A COMPARATIVE STUDY BETWEEN SINGLE VERSUS DOUBLE LAYERED INTESTINAL ANASTOMOSIS

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Dissertation submitted for
M.S. DEGREE (Branch I) in General Surgery
April - 2015

The Tamil Nadu Dr. M.G.R. Medical University
Chennai – 600 032.
CERTIFICATE

This is to certify that this dissertation titled “A COMPARATIVE STUDY BETWEEN SINGLE VERSUS DOUBLE LAYERED INTESTINAL ANASTOMOSIS” submitted by Dr. SARAVANAN. M to the faculty of General Surgery, The Tamil Nadu Dr M.G.R Medical University, Chennai in partial fulfillment of the requirement for the award of MS degree Branch I General Surgery, is a bonafide research work carried out by him under our direct supervision and guidance from August 2013 - August 2014.

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This is submitted to The Tamil Nadu Dr M.G.R Medical University, Chennai, in partial fulfilment of the regulations for the Award of MS Degree (Branch I) in General surgery.

Place : Madurai

Date : 23.09.2014

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ACKNOWLEDGEMENT

It is my honor and privilege to thank Prof. Dr. S. SELVACHIDAMBARAM, M.S., Professor of General Surgery, who helped me in choosing the subject for this study and guided me at every stage. His valuable suggestions and timely advice were of immense help to me throughout all phases of this study.

I express my gratitude towards Dr. SANKARAMAHALINGAM, M.S., Head of the Department of General Surgery, Madurai medical College, Madurai, for his valuable suggestions and guidance.

I thank Dr. K.G. Subangi, M.S., DGO., Dr. Muniasamy, M.S., Dr. Jagadeesh Singh, M.S., Dr. A.N. Gurumoorthy, M.S, for their encouragement and guidance.

I am very thankful to my colleagues who helped me in preparing this Dissertation.

My ‘Sincere Thanks’ to all the patients, without whose co-operation this study would have not been possible and last but not the least, I wish to express my gratitude to my family & friends also, without them, this study would have not been possible.

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Objective

This comparative study is intended to determine the efficacy of single layer intestinal anastomosis in comparison with double layered intestinal anastomosis in terms of duration required to perform an anastomosis, complications like anastomotic leak, and the number of duration of hospital stay.

Methods

This prospective comparative study was conducted at Govt. Rajaji Hospital, Madurai Medical College, Madurai, between August 2013 to August 2014. The study had two groups, group A (single layer) and group B (double layer) and cases were allotted to either groups alternatively requiring single layer anastomosis and double layer anastomosis for various clinical conditions of small and large bowel after fulfilling inclusion and exclusion criteria. Single layer continuous extra-mucosal anastomotic technique was done using 3-0 PDS and double layer continuous technique with 2-0 vicryl & 2-0 mersilk. Duration was noted and all cases were followed up to discharge and subsequently for 2 weeks any complications like leak.

Results

The mean age in group A was 41.4 years and in group B was 41.72 years. Ileal stricture was diagnosed in maximum number of patients i.e. 17 (34%) cases and resection of ileum and ileoileal anastomosis was performed in maximum number
of patients i.e. 19 (36%) cases. In group A mean duration to perform anastomosis was 19.04 minutes to perform a single layer anastomosis and 28.8 in Group B. The mean difference between two groups was 9.76 minutes, and P value was <0.001 highly significant. Overall complication in the form of anastomotic leak was noted in 3 patients (6%). In group A leak was observed in 1 (4%) and in Group B in 2 (8%) patients. The p value was not significant. One patient in Group B died due to septicaemia and the other two recovered.

**Conclusion**

Single layer extra mucosal continuous intestinal anastomosis can be constructed in significantly shorter duration. No dogmatic evidence was found that double layered anastomosis is superior to single layered closure of bowel anastomosis.

**Keywords**

Single layer; double layer; duration; hospital stay; anastomotic leak
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INTRODUCTION

Gastrointestinal anastomosis has been excited interest in our day to day surgical practice and aim of anastomosis is to make a sound alignment of bowel through which the contents will pass in as early as possible.

Patients undergoing resection anastomoses for various causes like bowel obstruction, incarcerated hernias, benign and malignant tumors of small and large bowel is not so uncommon. Surgery stands major modality of treatment in such cases in diagnosis, treatment and even palliation in few situations.

Bowel anastomoses after resection of bowel may be either end to end anastomoses and side to side or side to end anastomoses depending on surgery and the operating surgeon. Different techniques of intestinal anastomosis are single, double layered closure, staples, glue, laser welding[2]

Various complications following bowel anastomoses are anastomotic leak resulting into peritonitis, abscess, fistula, necrosis, stricture. Various factors contribute to these complications like suturing technique, suture material, presence of concurrent sepsis, vascular compromise and so on. Leakage from the bowel anastomoses in the gastrointestinal tract is major complication and accounts for about 1.3 to 7.7%, that is often associated with increased morbidity and mortality and prolonged stay[3,4].
In double layered closure where mucosa and seromuscular layers are sutured separately though haemostatic there is more chance of strangulation of mucosa due because of damage of submucosal vascular plexus\textsuperscript{[5]}.

In single layer technique, only seromuscular layer of gut wall is approximated. This technique incorporates the strongest layer (submucosa) of gut and causes minimal damage to the submucosal vascular plexus, anatomy is maintained and hence less chances of necrosis and superior to double layered closure\textsuperscript{[6,7]}.

This comparative study endeavours to compare outcome of single layer versus double layer intestinal anastomosis in small and large bowel in terms of duration required to perform intestinal anastomosis, post operative complications like anastomotic leak, duration of hospital stay in each group.
OBJECTIVES

➢ To compare duration required to perform single and double layered intestinal anastomosis.

➢ To compare the duration of hospital stay in single vs double layered bowel anastomosis.

➢ To study post operative complications like anastomotic leak in single and double layered intestinal anastomosis.
REVIEW OF LITERATURE

The basic principle of intestinal suture was established more than 100 years ago by Travers, Lambert and Halsted. Controversy regarding single vs double layered closure of anastomoses goes as back as 1887 when Halsted proposed interrupted extra mucosal suturing\cite{4}.

Then Senn in 1893 advised double layer anastomosis. By 1931, more than 52 techniques for G.I anastomoses had been described. The single-layer continuous anastomosis is a newly discovered technique first described by Hautefeuille in 1976. The first mention of this technique was described by Allen et al at USA\cite{5}.

Satoru Shikata, Hisakazu Yamagishi et al at Kyoto, Japan, did a meta-analysis of all the articles related to single vs double layered anastomoses from 1966-2004. There was no evidence found that two-layer intestinal anastomosis leads to fewer postoperative leaks than single layer. Also comparing the duration of the anastomosis procedure and medical expenses, the single-layer intestinal anastomosis appears to represent the optimal choice for most surgical situations\cite{5}.

Muhammad Jawaid Rajput, Abdul Sattar Memon et al at Muhammed Medical College, Mirpurkhas did a prospective study on 72 patients with end to end single interrupted extramucosal anastomoses using polyglactin and found out that Single-layer extramucosal interrupted suture gut anastomosis is safe
method of hand sewing technique. It is suitable for all anastomosis in the gastrointestinal tract[6].

Shahnam Askarpour, Mohammad Hossein Sarmast et al at University of Medical Sciences, Iran in 2005-06 did a study comparing single vs double layered anastomoses and its complications in 126 patients and they found out that complications in single and double layered anastomoses is the same and single layer had an additional advantage of decreased operation time and cost of surgery[7].

Rullier E, Laurent C et al at University of Bordeaux, France did a study from 1980-95 on 272 anterior resections and anastomoses for rectal cancers and found out that male sex and level of anastomoses were independent risk factors for anastomotic leak and obesity contributed for leak and anastomotic leak contributed for 6-22% mortality[8].

Arnaud Alves, Yves Panis et al at Lariboisiere hospital in France did a Multivariate analysis of 707 patients to study the factors associated with clinically significant anastomotic leakage after large bowel resection and they found out that after colorectal resection and intraperitoneal anastomoses a temporary protective stoma is proposed for patients with high risk of anastomotic leak[9].

Currently single layer extra mucosal anastomoses is popular as advocated by Norman Matheson of Aberdeen as it probably causes the least tissue necrosis and luminal narrowing. Different trials and clinical studies have proven the
superiority of single layer anastomosis, which besides being quicker to create, are apparently as strong as two-layered anastomoses\textsuperscript{[5]}. 
Embryology of alimentary tract

The epithelial lining of various parts of gastrointestinal tract are endodermal in origin.

Endoderm, which is at first in the form of a flat sheet, is converted into a tube by formation of head, tail and lateral folds of the embryonic disc. This tube is the gut.

The gut consists of foregut, midgut and hindgut. In earlier stage the midgut has wide communication with the yolk sac. Later it becomes tubular. Part of it forms a loop that is divisible to prearterial and postarterial segments.

Fig. 1 : Parts of the primitive gut
**Duodenum**

The superior (or first) part and upper half of the descending (or second) part of duodenum are derived from foregut. The rest of the duodenum develops from the most proximal part of the midgut.

**Jejunum and ileum**

The jejunum and most of the ileum are derived from pre-arterial segment of the midgut loop. The terminal portion of the ileum is derived from the postarterial segment proximal to the caecal bud.

**Caecum and appendix**

Caecal bud is a diverticulum that arises from the post-arterial segment of the midgut loop. The caecum and appendix are formed by enlargement of this bud. The proximal part of the bud grows rapidly to form the caecum. Its distal part remains narrow and forms the appendix.

**Ascending colon**

It develops from the post-arterial segment of the midgut loop distal to the caecal bud.

**Transverse colon**

The right two-thirds of the transverse colon develop from the post-arterial segment of the midgut loop. The left one-third arises from the hindgut. This mode of origin is reflected in its arterial supply; the right two-thirds are supplied
by the superior mesenteric artery and the left one-third by the inferior mesenteric.

Fig. 2. Derivation of various parts of the gut.

**Descending colon**

The descending colon develops from the hindgut.

**Rectum**

The rectum is derived from primitive rectum, i.e., the dorsal subdivision of the cloaca. The upper part of the rectum is derived from hindgut proximal to the cloaca.
Anal canal

The anal canal is formed partly from endoderm of the primitive rectum and partly from ectoderm of the anal pit or proctodaeum. The line of junction of endodermal and ectodermal part is represented by anal valves (pectinate line).

Thus the alimentary canal consists of foregut, midgut and hindgut, each of which has its own artery and each of which is destined for a specific function as follows:

<table>
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<th>Extent</th>
<th>Artery</th>
<th>Function</th>
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<td>Stomach and duodenum up to ampulla of Vater</td>
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Gut rotation and fixation results in the appropriate positioning of various parts of the gastrointestinal tract in the abdomen.
ANATOMY

SMALL INTESTINE

The small intestine consists of duodenum, jejunum and ileum and extends from pylorus to ileocecal valve. Its total length is 5 metres but this can range from widely from less than 3 metres to more than 7 metres.\(^{[18]}\)

It is divided into upper fixed part called duodenum, measuring 2.5 cm in length, lower mobile part, forming a very long convoluted tube. The upper two fifth of mobile part is known as jejunum and lower three fifth are known as ileum.\(^9\) The small gut is suspended by its mesentery which extends from the left side of the 2\(^{nd}\) lumbar vertebra to the right iliac fossa, crossing the third part of the duodenum, aorta, vena cava, and right ureter in its course. It is 1.5 metres in length along this line of attachment, but along its free border it is as long as the small gut. Its depth is 15 cm, except in relation to the parts of the small gut which occupy the pelvis, where it is 20 cm.

The parts of the small intestine which lie in the pelvis are the terminal ileum (except the last 5 cm which are fixed in the right iliac fossa), and about 1.5 metres of small gut beginning at a point 1.8m from the duodenojejunal flexure to a point 3.4 metres from the flexure.\(^{20}\)
DUODENUM

The duodenum is 20-25cm long and is shortest, widest and most predictably placed part of small intestine extending from pylorus to the duodenojejunal flexure.\textsuperscript{19}

\textbf{Fig. 3 : Duodenum in situ}
**Duodenojejunal flexure**

The duodenojejunal flexure is at the left side of second lumbar vertebra just below pancreas. It is supported by ligament containing unstripped muscle which passes to it from region of left crus of diaphragm and the tissue about the celiac plexus. This is the suspensory ligament of duodenum called ligament of Treitz.\(^{20}\)

**Arterial supply**

The main vessels supplying the duodenum are superior and inferior pancreatic duodenal arteries.\(^{18}\)

**Lymphatics**

Duodenal lymphatics run to anterior and posterior pancreatic nodes that lie in the anterior and posterior groove between the pancreatic head and duodenum.\(^{18}\)

**Venous drainage**

The veins of duodenum drain into splenic, superior mesenteric and portal vein.\(^{18}\)

**Nerve supply**

Sympathetic nerve from thoracic ninth and tenth spinal segments and parasympathetic nerves from the vagus, pass through the coeliac plexus reach the duodenum along its arteries.\(^{19}\)
Fig. 4: Arterial supply of Duodenum
JEJUNUM AND ILEUM

The jejunum and ileum are suspended from posterior abdominal wall by the mesentery and therefore had considerable mobility. The jejunum constitutes the upper two-fifths of the mobile part of the small intestine, while the ileum constitutes the lower three-fifths. The jejunum begins at duodeno jejunal flexure. The ileum terminates at ileocecal region\textsuperscript{19}

Root of mesentery

It is marked by two parallel lines close together, extending from the duodenojejunal flexure to the junction of the right lateral and transtubercular planes. The duodenojejunal flexure lies 1 cm below the transpyloric plane and 3 cm to the left of the median plane.\textsuperscript{19}

Arterial supply

The arterial supply to jejunum and ileum arise from superior mesenteric artery. Jejunal branches arise from left side of upper portion of superior mesenteric artery. Ileal branches arise from the left and anterior aspect of superior mesenteric artery. The only distinction to operating surgeon whether the part of the gut is upper or lower small gut depends on blood supply. Jejunum has one or two arterial arcades in the mesentery with parallel vessels 3.7 cm long going to gut. Ileum has two or three arterial arcade in the mesentery with parallel vessels 1.2 cm long going to gut. There is no collateral circulation beyond the terminal arcades in small gut. There is no communication between vasarecta or between the branches they give off to bowel wall, but there is rich
submucosal anastomoses which ensures an adequate blood supply after small bowel anastomoses, provided vasa recta are not damaged too extensively.\textsuperscript{20}

\textbf{Fig. 5 : Arterial supply of Small intestine}
Lymphatics

Lymph vessels, called lacteals are arranged at two levels within wall of small bowel. The first is mucosal and second in the muscular cost and drains into plexus in the wall of gut. From there it passes into lymphatic vessels in the mesentery passing through numerous lymph nodes present in mesentery and along the superior mesenteric artery$^{18,19}$
**Venous drainage**

The veins correspond to branches of superior mesenteric artery and drain into superior mesenteric vein.\(^{19}\)

**Nerve supply**

The nerves are derived from sympathetic and parasympathetic nerves from superior mesenteric plexus.

*Fig. 7: Small intestine internal view and external view*
LARGE INTESTINE

The large intestine is a muscular tube which extends from distal end of ileum to the anus and is comprised of caecum, appendix, colon, rectum and anal canal. Large bowel is approximately 135 cm long and there considerable variations in length. The circular muscle layer is continuous, but longitudinal muscle is arranged in three bands, the taeniae coli, as far as the rectum where these bands fuse to form continuous layer. The voluminous large bowel is gathered by taeniae coli to form characteristic sacculated appearance.20 Broadly the large intestine lies in a curve which extends from right iliac fossa ascends into right flanks, crosses mid upper abdomen in a variable course, descends in of the left flank, passes through left iliac fossa and then posteroinferiorly into pelvis. Transverse colon, pelvic colon and appendix are completely surrounded by other parts are devoid of peritoneum posteriorly. The caecum is completely surrounded by peritoneum, expect a small part posteriorly and superiorly.18,20

Caecum

This is a large blind sac 6 cm in long and 7.5 cm broad, forming the commencement of colon. It is situated in the right iliac fossa above the lateral half of the inguinal ligament communicating superiorly with the ascending colon, medially at the level of the caecocolic junction with the ileum, and posteromedially with the appendix.20
Fig. 8: Large intestine internal view and external view
MESENTERIES OF THE LARGE GUT

Transverse mesocolon

It is a double fold of peritoneum which suspends the transverse colon from anterior border of the pancreas. The middle colic artery runs in the mesocolon.

Pelvic mesocolon

It has an inverted v-shaped attachment. The left limb is attached to the brim of the left side of pelvis. The right limb passes from the apex down to the third space of sacrum. The apex of the v is situated exactly over the left ureter where it crosses the pelvic brim. This is surgeon's guide to the left ureter. The mesocolon carries the superior rectal vessels.

Mesentery to the ascending colon

Either the ascending or descending colon may have a mesentery due to faulty fixation of the gut to the posterior abdominal wall during its development. If a mesentery exists, the ascending or descending colon is not firmly fixed to the loin, but is dependent from it by a fold of peritoneum. It is not common in descending colon and is of little significance. In ascending colon, it plays an important role in volvulus of the caecum and ileocaecal intussception.
ASCENDING COLON

Ascending colon is 12.5 cm long and extends from caecum to inferior surface of right lobe of the liver and bends here to the left to form right colic flexure.

Right Colic Flexure (Hepatic flexure)

Right colic flexure lies at junction of ascending colon and transverse colon and bends forwards, downwards and to the left here.\textsuperscript{19}

TRANSVERSE COLON

Transverse colon is about 50 cm long and extends across the abdomen from right colic flexure to left colic flexure. It is not transverse, but hangs low as a loop to a variable extent sometimes reaching pelvis. It is suspended by transverse mesocolon attached to the anterior border of pancreas, and has wide range of mobility.\textsuperscript{19}

LEFT COLIC FLEXURE (Splenic flexure)

Left colic flexure lies at junction of transverse colon and descending colon and bends downwards and backwards here. This flexure is attached to the eleventh rib by a horizontal fold of peritoneum, called the phrenicocolic ligament. This ligament supports the spleen and forms a partial upper limit of left paracolic gutter.\textsuperscript{19}
DESCENDING COLON

Descending colon is about 25 cm long and extends from the left colic flexure to the sigmoid colon. It runs vertically up to iliac crest and then inclines medially on the iliacus and psoas major to reach the pelvic brim, where it is continuous with sigmoid colon. Descending colon is narrower than the ascending colon. It is retroperitoneal and rarely it posses descending mesocolon.19

SIGMOID COLON (Pelvic colon)

Sigmoid colon is about 37.5 cm long, and extends from pelvic brim to the third piece of the sacrum, where it becomes rectum. It forms a sinuous loop and hangs down in pelvis over the bladder and uterus. Occasionally, it is very short, and takes a straight course. It is suspended by sigmoid mesocolon and is covered by coils of small intestine.19

RECTOSIGMOID JUNCTION

In patients with a long sigmoid loop which hangs down into pelvis, the rectosigmoid junction is marked by a distinct flexure. At operation with the patient in head down position or in patients in whom the sigmoid colon is short, this flexure may not be noticeable. To most surgeons rectosigmoid implies a segment of bowel comprising the last 7 cm of sigmoid and upper 5 cm of rectum rather precise point. The promontory of the sacrum is a useful landmark to which tumour is situated entirely below the promontory it is said to be rectal
tumour. On the sigmoidoscopic examination, the rectosigmoid junction is taken to be point 15 cm from the anal verge.\textsuperscript{20}
Course of Rectum

The rectum is distal part of large gut placed between sigmoid colon above and anal canal below. The rectum proceeds downwards and forwards, closely applied to the concavity of the sacrum and coccyx. It ends 2-3cms in front and below the tip of coccyx by turning abruptly downwards and backwards through the levator ani muscle to become the anal canal almost 4cms from the anal verge.

Peritoneal reflections of rectum

The upper third of rectum is covered on its front and sides by peritoneum. The middle third is covered on the front only and the lower third is extra peritoneal. From the middle third of the rectum, the peritoneum is reflected onto seminal vesicles and bladder in males and the posterior fornix of vagina in the female. The peritoneal reflections form the rectovesical pouch in males and rectouterine pouch in females. The point of anterior peritoneal reflections shows considerable variations, in males it is 8-9 cm from perineal skin and in the female it is 5-8 cm. On rectal examination it may be possible to feel a secondary deposit in the rectovesical pouch or rectouterine pouch.\textsuperscript{20}
FASCIA OF RECTUM

Lateral ligaments

Condensations of areolar tissue around the middle rectal vessel form the lateral ligaments of the rectum. These ligaments have to be divided during excision of rectum.  

Fascia of Waldeyer

This fascia is a strong thick layer of parietal pelvic fascia between rectum and sacrum, and coccyx, and is seen as thick white layer of fascia after anococcygeal ligament has been divided to gain access to the retrorectal space. Failure to incise this ligament, surgeon will dissect posterior to it and serious haemorrhage will occur due to injury of sacral veins.  

Fascia of Denonvilliers

This is a layer of visceral pelvic fascia anteriorly to extraperitoneal rectum and extends from the anterior reflection of peritoneum above to the superior layer of urogenital diaphragm. During excision of rectum for cancer, this fascia together with the rectum is separated from the anteriorly placed seminal vesicles in the male and vagina in the females. At the level of the base of prostate, the fascia of Denonvilliers is incised transversely to develop a plane of dissection between it and the rectum. The fascia of Denonvilliers remains adherent to the posterior aspect of prostate gland.
Arterial Blood supply to the colon and rectum

Arterial blood is supplied by the superior and inferior mesenteric arteries. The internal iliac supplies the important middle and inferior rectal arteries to anus and rectum. Caecum is supplied by caecal branches of ileocolic artery. The ascending branch of ileocolic artery supplies the lower half of ascending colon and anastomosis freely with right colic artery. Right colic artery divides into descending branch which anastomoses with ileocolic arteries, and an ascending branch which anastomoses with middle colic arteries, these braches forms arches and supplies upper two thirds of ascending colon and hepatic flexure. The proximal two thirds of transverse colon are supplied by middle colic artery branch of superior mesenteric artery. The distal two thirds are supplied by left colic artery branch of inferior mesenteric artery.

The arterial supply of descending colon is left colic artery branch of inferior mesenteric artery which also anastomoses with marginal artery of colon and sigmoid artery.

Marginal artery

It is the paracolic vessel of anastomosis between colic and from which vasa recta arise. The vasa recta are terminal arteries to the colon. Marginal artery extends from ascending colon to the end of pelvic colon. During intestinal anastomosis, when one or both of vessel ends is dependent for its blood supply on marginal artery, the mesentery containing the artery should be divided as to maintain the integrity of the vasa recta.
The principal arterial supply to the upper two thirds of rectum is the superior rectal artery. Branches of middle rectal artery provides some additional supply to the middle third and ascending branches of inferior rectal artery supply the distal third.
Lymphatic drainage of the large intestine

They are very numerous and arranged in three groups

- The proximal nodes which are situated on the main blood vessels to the gut, i.e. superior mesenteric, ileocolic, right colic, left colic, middle colic, inferior mesenteric, superior rectal, sigmoid.

- The intermediate nodes are situated along the larger branches of named vessel.

- The distal nodes are situated near the gut between the numerous small vessels entering the gut. Some of these nodes lie on the gut. The first importance to realize is that lymph from the gut may miss the distal set and go direct to the intermediate or even the proximal set.

Lymphatic drainage of the rectum

Lymphatics from more than the upper half of the rectum pass along the superior rectal vessels to the inferior mesenteric nodes after passing through the pararectal and sigmoid nodes. Lymphatics from lower half of rectum pass along the middle rectal vessels to internal nodes.
Fig. 10: Lymph vessels and nodes of large intestine
**Venous drainage of large intestine**

The venous drainage of the large intestine is primarily into the hepatic portal vein via the superior mesenteric and inferior mesenteric veins, although a small amount of drainage from the rectum occurs via middle rectal veins into the internal iliac vein and via inferior rectal veins into the pudendal vein. Those parts of the colon derived from the midgut (caecum, appendix, ascending colon and right two-thirds of the transverse colon) drain into colic branches of the superior mesenteric vein, whilst hindgut derives (left pat of the transverse, descending and sigmoid colon, rectum and upper anal canal) drain into the inferior mesenteric vein.¹⁸

**Nerve supply of large intestine**

The colon and rectum are innervated by the sympathetic and parasympathetic systems. The sympathetic supply to the caecum, appendix, ascending colon and right two-thirds of the transverse colon (derivatives of the midgut) originates in the fifth to the twelfth thoracic spinal segments.

The sympathetic supply of the left third of the transverse colon, the descending and sigmoid colon, rectum and upper anal canal derivatives of the hindgut - originates in the lumbar and upper anal canal - derivatives of the hindgut - originates in the lumbar and upper sacral spinal segments.¹⁸
Fig. 11 : Veins of large intestine
ANAL CANAL

The anal canal is terminal part of large intestine and begins at the ano rectal junction and ends at the anal verge.\textsuperscript{18,19}

The muscular anal canal forms a sphincter at the distal end of gastrointestinal tract. The adult canal is about 4 cm. The lining of canal above the dentate line is columnar epithelium continuous with that of rectum and below in skin. In upper anal canal longitudinal folds of columnar epithelium run down to the dentate line level and cover vascular submucosal connective tissue to form anal cushion.\textsuperscript{20}

The anal sphincter

The internal and external sphincter form the sphincter mechanism of anal canal. The internal sphincter is a downward extension of circular layer of rectal muscle wall. It is thus a smooth muscular tube which is under the control of autonomic nervous system. The external sphincter surrounds the internal sphincter and is continuous with fibres of levator ani muscle and forms the skeletal muscle extension of pelvic floor.\textsuperscript{20}

The upper part of external sphincter is at the level of ano rectal junction. Its the puborectalis muscle which forms a shiny layer around the anorectal junction and is responsible for continence mechanism.\textsuperscript{20}

The internal sphincter is a well developed documented extension of irrcular muscle layers of rectum. The longitudinal layer contributing a far less discrete
component. The levator ani forms the pelvic diaphragm which supports the pelvic viscera. The interval between internal and external sphincter is known as the intersphincteric space.\textsuperscript{20}

**Arterial supply**

The arterial supply to anal canal is derived from terminal branches of superior, inferior rectal artery branch of pudendal artery and branches of median sacral artery\textsuperscript{18} The part of the anal canal which lies above pectinate line is supplied by superior rectal artery and which lies below the pectinate line is supplied by inferior rectal artery.\textsuperscript{19}

**Lymphatic drainage**

The Lymphatic vessels from the part of the rectum above pectinate line drain into internal iliac nodes. The part of rectum which lies below the pectinate line drain into medial group of superficial inguinal nodes.\textsuperscript{19}

**Venous drainage**

The internal rectal venous plexus or hemorrhoidal plexus drains mainly into superior rectal vein. The lower part of external plexus is drained by inferior rectal vein into pudendal vein, middle part by middle rectal vein into internal iliac vein.\textsuperscript{19}

**WOUND HEALING**

The word “wound healing”, used in pathological context, refers to the body’s replacement of destroyed tissue by living tissue. “If there were no
regeneration there could be no life, if everything regenerated there would be no death.”

**Wound healing**

The healing process has two aspects

- Contraction, a mechanical reduction in the size of the defect occurring in the first few weeks.

- Replacement of lost tissue, which is brought about by migration of cells as well as division of adjacent cells to provide extra tissue to fill the gap.

**Replacement**

Replacement can be accomplished in two ways, regeneration and repair.

**Regeneration**

Regeneration is a process whereby lost specialised tissue is replaced by proliferation of surrounding undamaged specialised cells.

**Repair**

Repair is the replacement of lost tissue by granulation tissue which matures to form scar tissue.
Phases of repair\textsuperscript{23}

In repair, tissue lost as a result of injury is replaced with a series of connective tissues, beginning with granulation tissue, which matures to form a scar. There are three major overlapping phases in wound healing.

- Inflammatory phase
- Proliferative phase
- Maturation phase

**Inflammatory phase**\textsuperscript{23,34}

Inflammatory phase is the immediate response to injury, also called reactive phase. This phase represents an attempt to limit damage by stopping the bleeding, sealing the surface of the wound and removing any necrotic tissue, foreign debris or bacteria.

This phase is characterised by haemorrhage or plasma exudation into wound site, increased vascular permeability, migration of cells into wound by chemotaxis, secretion of cytokines and growth factors into the wound, and activation of migrating cells. A fibrin clot forms as a result of the coagulation cascade being activated. The presence of clot and the cross linking of plasma proteins with ECM molecules provides the initial tensile strength in a wound. The generation of plasmin by coagulation cascade, as well as chemoattractants produced by neutrophils and macrophages are critical in this phase. Platelets and macrophages release growth factors which are chemoattractants and mitogenetic,
thus supportive of angiogenesis. In summary, the inflammatory phase is responsible for providing the initial tensile strength to a wound, the initiation of the removal of damaged tissue and the beginning of angiogenesis.

**Proliferative phase**\(^{23, 24}\)

Proliferative phase is a reparative process, as the acute responses of haemostasis and inflammation begins to resolve, the scaffolding is laid for repair of wound through angiogenesis, fibroplasia and epithelialization. Proliferative phase also called as regenerative phase or reparative phase is characterised by formation of an immature highly vascular connective tissue which has a granular appearance on gross examination and hence called as granulation tissue. This granulation tissue consists of capillary bed, fibroblasts, macrophages and loose arrangement of collagen, fibronectin and hyaluronic acid.

Several factors are responsible for migration of these cells into injured area, including cytokines derived from platelets and macrophages, as well tumour growth factor. Low oxygen tension at the centre of the wound is also a chemoattractant for these cells. The newly formed blood vessels enter into wound site; they are accompanied by fibroblast and myofibroblasts which typically arrange them in an orderly manner around adjacent blood vessels. Angiogenesis, the formation of new vessels is a prominent event in the formation of granulation tissue. In wounds the new vessels sprout from pre existing vessels resulting from proliferation of endothelial cells in the wall of pre-existing vessels in conjunction with degradation of vascular basement membrane. The
capillaries that develop by sprouting have poorly formed intercellular membrane and are thus leaky vessels, leading to the considerable oedema characteristic of granulation tissue.

**Maturation phase**

The maturation or remodelling phase is the final phase of wound healing. This phase is the period of scar contracture with collagen cross linking, shrinking and loss of oedema. Contraction occurs by centripetal movement of whole thickness of surrounding skin and reduces the amount of disorganised scar. This phase is characterised by restitution or restoration of prior tissue with various degree of replacement of that tissue by fibrous connective tissue or scar. The cellularity of the wound from cells including macrophages, inflammatory cells, myofibroblast and fibroblast decreases during this phase, with accumulation of type 1 collagen and formation of definitive scar composed of dense collagen bundles. This phase may go on for months to years and exact dating of wounds is impossible.
Factors modifying wound healing

Factors that are critical in the control of wound healing are divided into local and systemic factors.

Local factors

Local factors like infection and the type of wound, size and location of wound has a considerable effect on the final outcome of an injury. The ability to vascularise a wound site is a critical event in the formation of granulation tissue. Therefore tissues that are better vascularised provide a superior environment for wound healing than a poorly vascularised tissue.

Systematic factors

Systematic factors and nutritional status play an important role in wound healing. Vitamin C (ascorbic acid) is an essential cofactor of collagen synthesis and deficiency leads to poor wound healing, fragile vessels and life threatening haemorrhages. During starvation or protein depletion there is impairment of granulation tissue and collagen formation. This results in prolonged delay in wound healing.

Glucocorticoids and chemotherapeutic agents that depress protein synthesis will inhibit wound healing. Diabetes mellitus, ionizing radiation and aging impair wound healing at all stages. Deoxycorticosterone acetate and anabolic steroids like testosterone increases the speed of wound healing.
Rapid and effective wound healing is of paramount importance to the surgeon and to the patient. Failure of wound-healing generally leads to potentially life threatening complications, additional surgical procedures, and increased length of hospital stay, increased cost and long-term disability.

**Healing in the gastrointestinal tract**

The gastrointestinal tract consists of four layers: mucosa, submucosa, muscularis propria and serosa. In 1887, Halsted discovered that the submucosa provides the GI tract with the majority of its tensile strength. The bulk of collagen is contained within this layer, along with blood vessels, lymphatics and nerve fibres.

The muscularis propria layer consists of smooth muscle cells which are intermixed with dense network of collagen. The collagen content in this layer increases significantly with response to chronic obstruction. The serosa is a thin layer of connective tissue which covers the muscularis propria. During creating anastomosis, direct apposition of this layer minimizes the leak risk.
**Intestinal healing**

The process of healing in intestinal anastomosis mimics that of wound healing elsewhere in the body. This process can be divided into three phases:

1. an acute inflammatory (lag) phase,

2. a proliferative phase,

3. a remodelling or maturation phase.

The single most important molecule in determining intestinal wall strength is collagen. During the proliferative stage, fibroblasts become the predominant cell type. This fibroblasts play an important role in laying down collagen into extra cellular space. At the epithelial level, the crypts undergo division which covers the defect on the luminal surface of the bowel. After surgery, degradation of mature collagen begins in the first few hours. This predominates for the first 4 days. This family includes 20 zinc-dependent endopeptidases, in which is collagenase (MMP-1) is also included.

At the end of 3rd post operative day, in vivo use of MMP inhibitors has found to increase the strength of intestinal anastomoses by up to 48%. This suggests that these enzymes play an important role in determining the risk of anastomotic leak. Sepsis is thought to increase the level of transcription and activity of these endopeptidases. This may lead to anastomotic leak in early postoperative period.
By 7th postoperative day, collagen synthesis becomes the dominant force, particularly proximal to anastomotic site. After one and half months, there is no significant increase in the amount of collagen in the process of wound healing.

The strength of the scar continues to increase for many months after injury. The cross-linking between collagen fibres and their orientation are major factor which determines the tensile strength of tissues. Its the submucosal layer where the tensile strength of the bowel lies, because of its high content of collagen fibres. Therefore, in constructing a hand-sewn intestinal anastomosis, it is important that this layer is included when extramucosal bites are taken. Collagen synthetic capacity is usually uniform throughout the large bowel but its less in the small bowel. Collagen is significantly higher in the proximal and distal small bowel than in the mid jejunum. Overall collagen synthetic capacity is comparatively less in the small intestine.

Although no significant difference has been found between the strength of ileal anastomoses and that of colonic anastomoses till 4th post operative day, colonic collagen formation is much greater in the first 48 hours. The presence of the visceral peritoneum on the bowel wall has an influence in which two bowel ends can be joined.
Physiology of anastomotic healing

Healing in gastrointestinal tract anastomosis begins with inflammation phase or the “lag phase”. Initially a haemostatic response occurs with vasoconstriction which is followed by increased vascular permeability. This facilitates the efflux of inflammatory cells (neutrophils) into the wound. In the next stage, macrophages can be seen at anastomotic site, where they synthesize and release tissue growth factors.

Granulation tissue in the anastomotic site marks the beginning of proliferative phase and wound collagen undergoes both lysis and synthesis. The strength of anastomotic site is mainly derived from collagen fibrils, which are located within the submucosal layer.

During the first postoperative days, anastomotic strength is restricted as collagen is degraded secondary to collagenase activity at the site of injury. Early anastomotic strength is therefore dependent on suture or staple holding capacity of existing collagen, until a large amount of new collagen can be synthesized by both fibroblasts and smooth muscle cells.

Post operatively, anastomotic site will be weak for 1 or 2 days. The final phase of healing involves maturation of the newly formed anastomotic site. The density of macrophages and fibroblasts in the anastomotic site decreases, and hence newly formed collagen transforms into thick bundles and contractile units.
FACTORS INFLUENCING
HEALING OF GASTRO INTESTINAL ANASTOMOSIS

Wound-healing consists of a complex process that involves the interaction of predictable, orderly and time-dependent components. The outcomes of healing can be measured with time using wound healing curve. The curve begins with a flat “lag phase”. The risk of wound failure is greatest at this time, especially in gastrointestinal tract healing, when collagenase activity is greatest. After 2 days, the strength in colonic anastomoses loses 70% of their initial strength. Finally proliferation is demonstrated on the graph with a steep slope.25

Wound healing failure occurs when there is an abnormality in either the degree or duration of one of the components of tissue repair. Local and systemic factors may cause failure of gastrointestinal healing.

General factors

- Age and sex
- Circumstances (elective or emergency surgery)
- Sepsis
- Drugs (corticosteroids and immune suppressives)
- Systemic illness
Systemic factors

The role of systemic factors in aetiology of anastomotic leak is not yet completely defined. Among systemic factors at least three of them do seem to play a significant role and they are:

- Poor nutrition (serum albumin level below 3.0 g/dl)
- Anaemia (Hb below 11 g% and hematocrit below 33%)
- Excessive blood loss
- Therapeutic radiotheraphy
- Infected anastomosis
- Antibiotics
- Suture line disease

Local factors

- Site of anastomosis
- Tension
- Distruction of anastomosis
- Drains
- Suturing technique
- Suture materials
GENERAL FACTORS

Age and sex

In study of Irvin and Goligher, more than 50% of the patients were over years of age and the incidence of anastomotic break down in such cases was significantly higher than that encountered in patients below the age of 60 years.

Later in study of Goligher et al the somewhat higher incidence of dehiscence which was found in female patients compared to male is without statistical significance, as is the greater tendency to dehiscence noted by then in patients over the age of 60 than in those below this age\textsuperscript{27}

1. Circumstances

In emergency surgery or obstructed bowel, where the bowel is unprepared or the general condition of the patient is poor (ex. shock, malnutrition) lead to high chances of anastomotic dehiscence. On the other hand, in cases of elective surgery, where there is enough time to improve the general condition of the patient and the bowel can be well prepared, anastomosis heals well.\textsuperscript{28}

2. Sepsis

There is evidence from clinical and experimental studies that peritoneal sepsis have a adverse effect on the healing of anastomoses. A significant incidence of anastomotic dehiscence is encountered when a primary anastomoses of the colon is performed in the management of perforated diverticulitis or carcinoma, and traumatic injuries of the left colon. This may be
due to impaired synthesis of collagen in colonic anastomosis. The surgeon should avoid an anastomoses in the presence of established peritoneal sepsis and the bowel should be exteriorized and alimentary continuity can be established at a later date.

3. Drugs (corticosteroids and immunosuppressives)

Steroids impair wound healing. Higher dose of steroids impair wound healing to a greater degree. Steroids have a known anti-inflammatory effect that is partly attributed to lysosome membrane stabilization and this has been postulated as the cause of impaired healing. Vitamin A administration may reverse the steroid induced impairment of wound healing.28

4. Systemic illness

- **Jaundice**: Affects fibroblasts migration and collagen synthesis.30
- **Uraemia**: It delays the formation of granulation tissue and inhibits fibroblast growth.31
- **Malignancy**: Experimental evidence indicates that in patients with malignancy elsewhere in the body undergoing anastomosis due to any gastrointestinal pathology may have associated anaemia, malnutrition, jaundice, uraemia, exposure to irradiation, etc. which may impair anastomotic healing.21
- **Diabetes Mellitus**: Associated with post granulocyte function, including phagocytosis, and chemotaxis and decreased collagen synthesis.31
SPECIFIC FACTORS

1. Poor nutrition

Severe protein malnutrition is associated with abnormally low collagen content and reduced bursting strength of anastomosis - especially colonic, but malnutrition is less detrimental to healing of the intestine than of abdominal or skin wounds. In general perioperative total parental nutrition sees to be most effective in patients suffering from severe malnutrition preoperatively. ³¹

2. Anaemia

Leads to low oxygen tension resulting in impaired healing. ³¹

3. Excessive blood loss

Excessive blood loss results in reduction of colonic blood flow with subsequent tissue necrosis. Blood loss inevitably leads to the need of transfusion which in turn has been shown to decrease the patient's immunocompetence. ²⁶
4. Therapeutic radiotherapy

Acute change occurs within 3 weeks and is characterized by epithelial cell loss, decreased mitotic rate, reduction of villous height, and submucosal and muscular oedema. These entire changes are nearly resolved at 22 days, thus the current recommendation of a 3 week waiting period after radiation therapy and before surgery. Between 5% and 10% of patients treated with peri operative radiation therapy develop anastomatic complications.³⁰

Adenosine triphosphate-MgCl₂ appears to have a protective effect and may have an important future role in decreasing complications secondary to radiation therapy. Vitamin A may also have protective effects.³⁰

1. Infected anastomosis

Infection at the suture line enhances collagen lysis and leads to anastomotic breakdown.

2. Antibiotics

Antimicrobial preparation of the bowel is beneficial to anastomotic healing. However, complete sterilization of the colon is impossible. Although systemic antibiotics reduce the incidence of wound infection in colorectal surgery, their effects on preventing anastomotic dehiscence are certainly less.³²

3. Suture line disease

Especially malignancy, diverticular disease, crohns disease, ulcerative colitis, familial polyposis coli, and after the resection of an inviable segment of
the bowel a doubt full viability of the resected ends at the suture line are all constitute for the impairment of the anastomatic healing.\textsuperscript{32}

**LOCAL FACTORS**

1. **Site of anastomosis**

   Since serosal layer plays very important role in anastomotic healing, anastomoses at sites lacking serosa (oesophagus, lower rectum) have high rates of leakage.\textsuperscript{32}

2. **Tension**

   Tension at the suture line hampers the suture line blood flow, hence tension should be avoided by generous mobilisation of the bowels especially fixed parts like duodenum, ascending and descending colon and rectum.\textsuperscript{32}

3. **Destruction of the anastomoses**

   It occurs with dilated proximal bowel and proximal faecal loading. This calls for an adequate decompression and cleansing of the proximal bowel. Destruction of the bowel ends may occur if neostigmine is used to reverse the effects of relaxants and so some advocate using pyridostigmine instead. Stimuli like early postoperative feeding, contrast x-ray examination may also be dangerous.\textsuperscript{32}
4. Drains

Drains inserted in close proximity to the suture line may produce harmful effects by provoking a marked inflammatory response. Drains have been demonstrated to potentiate infection in both experimental and clinical studies. This may impair healing.\textsuperscript{32}

5. Suturing technique

Mucosal inversion is proved beyond doubt, by both experimental and clinical studies, to be superior to mucosal eversion\textsuperscript{32} There has been no significant difference in results of single layer and double layer suture techniques in much clinical trial. Single layer techniques proved to be superior and preferred by many surgeons in anastomosis involving extra peritoneal portion of the rectum and oesophagus, as this preserves the blood supply and full lumen width better than a double layer technique.\textsuperscript{34}

A single layer anastomoses is the method of choice throughout the gastrointestinal tract, with modification according to site as it is simple and safe.\textsuperscript{35}

6. Suture materials

Suture materials is described as follows:

**SUTURE MATERIALS**

The word “suture” describes any strand of material used to ligate (tie) blood vessels or approximate (bring close together) tissues.\textsuperscript{37}
## Types of Suture materials

<table>
<thead>
<tr>
<th>Absorbable</th>
<th>Nonabsorbable</th>
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<tbody>
<tr>
<td>Catgut, Collagen Homopolymer of glycolide Copolymers of glycolide and lactide Homopolymer of polydioxanone</td>
<td>Polyester, Polyamide&lt;br&gt;Polypropylene, Polyethylene&lt;br&gt;Steel, Silk&lt;br&gt;Cotton, Linen</td>
</tr>
<tr>
<td><strong>Biological</strong></td>
<td><strong>Artificial</strong></td>
</tr>
<tr>
<td>Catgut, collagen&lt;br&gt;Silk, linen, cotton</td>
<td>Polyester, Polyamide&lt;br&gt;Polyamide, polypropylene&lt;br&gt;Polylactide, polylactide&lt;br&gt;Polydioxanone, steel</td>
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<tr>
<td><strong>Monofilament</strong></td>
<td><strong>Multifilament</strong></td>
</tr>
<tr>
<td>Polyamide, polypropylene&lt;br&gt;Polyethylene, polydioxanone&lt;br&gt;Catgut, steel</td>
<td>Polyester, Polyamide&lt;br&gt;Polyglycolide, Polylactide&lt;br&gt;Silk, Cotton, Linen, Steel.</td>
</tr>
<tr>
<td><strong>Braided</strong></td>
<td><strong>Twisted</strong></td>
</tr>
<tr>
<td>Polyester, Polyamide&lt;br&gt;Polyglycolide, Polylactide, Silk</td>
<td>Cotton, Linen</td>
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<tr>
<td><strong>Coated</strong></td>
<td><strong>Uncoated</strong></td>
</tr>
<tr>
<td>Polyester, Polyglycolide&lt;br&gt;Polylactide, Cotton, Linen Polyethylene, Catgut, Collagen, Steel</td>
<td>Polyamide, Polypropylene.</td>
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</tbody>
</table>
A summary of various materials available and categories of suture material

<table>
<thead>
<tr>
<th>Absorbable</th>
<th>Monofilment</th>
<th>Braided (Multifilament)</th>
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<tbody>
<tr>
<td></td>
<td>Catgut</td>
<td>Polyglycolic Acid</td>
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<td></td>
<td>Polydioxanone (‘PDS’)</td>
<td>(‘Dexon’)</td>
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<td></td>
<td>Polyglyconate (‘Maxon’)</td>
<td>Polyglactin 910</td>
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<td></td>
<td>Poliglecaprone (‘Monocryl’)</td>
<td>(‘Vicryl’)</td>
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<td>Non-absorbable</td>
<td>Nylon (‘Ethilon’)</td>
<td>Silk</td>
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<tr>
<td></td>
<td>Polypropylene (‘Prolene’)</td>
<td>Stainless Steel (staples)</td>
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<tr>
<td></td>
<td>Stainless Steel (suture material)</td>
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</tbody>
</table>

**Ideal suture material**

- The ideal suture material should
- Have good handling characteristics
- Not induce a significant tissue reaction
- Allow secure knots
- Have adequate tensile strength
- Not cut through tissue
- Be sterile
- Be non-electrolytic
- Be non-allergenic
- Cheap and sterile
Suture Materials

Non-absorbable sutures\textsuperscript{39}

These are suture materials which are strands of material that are suitably resistant to the action of living mammalian tissue. They are subclassified into natural, metallic and synthetic. They further classified into monofilament and multifilament. Some of the sutures may be coated. They possess high tensile strength, which does not deteriorate immediately. They are ideal for wound closure, hernia repairs and in cardiovascular surgery.

Non-absorbable sutures

Silk is derived from the cocoon of the silk worm larvae. It is basically a protein like keratin of hair and skin and is covered by an albuminous layer. The suture is braided round a core and coated with wax to reduce capillary action. The material has high tensile strength which is probably totally lost after 2 years. Tissue reaction is greater to silk than to the synthetic non-absorbable.

Linen

Linen is made from flax and is cellulose material. It is twisted to form a fibre to make a suture. Tissue reaction is similar to silk and the material handles and knots well.
**Polypropylene**

This fibre is better known as PROLENE it is a monofilament and is chemically extruded from a purified and dyed polymer. It has an extremely high tensile strength which it retains indefinitely on implantation. Handling is good and knotting very secure since the material deforms on knotting and allows the knot to bed down on itself. It is less thrombogenic as compared to silk. It is inert and non-biodegradable.

**Stainless steel**

It has an enviable reputation among non-absorbable sutures for strength and low tissue reaction. The steel technique is very exacting and the penalties for poor techniques costly. Stainless Steel Sternum Bands are available for sternum closure. They are specially designed for sternum closure that they do not penetrate the bone and prevent its cracking. They are highly stable, simple to remove and promote faster healing.

**Tissue adhesives (‘Vetbond’, ‘Vetseal’)**

The ideal adhesive would

- Be safe for topical application
- Be easy to apply
- Be polymerize rapidly
Absorbable suture materials

Absorbables can further be sub classified into natural and synthetic. It is defined as sterile strand prepared from collagen derived from healthy mammals or a synthetic polymer. It is capable of being absorbed by living mammalian tissue, but may be treated to modify its resistance to absorption. It may be impregnated or coated with a suitable antimicrobial agent. Two major mechanisms of absorption result in the degradation of absorbable sutures. Sutures of biological origin such as surgical gut are gradually digested by tissue enzymes.
Absorbable materials

Catgut

Surgical Gut is derived from animal intestines and is over 99 percent pure collagen. It is made of submucosa of sheep intestines or the serosa of beef cattle intestines. It is ‘monofilament’ and absorbs by a process of enzymatic digestion by proteolytic enzymes derived from lysozymes contained within polymorphs and macrophages.

Polyglactin 910 (‘Vicryl’)

They can be either monofilament or braided. MONOCRYL and PDS II are monofilament while Coated VICRYL, VICRYL Plus and VICRYL Rapide are braided. Finer sizes in Coated VICRYL may also be monofilament.

‘Vicryl Rapide’

It is from a copolymer of glycolide and lactide. The substances are derived from glycolic and lactic acids.

Polydioxanone (‘PDS’)

These are monofilament synthetic absorbable suture. They are formed by polymerizing the monomer - para - dioxanone in the presence of a catalyst to form a strong pliable filament. They are available in two forms. PDS I & PDS II. At 14 days, PDS II sutures still retain 70% of their original strength.
PDS II is recommended for the following:

- Wound closure
- Orthopaedic surgery.
- G.I. Surgery
- Ob-gyn. Procedures
- Paediatric Cardiovascular Surgery.

**Poliglecaprone 25 (‘Monocryl’)**

It is synthetic absorbable suture composed of co-polymer of 75% glycolide and 25% caprolactone. It has high initial tensile strength. The major benefit of MONOCRYL is its predictable loss of tensile strength over three week period. This is achieved by systematic hydrolysis of the suture material. Its commonly used in intradermal and subcutaneous wound closures.

*Fig. 13: Absorbable suture material*
Original tensile strength of Vicryl is retained by 75% at 2 weeks and 50% at 3 weeks. The Monocryl retains 60-70% of original strength in 1 week and 30-40% in 2 weeks. PDS II retains 50% of its strength at 4 weeks after implantation.\textsuperscript{39}

\textbf{MONOFILAMENT AND MULTIFILAMENT}\textsuperscript{39}

It should also be noted that some of these suture materials consist of a single smooth strand (monofilament) and others consists of multiple fibres woven together (multifilament). Characteristically, multifilament suture material (e.g., silk or mersilene) tends to be easier to handle and tie and knots in multifilament material are less likely to slip. On the other hand, monofilament materials (e.g., nylon or Prolene) are less traumatic, since they glide through tissues with less friction and they may be associated with lower rates of infection. Since monofilament materials are more likely to slip, one generally ties knots with 5 or 6 “throws” when using monofilament materials (in contrast to 3 throws with silk or Mersilene). Despite the greater number of knots required, monofilament materials such as nylon are generally preferred for skin
closure because they stimulate less tissue reaction, are less traumatic, may have less chances of infection and provide a better cosmetic result.

Among the absorbable suture materials, Vicryl is a multifilament material, but there is also a coated vicryl that provides decreased drag through tissue. For this reason, coated vicryl is used by some surgeons for the interior layer of bowel anastomoses. Monocryl is an absorbable monofilament material, but has excellent pliability and provides easy handling and good knot security.

![Fig. 15: Multifilament and monofilament suture](image)

**Needles**

The choice of surgical needle is as important as the choice of suture. The needle holder chosen also needs to be appropriate; a large needle holder damages a small needle, and a large needle is unmanageable in a small needle holder. The passage of a needle through tissue should follow its curvature. This minimizes tissue damage. The appropriate size and shape of cutting, or round-bodied
atraumatic needle, needs to be chosen for the least traumatic passage through tissue. Shaped needles allow easier access for suturing. Examples are the J-shaped needle useful in low-approach femoral hernia repair, or the compound curve needle used in ophthalmic surgery. Hand needles should be avoided because of the risk of needlestick injury.

The tips of laparotomy closure needles are deliberately blunted by some of the manufacturers to reduce the risk of needle-stick injury. Needles may come with a loop suture (to avoid a knot at the end of a laparotomy) or as double-ended sutures.

**Methods of suturing**

There are various methods of suture techniques. It can be created by either a simple or interrupted sutures or by a continuous or running statures. There are various advantages of one technique over other. Main advantage of continuous suture technique is the suture line is water tight but integrity of the suture line is based on only one stitch.

Also haemostasis is better with continuous suturing technique, but it may constrict anastomotic site blood flow more than interrupted technique. Irrespective of the technique, bowel anastamosis must follow basic principle as follows:

- Anastomotic site must be water tight and also must have mucosal apposition.
➢ The submucosal layer must be included in the anastomotic site.

➢ Also edges should not get strangulated in order to avoid stricture or necrosis.

**Lembert suture**

Its the most commonly used suturing technique in GIT surgery. Its used mainly as outer layer of a two-layer bowel anastomosis. Its also used to repair seromusular tears in bowel wall. The stitches are started 3 to 4 mm lateral to incision and is placed in a right angle to long axis of incision. It includes only the seromuscular layer. Care is taken not to include full thickness of bowel wall.

Tip of the needle is brought out as close to the edge of incision as possible and is reinserted to the apposing wound edge. And again brought out 3 to 4 mm away from wound edge.

The sutures are then tied in such a way that the tissues are approximated, but without tearing the tissues. Most common suture metrical used in this technique is PDS suture or silk. It can be performed in continuous or interrupted fashion.
**Halsted suture**

**Horizontal mattress suture** : The traditional stitch which taken in all coats, attributed to William Halsted (1852-1922). This is most commonly used for seromuscular apposition in a multilayer bowel anastomoses. In this method, the suture martial is passed through seromuscular layer apparently 2 to 3 mm lateral to wound edge and is brought out wound edge.

The needle is passed though opposing edge of wound and brought out 2 to 3 mm lateral. The suture is ended by bringing the distal end of suture line the needle is passed though both edges of wound to create two free ends of suture on one side of wound edge with loop of suture on other side.

This suturing technique is mostly used in inflamed, damaged or abnormal tissues where a lembert suture pulls through tissues. Since this mattress sutures distributes tissue tension in a perpendicular plane compared to a lembert suture,
this technique allows for a better apposition of tissue with least crushing effects on them.

![Fig. 17: Halsted Suture](image)

**Purse string suture**

This suturing technique is mostly used for inverting appendiceal stumps or for proper placement of drainage tubings or to secure feeding tubings. Its basically a lembert suture in a continuous fashion about a fixed point or opening the GIT. This mostly performed using a non-absorbable suture material.

![Fig. 18: Purse-String Suture](image)
Connell suture

This stitch gets popularised after the 19th century by an American surgeon, is a full thickness, mostly continuous suture which allows for mucosa to be inverted into the lumen of intestinal anastomosis. It’s a full thickness suturing technique started at edge of anastomosis and is brought in a full thickness starting from inside to outside and from one side and from outside to inside on opposite end. The suturing is done in such a way that knot is kept inside the lumen.

The suture is then passed all through the tissues from inside to outside to outside on one side to begin the Connell stitch. On the other side of the anastomosis, the suture is driven through the tissues in a full thickness including all layers of gut from outside to inside.

On the inside of bowel lembert the stitch is advanced 2 to 3 mm along the bowel wall which is driven through bowel wall from inside to outside on same side with the suture being new on the outside of bowel, the next knot is performed on opposite end in a similar fashion. This forms an U-shaped, full thickness, running inverting suture line. This serves an inner layer of a two-layer anastomosis.
Comparison between inverted and everted anastomosis:

For a long duration, there exist a debate between the concept of inverting and everting intestinal anastomoses. Majority of hand-sewn anastomoses are recently being done using an inverting intestinal anastomoses technique either in single or double layers.

In the year 1956, its Gamine & associates made a publication on 156 patients series about bowel anastomases using a single layer technique using non absorbable sutures. This study reports around 5 deaths due to anastomotic leak. The overall incidence of all anastomotic complications was around 8.6% but in most of the patients there were no radiographic evidence.

In the year 1966, another clinical study being done on GIT anastomoses showing only one leak occurred. This study was done by Getzen comparing inverting and everting intestinal anastomoses in lower animals. In 293 bowel
anastomoses in dogs, there was no evidence of fistula or mucocel formation. Anastomatic edema was noted more in evened group upto 3 weeks after surgery.

Its noted that the tensile strength of inverting sutures was 2/3rd when compared to everting group upto 3 weeks after surgery. Anastomotic strength was comparable in two groups after 3 weeks.

Also its noted that no deaths occurred to everted mucosa. As with other wounds, healing occurs in intestinal anastomoses by primary intention. Among all layers of bowel lumen submucosa layer plays an important role since, it has fibroblasts which helps in producing collagen which holds the intestinal anastomoses together.

In inversion technique, the anastomotic site presents with ends of mucosa to lumen, where they are degraded. In this technique, the exposed submucosa tends to become adherent to other surrounding structure producing adhesions and hence delaying healing. From this study most have adopted this technique of inverting bowel anastomosis.

**Principles of successful bowel anastomoses**

1. **Nutrition status**

   Nutritional status can be assessed on two important biochemical parameters namely, hemoglobin and serum albumin estimation. Many studies shows that prolonged and short term malnutrition decreases anastomotic healing.
The mechanism in which poor nutrition affects anastomotic healing may be due to lack of essential amino acids for collagen synthesis or deterioration in the patient's immune competence. The majority of well nourished gastrointestinal surgery patients do not require special nutritional regimens. Enteral nutrition is the first choice whenever possible. It has the advantage of augmenting host defences by sustaining the gut barrier and so diminishing the problem of bacterial translocation, an important factor implicated in multi organ failure. Only if the patient exhibits intolerance to various enteral nutrients, then total parental nutrition is considered. Vitamin C is an important vitamin in the process of intestinal healing. Vitamin C deficiency leads to an inability to secrete procollagen into the extracellular space. Ketone bodies as a nutritional factor in gastrointestinal surgery appear to be superior to glucose. They inhibit the intestinal mucosal atrophy associated with glucose based parenteral nutrition. Growth hormone has been shown to increase the uptake of glutamine and several other amino acids by the small intestine a process which explains the anabolic effect and nitrogen retention attributed to growth hormone.43

2.No contamination in abdominal cavity

Among the factors which affects outcome of intestinal anastomoses, bacterial contamination plays a major role. Its found that early and major decreases in suture holding ability of anastomotic site occurs in esophagus, stomach and small bowel and larger bowel.
64% loss of strength found in gastroduodenostomies and 72% loss of strength occurs in colonic anastomoses. This loss in strength occurs due to an imbalance between collagen synthesis and degradation and it occurs usually within first 3 days of healing. This 3 days in immediate postoperative period is crucial in intestinal anastomoses due to its integrity depend on suture holding capacity of tissues. Contamination of peritoneal cavity with bacteria causes an increase in local concentration of leucocytes. These leucocytes are responsible for a significant degree of lysis of collagen.

3. Surgical Exposure and accessibility

Accessibility in a critical treatment and incision should be made in such a way so as to allow adequate exposure to operating field. The lateral aspects and peripheral areas of surgical field can be controlled by using a suitable retractor. These retractors can sometimes be attached to the surgical table.

These measures allows more uses of effective and efficient use of surgical assistants and space. Hence its important to divide the abdomen into compartments while operating. This can be done by many ways. The small bowel is extremely difficult to handle, and hence commonly packed away from surgical field by placing a wet guaaze. The next step is mobilizing the bowel to surface.

In absence of dense adhesions because of underlying pathology, the small intestine can be mobile to allow the relevant segment to brought outside the abdominal cavity. In many situation, transverse colon and sigmoid colon can be
easily mobilised and brought to the surface. Mostly as with other portion of large bowel, the peritoneum must be divided along the lateral border of colon and retroperitoneal structures should be reflected posteriorly.

Increased lysis of collagen leads to increased incidence of anastomotic breakdown. Anastomotic healing is significantly affected by bacterial population in respective part of intestine. The fibropurulent exudates filling anastomotic space despite vigorous lavage in peritoneal sepsis presents fibroplasia and new blood vessel formation from bridging the gap as similar to healing by secondary intention. Usage of antibiotics reverses this process of primary healing. The process of sepsis increases lysis of collagen. Also synthesis of collagen in presence of sepsis also decreased.

4. Gentle tissue handling and meticulous technique

As with any operation, gentle tissue handling is paramount. When suturing the bowel, use atraumatic graspers and pick up the tissue only when necessary to prevent crushing injury from the forceps. Pass the needle perpendicular to tissues, taking bites that include the submucosa. Minimize lateral movement to avoid tissue shearing. An inverting technique is probably preferable, but an everting anastomosis, which minimizes exposed mucosa, is likely safe as well. Follow the adage "approximate, do not strangulate" to avoid ischemia of the bowel wall at the anastomosis. For hand sutured anastomosis, do not pull or tie down too tightly.44
5. Role of vascularity in Anastomoses

Vascularity plays a major role in anastomoses. The adequacy of blood supply to anastomoses site can be assessed by presence of bleeding form cut ends of bowel site, colour of bowel and pulsations of adjacent mesentric vessels before constructing anastomoses.

The tissues around the intestine are divided with scissors, but the mesentry is divided between clamps and tied using a suitable thread. Tissues planes are separated by means of blunt dissection either with fingers or using swab. Minor bleeding points are occluded using a coagulating electrocautery.

Major disadvantages of dissection technique are oozing from raw surfaces makes difficulty in operating field for anastomoses to be constructed. Also the tissues which lies beyond a tie are bulky which leaves dead tissues inside the body which may act as focus for infection and adhesions.

Many new methods are used for dissection which includes ultrasonic scalpel, bloodless bipolar electrocautery which prevents problem by coagulating a small section of tissue between jaws of instrument. Along with coagulation the blood vessels are getting occluded simultaneously. Finally bleeding is reduced which requires no ties further.43

6. Avoiding tension in anastomotic site:

Anastomotic site should be of least tension to prevent complications. Mobilisation of bowel plays a critical factor in determining further perfusion at
anastomotic site. Rough mobilization mostly damages critical vessels. Also its most important to check for distal obstruction beyond anastomotic site.

Constructing small bowel anastomoses without tension possess not much difficulties. But for large bowel anastomoses both splenic flexure and hepatic flexure must be mobilized freely before constructing anastomoses.\(^{42}\)

7. Approximation of well vascularised cut ends of the bowel

If anastomotic site is constructed in tension, without proper mobilization, tension on anastomoses compromises anastomotic perfusion and leads to inflammatory cellular infiltrates. Hence before starting to perform anastomoses adequate pulsation of mesenteric vessels, colour of bowel ends to be anastomosed distal patency of lumen of intestine must be examined and confirmed.\(^{42}\)

INTESTINAL ANASTOMOSES - METHODS & TECHNIQUES

Various methods are available for construction of intestinal anastomoses. These methods can be used depending on circumstances and on individual choice. These are as follows.

Mobile bowel, edge to edge, single layer, interrupted stitches

- Insert sutures joining the anterior walls. Carefully avoid picking up the back wall. Tie the knots on the outside of the bowel.
After completing the anterior wall, the bowel is turned over, to bring what was the back wall to the front and insert a series of sutures to close this, completing the anastomosis.

If stay sutures are used, it should be cut out or tied.

The mesenteric and antimesenteric edges of the bowel are carefully checked. The junctions of the anterior and posterior suture lines are most likely to have defects. If necessary extra sutures are inserted.

**Edge to edge, single layer, continuous stitches**

This can be done by starting on the back wall, and inserting a stitch at one end from outside in on one side, and inside out on the other side and tying them. Cliping the short end, and insert the needle back through into the lumen and introducing a continuous, unlocked, spiral stitch joining the back walls as far as the other end.

If the line of anastomosis lies in the sagittal plane start at the near end, complete the stitching of the back wall, by continuing round the far corner and dose the anterior walls from far to near, to reach the starting point. When continuing the spiral stitch onto the anterior wall there it will be found to have stitch with an unnatural action, starting with hand held supine and pronating it to drive the stitch through.

For a right-handed surgeon, to avoid this, at the far end, having passed the needle through to the left side, reverse the needle and pass it from within
out, creating a loop on the mucosa - single 'Connell' stitch. You can now continue to sew naturally, driving the needle from right to left along the anterior wall, to reach the starting point. Remove and discard the needle and tie the free end to the clamped short end. Reverse this procedure if the surgeon is left-handed.

- If the line of anastomosis lies in the transverse (coronal) plane, start at the right end. Insert the first stitch from without in, then from within out, and tie the stitch and clamp the short end. The needle is reinserted from without on the near side. Further anstomoses is carried on with the over and over spiral stitches, uniting the back walls from right to left.

- Again, at the left end, having taken the last stitch from far to near, reverse the needle to create a single Connell (mattress stitch with a loop on the mucosal aspect) stitch, coming out on the near side. Continue on the anterior suture line from left to right, inserting stitches from far to near. When the right end is reached, cut off the needle and tie the free end to the clamped short end.

- The anastomosis is checked for its patency
Fixed bowel, single layer, interrupted stitches

- This method is particularly applicable in the large bowel to anastomose it with the rectum, which lies against the sacrum and cannot be rotated. In addition, access is limited, so the anastomosis is fashioned not at the surface but in the depths.

- The posterior layers are united using carefully placed all-coats stitches, with the knots tied within the lumen. If the bowel is fixed, and subsequent access will be greatly restricted. Now these stitches are tied with the bowel ends apart, clipping but not tying them until they are all inserted.

- Now, keeping the sutures taut and in the correct order, the mobile end is slide down to lie accurately apposed to the fixed edge of bowel and tie them. This is the “parachute” technique. Leave the outer ligature ends long for the present but cut the ligature ends of the remainder, leaving the knots on the interior of the bowel.

- Many colorectal surgeons use inverting, longitudinal (vertical) mattress sutures for the back wall. These pass out through all coats at a distance from the edge, enter the other bowel end at a similar distance from the edge, then take a small bite of each of the edges before being tied within the lumen.

- Insert interrupted inverting anterior stitches to complete the anastomosis. These may be simple or inverting longitudinal mattress stitches. The bowel
must be sutured using all-coats stitches. Many colorectal surgeons employ extramucosal or even seromuscular stitches with success.

**Technique of single layer inverting suture**

Our newly devised anastomotic technique involves a single layer inverting anastomosis in which sutures are placed through the serosa, submucosa and muscularis mucosae. In practice, the needles should enter from the serosal side through the muscle layer, the submucosa and muscularis mucosae. The needle is pulled out between the muscularis mucosae and mucosa, and then placed back in an opposite fashion on the other side of the anastomosis. The suture is placed about four millimeters distant from the anastomotic edge on the serosa, two millimeters from the nt edge in the submucosa and one millimeter from the edge in the muscularis mucosae.

The suture is knotted on the serosal side. As the needle does not go through the mucosa, the sutures are not exposed on the inside surface of the alimentary tract, and impairment of the mucosa is minimal. A wide union from the serosa to the muscularis mucosae is obtained. The technique is simple and either interrupted or continuous suturing is possible. Interrupted and continuous sutures are available.

![Fig. 20: One layer inverting anastomosis](image)
End to end two layer techniques

In this technique the bowel ends must be brought together without tension. Stay sutures, which avoid the need for tissue forceps, may help with the placement of the posterior, continuous, seromuscular layer and allow rotation of the anastomosis. The all-layers continuous inner suture can be undertaken with a double-ended suture to help to keep the anastomosis even, going from the middle posteriorly to the lateral om edge on each side. At the corners, one or two Connell 'loop-on-the-mucosae' sutures help to invert the mucosa. The double-ended suture can then be tied in the middle (on the anti-mesenteric side of the bowel). Finally, the anastomosis is inverted using a seromuscular, anterior, continuous Lembert suture. The apposition of bowel edges should, in each layer, be as accurate as possible. Bites should be approximately 5 mm deep and 5 mm apart. Suture materials should be of 2/0-3/0 size and made of an absorbable polymer, which can be braided (e.g. polyglactin), or a monofilament (e.g. polydioxanone), mounted on an atraumatic round-bodied needle. Braided,
coated sutures are the easiest to handle and knot. Alternatively, the inner continuous all layers sutures can be undertaken first. An inverting seromuscular Lembert layer is then applied second. This risks mesenteric vascular damage and is not recommended. It is crucial to make sure that only bowel of similar diameter is brought together to form an end-to-end anastomosis.

‘Parachuting’ or ‘purse-stringing’ a proximal dilated bowel lumen into narrower distal bowel risks a poor anastomosis and subsequent leakage. In such a case, a side-to-side or end-to-side anastomosis may be safer. The Cheatle split (making a cut into the antimesenteric border) may help to enlarge the lumen of
distal, collapsed bowel. The mesentery should always be closed to avoid the later risk of an internal hernia through a persistent mesenteric defect. Care must be taken in preventing mesenteric vessel damage as the anastomosis may need to be revised.

- The loop on the mucosa Connell stitch, which inverts the corners but is not haemostatic.
- The second seromuscular outside layer that ensures mucosal inversion and can be performed as single layer without the internal all layers suture End to end one layer technique; end to side anastomosis.\(^4\)

These anastomoses can be undertaken using open, avoiding the use of occlusion clamps, or closed techniques. They are useful in the following circumstances.

- When access is not easy, as in transabdominal oesophagogastric anastomosis or after low anterior resection when there is disparity in the bowel lumen when the bowel serosa is lacking
- When interrupted sutures are required, a wide choice is available.
There is no evidence that one technique is significantly superior to another, but the interrupted single-layer extramucosal (seromuscular) suture is probably the most widely practiced.

Fig. 23: End to end, one layer anastomosis in bowel (open)
Important complications following intestinal anastomosis include the following:

- Anastomotic leak
- Bleeding
- Wound infection
- Anastomotic stricture

**Anastomotic Leak**

Anastomotic leak is the most feared early complication of intestinal anastomosis. The healing of intestinal anastomosis is broadly divided into three phases: the inflammatory phase, the fibroplasia phase, and the remodelling phase. During the inflammatory phase, the integrity of anastomosis is dependent on mechanical strength provided by sutures. The inflammatory phase is followed by the fibroplasia phase around postoperative days 5-7, characterized by a switch from collagen degradation to collagen deposition that gives strength to anastomosis. Any systemic or local factor that causes delay in transition from inflammatory phase to fibroplasia phase can result in poor healing and anastomotic leak. Systemic conditions that increase the risk of anastomotic leak are anemia, diabetes mellitus, malnutrition with hypoalbuminemia, vitamin deficiencies, and steroid therapy. Local factors such as the presence of irradiated
bowel, anastomosis involving disease-affected bowel, and inadequate blood flow are associated with delayed healing and contributes to anastomotic leak.

Anastomotic leak presenting on postoperative day 1 or 2 is invariably due to technical reasons. Anastomotic leak secondary to interference in the normal healing mechanism usually presents around the end of the first postoperative week. Anastomotic leak can present either as frank peritonitis when the leak is uncontrolled or as localized intra-abdominal collection/abscess if the leak is controlled. An uncontrolled leak with diffuse peritonitis is associated with high morbidity and mortality and requires re-exploration. During relaparotomy, a thorough lavage of the peritoneal cavity should be carried out. In most circumstances, it is better to dismantle the anastomosis and bring the bowel loops as stoma. A controlled leak presenting with a localized intra-abdominal abscess can effectively managed conservatively by means of percutaneous drainage of the abscess under imaging guidance and antibiotics.

**Bleeding**

Bleeding-related complications following intestinal anastomosis are common in patients with sepsis and deranged coagulopathy. Bleeding may manifest in the immediate postoperative period as either hemorrhagic aspirate from the nasogastric tube, hematemesis, melena, or bleeding from an intra-abdominal drain. Patients with bleeding should be aggressively managed with correction of coagulopathy (if present) and blood transfusion. If the bleeding results in hemodynamic instability with a significant decrease in hemoglobin,
urgent reexploration should be performed. Intraoperative anastomotic site bleeding is characterized by blood in the intestinal lumen distal to the anastomosis. In such circumstances, the anterior layer of the sutures is opened and both layers are examined for evidence of any bleeding. Once the bleeding site is identified, it can be controlled by hemostatic sutures. The decision to reanastomose or convert into stoma depends upon the general condition of the patient. Conversion to stoma is preferred in patients with hemodynamic instability.

**Wound Infection**

Wound infection occurs when there is uncontrolled spillage of intestinal contents during anastomosis. It is managed by removing a few skin sutures and ensuring proper drainage of pus. Superficial surgical site wound infection does not require treatment with systemic antibiotics.

**Anastomotic Stricture**

Anastomotic stricture is a late complication of intestinal anastomosis. The risk of anastomotic stricture is marginally increased after end-to-end anastomosis, especially when performed using a stapled technique. The most important risk factor for anastomotic stricture is a controlled anastomotic leak managed conservatively. This scenario is more common after cervical esophageal and colorectal anastomotic leak. Anastomotic strictures occurring in these areas can be conservatively managed with endoscopic or colonoscopic dilatation. If this fails, surgical revision might be required.
MATERIALS AND METHODS

The comparative study was done on patients presenting to Govt. Rajaji Hospital, attached to Madurai Medical College, either in emergency or elective undergoing resection anastomosis of bowel from August 2013 to August 2014.

The patients selected for this study are those who were admitted with various clinical conditions requiring resection and anastomosis of small and large bowel. Based on detailed history, thorough clinical examinations, radiological examinations and ultrasound of abdomen, the diagnosis was made. These patients were subjected to the required pre operative investigations; after bowel preparation, ensuring fitness elective surgery was done. Cases were allotted to either group alternatively, requiring single layer anastomosis and double layer anastomosis for various clinical conditions of small and large bowel. Intestinal anastomosis was carried out in single layer continuous extramucosal technique with 3-0 PDS and double layer continuous technique with 3-0 vicryl taking through all layers and seromucusular layer with 3-0 mersilk.

Each case was analyzed with respect to duration required to perform intestinal anastomosis, post operative complications like anastomotic leak and the duration of hospital stay. The duration of anastomosis begin with placement of first stitch on the bowel and ended when the last stitch was cut. All single layer anastomosis was done with PDS 3-0 pack which had a suture material of 90 cm length. For double layer, 3-0 vicryl was used taking through all layers and
seromucosal layer with 3-0 mersilk pack which had suture material measuring 90 cm. Cost effectiveness is not studied here in our study. All cases were followed up to discharge and subsequently for a follow up period of 2 weeks. A minimum of 50 cases with the following inclusions and exclusion criteria were selected for the study and were allocated alternatively to each of the comparative study group.

**Inclusion criteria:**

- Patients giving written informed consent (Annexure 1)
- Patients undergoing resection and anastomoses of small bowel and large bowel at our hospital for causes like small bowel gangrene, strangulated hernia with bowel loop as content, small and large bowel tumours, intestinal ischaemia.
- Age more than 18 years.

**Exclusion criteria:**

- Patients who are not willing to give written informed consent. Resection anastomoses done for perforation with gross contamination of peritoneal cavity.
- Associated co-morbid diseases like sepsis, known cardiovascular disease, grossly deranged liver function.
A pretested proforma will be used to collect relevant information (patient data, clinical findings, lab investigations, follow up events etc.,) from all the selected patients.

**Statistical analysis**

Results are expressed as mean and standard deviation for continuous data and frequency as number and percentage. Unpaired t test was used to compare mean levels between two groups. Categorical data was analysed by Chi square test and fischer exact test. A value of 0.05 or less was considered for statistical significance.

*Fig. 24: Terminal ileal stricture*
Fig. 25 Single layer anterior ileo transverse anastomosis

Fig. 26 : Single layer jeuno jeunal anastomosis
Fig. 27: Double layered duodeno jejuna anastomosis
RESULTS

Table -1: AGE DISTRIBUTION

<table>
<thead>
<tr>
<th>Age Groups (Years)</th>
<th>Group A (Single Layer) n (%)</th>
<th>Group B (Double Layer) n(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-30</td>
<td>5 ( 20% )</td>
<td>5 ( 20% )</td>
</tr>
<tr>
<td>31-40</td>
<td>8 ( 32% )</td>
<td>6 ( 24% )</td>
</tr>
<tr>
<td>41-50</td>
<td>6 ( 24% )</td>
<td>9 ( 36% )</td>
</tr>
<tr>
<td>51-60</td>
<td>6 ( 24% )</td>
<td>5 ( 20% )</td>
</tr>
<tr>
<td>TOTAL</td>
<td>25 ( 100% )</td>
<td>25 ( 100% )</td>
</tr>
<tr>
<td>MEAN AGE</td>
<td>41.4</td>
<td>41.32</td>
</tr>
</tbody>
</table>

In our study we had two groups, Group A (single layer) and Group B (Double layer). Maximum number of patients in group A (single layer) were in the age group of 31-40 years i.e. 08 (32%) and in group B (double layer) maximum number of patients were in the age group of 41-50 years i.e. 09 (36%). The mean age in group A (single layer) was 41.4 years and in group B (double layer) was 41.32 years.
Table -2: SEX DISTRIBUTION

<table>
<thead>
<tr>
<th>Gender</th>
<th>Group A (Single Layer) n (%)</th>
<th>Group B (Double Layer) n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>17 ( 68% )</td>
<td>15 ( 60% )</td>
</tr>
<tr>
<td>Female</td>
<td>08 ( 32% )</td>
<td>10 ( 40% )</td>
</tr>
</tbody>
</table>

In our study, In Group A (single layer) there were 17 (68%) males and 08 (32%) females. In group B (Double layer) there were 15 (60%) males and 10 (40%) females.
Graph 2- SEX DISTRIBUTION

Table-3: DISEASE GROUP AND PATIENTS

<table>
<thead>
<tr>
<th>Disease group</th>
<th>No. of cases</th>
<th>N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caecal mass (GIST)</td>
<td>2</td>
<td>4%</td>
</tr>
<tr>
<td>Carcinoma ascending colon</td>
<td>5</td>
<td>10%</td>
</tr>
<tr>
<td>Carcinoma caecum</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>Caecal perforation</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>Carcinoma transverse colon</td>
<td>3</td>
<td>6%</td>
</tr>
<tr>
<td>Carcinoma descending colon</td>
<td>3</td>
<td>6%</td>
</tr>
<tr>
<td>Carcinoma rectosigmoid</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>Ileocaecal tuberculosis</td>
<td>7</td>
<td>14%</td>
</tr>
<tr>
<td>Jejunal stricture</td>
<td>2</td>
<td>4%</td>
</tr>
<tr>
<td>Disease</td>
<td>Count</td>
<td>Percentage</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>-------</td>
<td>------------</td>
</tr>
<tr>
<td>Multiple ileal perforation</td>
<td>2</td>
<td>4%</td>
</tr>
<tr>
<td>SMA syndrome</td>
<td>2</td>
<td>4%</td>
</tr>
<tr>
<td>Terminal ileal stricture</td>
<td>13</td>
<td>26%</td>
</tr>
<tr>
<td>Terminal ileal TB stricture</td>
<td>4</td>
<td>8%</td>
</tr>
<tr>
<td>Strangulated inguinal hernia</td>
<td>4</td>
<td>8%</td>
</tr>
</tbody>
</table>

In our study of fifty cases in both groups terminal ileal stricture was diagnosed in maximum number of patients i.e. 13 (26%) cases.
Table-4: TYPE AND NUMBER OF PROCEDURES PERFORMED

<table>
<thead>
<tr>
<th>Procedure</th>
<th>No of cases</th>
<th>n %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior resection and colorectal anastomosis</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>Left hemicolecotomy with colorectal anastomosis</td>
<td>4</td>
<td>8%</td>
</tr>
<tr>
<td>Resection of terminal ileum, caecum with ileo-ascending anastomosis</td>
<td>13</td>
<td>26%</td>
</tr>
<tr>
<td>Resection of ileum with ileo-ileal anastomosis</td>
<td>21</td>
<td>42%</td>
</tr>
<tr>
<td>Right hemicolecotomy with ileo-transverse anastomosis</td>
<td>8</td>
<td>16%</td>
</tr>
<tr>
<td>Resection of jejunum with jejuno-jejunal anastomosis</td>
<td>2</td>
<td>4%</td>
</tr>
<tr>
<td>Resection of jejunum and ileum with jejuno-jejunal anastomosis</td>
<td>1</td>
<td>2%</td>
</tr>
</tbody>
</table>

In our study of fifty cases in both groups resection of terminal ileum and ileoileal anastomosis was performed in maximum number of patients i.e. 21 (42%) cases.
Table -5: ANASTOMOTIC SITE

<table>
<thead>
<tr>
<th>Anastomotic site</th>
<th>Group A (Single Layer) n (%)</th>
<th>Group B (Double Layer) n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entero enteric</td>
<td>11 (44)</td>
<td>13 (52)</td>
</tr>
<tr>
<td>Entero colic</td>
<td>12 (48)</td>
<td>9 (36)</td>
</tr>
<tr>
<td>Colo Colic</td>
<td>2 (8)</td>
<td>3 (12)</td>
</tr>
<tr>
<td>Total</td>
<td>25 (100)</td>
<td>25 (100)</td>
</tr>
</tbody>
</table>

This study included a total of fifty anastomosis at different levels of small intestine and large intestine. The maximum number of anastomosis in group A (single Layer) were performed at entero colic level in 12 (48%) patients, next at entero enteric site in 11 (44%) patients and least at colo colic site in 2 (8%) patients. In group B (double layer), out of 25 anastomosis maximum number of
anastomosis were performed at entero enteric level in 13 (52%) patients, next common site for anastomosis was at entero colic site in 9 (36%) patients and followed by colo colic site in 3 (12%) patients.

Graph - 5: ANASTOMOTIC SITE

Table -6: TYPE OF ANASTOMOSIS

<table>
<thead>
<tr>
<th>Type of anastomosis</th>
<th>Group A (Single Layer) n (%)</th>
<th>Group B (Double Layer) n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>End to end</td>
<td>25 ( 100 )</td>
<td>25 ( 100 )</td>
</tr>
<tr>
<td>Side to side</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>End to side</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>25 ( 100 )</td>
<td>25 ( 100 )</td>
</tr>
</tbody>
</table>

The study included three different types of anastomosis all together in both groups depending up on the position of the viscera. In both the groups end
to end type of anastomosis was done in all of the cases, i.e. in group A (single layer) 25 (100%) patients and in group B (double layer) 25(100%) patients. No side to side type of anastomosis or end to side anastomosis was performed in either of groups.

**Graph - 6: TYPE OF ANASTOMOSIS**

![Bar chart showing the distribution of anastomosis types across groups A and B.]

**Table -7: DURATION OF ANASTOMOSIS**

<table>
<thead>
<tr>
<th>Duration of anastomosis (in minutes)</th>
<th>Group A (Single Layer) n (%)</th>
<th>Group B (Double Layer) n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-15</td>
<td>1 (4)</td>
<td>-</td>
</tr>
<tr>
<td>16-20</td>
<td>22 (88)</td>
<td>-</td>
</tr>
<tr>
<td>21-25</td>
<td>2 (8)</td>
<td>1 (4)</td>
</tr>
<tr>
<td>26-30</td>
<td>-</td>
<td>19 (76)</td>
</tr>
<tr>
<td>31-35</td>
<td>-</td>
<td>5 (20)</td>
</tr>
<tr>
<td>Total</td>
<td>25 (100)</td>
<td>25 (100)</td>
</tr>
</tbody>
</table>
In this comparative study, in group A (single layer) the minimum time required to perform anastomosis was between 10 to 15 minutes in 1 (4%) patient and maximum time was between 21 to 25 minutes in 2 (8%) patients, followed by 22 (88%) patients between 16-20 minutes and no anastomosis took more than 25 minutes.

In group B (double layer) the minimum time required to perform anastomosis was between 21 to 25 minutes in 1 (4%) patients and maximum time was between 31 to 35 minutes in 5 (20%) patients and no anastomosis required beyond 35 minutes. Maximum were done in between 26 to 30 minutes 19 (76%). P value was <0.001 HS.

Graph – 7: DURATION OF ANASTOMOSIS
Table-8:
COMPARISON OF MEAN DURATION OF
ANASTOMOSIS BETWEEN TWO GROUPS

<table>
<thead>
<tr>
<th>Groups</th>
<th>Range</th>
<th>Mean±SD</th>
<th>Mean difference</th>
<th>t* value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A (Single Layer)</td>
<td>14 - 22</td>
<td>19.04±1.60</td>
<td>10.16</td>
<td>19.6</td>
<td>0.000</td>
</tr>
<tr>
<td>Group B (Double Layer)</td>
<td>25 - 35</td>
<td>28.8±2.02</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Unpaired t test

Mean difference of duration between the two groups is found to be 10.16 and p value is 0.000 which is < 0.005 and is highly significant.

Table -9: COMPLICATION- ANASTOMOSTIC LEAK

<table>
<thead>
<tr>
<th>COMPLICATION</th>
<th>Group A (Single Layer) n(%)</th>
<th>Group B(Double Layer) n(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANASTOMOTIC LEAK</td>
<td>1 ( 2 )</td>
<td>2 ( 4 )</td>
</tr>
</tbody>
</table>

p = 0.5 , not significant ( chi-square test )

In our comparative study, overall complication in the form of anastomotic leak was noted in 3(6%) patients. Anastomotic was observered in group A (single layer) in 1 (4%) patient and occurred in group B (double layer) in 2(4%) patients. The p value was 0.5 (chi-square test)
Graph 8. Complication - Anastomotic leak

Table -10: FINAL OUTCOME

<table>
<thead>
<tr>
<th>Out come</th>
<th>Group A (Single Layer) n(%)</th>
<th>Group B (Double Layer) n(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEATH</td>
<td>0 ( 0 )</td>
<td>1 ( 4 )</td>
</tr>
<tr>
<td>RECOVERED</td>
<td>1 ( 4 )</td>
<td>1 ( 4 )</td>
</tr>
<tr>
<td>ASYMPTOMATIC</td>
<td>24 ( 96 )</td>
<td>23 ( 92 )</td>
</tr>
</tbody>
</table>

p = 0.14 ns (fisher's exact test)

In this study two patients who had developed anastomotic leak in group B(double layer), among them 1(4%) patient responded well to conservative management and recovered. One more patient (4%) who had anastomotic leak in group B (double layer) died due to septicaemia and rest 23 patients (92%) were asymptomatic. In group A (single layer) one patient (4%) developed anastomotic
leak and recovered with conservative management. p value if found out to be 0.14 and is not significant.

**Graph 9. Final outcome**

Table -11: COMPARISION OF MEAN DURATION OF HOSPITAL STAY

<table>
<thead>
<tr>
<th>GROUP</th>
<th>Range (Duration in days)</th>
<th>Mean±SD</th>
<th>Mean difference</th>
<th>t value</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A (Single Layer)</td>
<td>5 - 14</td>
<td>7.32±1.72</td>
<td>0.6</td>
<td>1.002</td>
<td>0.322</td>
</tr>
<tr>
<td>Group B (Double Layer)</td>
<td>5 - 15</td>
<td>7.92±2.44</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Unpaired t test*
In our comparative study the mean duration of hospital stay in Group A was 7.32 days and in Group B it is 7.92 days. Mean difference being 0.6. Unpaired t test and p value shows that the comparison is insignificant.

**Graph 10. Mean duration of hospital stay**
DISCUSSION

The present study assessed the efficacy and safety of single layered anastomosis in comparison with double layer anastomosis after intestinal resection and anastomosis. The study included two groups single layer and double layer, each group had 25 cases altogether 50 cases. Cases were allotted to either group alternatively, requiring single layer anastomosis and double layer anastomosis for various clinical conditions of small and large bowel. Anastomosis was done at different levels of intestine and depending up on the position of the viscera. The efficacy of both groups were compared in terms of duration required to perform single and double layered intestinal anastomosis, study post operative complications like anastomotic leak in single and double layered intestinal anastomosis, the outcome associated with single and double layered anastomosis and the duration of hospital stay in either of them.

Comparison of mean age in present series with Gangat S series

<table>
<thead>
<tr>
<th>Groups</th>
<th>Present series</th>
<th>Gangat S series</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean age(in years)</td>
<td></td>
</tr>
<tr>
<td>Group A (Single Layer)</td>
<td>41.4</td>
<td>37.5</td>
</tr>
<tr>
<td>Group B (Double Layer)</td>
<td>41.32</td>
<td>40.2</td>
</tr>
</tbody>
</table>

In present series mean age in group A (single layer) was 41.4 years and in group B (double layer) 41.32 years. In Gangat series mean age in group A (single layer) was 37.5 years and in group B (double layer) 40.2 years.
Comparison of duration of anastomosis of Khan RAA and Burch ET series with present series\(^{26}\)

<table>
<thead>
<tr>
<th>Groups</th>
<th>Present series</th>
<th>Khan RAA series</th>
<th>Burch ET series</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean duration of anastomosis (in minutes)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group A (Single Layer)</td>
<td>19.04</td>
<td>20</td>
<td>20.8</td>
</tr>
<tr>
<td>Group B (Double Layer)</td>
<td>28.80</td>
<td>35</td>
<td>30.7</td>
</tr>
</tbody>
</table>

In Khan RAA series, the arithmetical mean duration required to perform an anastomosis procedure was 20 minutes for single layer and 35 minutes for double layer. In Burch ET series duration required to perform a single layer anastomosis was 20.8 minutes and 30.7 minutes for double layer. In our study the mean duration required to construct a single layer anastomosis was 19.04 minutes and 28.80 minutes for double layered anastomosis. The difference in average time is statistically significant as p value <0.001HS in present series. Therefore in our series the time required to perform anastomosis is well within the average time.
Comparison of percentage of anastomotic leak in
Khan RAA series with present series\textsuperscript{16}

<table>
<thead>
<tr>
<th>Groups</th>
<th>Present series</th>
<th>Khan RAA series</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Anastomotic Leak n (%)</td>
<td></td>
</tr>
<tr>
<td>Group A (Single Layer)</td>
<td>1 (4)</td>
<td>1 (6)</td>
</tr>
<tr>
<td>Group B (Double Layer)</td>
<td>2 (8)</td>
<td>2 (12)</td>
</tr>
</tbody>
</table>

The complication rate in our present series was 1 (4\%) patient in single layer and 2 (8\%) in double layered anastomosis. In Khan RAA series one (6\%) patient had anastomotic leak in single layer and 2 (12\%) of patients had anastomotic leak in double layer. Finally complication rates put all together double layer had more complication in terms of anastomotic leak in both series.
CONCLUSION

This prospective comparative study included fifty cases of various clinical conditions of small and large bowel requiring resection and anastomosis. The study had two groups, single layer and double layer comprising twenty five cases in each group. Each group was evaluated and compared with respect to duration required, anastomotic leak in single and double layered intestinal anastomosis, outcome associated and the duration of hospital stay in single vs double layered bowel anastomosis.

Though a large number of patients need be to studied to do a dogmatic conclusion, based on the results obtained in the present study following conclusions can be drawn:

- Duration required to perform a single layer intestinal anastomosis is significantly lesser when compared to double layer.
- There is no significant difference in anastomotic leak between two groups.
- There is no significant difference in duration of hospital stay in single vs double layered bowel anastomosis.
SUMMARY

This comparative study included fifty cases, comprising of two groups twenty five cases in each group and was conducted from August 2013 to August 2014 (1 year) at Govt. Rajaji Hospital, attached to Madurai Medical College.

Institute either in emergency or elective undergoing bowel resection and anastomosis were included in the study. All patients were subjected to thorough clinical examinations and radiological examinations. After confirming the diagnosis ensuring fitness emergency or elective surgery were performed after full filling exclusion and inclusion criteria.

Patients data, operative findings, duration of anastomosis and length of hospital stay of all patients were followed till discharge to asses any complications in the form of anastomotic leak. All these data was collected in pretested proforma and were entered in the master chart in both groups. Each case was analysed with respect to duration required, length of hospital stay and to study post operative complications like anastomotic leak in single and double layered intestinal anastomosis. After drawing the results from the statistical test, results were analysed and compared with other comparative studies. In our present series following results were drawn.
With respect to duration of intestinal anastomosis, In group A (single layer) the range was between 7.67 minutes to 18.00 minutes and mean duration was 14.35 minutes to perform a anastomosis, in group B (double layer) the range was between 16.83 minutes to 24.83 minutes and mean duration was 21.43 minutes to perform a double layered anastomosis per operatively. The mean difference between two groups was 7.08minutes, t value was 11.9 minutes and P value was <0.001 and was highly significant. Considering duration of the

anastomosis extra mucosal single layer continuous intestinal anastomosis appears to represent the optimal choice for most surgical situations and in shorter duration.

In comparative study of ours complication rate in the form of anastomtic leak, overall complication in the form of anastomotic leak was noted in 3 patients (6%). Anastomotic leak was observed in one patient who underwent single layered bowel anastomosis whereas two patients in the group of double layered bowel anastomosis had leak. The p value was 0.5 which was not significant. To conclude complication of intestinal anastomosis in our study no evidence was found that single layered intestinal anastomosis leads to fewer postoperative leaks than double layer and either single layer or double layer is superior.
In our comparative study the duration of hospital stay in the Group A consisting of single layered bowel anastomosis and Group B consisting of double layered bowel anastomosis were compared. The mean duration of hospital stay in Group A is 7.32 days and in Group B is 7.92 days. The p value obtained is insignificant. To conclude the duration of hospital stay is the same and one is not superior over the other in this regard.
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38. LaMorte WW. Suturing Basics, Basics of Wound Closure and Healing.


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ANNEXURE

"A COMPARATIVE STUDY BETWEEN SINGLE vs DOUBLE LAYERED BOWEL ANASTOMOSIS IN A TERTIARY CARE HOSPITAL"

PROFORMA

Name of the patient :

Age : I.P. No. :

Sex : D.O.A :

Occupation : D.O.S :

Address : D.O.D :

Surgical Unit :
CLINICAL DIAGNOSIS

INVESTIGATIONS:

I) Routine

a) Blood Hb: TC: DC: ESR:
   BT: CT:

b) Urine routine:

c) RBS /FBS:

d) Blood urea : Serum Creatinine:

e) Serum electrolytes

f) Liver function test:

g) HIV and HBsAg:

h) X-ray Chest:

i) E.C.G

j) II) Specific investigation
a) **Radiological investigation**

- Plain erect x ray abdomen :
- Ultra sound abdomen and pelvis :
- Barium meal follow through :
- Barium Enema :
- Fistulogram :

**Endoscopy**

Colonscopy :

**FINAL DIAGNOSIS**

**PRE OPERATIVE PREPARATION** :

- Nil orally overnight :
- Ryles tube insertion / aspiration :
- Bowel wash :
- Soap water enema :
- Antibiotics :
ANAESTHESIA:

- Elective / emergency
- Incision
- Operative findings
- Per operative diagnosis
- Operative procedure
- Anastomosis

1. Site:
   i) Entero enteric
   ii) Entero colic
   iii) Colo colic

2. Type:
   a. End to end
      End to side
      side to side
   b. Single layer / Double layer
3. Suture material
   i) PDS 3-0
   ii) Vicryl 3-0
   iii) Mersilk 3-0

4. Duration of anastomosis : 

5. Drain used : yes/no 

6. Per-operative Blood transfusion : yes/no

**POST OPERATIVE FOLLOW UP :**

- Antibiotics used
- Ryle's tube aspiration - number of days
- Intravenous fluids - number of days
- Oral feeding started on day
- Bowel peristalsis reappearance on post op day

**COMPLICATIONS :**

1) Complications of anastomosis :
   Postoperative Leak/Fistula
HISTOPATHOLOGY REPORT:

FOLLOW UP:

SUMMARY:
**MASTER CHART 1. SINGLE LAYERED CLOSURE OF BOWEL ANASTOMOSIS**

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Name</th>
<th>Age</th>
<th>Sex</th>
<th>IP number</th>
<th>Diagnosis</th>
<th>Procedure</th>
<th>Duration of anas. (mins)</th>
<th>Complications like Anas leak</th>
<th>Duration of hospital stay (days)</th>
<th>Follow up</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Murugan</td>
<td>26</td>
<td>M</td>
<td>61525</td>
<td>Strangulated inguinal hernia</td>
<td>Resection with ileo-ileal anastomosis</td>
<td>18</td>
<td>N</td>
<td>7</td>
<td>NS</td>
</tr>
<tr>
<td>2</td>
<td>Selvam</td>
<td>45</td>
<td>M</td>
<td>26272</td>
<td>TB stricture Ileum</td>
<td>Resection with ileo-ileal anastomosis</td>
<td>18</td>
<td>N</td>
<td>6</td>
<td>NS</td>
</tr>
<tr>
<td>3</td>
<td>Idumban</td>
<td>48</td>
<td>M</td>
<td>61732</td>
<td>Ca transverse colon</td>
<td>Rt.hemicolectomy e ileotransverse anas</td>
<td>17</td>
<td>N</td>
<td>5</td>
<td>NS</td>
</tr>
<tr>
<td>4</td>
<td>Paramasivam</td>
<td>56</td>
<td>M</td>
<td>64737</td>
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<td>Resection with ileo-ileal anastomosis</td>
<td>16</td>
<td>N</td>
<td>7</td>
<td>NS</td>
</tr>
<tr>
<td>5</td>
<td>Ranjini</td>
<td>51</td>
<td>F</td>
<td>64567</td>
<td>Ileocaecal TB</td>
<td>Rt.hemicolectomy e ileascending anas</td>
<td>20</td>
<td>N</td>
<td>6</td>
<td>NS</td>
</tr>
<tr>
<td>6</td>
<td>Vennila</td>
<td>23</td>
<td>F</td>
<td>66753</td>
<td>Multiple ileal perf</td>
<td>Resection with ileo-ileal anastomosis</td>
<td>18</td>
<td>N</td>
<td>7</td>
<td>NS</td>
</tr>
<tr>
<td>7</td>
<td>Jayakumar</td>
<td>38</td>
<td>M</td>
<td>68949</td>
<td>Ca Ascending colon</td>
<td>Rt.hemicolectomy e ileotransverse anas</td>
<td>19</td>
<td>N</td>
<td>6</td>
<td>NS</td>
</tr>
<tr>
<td>8</td>
<td>Arun</td>
<td>32</td>
<td>F</td>
<td>69383</td>
<td>Ileal stricture</td>
<td>Resection with ileo-ileal anastomosis</td>
<td>22</td>
<td>N</td>
<td>6</td>
<td>NS</td>
</tr>
<tr>
<td>9</td>
<td>Sathyan</td>
<td>60</td>
<td>M</td>
<td>73928</td>
<td>Caecal mass( GIST )</td>
<td>Rt.hemicolectomy e ileotransverse anas</td>
<td>18</td>
<td>N</td>
<td>7</td>
<td>NS</td>
</tr>
<tr>
<td>10</td>
<td>Bharathi</td>
<td>40</td>
<td>M</td>
<td>77484</td>
<td>Str. inguinal hernia</td>
<td>Resection with ileo-ileal anastomosis</td>
<td>18</td>
<td>N</td>
<td>8</td>
<td>NS</td>
</tr>
<tr>
<td>11</td>
<td>Vijayakumar</td>
<td>49</td>
<td>M</td>
<td>74585</td>
<td>Ca descending colon</td>
<td>Lt.hemicolectomy with colorectal anas</td>
<td>20</td>
<td>N</td>
<td>7</td>
<td>NS</td>
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<tr>
<td>No.</td>
<td>Name</td>
<td>Age</td>
<td>Gender</td>
<td>ID</td>
<td>Diagnosis</td>
<td>Procedure</td>
<td>No. of Cases</td>
<td>Gender</td>
<td>Age</td>
<td>Race</td>
</tr>
<tr>
<td>-----</td>
<td>--------------</td>
<td>-----</td>
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