II) suture can be preferable in emergency & elective surgery. However the difference between the two technique is not statistically significant (p=0.704).

Incidence of wound infection reported in previous studies is up to 37.5%. The rate of wound infection is higher after emergency surgery. The results of present study is consistent with previous studies.

3) Suture Sinus:

Suture sinus is blind ending tract leading from skin into surrounding tissue with presence of suture material in it. Incidence of suture sinus formation in previous studies is reported to be 2% - 25%. Frequency of suture sinus formation is directly related to the degree of contamination and suture material used .[24]

In the present study there was 1 case (3.3%) of suture sinus formation in Polydiaxanone (PDS II) group and 3 cases (10%) in Polypropylene (PPL).so the risk of developing suture sinus was more with polypropylene.

Our study is a smaller one for estimating any statistical difference between two suture materials but the results have been found superior with Polydiaxanone as compared to Polypropylene suture material.

CONCLUSION

Based on the observations made in this study, it has been concluded that interrupted X suture technique using no.1 Polydiaxanone (PDS II) for closure of midline laparotomy incision is superior to no.1 Polypropylene (Prolene) suture material when post operative complication like burst abdomen wound infection & suture sinues were considered .

SUMMARY

60 cases of laparotomy closure of midline incisions were studied to compare the results of Polydiaxanone (PDS II) and Polypropylene (Prolene) suture material.

Equal number of cases (30 each) were randomly selected and divided in both the Polydiaxanone (PDS II) and Polypropylene (Prolene) suture materials. Both elective and emergency cases were included in the study, out of which elective cases were 30 and emergency cases were 30 cases.

The male to female ratio was 1.7: 1. Patients aged 45-60 years formed the maximum number of this study.

The early and late wound complications encountered in both the suture materials used were as follows.

There were 1 cases of burst abdomen in the present study which was done on an emergency basis in the Polypropylene (Prolene) (7%) and it was associated with wound infection. There was no case of burst abdomen in Polydiaxanone (PDS II) group.

The use of Polydiaxanone (PDS II) was better in emergency cases with no case of burst abdomen as compared to Polypropylene (Prolene) suture material technique with incidence of burst abdomen of 3.3%.

The incidence of wound infection was higher in Polypropylene (Prolene) (16.6%) compared to Polydiaxanone (PDS II) (10%). The use of Polydiaxanone (PDS II) was better in emergency cases with low infection rate of 21% as compared to Polypropylene (Prolene) suture material with infection rate of 25%. The incidence of suture sinus was 3.3% in Polydiaxanone (PDS II) and 3 in Polypropylene (Prolene) sutures (10%).

Intraperitoneal sepsis was the most important factor in predicting burst abdomen.

It was also associated with higher incidence of wound infection and suture sinus formation. Abdominal distension, cough, malnutrition, anemia and sepsis are other risk factors for burst abdomen.

Thus there was an advantage of Polydiaxanone (PDS II) suture material over Polypropylene (Prolene) suture material. The overall morbidity from abdominal closure was considerably reduced in the Polydiaxanone (PDS II) group. We encountered reduction in wound complications like burst abdomen and wound infection.

Numbers of factors have been associated with dehiscence, most common cause being suture material used. Polydiaxanone (PDS II) is a synthetic absorbable material which is a monofilament has a tensile strength 1.7 times greater than Polypropylene (Prolene) which retains approximately 50% of its strength for 6 weeks. It can be employed rewardingly in emergency situations where closure can be carried out safely and rapidly.

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PROFORMA

JAWAHARLAL NEHRU MEDICAL COLLEGE, BELGAUM

DEPARTMENT OF SURGERY

Sl. No.	I.P. No.	Ward:
Name & Address	:	
Age	:	Sex:
DOA	:	DOD:

Diagnosis: Preoperative:

Postoperative:

No. of days stay in Hospital:

Investigations Hb%	:	ESR:
	Blood sugar:	Blood Urea:
	Urine – Alb.:	
	- Sug.:	
	- Micro.:	
Radiological Studies	:	
Ultrasonography	:	
Gastroscopy	:	

Others:

Associated Factors:

- Anaemia	Present/Absent
- Diabetes	Present/Absent
- Obesity	Present/Absent
- Malignancy	Present/Absent
- Jaundice	Present/Absent
- Respiratory tract infection	Present/Absent

Preoperative preparation of the part in Ward:

In Operation Theatre:

Type of Anaesthesia :

Nature of Surgery :

Incision :

Procedure performed :

Peritoneal cavity : Drained/not drained

Type of closure :

Suture material used : Polydiaxanone (PDS II) / Polypropylene (Prolene)

Time required for closure:

Postoperatively:

Abdominal distension :

Chest infection :

Wound dehiscence :

Wound infection : C/s report:

Sinus formation :

Other complications :

Condition of wound postopertively:

2^{nd} day :

5^{th} day :

7^{th} day :

9^{th} day :

Condition of wound on discharge:

Follow-up:

4 weeks :

6 weeks :

Remarks:

CONSENT FOR PARTICIPATION IN RESEARCH

Mr./Mrs.________________________________we are requesting you to enroll yourself in study titiled conducted by DRGanesh MK, postgraduate student in M.S General Surgery under the guidance of DR AS GOGATE at J.N Medical College, Belgaum

You have been requested to participate in research because you are into the study group. During the study you will be asked some questions and you are supposed to answer to the best of your knowledge.

Your participation in research is voluntary. Your decision whether or not to participate in the study will not affect your relationship with J.N.M.C.If you decide to participate you are free to withdraw at any time.

. The purpose of research is to compare the efficacy of innterpted x sutures versus mono layer continous interlocking sutures in mid line vertical abdominal incision in case of burst abdomen.

PROCEDURE INVOLVED:

If you agree in this research study we would ask you present , past and family history

After detailed clinical examination and routine investigation ,when found fit for surgery you will be randomly selected for the treatment with conventional polypropylene suture material or newly introduced polydiaxanone suture material. To evaluate the post-operative complication

RISKS AND BENEFITS:

There are many risk involved in laprotomy operation during post operative period .if any complication during the operation or during post operative period occurs then you will be treated with best of over knowledge . there is no compensation or payment for such medical treatment .

ALTERNATIVES:

Even if you decline the participation, you will get the routine line of management.

PRIVACY AND CONFIDENTIALITY:

The only people to know that you are a research subject are members of the research team. No information about you or provided by you during the research will be disclosed to others without your written permission except:

1.In emergency to protect your rights and welfare.

2.If required by law.

AUTHORIZATION TO PUBLISH RESULTS:

When the results of the research are published or discussed, in a conference, no information will be displayed that would disclose your identity. Any information that is obtained in connection with this study and that can be identified with you will remain confidential.

FINANCIAL INCENTIVES FOR PARTICIPATION:

You will not be paid/offered any free gifts for participating in the research. You will not be reimbursed for expenses.

CONSENT FORM:

I undersigned________________________ have been explained in my vernacular language about the study and my participation in the study is voluntary. If I want, I can withdraw at any time. Also I have been given enough time to clear my doubts and rights as study participant.

In case you have any questions related to the study, you can contact Dr GANESH MK(Phone No 9886780798)

In case you have any questions about my rights as a study participant, you can contact Dr V.D Patil (0831-2471350)

Signature or the Left Thumb print of Participant or legally authorized representative

Participants Name____________________ Signature_____________________

Witness Name______________________ Signature_____________________

Experimenter's Name_________________ Signature_____________________

Date________________

Place_______________

KEY TO MASTER CHART

APR	:	Abdominoparineal resection
AIO	:	Acute intestinal obstrction
BA	:	Burst abdomen
Ca	:	Carcinoma
EL	:	Elective
EM	:	Emergency
F	:	Female
GOO	:	Gastric outlet obstruction
H	:	Healthy
Hs	:	Hypertrophied scar
SAIO	:	Sub acute Intestinal obstruction
Lt	:	Left
M	:	Male
Rt	:	Right
SS	:	Suture sinus
WI	:	Wound infection

POLYDIAXANONE SUTURE														
S. No.	Name	Age (Yrs)	Sex	IP No.	Diagnosis	Operation	Type	Complication			Follow-up		
								BA	WI	SS	2	4	6
1	Ananda	42	M	205095	Pancretic psedocyst	Cystogastrostomy	EL	-	-	-	H	H	H
2	Sangappa T	28	M	208265	mesentric lipoma	laprotomy &excision	EL	-	-	-	H	H	H
3	Gurudatta	40	M	213676	Blunt abdominal injury	Primary closer of jejunal tear	EM	-	-	-	H	H	H
4	Renuka	40	F	213703	Ca stomach	Gastrojejunostomy	EL	-	-	-	H	H	H
5	Pooja Thane	18	F	214118	SAIO	Adeshinolysis	EM	-	-	-	H	H	H
6	Zareena A	45	F	214318	Ca stomach	Feeding jejunostomy	EL	-	-	+	H	H	SS
7	Krishna raj bhat	54	M	216567	Ca sigmoid colon with AIO	Anterior resection	EM	-	-	-	H	H	H
8	Rukiya	65	F	217523	Diverticulitis	Hartmans procedure	EM	-	+	-	WI	H	H
9	Jayaram Redkar	40	M	219030	SAIO	Laprototmy&adeshinolysis	EM	-	-	-	H	H	H
10	Vittal das	60	M	220375	CA Esophagus	gastric pull up	EL	-	-	-	H	H	H
11	Baburao	22	M	221150	Blunt abdominal injury	Explorative laprotomy	EM	-	-	-	H	H	H
12	Rekha .S	32	F	221154	Blunt abdominal injury	Explorative laprotomy	EM	-	-	-	H	H	H
13	Khemani	55	M	223468	DU perf.	Laprotomy &primary closer	EM	-	+	-	WI	H	H
14	Channabasappa	55	M	223753	Ca stomach	Feeding jejunostomy	EL	-	-	-	H	H	H
15	Siddappa	67	M	224686	Ca Esophagus	Feeding jejunostomy	EL	-	-	-	H	H	H
16	Srishil Patil	52	M	227965	Jejunal stricture	Resection Anastomosis	EL	-	-	-	H	H	H
17	Pushpaya	38	M	227965	Ca colon	Rt hemicolectomy	EL	-	-	-	H	H	H
18	Yeshwanth desai	55	M	231943	mesentric ischemia	Resection Anastomosis	EM	-	-	-	H	H	H
19	Bhikaji	65	M	233560	Ca rectum	Anterior resection	EL	-	-	-	H	H	H
20	Ramesh .K	30	M	235258	Strangulated inguinal hernia	Resection anastomosis	Em	-	-	-	H	H	H
21	Fariza balakundri	55	F	237654	Ca colon	Anterior resection	EL	-	-	-	H	H	H
22	Mangala karabagi	44	F	239226	Necrotizing entrities	Resection Anastomosis	EM	-	+	-	WI	H	H
23	sujatha	27	F	242202	Rt ovarian mass	Laprotomy & excision	EL	-	-	-	H	H	H
24	Gangawwa	65	F	256802	surgical jaudice	Laprotomy & biopsy	EM	-	-	-	H	H	H
25	Athmaram	64	M	245804	Ca stomach	Bilroth II	EL	-	-	-	H	H	H
26	Mahadev	19	M	250009	Blunt abdominal injury	Explorative laprotomy	EM	-	-	-	H	H	H
27	Ddharmashree	19	F	251601	Ruptured ovaria cyst	Laprotomy & excision	EM	-	-	-	H	H	H
28	Jaya P Naik	59	F	251644	Ca colon	APR	EL	-	-	-	H	H	H
29	Lakshmi bai	70	F	254118	Ca ascending colon	Rt hemicolectomy	EM	-	-	-	H	H	H
30	Hassan sab	60	M	255120	Ca stomach	Gastrojejunostomy	EL	-	-	-	H	H	H

POLYPROPYLENE SUTURE													
S. No.	Name	Age (Yrs)	Sex	IP No.	Diagnosis	Operation	Type	Complication			Follow-up		
								BA	WI	SS	2	4	6
1	Rudrawwa	80	F	211435	Gastric perforation	Laprotomy &primary closer	EM	-	-	-	H	H	H
2	Praveen	40	M	212345	Gastric perforation	Laprotomy &primary closer	EM	-	-	-	H	H	H
3	Veerabhadrayya	70	M	213773	GOO	Gastrojejunostomy	EL	-	-	-	H	H	H
4	Geetha	26	F	214769	Necrotizing entertis	Resection anastomosis	EM	-	-	-	H	H	H
5	Ravi	20	M	216012	Gastric perforation	Laprotomy &primary closer	EM	+	+	-	H	H	H
6	Maslum Pattan	20	M	216807	SAIO	Adhesinolysis	EM	-	-	-	H	H	HS
7	Annappa Patil	45	M	218170	Liver abscess	Laprotomy & abscess drinage	EL	-	-	-	H	H	H
8	Yayakhan	32	M	219782	Traumatic jejunal injury	Resection anastomosis	EM	-	-	-	H	H	H
9	Sanganagouda	62	M	219922	SAIO sec to abdominal TB	Resection anastomosis	EL	-	-	-	H	H	H
10	Anshul	22	M	222264	Necrotizing entertis	Resection anastomosis	EM	-	+	+	WI	H	H
11	Srikanth	65	M	223287	Ca stomach	Feeding jejunostomy	EL	-	-	-	H	H	H
12	Kasthuri	35	F	224365	traumatic renal injury	Nephrectomy	EM	-	-	-	H	H	H
13	Chanawwa	40	F	226598	Necrotizing entertis	Resection anastomosis	EM	-	+	+	WI	SS	H
14	Malik	25	M	227689	Ileal Perforation	Laprotomy &primary closer	EM	-	-	-	H	H	HS
15	Manjula	31	F	225951	Rt Iliac fossa abscess	Laprotomy &peritoneal lavage	EL	-	-	-	H	H	H
16	Bhumal Devappa	55	M	227659	Ca desending colon	Resection anastomosis	EL	-	-	-	H	H	H
17	Verupakshya	44	M	233169	Gastric perforation	Laprotomy & primary closer	EM	-	+	-	H	H	H
18	Ajay Mangle	76	M	234050	mesentric ischemia	Resection anastomosis	EM	-	-	-	H	H	H
19	Mahadev	36	M	235431	SAIO	Resection anastomosis	EL	-	-	+	H	H	H
20	Fakirappa	64	M	247108	Ca sigmoid	Anterior resection	EL	-	-	-	H	H	H
21	Lakshmibai	70	F	243118	Ca esophagus	Feeding jejunostomy	EL	-	-	-	H	H	H
22	Amarjeeth	60	M	245803	Jejunal obstruction	Adhesinolysis	EL	-	+	-	H	H	H
23	Arjun	60	M	247432	Carcinoid tumor of ilium	Resection anastomosis	EL	-	-	-	H	H	H
24	Renuka	40	F	249873	pancretic psedocyst	Cystogastrostomy	EL	-	-	-	H	H	HS
25	Yallappa	56	M	251412	Gastric perforation	Laprotomy &primary closer	EM	-	-	-	H	H	H
26	Sushila	32	F	252164	GOO	Gastrojejunostomy	EL	-	-	-	H	H	H
27	Seema	25	F	252822	Splenic injury	Splenectomy	EM	-	-	-	H	H	H
28	Mallappa	42	M	256132	Small bowel perforation	Resection anastomosis	EM	-	-	-	H	H	H
29	MallyyaGirimath	32	M	255331	Splenic injury	Splenectomy	EM	-	-	-	H	H	H
30	UmeshNayak	56	M	253576	Hepatic abscess	laprotomy & drinage	EL	-	-	-	H	H	