
"A COMPARISON OF SIMPLE LIGATION APPENDICULAR
STUMP VERSUS STUMP INVAGINATION IN
APPENDICECTOMY DONE ON NONPERFORATED
APPENDICITIS IN TERMS OF POST OPERATIVE WOUND
INFECTION - A RANDOMIZED CLINICAL TRIAL"

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This is to certify that the dissertation entitled “**A COMPARISON OF SIMPLE LIGATION APPENDICULAR STUMP VERSUS STUMP INVAGINATION IN APPENDICECTOMY DONE ON NONPERFORATED APPENDICITIS IN TERMS OF POST OPERATIVE WOUND INFECTION - A RANDOMIZED CLINICAL TRIAL**” is a bonafide research work done by **THE CANDIDATE REG NO. BH0108003** in the Department of General Surgery, Jawaharlal Nehru Medical College, Nehru Nagar, Belgaum – 590 010.

Dr. S. M. UPPIN MS, FICS
Professor and Head,
Department of General Surgery,
J. N. Medical College,
Nehru Nagar, Belgaum – 10

Dr. V. D. Patil MD, DCH
Principal,
J. N. Medical College,
Nehru Nagar, Belgaum – 10

Date:
Place: Belgaum

Date:
Place: Belgaum

LIST OF ABBREVIATIONS USED

$^{\circ}\text{C}$	-	Degree centigrade
$^{\circ}\text{F}$	-	Degree Fahrenheit
BP	-	Blood pressure
C.V.S.	-	Cardiovascular system
CDC	-	Centre for Disease Control
Cm	-	Centimeter
CRP	-	C-reactive protein
CT	-	Computed tomography
DC	-	Differential count
E.Coli	-	Escherichia coli
F	-	Female
H ₂ O	-	Water
I.P.	-	In patient
Inj	-	Injection
Intra-op	-	Intra-operative
IV	-	Intravenous
M	-	Male
MHz	-	Mega Hertz
mL	-	Millilitre
mm	-	Millimeter
MRI	-	Magnetic resonance imaging
n	-	Number of patients
No.	-	Number
P/A	-	Per abdomen

Post-op	-	Post-operative
R.S.	-	Respiratory system
RBC	-	Red blood cell
RIF	-	Right iliac fossa
RLQ	-	Right lumbar quadrant
TC	-	Total count
Temp	-	Temperature
USG	-	Ultrasonography
WBC	-	White blood cell
χ^2	-	Chi square

ABSTRACT

Background and objectives

Appendicectomy is one of the commonest operations in abdominal surgery. The most common method is to crush and ligate the stump and then invaginate into caecal wall by means of purse string suture. The objectives of the present study were compare and evaluate the technique of simple ligation of appendicular stump versus stump invagination and to compare the duration of post-operative hospital stay in treatment of appendicectomies in terms of post operative wound infection.

Methodology

The present one year randomized clinical trial was conducted in the Department of General Surgery, KLES Dr. Prabhakar Kore Hospital and Medical Research Centre, Belgaum over a period from January 2009 to December 2009 on 60 patients with non perforated appendicitis. A total of 30 patients in each group that is simple ligation and stump invagination were allotted by simple randomization. Wound infection was identified according to the NNIS program definition.

Results

In the present study 43.33% were males and 56.67% were females in simple ligation and in stump invagination group both sexes equally distributed. Mean age in simple ligation group was 27.73 ± 11.15 years compared to stump invagination group 27.40 ± 11.99 years. All the patients (100%) in this study presented with pain in right lower abdomen. On day 3 minor wound infection

was seen in 13.33% of patients in stump invagination group compared to 6.67% in simple ligation group. On day 7, 16.67% patients had minor and 3.33% had major wound infection in stump invagination group compared to 10.00% and 3.33% simple ligation group respectively. The mean hospital stay in simple ligation group was significantly less (5.23 ± 3.40 days) compared to stump invagination (7.00 ± 3.03 days) ($p=0.046$).

Conclusion

The study showed reduced incidence of wound infection and significantly reduced hospital stay with simple ligation compared to stump invagination during appendectomy done on non perforated appendicitis.

Key words

Appendicitis; Appendectomy; Simple ligation; Stump invagination; Wound infection;

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INTRODUCTION

Acute appendicitis is the most common surgical emergency in the developed countries that is common in the second decade of life. The incidence of acute appendicitis is 1.5/1000 in males and 1.9/1000 in females with an overall lifetime risk of 6 to 20%. It is uncommon before two years of age.¹

Appendectomy is one of the commonest operations in abdominal surgery. The most common method is to crush and ligate the stump and then invaginate into caecal wall by means of purse string suture. However some surgeons prefer to omit the step of invagination.²

Appendicitis remains one of the most common surgical diseases. The technique of appendectomy may vary, starting from skin incision to the ligation and invagination of appendectomy stump. Through the last century, the optimum management of appendectomy stump has frequently been discussed and in 1937, a detailed historical review was made by Ochsner and Lilly.³

Theoretically advantages of invagination of the ligated stump are - better control of hemorrhage from the stump, doubly secured closure of the caecal wall, less chances of peritoneal contamination due to burial of the infected stump and reduced risk of post operative adhesion by minimising the extent of raw surface.²

But there have been reports published stating that, burial of the stump occasionally leads to formation of an intramural abscess,^{4,5} intussusception of the caecum, peritonitis resulting from rupture of an abscess.⁶ In addition, higher

incidence of adhesions, and persistent postoperative pain in the right iliac fossa occur. Fewer complications were seen when invagination was omitted.⁷

“Simple ligation appendicectomy” procedure has been introduced to avoid complications of stump invagination like appendicular stumpitis, stump abscess, peritonitis and haemorrhage.⁷

In earlier retrospective study comparing invagination with simple ligation showed there was no intergroup difference in the incidence of wound infection.⁷ Another study conducted in India reported reduced infection rate in simple ligation group.²

Most centres routinely follow stump invagination in appendicectomy. While literature review suggest similar patient outcome following simple ligation with advantage of short surgical time and faster recovery in terms of hospital stay and lower incidence of wound infection.⁸

Hence the present study was undertaken to compare simple ligation appendicular stump versus stump invagination in treatment of appendicectomies done on nonperforated appendicitis in terms of post operative wound infection.

OBJECTIVES

Primary Objective

To compare and evaluate the technique of simple ligation of appendicular stump versus stump invagination during appendectomy in prevention of post operative wound infection in cases of non-perforated appendicitis.

Secondary Objective

To compare the duration of post-operative hospital stay in each study group.

REVIEW OF LITERATURE

HISTORICAL BACKGROUND

That the appendix lay hidden in the right lower abdominal quadrant has been known for millennia, its function and role in disease however has remained obscure.

Egyptians 2000 years before the Christian era, noted the presence of the appendix during post-mortem preservation and referred to it as the “worm” of the bowel. The appendix, along with other viscera, was preserved during the ritual process of mummification.

The appendix vermiformis as an anatomical structure was first described in 1521 by Jacopo Berengario da Carpi, (CA 1470-1530) professor of anatomy at Bologna. In 1554 the French physician Jean Fernel (1497-1558) reported the first case of perforative appendicitis at autopsy.⁹

A classical post-mortem description is owed to Lorenz Heister (1683-1758) a professor of medicine and also a practicing surgeon at the Universities of Altdorf-Nürnberg and Helmstedt in Germany (1712). Heister was the first to study the pathology of appendicitis (1711).¹⁰

The 19th century pathological concept is based on the notion “perityphilitis”, that is inflammation of the caecum (typhlon, blind). The caecum rather than the appendix was considered as the site of the disease. This is easily explained by advanced stages of inflammation which were observed in autopsies.

The condition now called ‘appendicitis’ became a surgical problem once it was obvious that the starting point of the disease was the appendix vermiformis. The first to clearly recognize this was Harvard University’s pathologist Reginald Heber Fitz (1843-1913) who communicated his finding at the first meeting of the Association of American Physicians in 1886.

In his paper, Fitz pointed out that the frequent abscesses in the right iliac fossa were not due to typhilitis, perityphilitis or epityphlitis but due to perforation of the vermiform appendix. Hence he gave the condition the name ‘appendicitis’ so as to avoid the possibility of misunderstanding and to localize the disease in its usual place of origin.¹¹

EMBRYOLOGY OF THE APPENDIX¹²

At an early embryonic stage it has the same calibre as the caecum and is in line with it. It is formed by excessive growth of the right wall of the caecum which pushes the appendix to the inner side. Congenital absence of the appendix is extremely rare.

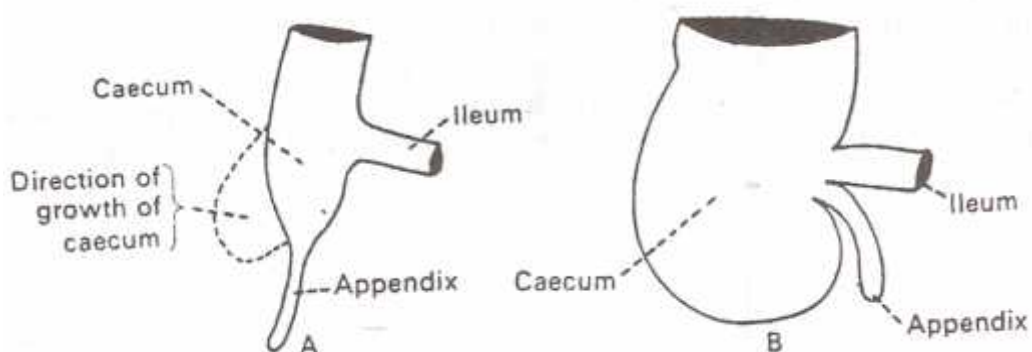


Figure 1. Development of the appendix

Abnormalities in development

These are quite rare. These may occur in form of agenesis, duplication diverticula and left sided appendix.

- i) **Agenesis** – the vermiform appendix is absent. Occasionally appendix may not be seen during appendicectomy following acute appendicitis. This is due to sloughing of the appendix.
- ii) **Duplication** – a few cases have been reported where there is double appendix
- iii) **Diverticula** – are very rarely seen in the appendix
- iv) **Left sided appendix** – in case of situs inversus .transposition of thoracic and abdominal viscera .in that case, appendix with caecum will be seen on the left side. In certain cases of non rotation of the midgut, the caecum and appendix may be seen as midline structure or on the left side.

ANATOMY OF VERMIFORM APPENDIX¹³

Position of appendix

The vermiform appendix is a narrow worm shaped tubular structure which springs from the postero –medial wall of the caecum. It may occupy one of the several following positions:

- 1) **Retrocaecal appendix:** behind the caecum and lower part of ascending colon (retrocecal 74%)

- 2) **Pelvic appendix:** may descend over the brim of the lesser pelvis (pelvic or descending 21%) in which case it lies in close relation to the right ureter in males and right uterine tube and ovary in females.
- 3) **Subcaecal appendix:** below the caecum that is subcaecal 1.5%
- 4) **Preileal:** in front of terminal part ileum and may then be in contact with anterior abdominal wall (Preileal 1%)
- 5) **Postileal:** behind the terminal part of the ileum (Postileal 0.5%)

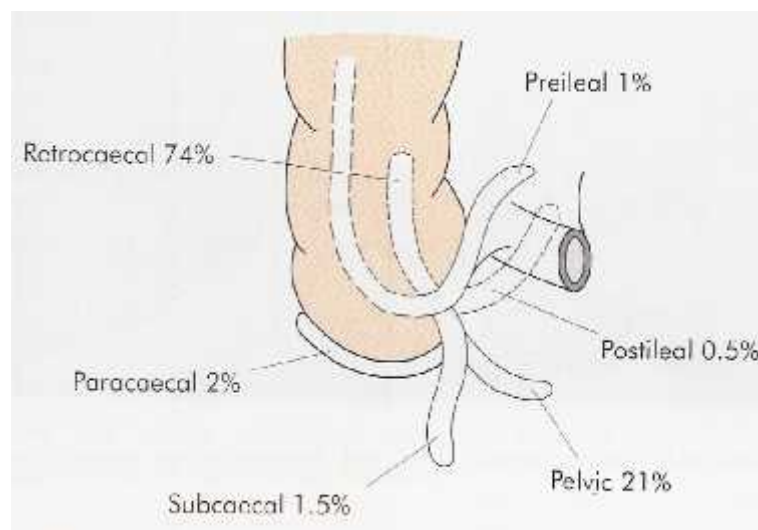


Figure 2. Various position of appendix

Commonest position is retrocaecal and the next common position is pelvic followed by subcaecal, preileal and postileal in descending order.

The three taenia coli of ascending colon and caecum converge on the base of appendix where they merge into its longitudinal muscular layer of appendix. The anterior taenia caecum is generally distinct and can be easily traced to the base of the appendix.

The appendix varies from 2 to 20 cms on length, with an average of 9 cms in length. It is longer in children than in adults, which might become atrophy and smaller after mid adult life .The lumen of appendix is small and communicates with the caecum by an orifice which is placed below and little behind the ileocaecal opening. The orifice is sometimes guarded by a semilunar valve formed by a fold of mucous membrane.

The luminal capacity of normal appendix is about 0.1ml i.e. there is no real lumen .Secretions as little as 0.5 ml Distal to the block increases the intraluminal pressure to about 60 cms of water.

Mesoappendix

The mesentery of the appendix is a triangular fold of peritoneum around the vermiform appendix. It is attached to the posterior surface of the lower end of the mesentery of the small intestine close to the ileocaecal junction. It usually reaches the tip of the appendix but some times fails to reach the distal third, in which case a vestigial low peritoneal ridge containing fat is present over the distal third. It encloses the blood vessels, nerves and lymph vessels of the vermiform appendix, and usually contains a lymph node.

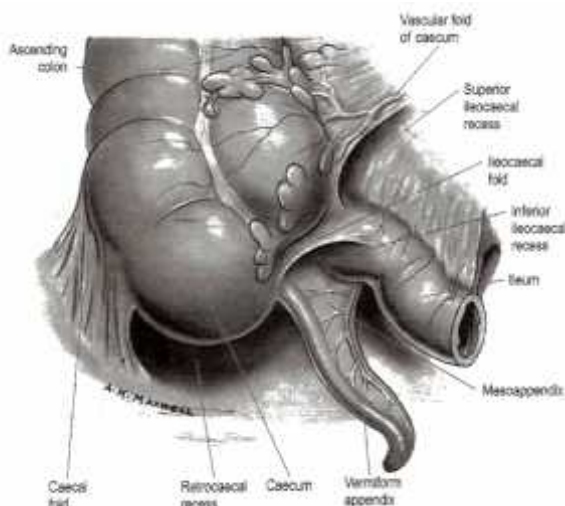


Figure 3. The peritoneal folds and recesses in caecal region

Vascular supply and lymphatic drainage

Appendicular artery

The main appendicular artery, a branch from the lower division of the ileocolic artery, runs behind the terminal ileum and enters the mesoappendix a short distance from the appendicular base. Here it gives off a recurrent branch, which anastomoses at the base of the appendix with a branch of the posterior caecal artery: the anastomosis is sometimes extensive. The main appendicular artery approaches the tip of the organ, at first near to, and then in the edge of, the mesoappendix. The terminal part of the artery lies on the wall of the appendix and may be thrombosed in appendicitis, which results in distal gangrene or necrosis. Accessory arteries are common, and many individuals possess two or more arteries of supply.

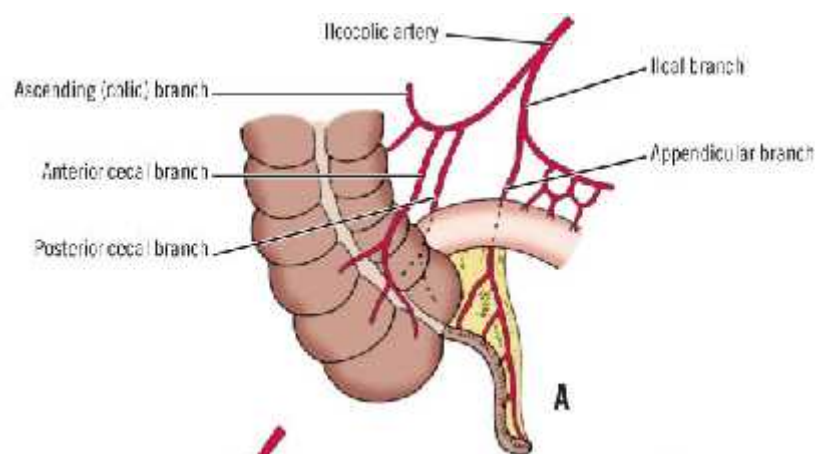


Figure 4. Blood supply of appendix

Appendicular veins

The appendix is drained via one or more appendicular veins into the posterior caecal or ileocolic vein and hence into the superior mesenteric vein.

Lymphatics

Lymphatic vessels in the appendix are numerous: there is abundant lymphoid tissue in its walls. From the body and apex of the appendix eight to 15 vessels ascend in the mesoappendix, and are occasionally interrupted by one or more nodes. They unite to form three or four larger vessels which run into the lymphatic vessels draining the ascending colon, and end in the inferior and superior nodes of the ileocolic chain.

Innervation

The appendix and overlying visceral peritoneum are innervated by sympathetic and parasympathetic nerves from the superior mesenteric plexus. Visceral afferent fibres carrying sensation of distension and pressure mediate the

symptoms of pain felt during the initial stages of appendicular inflammation. In keeping with other structures derived from the midgut, these sensations are poorly localized initially, and referred to the central (periumbilical) region of the abdomen. It is not until parietal tissues adjacent to the appendix become involved in any inflammatory process that somatic nociceptors are stimulated, and there is an associated change in the nature and localization of pain.

MICROSTRUCTURE OF THE APPENDIX¹⁴

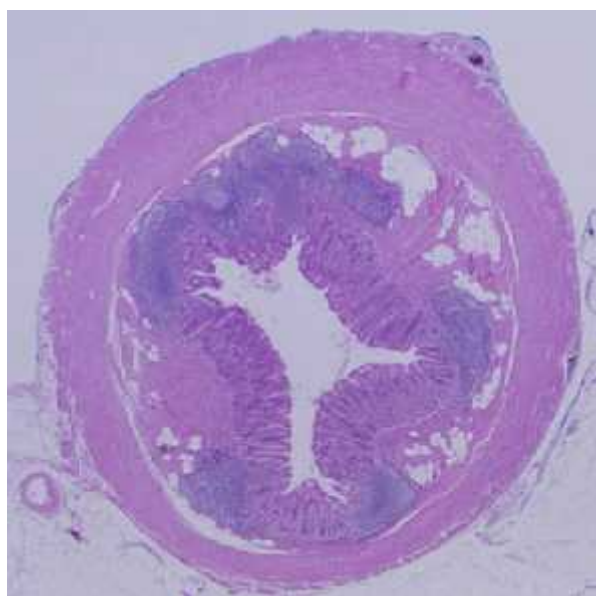


Figure 5. Normal histology of appendix

Structure

Histology

Vermiform appendix consists of the following coats:

Serosa

The serosa forms a complete covering, except along the mesenteric attachment. The longitudinal muscular fibres form a complete layer of uniform thickness, except over a few small areas where both muscular layers are deficient, leaving the serosa and submucosa in contact.

Muscularis Externa

The muscularis externa has outer longitudinal and inner circular layers of smooth muscle. The longitudinal fibres form a continuous layer but, with the exception of the uniform outer muscle layer of most of the appendix, macroscopically these are aggregated as longitudinal bands or taeniae coli. At the base of the appendix, the longitudinal muscle thickens to form rudimentary taeniae that are continuous with those of the caecum and colon. Between the taeniae coli the longitudinal layer is much thinner, less than half the circular layer in thickness.

Sub-Mucosa

The submucosa typically contains many large lymphoid aggregates that extend from the mucosa and obscure the muscularis mucosae layer: consequently this becomes discontinuous. These aggregates also cause the mucosa to bulge into the lumen of the appendix, so that it narrows irregularly. They are absent at birth but accumulate over the first 10 years of life to become a prominent feature. The submucosal lymphoid tissue frequently exhibits germinal centres within its follicles, indicative of B-cell activation, as it is in secondary lymphoid tissue elsewhere. In adults, the normal layered structure of the appendix is lost and the

lymphoid follicles atrophy and are replaced by collagenous tissue. In the elderly, the appendix may be filled with fibrous scar tissue.

Mucosa

The mucosa is covered by a columnar epithelium and M cells are present in the epithelium that overlies the mucosal lymphoid tissue. Glands (crypts) are fewer in number and thus less densely packed. They penetrate deep into the lymphoid tissue of the mucosal lamina propria.

SURFACE MARKING¹³

The surface marking commonly used for the base of the appendix is the junction of the lateral and middle thirds of the line joining the right anterior superior iliac spine to the umbilicus (Mc Burney's point).

AETIOLOGY OF APPENDICITIS¹⁵

Until the close of the nineteenth century, appendicitis remained unrecognized. Unquestionably, before this time it was a comparatively rare disease, but there can be no doubt that it existed even in remote times, for an acutely inflamed, perforated appendix was found preserved in the mummy of a young royal princess of Egypt.

The riddle of appendicitis – its actual cause and its meteoric rise from and insignificant disease to the most common serious intra- abdominal inflammatory affection of western civilized races – has been a matter for much speculation. So

far no satisfactory explanation has been forthcoming. The following aetiological factors are important, but for the most part they are purely contributory.

There is no unifying hypothesis regarding the aetiology of acute appendicitis. Decreased dietary fibre and increased consumption of refined carbohydrates may be important. As with colonic diverticulitis, the incidence of appendicitis is least in societies with a high dietary fibre intake. In developing countries that are adopting a more refined Western-type diet, the incidence continues to rise. This is in contrast to the dramatic decrease in the incidence of appendicitis in Western countries observed in the past 30 years. No reason has been established for these paradoxical changes; however, improved hygiene and a change in the pattern of childhood gastrointestinal infection related to increased use of antibiotics may be responsible.¹⁵

Intestinal parasites, particularly *Oxyuris vermicularis* (synonym: pinworm), can proliferate in the appendix and occlude the lumen.¹⁵

Incidence

The lifetime rate of appendectomy is 12% for men and 25% for women, with approximately seven percent of all people undergoing appendectomy for acute appendicitis. Over a 10 year period from 1987 to 1997, the overall appendectomy rate decreased parallel to a decrease in incidental appendectomy. Appendicitis is most frequently seen in patients in their second through fourth decades of life, with a mean age of 31.3 years and a median age of 22 years. There is a slight male to female predominance (Male:Female 1.2 to 1.3:1).^{16,17}

The incidence of appendicitis seems to have risen greatly in the first half of this century, particularly in Europe, America and Australia, with up to 16% of the population undergoing appendicectomy. In the past 30 years the incidence has fallen dramatically in these countries, such that the individual lifetime risk of appendicectomy is 8.6% and 6.7% among males and females respectively. The number of operations annually in England and Wales declined from 113 000 in 1966 to 48 000 in 1990, while in Sweden there has been an annual decrease of 17% in the numbers of appendicectomies performed between 1987 and 1996.

Acute appendicitis is relatively rare in infants, and becomes increasingly common in childhood and early adult life, reaching a peak incidence in the teens and early 20s. After middle age the risk of developing appendicitis in the future is quite small. The incidence of appendicitis is equal among males and females before puberty. In teenagers and young adults the male-female ratio increases to 3:2 at age 25; thereafter the greater incidence in males declines.¹⁵

Distribution

Appendicitis is most frequently observed in North America. The British Isles, Australia, New Zealand and among white South Africans. It is rare in most of Asia, Central Africa and among Eskimos. The distribution rather than genetically.

Race and diet

Appendicitis is particularly common in the highly civilised European, American and Australian countries, while it is rare in Asiatics, African and

Polynesians. Rendle Short showed that if individuals from the latter race migrate to countries where appendicitis is common, they soon acquire the local susceptibility to the disease. Even apes in captivity appear to acquire the human liability to appendicitis. These significant facts satisfy many that the rise of appendicitis amongst the highly civilised is due to departure from a simple diet rich in cellulose to one relatively rich in meat. But this cannot be the whole explanation, for acute appendicitis to occur lifelong vegetarian and even babies at the breast.

Social status

In England acute appendicitis is more common among the upper and middle class than in those belonging to the so called working class. Thus the mortality from acute appendicitis is about 20 % higher in men of social classes I and II (professional and managerial workers) than it is in social class V (unskilled labourers) (registrar general statistics)

Familial susceptibility

This unusual but generally accepted fact can be accounted for by an hereditary abnormality in position of the organ which predisposes to infection. Thus the whole family may have long retrocaecal appendices with comparatively poor blood supply.

Obstruction of lumen of appendix

When an acutely inflamed appendix has been removed, some form of obstruction to its lumen can be demonstrated in 80% of cases. The obstructing

agent is usually a faecolith or a stricture, exceptionally a foreign body, round worm, thread worm are found. Faecolith vary in size and have a laminated structure. They are composed of inspissated faecal material, calcium and magnesium phosphates and carbonates, bacteria and epithelial debris: rarely, a foreign body is incorporated in the mass. The presence of a fecolith or fecoliths postulates some form of appendicular stasis which may be related to initial swelling of the lymphoid tissue causing partial obstruction to the lumen of the organ.

Parasites

Worms and other intestinal parasites can injure the appendicular mucous membrane and occasionally block the lumen.

Distal obstruction of colon

Acute appendicitis can result from an obstructing (colon) carcinoma, usually of the right colon; these are usually elderly cases. The abuse of purgatives. It is abundantly clear that the ingestion of purgatives, particularly Castor oil, by patients with 'stomach ache' and the violent peristaltic action which results, favours, and often determines, perforation of an inflamed appendix. 'Purgation means perforation' is a wise statement.

Bacteriology

Cultures from inflamed appendices usually reveal that the infection is mixed and there is hardly a pyogenic organism which has not been isolated from such specimens. The most common organisms present are a mixture of Esch. Coli

found in 85% of cases, enterococci (30%) and bacteroides. In most instances the infection organisms are normal inhabitants of the lumen of appendix.

PATHOLOGY¹⁸

Morphology

At earliest stages, only a scanty neutrophilic exudate may be found throughout the mucosa, submucosa and muscularis propria. Subserosal vessels are congested and often there is a modest perivascular neutrophilic infiltrate. The inflammatory reaction transforms the normal glistening serosa into a dull, granular, red membrane; this transformation signifies early acute appendicitis for the surgeon. At a later stage, a prominent neutrophilic exudate generates a fibrinopurulent reaction over the serosa.

The histologic criteria for the diagnosis of acute appendicitis is neutrophilic infiltration of the muscularis propria. Usually, neutrophils and ulcerations are also present within the mucosa. Since drainage of an exudate into the appendix from alimentary tract infection may also induce a mucosal neutrophils infiltrate, evidence of muscular wall inflammation is requisite for the diagnosis.¹⁹⁻²⁰



Figure 6. Histology of inflamed appendix

PATHOGENESIS

Obstruction of the lumen is the dominant causal factor in acute appendicitis. Faecoliths are the usual cause of appendiceal obstruction. Less common causes are hypertrophy of lymphoid tissue, inspissated barium from previous x-ray studies, tumors, vegetable and fruit seeds, and intestinal parasites. The frequency of obstruction rises with the severity of the inflammatory process. Faecoliths are found in 40% of cases of simple acute appendicitis, 65% of cases of gangrenous appendicitis without rupture, and nearly 90% of cases of gangrenous appendicitis with rupture.

There is a predictable sequence of events leading to eventual appendiceal rupture. The proximal obstruction of the appendiceal lumen produces a closed-loop obstruction, and continuing normal secretion by the appendiceal mucosa rapidly produces distension. The luminal capacity of the normal appendix is only

0.1 millilitre (mL). Secretion of as little as 0.5 mL of fluid distal to an obstruction raises the intraluminal pressure to 60 cm H₂O. Distension of the appendix stimulates nerve endings of visceral afferent stretch fibers, producing vague, dull, diffuse pain in the mid-abdomen or lower epigastrium. Peristalsis is also stimulated by the rather sudden distention, so that some cramping may be superimposed on the visceral pain early in the course of appendicitis. Distension continues from continued mucosal secretion and from rapid multiplication of the resident bacteria of the appendix. Distension of this magnitude usually causes reflex nausea and vomiting, and the diffuse visceral pain becomes more severe. As pressure in the organ increases, venous pressure is exceeded. Capillaries and venules are occluded, but arteriolar inflow continues, resulting in engorgement and vascular congestion. The inflammatory process soon involves the serosa of the appendix and in turn parietal peritoneum in the region, producing the characteristic shift in pain to the right lower quadrant.

The mucosa of the gastrointestinal tract, including the appendix, is susceptible to impairment of blood supply, thus its integrity is compromised early in the process, allowing bacterial invasion. As progressive distension encroaches upon first the venous return and subsequently the arteriolar inflow, the area with the poorest blood supply suffers most: ellipsoidal infarcts develop in the antimesenteric border. As distension, bacterial invasion, compromise of vascular supply, and infarction progress, perforation occurs, usually through one of the infarcted areas on the antimesenteric border. Perforation generally occurs just beyond the point of obstruction rather than at the tip because of the effect of diameter on intraluminal tension.

This sequence is not inevitable, however, and some episodes of acute appendicitis apparently subside spontaneously. Many patients who are found at operation to have acute appendicitis give a history of previous similar, but less severe, attacks of right lower quadrant pain. Pathologic examination of the appendix removed from these patients often reveals thickening and scarring, suggesting old, healed, acute inflammation.¹⁸⁻²⁰

It is great importance to recognize two types of Acute Appendicitis.

Non-obstructive acute appendicitis: the inflammation usually commences in the mucus membrane, less often in the lymph follicles and can terminate in one of the following ways: 1) Resolution 2) Ulceration 3) Suppuration 4) Fibrosis 5) Gangrene . Once infection reached the loose submucous tissues it progresses rapidly. The organ becomes turgid, dusky red, and haemorrhage occurs into the mucus membrane. The vascular supply of the distal part of the appendix is often in jeopardy because at this point the artery is intramural and liable to occlusion inflammation or thrombosis. This may lead to gangrene of the tip. Non – obstructive appendicitis may progress sufficiently slowly for protective barriers to form, and the resulting peritonitis is localised. In many instance the infection never progresses beyond the mucus lining (that is, Catarrhal inflammation) but although the attacks passes off. Because the tip suffers most, after resolution of acute attack, fibrosis usually occurs there in and shrunken tip is a classical finding in recurrent appendicitis.²¹

Obstructive acute appendicitis: about two out of every three cases of acute appendicitis belong to this group. The obstruction can be in the lumen (fecolith,

foreign body, or parasites); in the wall (adhesions and kinking). Of these, much the most common is a fecolith. Fibrosis of the wall from previous attacks of acute appendicitis can contribute by narrowing the lumen and promoting fecolith impaction and (rarely) appendicitis accompanies ileocaecal Crohn's disease.²¹

In obstructive appendicitis the products of inflammation become pent up so that the inflammation proceeds more rapidly and more certainly to gangrene or perforation. Often within twelve to eighteen hours the appendix distal to the obstruction become gangrenous. Close examination of gangrenous appendices directly after the removal shows conclusively that they usually belong to the obstructive group. Perforation occurs most often at the site of an impacted faecolith before protective adhesions have had time to form. The escaping purulent and gaseous contents are under high pressure and early widespread peritonitis is liable to ensue. Subphrenic and pelvic abscesses are a common later sequel if the patient survives that initial peritonitis.²¹

Bacteriology

Table 1. Common organisms seen in patients with acute appendicitis.¹⁸

Aerobic and Facultative	Anaerobic
Gram-negative bacilli	Gram-negative bacilli
E. coli	Bacteroides fragilis
Pseudomonas aeruginosa	Bacteroides species
Klebsiella species	Fusobacterium species
Gram-positive cocci	Gram-positive cocci
Streptococcus anginosus	Peptostreptococcus species
Streptococcus species	Gram-positive bacilli
Enterococcus species	Clostridium species

Presentation

In 1905, Murphy clearly described the appropriate sequence of symptoms of pain followed by nausea and vomiting with fever and exaggerated local tenderness in the position occupied by the appendix.²²

The classic presentation of acute appendicitis begins with crampy, intermittent abdominal pain, thought to be due to obstruction of the appendiceal lumen. The pain may be either periumbilical or diffuse and difficult to localize. This is typically followed with nausea; vomiting may or may not be present. If nausea and vomiting precede the pain, patients are likely to have another cause for their abdominal pain, such as gastroenteritis. Classically, the pain migrates to the right lower quadrant as transmural inflammation of the appendix leads to

inflammation of the peritoneal lining of the right lower abdomen. This usually occurs within 12 to 24 hours of the onset of symptoms. The character of the pain also changes from dull and colicky to sharp and constant. Movement or Valsalva maneuver often worsens this pain, so that the patient typically desires to lie still.

Patients may report low-grade fever up to 38.3 °Centigrade (°C). Patients who have appendicitis commonly report anorexia; appendicitis is unlikely in those with a normal appetite.

The classic presentation of acute appendicitis is not present in all patients. Patients may have none or only a few of the symptoms just described. For instance, they may not notice or recall the initial colicky pain. When the pain becomes constant, it may localize to other quadrants of the abdomen due to an alteration in appendiceal anatomy as in late pregnancy or malrotation. In patients with a retrocecal appendix, the pain may never localize until generalized peritonitis from perforated appendicitis occurs. Urinary or bowel frequency may be present due to appendiceal inflammation irritating the adjacent bladder or rectum. Because appendicitis is so common, a high index of suspicion for appendicitis is warranted in all patients with abdominal pain.²³

CLINICAL FEATURES

Symptoms

Pain

Pain is present in all patients with appendicitis. The initial typical pain is diffuse and dull and is situated in the umbilical or lower epigastric region.

Sometimes the pain is moderately severe. Intermittent cramping may superimpose on such pain. Gradually the pain is localised in the right lower quadrant. It takes about 1 to 12 hours for such localisation. In some patients the pain of appendicitis begins in the right lower quadrant and remains there. Variation in the anatomical position of the appendix will account for variation of the principle site of the pain. In case of retrocaecal appendix, pain may be complained of more in the flank. In case of pelvic appendicitis, pain may be referred to the suprapubic region. Malrotation of the appendix will lead to more confusion of the site of pain.¹⁸

Anorexia

Nearly always anorexia is complained of in case of appendicitis. This symptom is so constant that the diagnosis should be questioned if the patient is not anorectic.

Nausea

Atleast of some degree, is present in 9 out of 10 patients with appendicitis. Vomiting is variable in children and teenagers but vomiting appears after the onset of pain. Typically pain, vomiting and temperature constitutes 'Murphy's Triad' of this condition. If vomiting precedes pain the diagnosis should be questioned.

Constipation or diarrhea

As appendicitis progresses, an ileus may develop leading to constipation or at least decreased frequency of the normal bowel habit. Diarrhea in

contradiction, is not a common component, except in patients with missed appendicitis and postileal appendix. Diarrhoea may be more common in children than in older patients.²⁴

Sequence

Sequence of symptom appearance has great diagnostic value. On over 95% of patients anorexia is the first symptom, followed by abdominal pain and this is followed by nausea and vomiting.

Physical signs

Temperature

Appendicitis may cause rise of temperature, but higher temperature is unusual with uncomplicated appendicitis. Temperature elevation is usually restricted to 90 or 100 °F (39 °C). Normal temperature is often present even with advanced appendicitis. In case of generalised peritonitis following rupture of appendicitis temperature may shoot up.

Pulse rate

The pulse rate is usually normal or slightly elevated. High pulse rate should question the diagnosis. Pulse rate increase in proportion with the temperature of the patient. In case of spreading peritonitis following rupture pulse rate rise up to 100 per minute.

Inspection

The patient looks anxious with pain and the tongue is dry. On careful inspection, in very acute condition, it may disclose some limitation of the respiratory movement of the lower half of the abdomen.

Palpation

Presence of peritoneal inflammation can be suspected if cough or percussion on the abdominal wall elicits pain.

1. Systemic gentle palpation will detect an area of maximum tenderness that corresponds to the position of appendix and is usually located in the right lower quadrant at or near Mc Burney point.²⁵
2. Muscle guarding or resistance to palpation roughly parallel to the severity of the inflammatory process. Early in the disease resistance, if persistent, consists mainly of voluntary guarding. As peritoneal irritation progresses, voluntary muscle guarding increases and is eventually replaced by reflex involuntary rigidity. One must try to differentiate voluntary guarding as opposed to involuntary rigidity. Involuntary rigidity does not diminish during expiration as is seen in voluntary guarding.
3. Cutaneous hyperaesthesia can be found out by light stroking of the skin of the right and left side of the abdomen. In acute appendicitis hyperaesthesia is found over Sherrin's triangle (formed by the anterior superior iliac spine, the symphysis pubis, and the umbilicus). This ordinarily is unpleasant and is not a very reliable sign.

4. Rebound tenderness – The classic method of demonstrating peritoneal inflammation is rebound tenderness. In this case gentle pressure is exerted on the inflamed area and sudden release of the hand will cause extreme pain of the patient at the inflamed area. This is called rebound tenderness may be elicited in only half the cases.
5. Rovsing's sign – Pain in the right lower quadrant is complained of when palpation pressure is exerted on the left lower quadrant .It is also called 'referred rebound tenderness' and when present is quite helpful in supporting the diagnosis. Retrograde displacement of the colonic gas strikes the base of inflamed appendix is the probable explanation of this sign.²⁶
6. Psoas sign – this test is performed by having the patient lie on his left side. The examiner then slowly extends the patient's right thigh, thus stretching the iliopsoas muscle. This will produce pain to make the sign positive. This indicated presence of irritative inflamed appendix in close proximity to the psoas muscle. This is possible in retrocaecal appendicitis.
7. Pointing test - When patient is asked to point the site of pain, it usually corresponds with the site of localized tenderness in McBurney's point that is, at the junction of lateral third with medial two thirds of the spino-umbilical line (McBurney's sign)²⁵
8. Dunphy's sign - When the patient cough vigorously and hold his or her right lumbar quadrant (RLQ) or refuses to cough because of pain, RLQ peritonitis is confirmed.

9. Blumberg's sign (Release sign) - Rebound tenderness in the RLQ suggests localized peritonitis.
10. Cope's obturator test - Flexion and internal rotation of hip in a patient with pelvic appendicitis initiates pain as it lies over obturator internus muscle.
11. Baldwin's sign - A hand is placed over the right flank and patient is asked to raise the right lower limb with knee extended. In retrocaecal appendicitis this initiates pain.
12. Ligat's sign - Hyperesthesia in Sherren's triangle (this is formed by lines joining the umbilicus, right anterior superior iliac spine and symphysis pubis) is an occasional but inconstant accompaniment of gangrenous appendicitis.
13. Percussion - Light percussion on Mc Burney's point will elicit pain in case of early appendicitis
14. Auscultation of the abdomen will reveal meagre or no bowel movement on the right iliac fossa. In spreading peritonitis following rupture of appendix abdomen remained absolutely silent and no bowel sound can be heard.
15. Rectal examination - This is important and should be performed in every patients suspected of suffering from appendicitis. Its primary function is to exclude any pelvic lesion particularly in females. Its secondary purpose is to elicit tenderness in cases of pelvic appendicitis. In case of pelvic

appendicitis there may not be any tenderness on the anterior abdominal wall, so rectal examination is very essential to exclude such appendicitis. When inflamed appendix lies in the pelvis, presence of a mass or tenderness will be present on the right side of the fornix.

Special features, according to position

Retrocaecal

Rigidity is often absent (silent appendix) and even on deep pressure tenderness may be lacking, the reason being that the caecum, distended with gas, prevents the pressure exerted by the hand from reaching the inflamed stricture, and gurgling may even be elicited. However, deep tenderness is often present in the loin, and rigidity of the quadratus lumborum may be in evidence.

Psoas spasm, due to the inflamed appendix being in contact with the muscle, may be sufficient to cause flexion of the hip joint may induce abdominal pain when a degree of psoas spasm is sufficient to cause flexion of the hip.

Pelvic

Occasionally early diarrhoea results from an inflamed appendix being in contact with rectum. When the appendix lies entirely within the pelvis there is usually complete absence of abdominal rigidity, and often tenderness over Mc Burney's point is lacking as well. In some instances deep tenderness can be made out just above and right to the symphysis pubis. In either event a rectal examination reveals tenderness in the rectovesical pouch or the pouch of Douglas, especially on the right side. Psoas spasm may also be present when the

appendix is in this position: alternatively, spasm of the obturator internus is sometimes demonstrable when the hip is flexed and internally rotated. If inflamed appendix is in contact with the obturator internus, this manoeuvre will cause pain in the hypogastrium. An inflamed appendix in contact with bladder may cause frequency of micturation. A child sometimes postpones micturation as it causes pain.

Post ileal

Although this is rare, it accounts for some of the cases of 'missed appendix. It presents the greatest difficulty in diagnosis because the pain may not shift, diarrhoea is a feature, marked retching may occur and tenderness, if any, is ill-defined, though it may be present immediately to the right of the umbilicus. As the appendix irritates the lower ileum, the patient usually passes small loose stools soon after eating or drinking.

Maldescended (subhepatic)

The tenderness is in the subhepatic region. It is sometimes mistaken for acute cholecystitis.

Special features, according to age

Acute appendicitis in infants

In infants under thirty-six months of age the incidence of perforation is over 80%, and the mortality is considerably higher than the general mortality; indeed, when acute appendicitis occurs during the first year of life, only 50% of

the patients reach their first birthday. One of the reason for rapid onset of diffuse peritonitis is that the greater omentum, being comparatively short and undeveloped, is unable to give much assistance in localising the infection. Even more importance is the difficulty in arriving at early diagnosis, and particularly in differentiating the condition from enteritis also acute appendicitis can complicate enteritis. In addition, acute appendicitis may be associated with acute respiratory infection or one of the exanthemas.

Acute appendicitis in children

It is rare to find a child with appendicitis ho has no vomiting and they usually have complete aversion to food. In addition, they do not sleep during the attack and very often bowel sounds are completely absent in the early stages.

Acute appendicitis in the aged

Gangrene and perforation occur much more frequently in elderly patients. Elderly patients with lax abdominal walls or obesity may harbour a gangrenous appendix with little evidence to it and old people are prone to self-medication with laxatives. In addition, the picture may simulate subacute intestinal obstructions and if enemas are given, peritonitis may spread more widely. The immune system becomes weaker in old age. For all these reasons, acute appendicitis in older age group carries a high mortality.

Acute appendicitis in the obese

Obesity can obscure and diminish all the local signs of acute appendicitis. It is safer to operate on such cases through a generous vertical incision rather than miss a gangrenous appendix.

Acute appendicitis in pregnancy

In pregnancy the appendix shifts to the upper abdomen, thus favouring peritonitis: the nearer to term, the greater the danger, even in cases without perforation. After the 6th month there is a maternal mortality of 20% ten times greater than that in first trimester. As pregnancy advances pain becomes higher and more lateral. Microscopical examination of specimens of urine will help to exclude pyelonephritis, but in doubtful cases it is best to perform early appendicectomy. The pregnant patient with acute perforated appendicitis aborts or goes into premature labour in 50% of cases, while in acute non-perforated appendicitis this figure is reduced to 30%.²⁷

LABORATORY STUDIES²³

Laboratory studies demonstrated acute phase reactants to be elevated secondary to acute inflammation.

- C-reactive protein (CRP)
- Total white blood cell (WBC) count
- Differential count

C-reactive protein has been studied and correlated with clinical and pathological findings. In general it is not a clinically useful laboratory study because it is non-specific.

The leucocyte count is usually elevated above 12,000 cells/mm³ on differential count usually there is increase in percentage of neutrophils, the left shift with a normal leucocyte count supports clinical diagnosis of acute appendicitis. A completely normal leucocyte count and differential count is uncommon in patients with appendicitis, but it can be seen.¹⁸

Laboratory studies can be helpful in the diagnosis of appendicitis, but no single test is definitive. A white blood cell count (WBC) is perhaps the most useful laboratory test. Typically, the WBC is slightly elevated in nonperforated appendicitis, but may be quite elevated in the presence of perforation. The clinician must remember, however, that the WBC can be normal in patients with acute appendicitis, particularly in early cases. Serial WBC measurements improve the diagnostic accuracy, with a rising value over time commonly seen in patients with appendicitis.¹⁸ Urinalysis is performed to diagnose other potential causes for abdominal pain, specifically urinary tract infection and ureteral stone. Significant hematuria with colicky abdominal pain suggests ureterolithiasis, and testing directed at this diagnosis is indicated. A urinary tract infection, on the other hand, is not uncommon in patients with appendicitis. Its presence does not exclude the diagnosis of acute appendicitis, but it should be identified and treated. Although pyuria suggests urinary tract infection, it is not uncommon for the urinalysis in a patient with appendicitis to show a few white blood cells solely due to inflammation of the ureter by the adjacent appendix.

In certain patient populations, other laboratory tests are indicated. In women of childbearing age, the urine human chorionic gonadotropin should be checked to alert the clinician to the possibility of ectopic or concurrent pregnancy. Ectopic pregnancy is another cause of right lower quadrant pain that demands emergent diagnosis and treatment.

Table 2: Scoring system in case of acute appendicitis

Symptoms	Score
Migratory right iliac fossa (RIF) pain	1
Anorexia	1
Nausea and vomiting	1

Signs	Score
Tenderness	2
Rebound tenderness	1
Elevated temperature	1

Laboratory	Score
Leucocytosis	2
Shift to left	1
TOTAL	10

Alvarado (Mantrels) score

A score of seven is strongly predictive of acute appendicitis.

Imaging Studies²³

The goal of an imaging study as a diagnostic aid in acute appendicitis should be to differentiate presence of disease in those with inflammation, without perforation and with equivocal clinical findings. In addition it should be quick, relatively noninvasive and accurate in those groups at highest risk of complication if perforation should occur. It should be free of interobserver variability, easily reproducible and easily obtained at any hour. Ideally, imaging should reveal inflammation of the appendix when it is located at an anatomically troublesome site to evaluate via clinical examination.

The potential imaging modalities for diagnosis of acute appendicitis include plain radiographs, barium enema, abdominal ultrasound (USG), and computed tomography (CT).

X-ray abdomen

Prior to the wide-spread use of modern imaging techniques, plain abdominal films were often obtained in patients with abdominal pain. Some helpful x-ray findings following acute appendicitis are

- a. Localized air fluid levels in the right iliac fossa.
- b. Localized ileus with gas in caecum, ascending colon or terminal ileum. In retrocaecal appendicitis caecum is distended with gas.

- c. Localized soft tissue shadow in the right lower quadrant.
- d. Presence of faecolith.
- e. Gas in appendix.
- f. Obliterated psoas shadow
- g. Altered flank right strips (flat line).
- h. Free intra peritoneal gas in perforated appendix.
- i. Deformity of cecal gas shadow due to adjacent inflammatory mass (this is difficult to interpret because there may be disturbance of caecal gas from intraluminal fluid or faeces).

Barium enema

Smith and associates have enumerated the radiologic signs of appendicitis after barium enema as;²⁸

- 1. Persistent non visualization of the appendix.
- 2. Partial visualization of the appendix.
- 3. Pressure defect on the caecum.
- 4. Irritability of the caecum and terminal ileum on screening.

Abdominal ultrasonography (USG)

Graded compression ultrasonography was done using 3.5 MHz, 5MHz or 7.5 MHz linear array transducers according to the situation. Some investigations have reported seeing normal appendices on a sonogram.²⁹ The normal appendix is compressible with wall thickness of less than or equal to 3 mm. The size of an appendix can differentiate normal from an acutely inflamed appendix.

The sonographic hallmark of appendicitis is direct visualization of the inflamed appendix. The typical appearance is that of concentrically layered, almost incompressible, sausage like structure demonstrated at the site of maximum tenderness.³⁰ The usual findings are:

- Visualization of noncompressible appendix as a blind-ending tubular aperistaltic structure.
- Target appearance of 6 mm in total diameter on cross section / maximal mural wall thickness 2 mm.
- Diffuse hypoechogenicity (associated with higher incidence of perforation).
- Lumen may be distended with anechoic/hyperechoic material.
- Loss of wall layers.
- Visualization of appendicolith
- Localized periappendiceal fluid collection.
- Prominent hyperechoic mesoappendix / pericaecal fat.

If the inflamed appendix becomes non-tender on pressure, one should consider a diagnosis of spontaneous resolving appendicitis. Many clinical 'look alike' of appendicitis can be demonstrated reliably by ultrasound. The most frequently encountered is the newly described bacterial ileocaecitis caused by yersinea, campylobacter or salmonella. Second in frequency are gynaecological conditions such as ovarian cysts, ectopic pregnancy, adnexal torsion and tubo-ovarian abscess. Other ultrasonically detectable alternative conditions are caecal

and sigmoid diverticulitis, cholecystitis, perforated peptic ulcer, Crohn's disease, urological conditions, small bowel obstruction and caecal carcinoma.³¹

A false positive diagnosis is possible in patients with perforated peptic ulcer, sigmoid diverticulitis or Crohn's disease because in these conditions, the appendix may be relatively thickened due to adjacent extrinsic inflammatory disease.

Conversely recent radiotherapy, primary bacterial peritonitis and peritonitis secondary to peritoneal dialysis may render the appendix ultrasonically invisible.³² The most important reason for a false negative ultrasound examination is overlooking the inflamed appendix. In experienced hands the inflamed appendix can be visualized in 90% of patients with non-perforated appendicitis, 85% of those with an appendiceal mass and in 55% of those with free perforation of the appendix. Peritonism preventing graded compression probably accounts for the limited success in patients with appendiceal perforation.³³ In addition air filled dilated bowel loops from adynamic ileus may hide the appendix from view.

Colour Doppler ultrasound findings

- Increased conspicuity (increase in size + number) of vessels in an around the appendix (hyperemia).
- Decreased resistance in arterial waveforms.
- Continuous/pulsatile venous flow.

A study has demonstrated that acute appendicitis is accompanied by inflammatory hypervascularity reflected as an increased number of colour signals and higher diastolic Doppler shifts as compared with those found in normal.³⁴ No Doppler shifts are identified in areas of appendiceal ischemia.

Computed tomography

Computed tomography is yet another imaging modality for acute appendicitis. Computed tomography benefits from a high diagnostic accuracy for appendicitis³⁵ and visualization and diagnosis of many of the other causes of abdominal pain that can be confused with appendicitis. The radiographic findings of appendicitis on CT include a dilated (more than six mm), thick-walled appendix that does not fill with enteric contrast or air, as well as surrounding fat stranding to suggest inflammation. In prospective studies, CT demonstrated a sensitivity of 0.94 and a specificity of 0.95.³⁵ Computed tomography thus has a high negative predictive value, making it particularly useful in excluding appendicitis in patients for whom the diagnosis is in doubt. Appendicitis is highly unlikely if enteric contrast fills the lumen of the appendix and no surrounding inflammation is present. The clinician must remember, however, that a CT performed early in the course of appendicitis might not show the typical radiographic findings. In confusing cases, it is reasonable to repeat the CT after 24 hours of observation.¹⁵

Magnetic Resonance Imaging

Although it is firmly established as the imaging modality of choice for the central nervous system and musculoskeletal system, MRI evaluation of the acute abdomen has not enjoyed similar widespread use. With the refinements in US and

CT technique, MRI currently plays a negligible role in the workup of the acute abdomen. The lack of ready availability, high costs, substantial image degradation with bowel and respiratory motion and the presence of cardiac pacemaker have contributed to its lack of widespread use.

A study on 60 patients have found that MRI is superior to USG in revealing suspected acute appendicitis.³⁶ Also they have concluded that MRI can be used after suboptimal or nondiagnostic sonography in cases of suspected acute appendicitis.

Diagnostic laparoscopy

This is mainly useful for selected group of patients specially women in child bearing age where the symptoms and signs leading to a diagnosis of acute appendicitis are in doubt.

When other medical conditions are present like leukemia, nephritic syndrome, dermatomyositis, thalassemia, jaundice, steroid therapy, antibiotic intake, then diagnosis becomes difficult. The diagnosis of acute appendicitis on laparoscopy is made if the following criteria are present.

- 1) The appendix is seen to be acutely inflamed.
- 2) Covered by adherent omentum
- 3) Not possible to see the appendix because of inflammatory adhesions or odema in the pericaecal region.

These cases can be taken as positive cases of acute appendicitis. At the same time, while viewing the peritoneal cavity another diagnosis of causes of

pain in the right iliac fossa may become evident which may not require surgery like mittelschmerz, salpingitis, ruptures ovarian cyst and torsion of paraovarian cyst. If the appendix is seen to be normal then it is not operated upon, but observation is done.

Radioactive isotope imaging

Patient's leukocytes can be labeled or tagged with a radioactive isotope. After reinjection, these leucocytes can be detected in an inflamed appendix on scanning. Technetium – 99 and Indium – 11 have been used.³⁷ The method was shown to be unreliable in diagnosing appendicitis in women. So it may need to be supplemented with an ultrasound scan to exclude gynaecological disease.

Although advancements have been made in laboratory analysis as well as imaging via ultrasonography and CT, nothing can replace careful evaluation by an experienced surgeon. Appendicitis remains a diagnosis based primarily on history and physical examination. Further studies are useful adjuncts in atypical cases which are more likely to occur in the very young or very old and most cost effective when ordered by the surgical consultant.

Acute appendicitis is most common cause of acute abdomen, although many patients have a classical presentation as described by Fitz, allowing prompt diagnosis and treatment some patients have typical and confusing presentations leading to misdiagnosis.

In a study Julien Pylaert described the value of grades compression sonography for examination of appendix.³⁸

A study, experience with diagnostic ultrasonography in 525 patients with suspected acute appendicitis was analysed.³⁹ They found that ultrasonography has higher accuracy and also reduces the number of negative appendectomies. The study has emphasized that ultrasonography does not replace the clinical diagnosis, but compliments it.

A comparative study of clinical judgment and diagnostic ultrasonography in diagnosis of acute appendicitis; experience with a score aided diagnosis was carried out on 148 patients.⁴⁰ They found that clinical judgment of junior surgeons was disappointing and diagnostic ultrasonography performed poorly as a routine procedure. So they suggest that an up to date scoring system might help in diagnosis of acute appendicitis.

Diagnostic scores are useful and easy methods which help in surgical decision. Their objective is to reduce a number of negative appendectomy. A study which evaluated USG and clinical diagnostic scoring in suspected appendicitis, stated that USG performed by trained radiologist is a valuable aid in differential diagnosis of appendicitis and when used with a classical scoring system it improves the results.⁴¹ The reliability and non-invasive nature of USG argues that it should be taken in to account in computer-aided decision supports system to be designed in future.

DIFFERENTIAL DIAGNOSIS

Usually there is a little difficulty in diagnosing acute appendicitis. However, one must remember other possibilities, particularly in a young female. These conditions may be divided into the following

Extra-abdominal

Right basal pneumonia and diaphragmatic pleurisy may be associated with abdominal symptoms, but the presence of respiratory symptoms and specific signs in the chest should cause little difficulty with the diagnosis.

Abdominal

Almost any abdominal condition can mimic appendicitis, some of these are:

Mesenteric adenitis

Approximately 5% of all operations performed for suspected acute appendicitis discover mesenteric adenitis. The presence of enlarged pink and fleshy lymph nodes in the mesentry of the terminal ileum associated with a normal appendix are the characteristic features. Mesenteric adenitis usually occurs in children and may be suspected when there is a history of recent sore throat together with a high fever, attacks of pain with complete relief between attacks, a tender spot medial to and above. McBurney's point, shifting tenderness and little or no muscle guarding. Under these conditions it may be permissible to observe the patient, particularly if the abdominal signs are minimal in degree. However, if there is any doubt, operation is indicated. In all cases the appendix should be removed to avoid further confusion when confronted with an appendicectomy scar and RIF pain.

Pyelitis

Right sided abdominal and loin pain associated with rigors and urinary symptoms is suggestive of a urinary tract infection. The absence of abdominal rigidity and the presence of pus in the urine indicate the diagnosis.

Ureteric colic

A calculus in the right ureter may cause confusion, but the radiation of the pain along the line of the ureter and the presence of blood in the urine should eliminate the doubt. A plain X-ray of the abdomen or an intravenous urogram will indicate the stone.

Gastroenteritis

Diarrhoea, vomiting, central abdominal or rigidity and fever, without local tenderness or rigidity over the appendix region, suggest gastroenteritis.

Crohn's disease

Terminal ileitis may present with RIF pain.

Meckel's diverticulitis

In this rare condition the clinical picture is very similar to appendicitis

Acute Cholecystitis

Right upper abdominal pain associated with acute cholecystitis may be confused with high retrocaecal appendicitis.

Diverticulitis

Acute diverticulitis of the sigmoid colon may be confused with pelvic appendicitis. The sigmoid colon may lie centrally or even on the right of the midline. Rarely a solitary caecal diverticulum becomes inflamed.

Gynaecological conditions

Pelvic inflammatory disease, which includes salpingitis, pyosalpingitis, tubo-ovarian abscess and parametritis, are the commonest condition to exclude while considering appendicitis as the cause of abdominal pain in non-pregnant women of reproductive age group. Gonococcal and Chlamydial infection are the commonest underlying causes. This condition is particularly common in large city hospitals where promiscuity and prostitution are frequent predisposing factors. A further variant is Fitz Hugh Curtis syndrome, in which infection spreads up the right paracolic gutter to involve the surface of the liver. The clinical features may mimic either acute appendicitis or acute cholecystitis. Pelvic examination of women who may have appendicitis is therefore mandatory. Torsion of a Fallopian tube, Hemorrhage from rupture of an ovarian tumour and endometriosis may have to be considered. Pain of sudden onset in the right iliac fossa, on the day a period begins, may be caused by the rupture of corpus luteal cyst. Mid cycle pain (mittelschmerz) may occur from rupture of a follicular cyst at ovulation.

During early pregnancy, abortion, retroverted and impacted uterus, degeneration of uterine fibroids and ectopic pregnancy require consideration. It should be remembered that acute appendicitis complicates 1 in 100 pregnancies.

During late pregnancy, labor, abruption-placentae, ruptured uterus, fulminating pre-eclampsia and rectus sheath haematoma require consideration. Women often develop recurrent acute or subacute RIF pain particularly in her 2nd decade. Frequently no cause is found. Appendicectomy should be avoided because it does no good

INDICATIONS FOR APPENDICECTOMY

1. Acute appendicitis.
2. Recurrent or chronic appendicitis.
3. Carcinoma of appendix.
4. Carcinoid tumor of appendix.
5. Tuberculosis of appendix.

Surgery for appendicitis

The first appendicectomy was performed at St. George's Hospital, London, in 1736 by Claudius Amyand, a surgeon at St. George's Hospital in London and Sergeant Surgeon to Queen Ann, King George I, and King George II. The acutely inflamed appendix, perforated by a pin, and surrounding omentum was removed through a scrotal wound while dealing with a faecal fistula in a chronic scrotal hernia. The patient was 11 year old boy and patient recovered.⁴²

The first surgical treatment for appendicitis or perityphlitis without abscess was made by Hancock in 1848. He incised the peritoneum and drained the right lower quadrant without removing the appendix.

Charles McBurney (1845-1913) was one of the surgeons pioneering the diagnostics and operative treatment of appendicitis. McBurney's classic report on early operative interference in cases of appendicitis was presented before the New York Surgical Society in 1889. In it he described the area of greatest abdominal pain in this disease process, now known as McBurney's point.

Five years later in 1894, he set forth in another paper the incision that he used in cases of appendicitis, now called McBurney's incision.⁴³

However, McBurney later credited McArthur with first describing this incision.⁴³

The first surgeon to perform deliberate appendectomy for acute appendicitis was Lawson tait, in 1880.

The first appendectomy was performed in 1884 by Kronlein (1886) and since that time, the operation has probably been performed more frequently.

The first surgical procedure performed on the appendix by Kronlein consisted of drainage of appendicular abscess. At the same time he removed the appendix and treated the stump by simple ligation.⁸

In 1888, Treves suggested that simple ligation was not sufficient and that the stump must be covered by several Lembert sutures.⁴⁴

In 1889, Senn first drew attention to the risk of the ligature slipping off the appendix stump with subsequent peritoneal contamination, he advised the stump should be buried.⁷

The US surgeon John Benjamin Murphy introduced and popularized early removal of the appendix in all cases of suspected appendicitis. In 1889 Murphy established a pattern of early symptoms for appendicitis and strongly urged immediate removal of the appendix when this pattern appeared. Although Murphy's program first met with incredulity and derision from his colleagues, his more than 200 successful appendicectomies over the next several years provided ample evidence to make the operation common medical practice.⁴⁵

In 1985, Dawbarn suggested the possibility of abscess formation around the stump inside the covering sutures and therefore advocated invaginating the unligated stump.⁷

Recently, appendicectomies are done by laparoscopy and gaining more popularity and may replace routine lapotomy appendicectomy.

TREATMENT¹⁵

The treatment of acute appendicitis is appendicectomy. There is a perception that urgent operation is essential to prevent the increased morbidity and mortality of peritonitis. While there should be no unnecessary delay, all patients, particularly those most at risk of serious morbidity, benefit by a short period of intensive preoperative preparation. Intravenous fluids, sufficient to establish adequate urine output (catheterisation is needed only in the very ill), and appropriate antibiotics should be given. There is ample evidence that a single preoperative dose of antibiotics reduces the incidence of postoperative wound infection. When peritonitis is suspected, therapeutic intravenous antibiotics to cover Gram-negative bacilli as well as anaerobic cocci should be given.

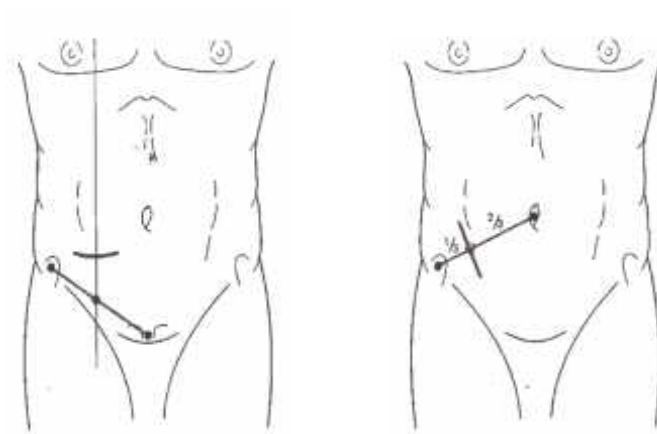
Hyperpyrexia in children should be treated with salicylates in addition to antibiotics and intravenous fluids. With appropriate use of intravenous fluids and parenteral antibiotics, a policy of deferring appendicectomy after midnight to first case of the following morning does not increase morbidity. However, when acute obstructive appendicitis is recognised, operation should not be deferred longer than it takes to optimise the patient's condition.

Procedure of appendicectomy¹⁵

Appendicectomy should be performed under general anaesthetic or spinal anaesthetic with the patient supine on the operating table. When a laparoscopic technique is to be used, the bladder must be empty. Prior to preparing the entire abdomen with an appropriate antiseptic solution, the right iliac fossa should be palpated for a mass. If a mass is felt, it may, on occasion, be preferable to adopt a conservative approach. Draping of the abdomen is in accordance with the planned operative technique, taking account of any requirement to extend the incision or convert a laparoscopic technique to open operation.

*Conventional appendicectomy*¹⁵

Incisions



**Figure 7. Gridiron incision for Appendicitis & Transverse or skin crease
(Lanz) incision for appendicitis**

When the preoperative diagnosis is considered reasonably certain, the incision that is widely used for appendicectomy is the so-called gridiron incision (gridiron : a frame of cross-beams to support a ship during repairs). The gridiron incision¹² is made at right angles to a line joining the anterior superior iliac spine to the umbilicus, its centre being along the line at McBurney's point. In the subcutaneous tissues, an arterial twig from the superficial circumflex iliac artery usually requires ligation. The external oblique is incised in the line of its fibres along the length of the incision. The fibres of the internal oblique and transversus abdominis are split, and with suitable retraction the peritoneum is opened. If better access is required, it is possible to convert the gridiron to a Rutherford Morison incision by cutting the internal oblique, transversus muscles in the line of the incision.

A transverse skin crease (Lanz) incision has become more popular, as the exposure is better and extension, when needed, is easier. The incision, appropriate in length to the size and obesity of the patient, is made approximately two cm below the umbilicus centred on the midclavicular-midinguinal line. The external oblique aponeurosis, internal oblique and transversus muscles are split in the direction of the fibres, and the peritoneum opened. When necessary, the incision may be extended medially, with retraction or suitable division of the rectus abdominis muscle.

When the diagnosis is in doubt, particularly in the presence of intestinal obstruction, a lower midline abdominal incision is to be preferred over a right lower paramedian incision. The latter although widely practised in the past, is difficult to extend, more difficult to close and provides poorer access to the pelvis and peritoneal cavity.

Rutherford Morisons incision is useful if the appendix is para or retrocaecal and fixed. It is essentially an oblique muscle-cutting incision with its lower end over McBurney's point and extending obliquely upwards and laterally as necessary. All layers are divided in the line of the incision.

Removal of the appendix¹⁵

A retractor is placed under the medial side of the wound and peritoneum and abdominal wall is elevated. Serous exudate is removed with a sucker. The caecum is identified by the presence of taeniae coli, and using a finger or a swab the caecum is withdrawn. A turgid appendix may be felt at the base of the caecum. Inflammatory adhesions must be gently broken with a finger, which is

then hooked around the appendix to deliver it into the wound. The appendix is conveniently controlled using a Babcock or Lane's forceps applied in such a way as to encircle the appendix and yet not damage it. The base of the mesoappendix is clamped in a haemostat, divided and ligated. When the mesoappendix is broad, the procedure must be repeated with a second or, rarely, a third haemostat. The appendix, now completely freed, is crushed near its junction with the caecum in a haemostat, which is removed and reapplied just distal to the crushed portion. An absorbable 2/0 ligature is tied around the crushed portion close to the caecum. The appendix is amputated between the haemostat and the ligature. The tip of the amputated stump is cauterized and cleaned with spirit. A non absorbable suture purse-string or 'Z' suture may then be inserted into the caecum about 1.25 cm from the base. The stitch should pass through the muscle coat, picking up the taeniae coli. The stump of the appendix is invaginated while the purse-string or 'Z' suture is tied, thus burying the appendix stump. Many surgeons believe invagination of the appendiceal stump is unnecessary.

The distal ileum visualised to rule out meckel's diverticulum. In female patients the ovary examined. The peritoneum closed with absorbable continuous suture. The muscles approximated with intermittent simple absorbable chromic sutures. The external oblique aponeurosis closed with continuous absorbable sutures. The skin closed with non absorbable subcuticular or mattress suture.

Methods to be adopted in Special circumstances¹⁵

When the caecal wall is oedematous, the purse-string suture is in danger of cutting out. If the oedema is of limited extent, this can be overcome by

inserting the purse-string suture into more healthy caecal wall at a greater distance from the base of the appendix. Occasions may arise when, because of the extensive oedema of the caecal wall, it is better not to attempt invagination.

When the base of the appendix is inflamed, it should not be crushed but ligated close to the caecal wall just tightly enough to occlude the lumen, after which the appendix is amputated and the stump invaginated.

Should the base of the appendix be gangrenous, neither crushing nor ligation must be attempted. Two stitches are placed through the caecal wall close to the base of the gangrenous appendix, which is amputated flush with the caecal wall, after which these stitches are tied. Further closure is effected by means of a second layer of interrupted seromuscular sutures.

Retrograde appendicectomy²³

When the appendix is retrocaecal and adherent, it is an advantage to divide the base between haemostats. The appendiceal vessels are then ligated, the stump ligated and invaginated and gentle traction on the caecum will enable the surgeon to deliver the body of the appendix, which is then removed from base to tip. Occasionally, this manoeuvre requires division of the lateral peritoneal attachments of the caecum.

Surgical procedures⁷

Simple ligation⁷

The technique of simple ligation consist of applying a clamp across the base of the appendix. A thread ligature is then tied tightly around the base of the uncrushed appendix and the appendix amputated between the two. This results in complete striangulation of the distal remnant of the appendicular stump with its subsequent atrophy.

Several points are important in this technique, use of catgut must be avoided as it causes incomplete striangulation due to stretching, thus favouring the formation of adhesions. On the other hand, use of a thread ligature causes atrophy of the stump which is immediately dealt by the peritoneal reaction to such a process, so that local abscess formation does not occur. Adhesions formation resulting from local inflammatory reactions is also reduced to a minimum. The thread ligature does not slip on uncrushed bowel.

As the appendicular branch of the posterior caecal artery is included in the ligature, haemostasis is secured. Finally, it can be performed with the least manipulation and the greatest speed.

Disadvantages which have been voiced are inadequate closure of the bowel may occur as serosa is not applied to serosa. The uncovered stump is contaminated, and there is atleast a theoretical risk that peritoneal infection may occur with subsequent formation of abscesses and adhesion if the ligature is not applied correctly.

Stump invagination⁷

In this technique, following the simple ligation procedure a purse string suture is inserted into the caecal wall around the appendicular stump. The stump is inverted and the purse string suture tied over it.

Advantages are that serosa is opposed to serosa, the peritoneal cavity is sealed off from the stump and haemostasis is set to be secure.

The use of pursed string ligature have been objected for a number of reasons. Chance of mucosal perforation, formation abscess around the stump and formation large sloughs in the head of the caecum.

COMPLICATIONS AFTER APPENDICECTOMY

Acute appendicitis

The complications vary with the degree of peritonitis that was present, and with the resistance of the patient to the infection. The complications include:

Early

Ileus, wound sepsis, residual abscess (local, pelvic, paracolic, subphrenic) intestinal obstruction from adhesions, faecal fistula, pylephlebitis, postoperative thrombosis and embolism, actinomycosis, pulmonary complications (pulmonary collapse or pneumonitis)

Late

Intestinal obstruction from adhesions, incisional hernia, right inguinal hernia following the grid-iron incision (especially if a drain is brought through the wound). Sterility in the female from frozen pelvis.¹⁸

CLASSIFICATION OF WOUND INFECTION⁴⁶

According to a report by the NNIS program surgical site infections are defined as follows:

- Superficial incisional SSI
 - Occurs within 30 days after the operation.
 - Involves only the skin or subcutaneous tissue.
 - At least 1 of the following:
 - Purulent drainage is present (culture documentation not required).
 - Organisms are isolated from fluid/tissue of the superficial incision.
 - At least 1 sign of inflammation (eg, pain or tenderness, induration, erythema, local warmth of the wound) is present.
 - The wound is deliberately opened by the surgeon.
 - The surgeon or clinician declares the wound infected.

A wound is not considered a superficial incisional SSI if a stitch abscess is present; if the infection is at an episiotomy, a circumcision site, or a burn wound; or if the SSI extends into fascia or muscle.

- Deep incisional SSI.
 - Occurs within 30 days of the operation or within 1 year if an implant is present.
 - Involves deep soft tissues (eg, fascia and/or muscle) of the incision
 - At least 1 of the following:
 - Purulent drainage is present from the deep incision but without organ/space involvement.
 - Fascial dehiscence or fascia is deliberately separated by the surgeon because of signs of inflammation.
 - A deep abscess is identified by direct examination or during reoperation, by histopathology, or by radiologic examination.
 - The surgeon or clinician declares that a deep incisional infection is present.

- Organ/space SSI
 - Occurs within 30 days of the operation or within 1 year if an implant is present.
 - Involves anatomical structures not opened or manipulated during the operation.
 - At least 1 of the following:
 - Purulent drainage is present from a drain placed by a stab wound into the organ/space.
 - Organisms are isolated from the organ/space by aseptic culturing technique.

- An abscess in the organ/space is identified by direct examination, during reoperation, or by histopathologic or radiologic examination.
- A diagnosis of organ/space SSI is made by the surgeon or clinician.

LITERATURE REVIEW FOR SIMPLE LIGATION VERSUS STUMP INVAGINATION

A study in Pajjat-Haeme Central Hospital, Finland suggested that, although modern gastrointestinal surgery has abandoned the invagination of stapler closures, the traditional technique for appendicectomy with appendix stump invagination is still in common use. In a prospective study, altogether 200 patients operated on for acute appendicitis were treated either by simple ligation or ligation and inversion of appendix stump. The complications between the two groups were same. Thus, simple ligation is recommended for conventional as well as for laproscopic appendicectomy because it is simpler and faster and it preserves the intact anatomy of the caecal wall.⁴⁷

Another prospective randomised trial of 134 consecutive appendicectomies conducted in Netherland compared two methods of treatment of the appendix stump after appendicectomy in which the appendix stump was either simply ligated or doubly invaginated. During a period of 15 months, all patients in whom an appendicectomy was done were allocated into two random groups. The following data were recorded: age, sex, histological diagnosis, hospital stay and occurrence of complications. All patients were followed until 6

months after the operation. The data were analysed statistically with the chi-square –test and the Mann- Whitney test, P less than 0.05 was considered significant. The appendix stump was ligated in 70 patients and invaginated in 55. Both groups were similar with respect to age, sex, degree of appendiceal inflammation, antibiotic treatment and hospital stay. There were significantly more wound infections in the invagination group (p=0.017). The other complications showed no statistical intergroup difference. Simple ligation facilities and shortens appendectomy. It is a safe procedure, preventing deformation of the caecal wall and possibly reducing the risk of postoperative ileus due to adhesions. Therefore simple ligation is recommended as the standard procedure at appendectomy.⁴⁸

A study used the records of 886 patients who had appendectomy performed by the same surgeons within a five year period to contrast appendiceal stump inversion versus simple ligation. Our analysis contrasted inversion versus simple ligation techniques as related to postoperative complications, hospital stay and pathologic diagnosis. Adhesions requiring repeated operation to relieve bowel obstruction occurred in five of 87 patients with acute gangrenous appendicitis treated by inversion. Of 106 patients with acute gangrenous appendicitis treated with simple ligation, post operative obstruction developed in none. No other statistically significant difference existed between the two techniques. These data suggest that simple ligation is atleast as good as and probably better than inversion of the appendiceal stump.⁴⁹

Another prospective randomized trial was conducted on 1340 patients to compare simple ligature with invagination of the appendix stump on 64 and 66

well matched for age, sex, weight, and severity of appendicitis patients, respectively. One patient in the invagination group developed wound infection but there was no infection in the other group. This difference was not statistically significant ($p > 0.05$) and there was no evidence of adhesive ileus in either group after a mean follow-up period of nine months. They recommended a simple ligation of the appendix stump as safe procedure.⁵⁰

A study reported a ten year experience on simple ligation in appendicectomy. After having reviewed the various surgical procedures, the authors report their clinical experience and considering the good postoperative results with this method, regard this procedure as an alternative to the technique of ligation with inversion of the stump.⁵¹

In another prospective randomized trial was conducted to assess stump invagination versus simple ligation. Total 735 patients were studied out of which 374 patients underwent stump ligation with invagination. 361 patients underwent simple ligation. The two groups were similar with respect to age, sex, degree of appendiceal inflammation and antibiotic treatment. The incidence of wound infection and post operative pyrexia and post operative hospital stay showed no significant intergroup difference. The median operating time was slightly shorter in the group without invagination. Simple ligation facilitates and shortens appendicectomy. It produces no deformation of the caecal wall that subsequently may be mistaken for caecal neoplasm. So they concluded that simple ligation is therefore recommended as standard procedure in appendicectomy.⁸

A review of 732 cases found that omission of invagination of crushed and ligated appendix stump after appendicectomy simplifies and shortens the operation, the post operative hospital stay was less and incidence of wound infection was lower.²

Another study recommended the simple ligation technique for conventional appendicectomy because it is simpler, faster and it preserves the intact anatomy of the caecal wall.⁴⁷

METHODOLOGY

The present study was conducted in the Department of General Surgery, KLES Dr. Prabhakar Kore Hospital and Medical Research Centre, Belgaum over a period from January 2009 to December 2009 on 60 patients with non perforated appendicitis.

Study design

The study design was one year randomized clinical trial.

Study period and duration

The present one year study was conducted during the period of January 2009 to December 2009.

Method of collection of data

Source of Data

Patients admitted with non perforated appendicitis at KLES Dr. Prabhakar Kore Hospital and Medical Research Centre, Belgaum over a period of one year.

Sample size

A total of 60 patients admitted with non perforated appendicitis at KLES Dr. Prabhakar Kore Hospital and Medical Research Centre, Belgaum were studied.

Sampling procedure

The sample size was calculated based on the formula mentioned below.

$$N = \frac{2(Z_1 + Z_2)^2 pq}{d^2}$$

$$\text{Where } P = p_1 + p_2 / 2 = 5.77 + 16.11 / 2 = 10.94$$

$p_1 = 5.77$ and $p_2 = 16.11$ based on the literature review⁴ the rate of wound infection in simple ligation was considered as 5.77% compared to stump invagination as 16.11%.

$$Q = 100 - p$$

$$d = 16.11 - 5.77$$

$$Z_1 = 1.65$$

$$Z_2 = 0.84$$

$$N = 120$$

Due to the limitation of the patients presenting with non perforated appendicitis in the hospital, the sample size was considered to be 30 in each group that is simple ligation and stump invagination by the “Rule of Thumb”

Randomization

A total of 30 patients in each group that is simple ligation and stump invagination were allotted by simple randomization. All the patients diagnosed with non-perforated appendicitis and undergoing appendicectomy will be divided into two groups based on the technique;

- Group A – I. P. No. ending in even number.

- Group B - I. P. No. ending in odd number.

Selection criteria

Inclusion criteria

- All the patients with non-perforated appendicitis (Acute, sub-acute, chronic and interval).

Exclusion criteria

- Perforated appendix.
- Appendicular gangrene.
- Appendicular Abscess.
- Appendicular Mass.
- Uncontrolled Diabetes mellitus.
- Uncontrolled Hypertension.

Procedure

The study was approved by the Ethical and Research Committee of Ethics Committee, Jawaharlal Nehru Medical College, Belgaum. Patients admitted in the wards of Department of General Surgery at KLES Dr. Prabhakar Kore Hospital and Medical Research Centre, Belgaum with non perforated appendicitis were evaluated based on selection criteria. The patients were selected by detailed medical history, physical examination and investigations. The selected patients were briefed about the nature of the study, the interventions used and a written informed consent was obtained (Annexure-I).

Demographic data like gender and age were collected along with relevant history and recorded on predesigned and pretested proforma (Annexure-II). A thorough clinical examination was conducted and the findings were also recorded.

Routine investigations such as complete blood count and special investigation such as ultrasound and X-ray abdomen was done.

The patients were divided in two groups that is;

- Group A - Simple Ligation
- Group B - Stump Invagination

The patients were given;

- Inj Ceftriaxone - 1 gm IV twice daily for one day
- Inj Metronidazole - 500 ml thrice daily for one day

Suture material used during the procedure was;

- Stump ligation: Silk (2, 0).
- Peritoneum was not closed.
- Closure of external Oblique was done with Vicryl (2, 0).
- Purse string suture with Silk (2, 0).
- Appendix specimen was sent for histopathological examination.
- Wound inspection was done on day 3 post operatively.
- Sutures were removed on day 7 post operatively and wound was inspected.

Follow up

Some patients who were discharged on day 3 were followed in the out patient department on post operative day 7 for suture removal and wound inspection.

Wound infection was identified as incisional superficial and deep surgical site infection according to a report by the NNIS program⁴⁶ surgical site infections as below.

- Minor wound infection - Superficial incisional SSI.⁴⁶
- Major wound infection - Deep incisional SSI.⁴⁶

Statistical analysis

The results were tabulated and the data was analysed using rates, ratios and percentages for different parameters. The data was compared using chi-square (χ^2) test, Man Whitney Test and student 't' test. A 'p' value of less than 0.05 was considered as statistically significant.

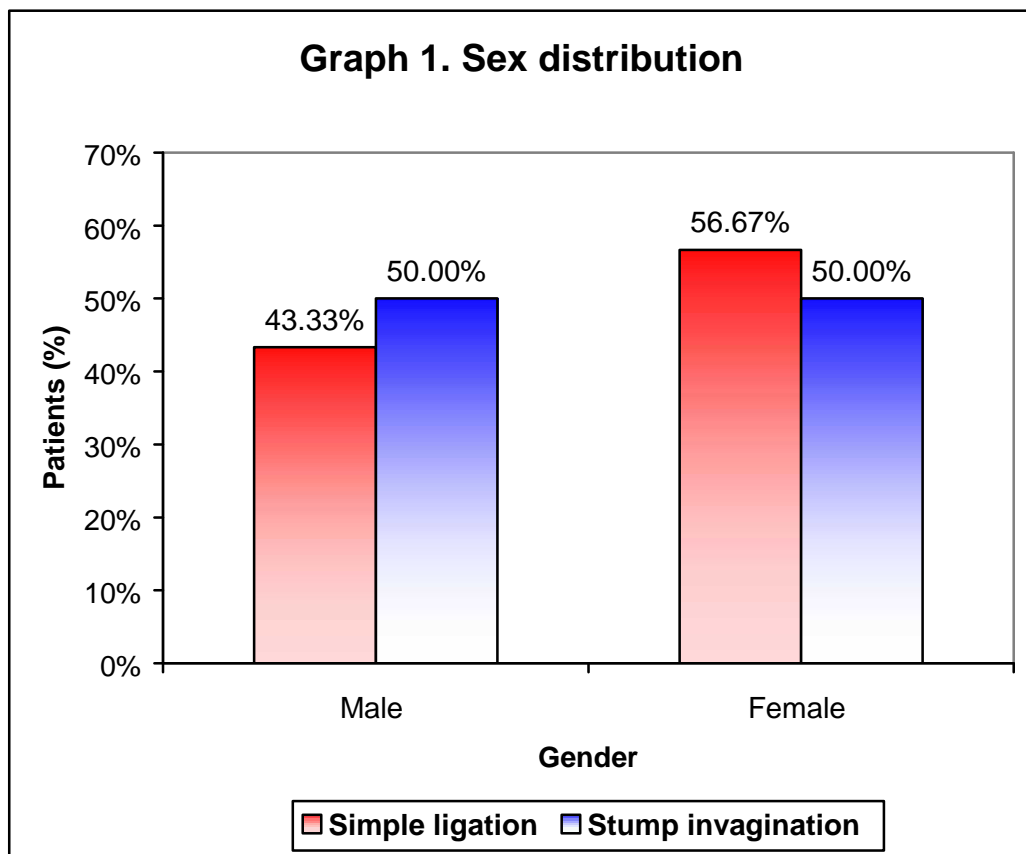
RESULTS

The present study was conducted in the Department of Surgery over a period from January 2009 to December 2009. During the study period 30 appendicectomies with simple ligation and 30 with stump invagination were done based on randomization. The data obtained was tabulated and analysed as below.

Table 3. Sex distribution

Gender	Simple ligation (n=30)		Stump invagination (n=30)	
	Number	Percentage	Number	Percentage
Male	13	43.33	15	50.00
Female	17	56.67	15	50.00
Total	30	100.00	30	100.00

p=0.604

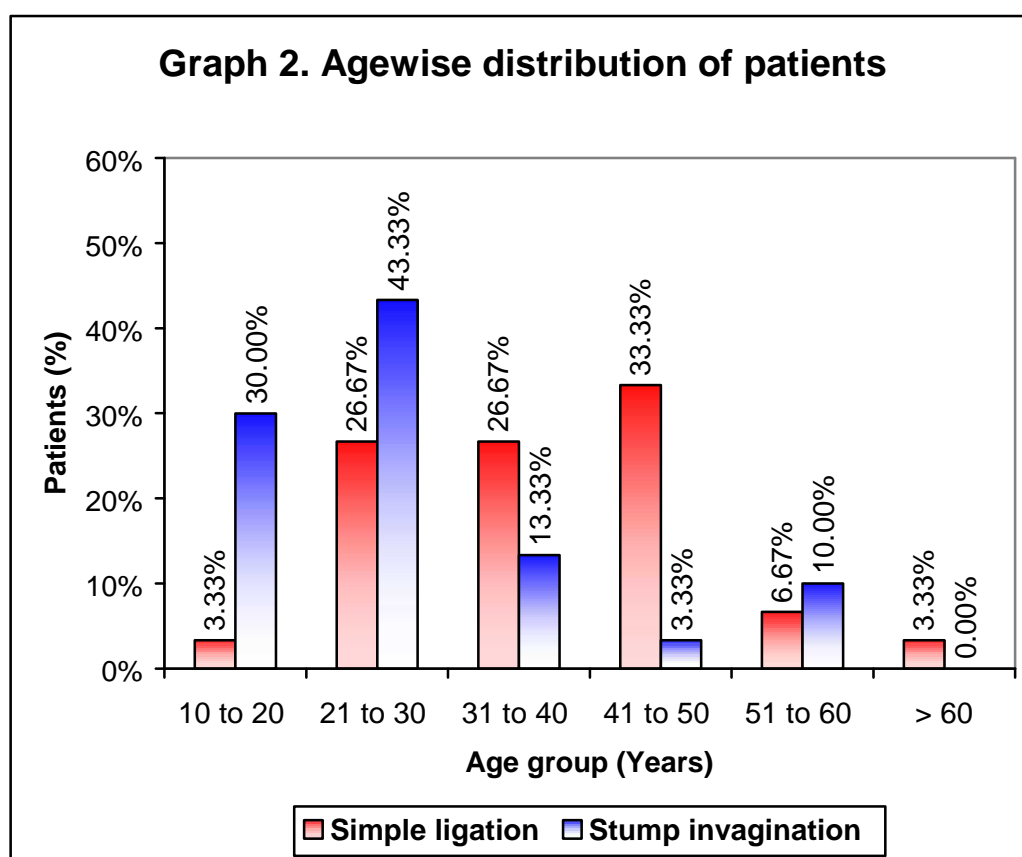


In the present study 43.33% were males and 56.67% were females in simple ligation whereas, in stump invagination group, males and females were equally distributed. The comparison of both the groups showed equal distribution with no statistical significance ($p=0.604$).

Table 3. Agewise distribution of patients

Age group (Years)	Simple ligation (n=30)		Stump invagination (n=30)	
	Number	Percentage	Number	Percentage
10 to 20	1	3.33	9	30.00
21 to 30	8	26.67	13	43.33
31 to 40	8	26.67	4	13.33
41 to 50	10	33.33	1	3.33
51 to 60	2	6.67	3	10.00
>61	1	3.33	0	0.00
Total	30	100.00	30	100.00

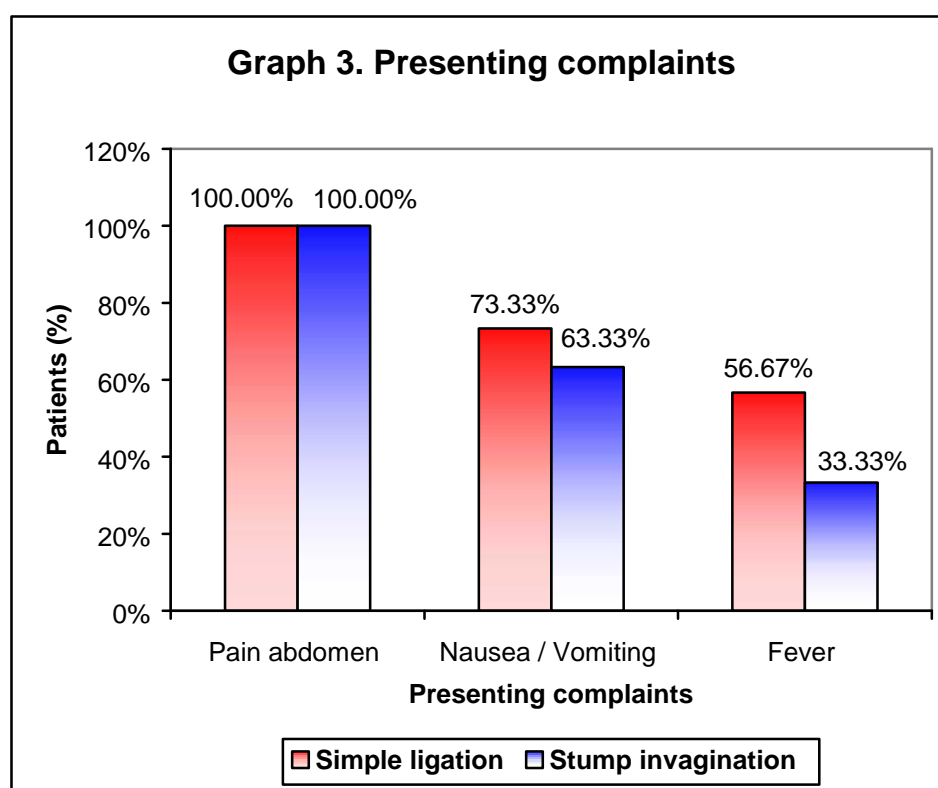
p=0.912



In this study among the patients undergoing simple ligation majority of the patients had age between 41 to 50 years whereas in stump invagination group majority of the patients had age between 21 to 30 years. The mean age in the simple ligation group was 27.73 ± 11.15 years with range being 8 to 55 years. The mean age in the stump invagination group was 27.40 ± 11.99 years with range being 18 to 55 years. However the difference between the age of both the groups was statistically not significant ($p=0.912$)

Table 5. Presenting complaints

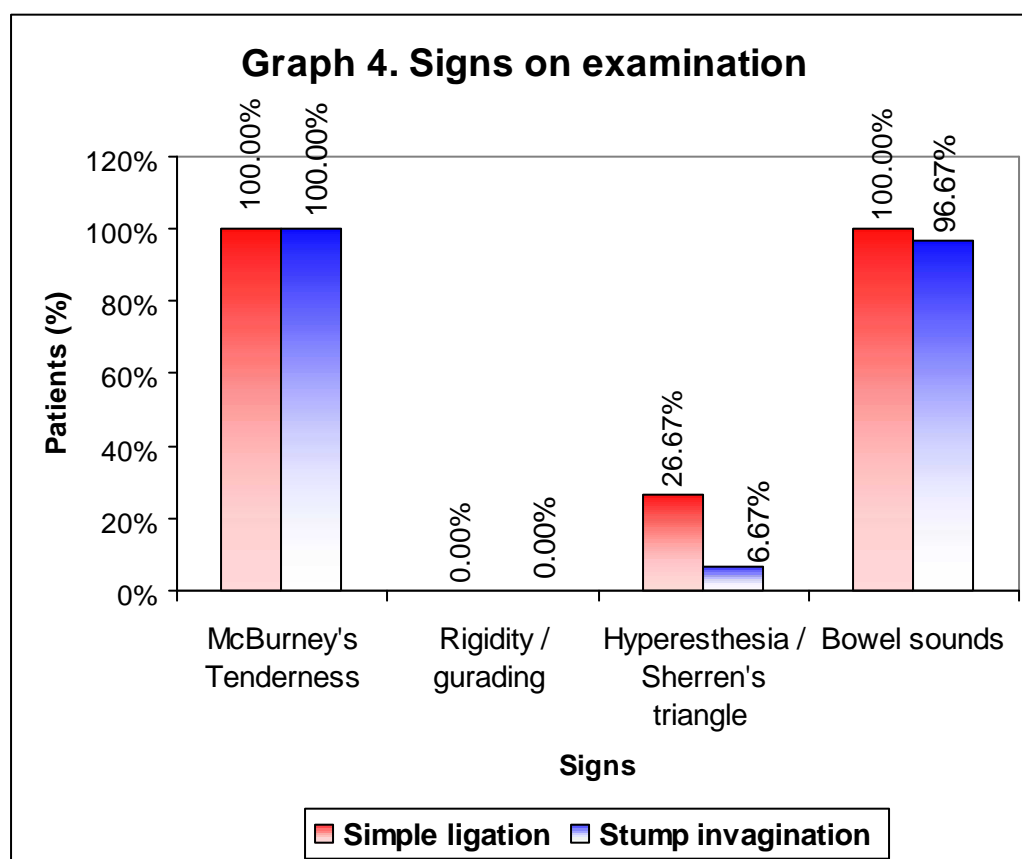
Presenting complaints	Simple ligation (n=30)		Stump invagination (n=30)	
	Number	Percentage	Number	Percentage
Pain abdomen	30	100.00	30	100.00
Nausea / Vomiting	22	73.33	19	63.33
Fever	17	56.67	10	33.33



In this study all the patients (100%) in both groups presented with pain in the right lower abdomen. Nausea / vomiting was next common complaint present in 73.3% of simple ligation group and 63.30% of stump invagination group. History of fever was present in 56.67% of simple ligation group and 33.33% of stump invagination group. Comparison of both the groups showed no statistical significant ($p>0.05$).

Table 6. Signs on examination

Signs	Simple ligation (n=30)		Stump invagination (n=30)	
	Number	Percentage	Number	Percentage
McBurney's Tenderness	30	100.00	30	100.00
Rigidity / guarding	0	0.00	0	0.00
Hyperesthesia/ Sherren's triangle	8	26.67	2	6.67
Bowel sounds	30	100.00	29	96.67



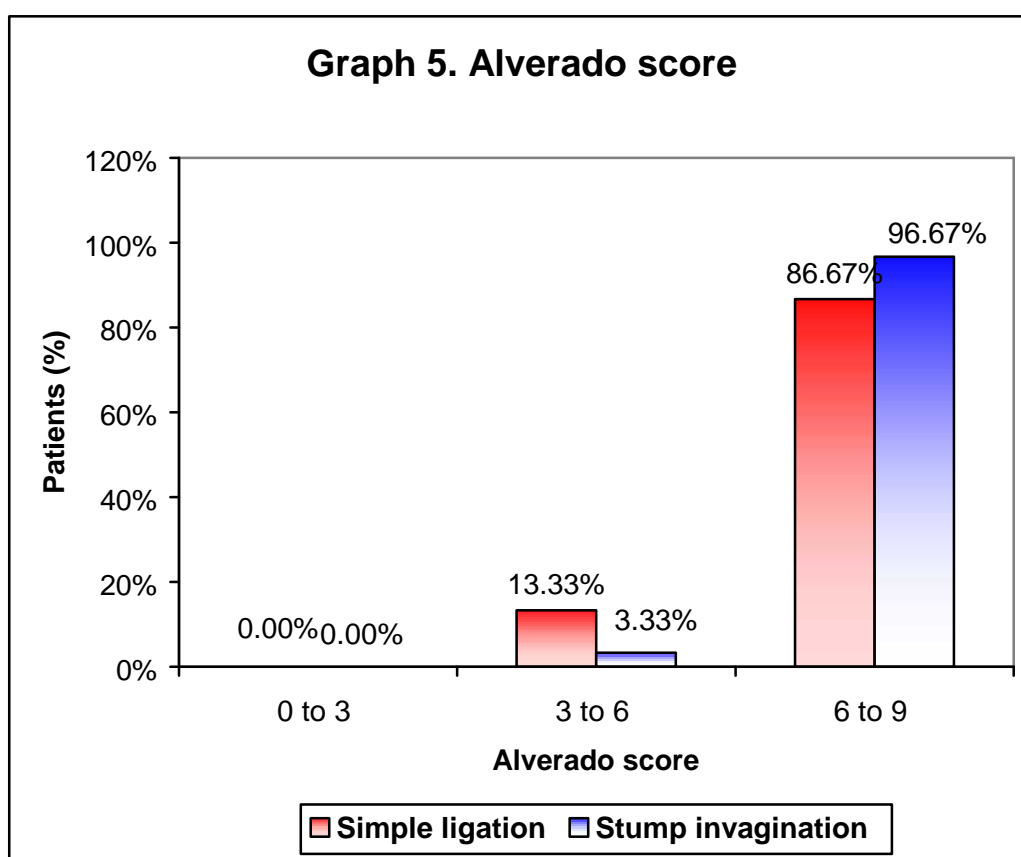
In this study McBurney Tenderness was present in all the patients (100%) in both the groups and none of the patients had rigidity or guarding.

Hyperesthesia or Sherrren's triangle was present in 26.6% of patients in simple ligation group and 6.6% in stump invagination group and this difference was statistically significant ($p=0.037$).

Bowel sound were present in all patients of simple ligation group compared 96.67% in stump invagination group. This difference was statistically not significant ($p=0.313$)

Table 7. Alverado score

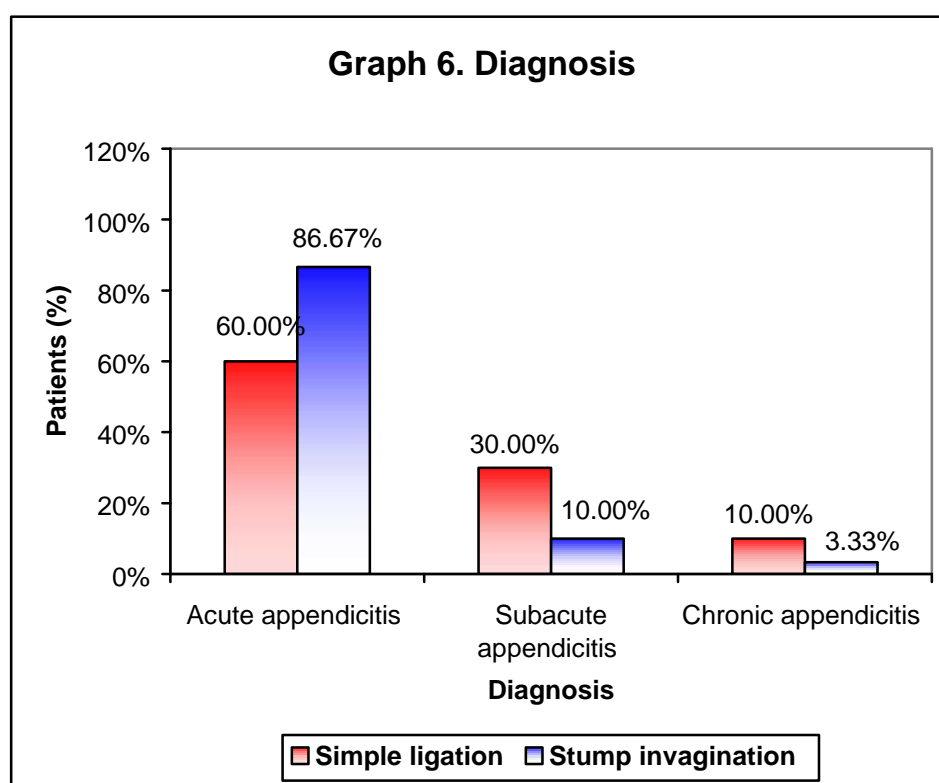
Alverado score	Simple ligation (n=30)		Stump invagination (n=30)	
	Number	Percentage	Number	Percentage
0 to 3	0	0.00	0	0.00
3 to 6	4	13.33	1	3.33
6 to 9	26	86.67	29	96.67
Total	30	100.00	30	100.00



In this study majority (86.67% in simple ligation and 96.67% in stump invagination) of the patients had Alverado score between 6 to 9 in both the groups. The median score was 8 in either group.

Table 8. Diagnosis

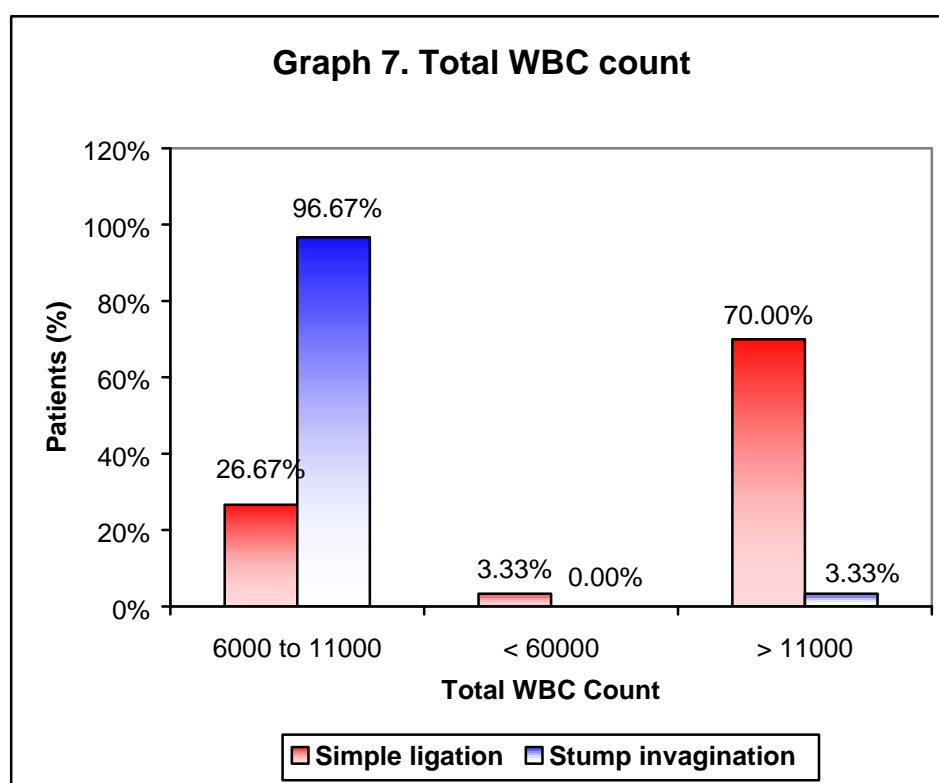
Diagnosis	Simple ligation (n=30)		Stump invagination (n=30)	
	Number	Percentage	Number	Percentage
Acute appendicitis	18	60.00	26	86.67
Subacute appendicitis	9	30.00	3	10.00
Chronic appendicitis	3	10.00	1	3.33
Total	30	100.00	30	100.00



In this study majority (Simple ligation group 60%; Stump invagination group 86.67%) presented with acute appendicitis, subacute in 30% and 10% and chronic appendicitis was seen in 10% and 3.33% patients of patients in simple ligation and stump invagination group respectively. Both the group were analysed by chi-square test and no statistical significance was found ($p=0.097$).

Table 9. Total WBC count

Total WBC count	Simple ligation (n=30)		Stump invagination (n=30)	
	Number	Percentage	Number	Percentage
6000 to 11000	8	26.67	29	96.67
< 6000	1	3.33	0	0.00
> 11000	21	70.00	1	3.33
Total	30	100.00	30	100.00

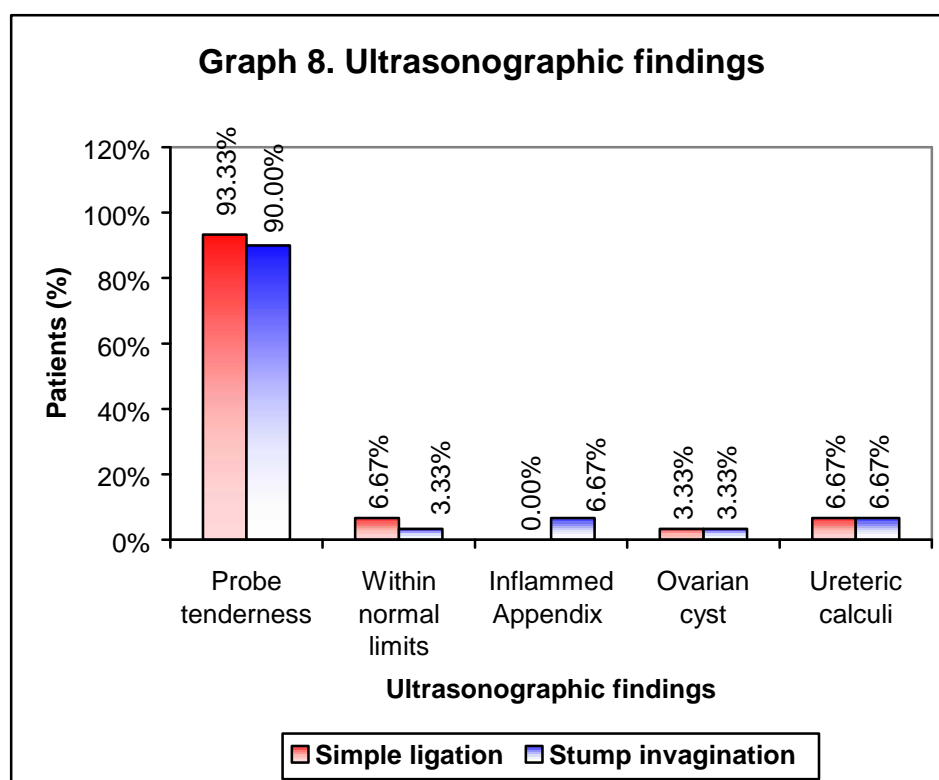


In this study 96.67% patients in stump invagination and 26.67% in simple ligation group had normal total WBC count. In 70% of the patients with simple ligation group had leukocytosis and 3.33% in stump invagination. The mean WBC count in simple ligation group was significantly high (17106 ± 22670.76

Cells/mm³) compared to stump invagination group it was 8548.33 ± 1226.74 (p=0.043).

Table 10. Ultrasonographic findings

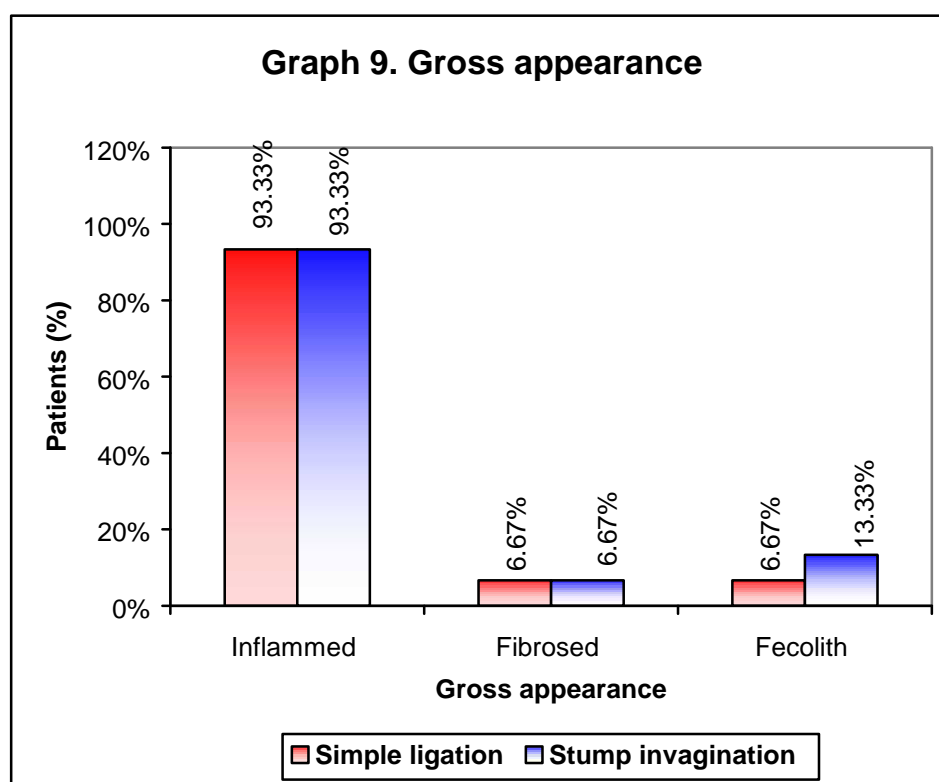
USG findings	Simple ligation (n=30)		Stump invagination (n=30)	
	Number	Percentage	Number	Percentage
Probe tenderness	28	93.33	27	90.00
Within normal limits	2	6.67	1	3.33
Inflammed appendix	0	0.00	2	6.67
Ovarian cyst	1	3.33	1	3.33
Ureteric calculi	2	6.67	2	6.67



In this study majority (93.33% in simple ligation and 90% in stump invagination) had probe tenderness whereas, 6.67% and 3.33% patients in simple ligation and stump invagination had within normal limits. Incidental findings like ovarian cyst was noted in 3.33% of either groups and ureteric calculi was recorded in 6.67% patients of both the groups. However no statistical significant difference was found in both the groups ($p=0.640$).

Table 11. Gross appearance

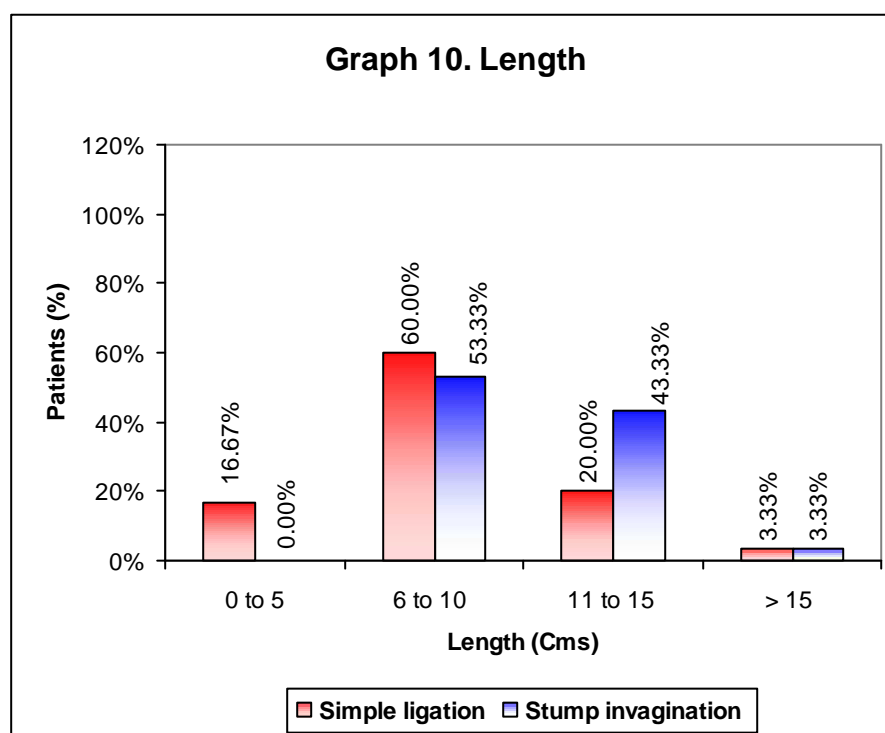
Gross appearance	Simple ligation (n=30)		Stump invagination (n=30)	
	Number	Percentage	Number	Percentage
Inflamed	28	93.33	28	93.33
Fibrosed	2	6.67	2	6.67
Fecolith	2	6.67	4	13.33



In this study, majority (93.33% each in simple ligation and stump invagination) had inflamed appendix whereas, 6.67% in either group had fibrosed appendix. Fecolith appendix was seen in 6.67% of patients in simple ligation and 13.33% in stump invagination.

Table 12. Length

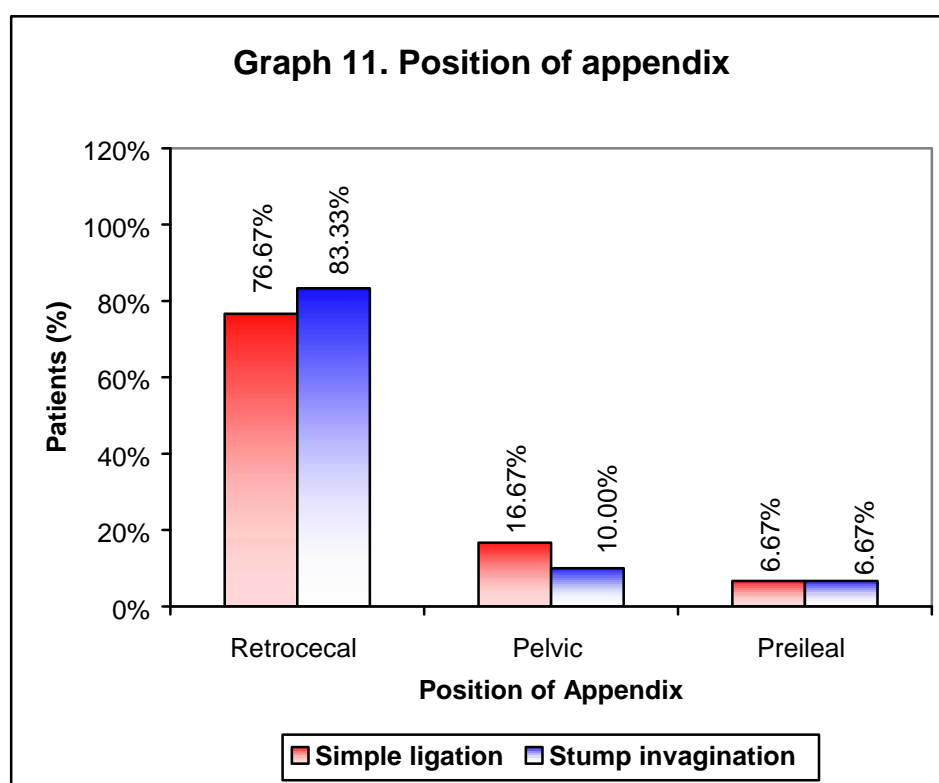
Length (Cms.)	Simple ligation (n=30)		Stump invagination (n=30)	
	Number	Percentage	Number	Percentage
0 to 5	5	16.67	0	0.00
6 to 10	18	60.00	16	53.33
11 to 15	6	20.00	13	43.33
> 15	1	3.33	1	3.33
Total	30	100.00	30	100.00



In the present study, majority (60% each in simple ligation and 53.33% stump invagination) had length between 6 to 10 cms followed by 20% and 43.33% between 11 to 15 cms. respectively. The mean length of appendix in simple ligation was 8.56 ± 3.23 cms whereas in stump invagination it was 10.60 ± 3.23 cms. This difference was statistically significant ($p=0.005$).

Table 13. Position of appendix

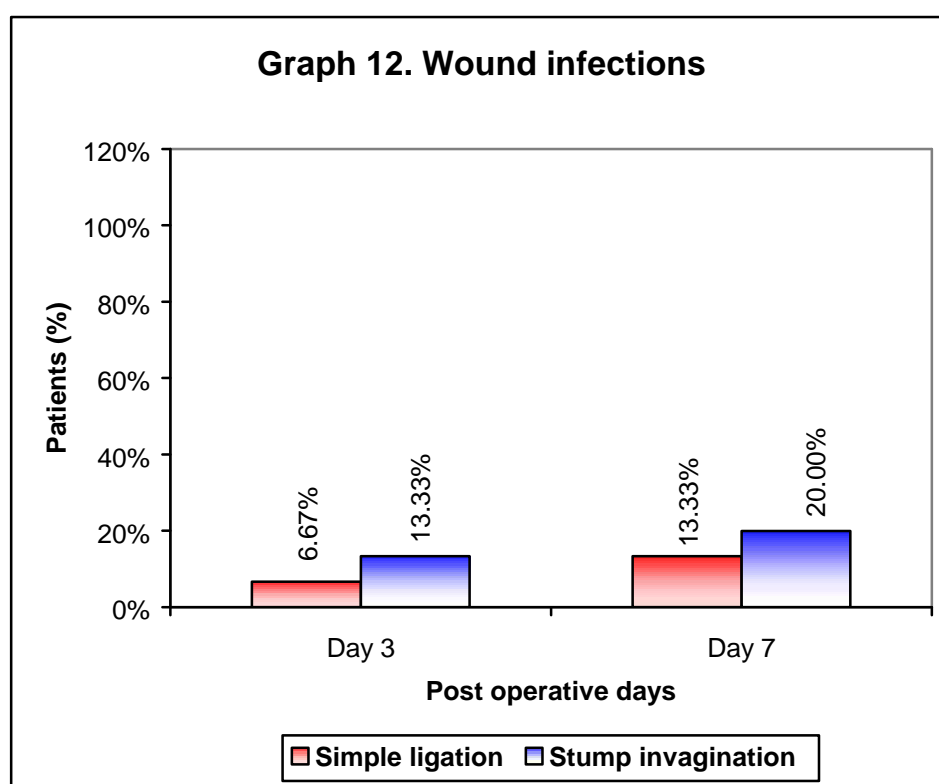
Position	Simple ligation (n=30)		Stump invagination (n=30)	
	Number	Percentage	Number	Percentage
Retrocecal	23	76.67	25	83.33
Pelvic	5	16.67	3	10.00
Preileal	2	6.67	2	6.67
Total	30	100.00	30	100.00



In the present study, majority (76.67% each in simple ligation and 83.33% stump invagination) had retrocecal position followed by 16.67% and 10% in pelvic position respectively. In 6.67% of patients in either group had preileal position.

Table 14. Wound infections

Post operative days	Simple ligation (n=30)		Stump invagination (n=30)	
	Number	Percentage	Number	Percentage
Day 3	2	6.67	4	13.33
Day 7	4	13.33	6	20.00



In this study wound infection was seen in 13.33% of the patients who underwent stump invagination on Day 3 compared to 6.67% of patients with simple ligation. On day 7 rate infection was increased to 20.00% among patients with stump invagination and 13.33% of patients in simple ligation group. However this difference was statistically not significant ($p=0.389$).

Table 15. Type of wound infections

Post operative day	Type	Simple ligation (n=30)		Stump invagination (n=30)	
		Number	Percentage	Number	Percentage
Day 3	Major	0	0.00	0	0.00
	Minor	2	6.67	4	13.33
Day 7	Major	1	3.33	1	3.33
	Minor	3	10.00	5	16.67

In this study on day 3 minor wound infection was seen in 13.33% of the patients who underwent stump invagination and 6.67% of patients who underwent simple ligation.

On day 7 minor wound infection was noted in 16.67% of patients who underwent stump invagination and major wound infection in 3.33% whereas in simple ligation group minor wound infection was noted in 10.00% of patients and major wound infection in 3.33%

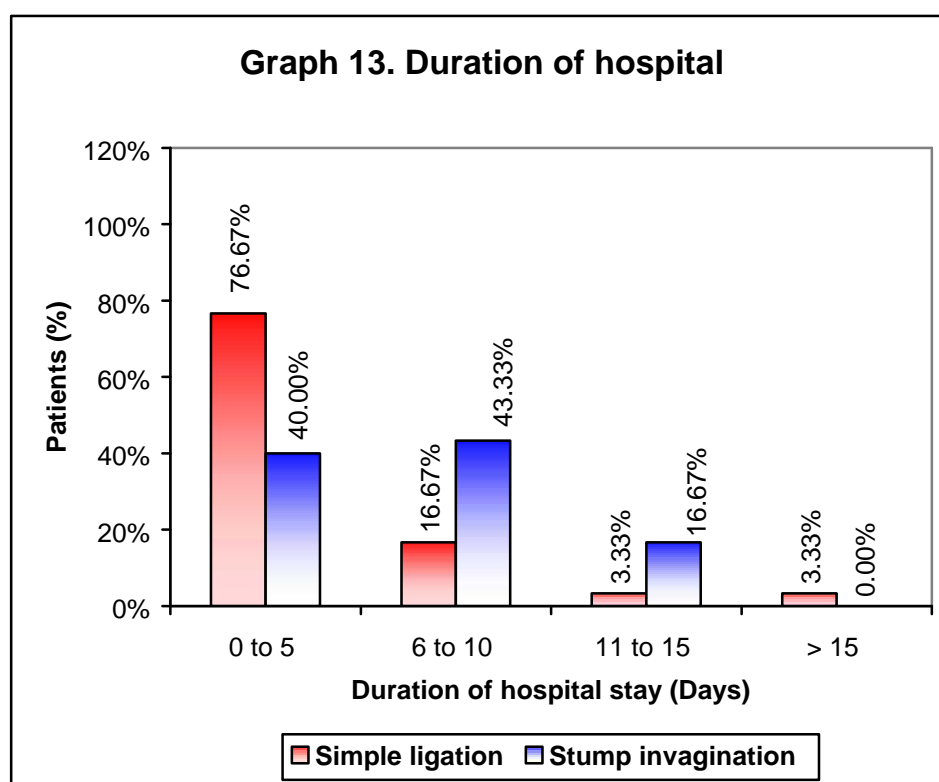
Table 16. Infections

Post operative days	Simple ligation (n=4)		Stump invagination (n=6)	
	Number	Percentage	Number	Percentage
E. Coli	1	25.00	1	16.67
Strept	1	25.00	0	0.00
Staph	0	0.00	2	33.33
Negative	2	50.00	3	50.00

In this study out of four patients in simple ligation group with wound discharge two (50%) had positive culture. The organism isolated were Escherichiac coli and streptococcus in each patient (25%). In stump invagination group out of six patients with wound discharge three (50%) had positive culture and organisms isolated were staphylococcus aureus in two cases (33.33%) and Escherichiac coli in one case (16.67%).

Table 17. Duration of hospital

Post operative days	Simple ligation (n=30)		Stump invagination (n=30)	
	Number	Percentage	Number	Percentage
0 to 5	23	76.67	12	40.00
6 to 10	5	16.67	13	43.33
11 to 15	1	3.33	5	16.67
> 15	1	3.33	0	0.00
Total	30	100.00	30	100.00



In this study, majority of patients (76.67%) who underwent simple ligation had the hospital stay less than five days while, in patients who underwent

stump invagination majority had hospital stay between six to ten days (43.33%). The mean hospital stay in simple ligation group was significantly less (5.23 ± 3.40 days) compared to stump invagination (7.00 ± 3.03 days) ($p=0.046$).

DISCUSSION

Over the years though appendicectomy is one of the commonest performed surgery, the choice of surgical technique remains controversial. Though the last century, the optimal management of appendicectomy stump has frequently been described and in 1937 a detailed historical review was made by Ochsner and Lilly.³ The present study was undertaken as there is a scarcity of literature in Indian population on this topic and there are controversial evidences regarding the incidence of post operative wound infection in either techniques.

In the present study 43.33% were males and 56.67% were females in simple ligation whereas, in stump invagination group, males and females were equally distributed. The male to female ratio in simple ligation group was 1:1.30 compared to 1:1 in stump invagination group. The comparison of both the groups showed equal distribution with no statistical significance ($p=0.604$).

In this study among the patients undergoing simple ligation majority of the patients had age between 41 to 50 years whereas in stump invagination group majority of the patients had age between 21 to 30 years. The mean age in the simple ligation group was 27.73 ± 11.15 years compared to stump invagination group 27.40 ± 11.99 years. However the difference between the age of both the groups was statistically not significant ($p=0.912$).

Similar pattern of demographic distribution was seen in conducted in Sweden.⁸

All the patients (100%) in this study presented with pain in right lower abdomen. Nausea and vomiting was present in 73% of simple ligation group and 63% of stump invagination group. Fever was present in 56.6% of simple ligation group and 33% in stump invagination group. None of the symptoms showed statistical significant difference in either groups.

All the patients had McBurney's tenderness as proved in literature it is one of the important sign which suggest appendicitis.¹⁸ None of the patients had rigidity or guarding as only patients non perforated appendicitis were selected for the study. Hyperaesthesia of Sherren triangle was present in simple ligation group among 26.67% and 6.67% patients of stump invagination. The statistical significant difference between the two groups ($p=0.037$) might be due to pitfall in eliciting the sign.

Literature reveals that, Sherren's Triangle hyperaesthesia is one of the most important single sign of appendicitis but it depends on the method of eliciting.⁵²

The bowel sounds were present in all the patients except one in stump invagination group. However there was no statistical difference was seen in either groups.

In the present study abdominal USG was done in all the patients though diagnosis of appendicitis was mostly clinical. But ultrasonography definitely ruled out the diseases of other abdominal conditions like cholecystitis, pancreatitis and ureteric calculi. Most of the patients in this study had probe tenderness which was highly suggestive of appendicitis.

In this study, only patients with non perforated appendicitis were selected of them majority presented with acute appendicitis (Simple ligation group 60%; Stump invagination group 86.67%) followed by subacute appendicitis (30% versus 10%) and chronic appendicitis (10% versus 3.33%). There was no statistical significance between both the groups ($p=0.097$).

Preoperative preparation and antibiotic regimens for all patients were standardized. Most of the patients underwent procedures by spinal anaesthesia, while few received general anaesthesia. Grid iron incision was standard for all cases and no cases in this study underwent Rutherford Morrison muscle cutting incision. The identification of appendix and management of mesoappendix was undertaken routinely as in any other appendicectomies and no difficulty in delivering caecum and appendix conveniently.

In this study wound infection was seen in 13.33% of the patients who underwent stump invagination on Day 3 compared to 6.67% of patients with simple ligation. On day 7 rate infection was increased to 20.00% among patients with stump invagination and 13.33% of patients in simple ligation group. However this difference was statistically not significant ($p=0.389$).

The question of which procedure has higher incidence of developing wound infection has been controversial.⁷ According to a study done in Sweden the incidence of wound infection was 8.6% and was similar in both groups.⁷ Another study done in India showed lower incidence (9.2% simple ligation versus 16.11% stump invagination) of wound infection in the simple ligation

group.² In a prospective randomized study of 103 patients post operative wound infection was equally frequent after stump invagination and simple ligation.¹

Another study conducted to compare two methods of treatment of the appendix stump after appendectomy for acute appendicitis showed significantly more wound infections in the stump invagination group.⁵³

The wound infection was identified as incisional superficial and deep surgical site infection according to the NNIS program⁴⁶ definition. In this study on day 3 minor wound infection was seen in 13.33% of the patients who underwent stump invagination and 6.67% of patients who underwent simple ligation. On day 7 minor wound infection was noted in 16.67% of patients who underwent stump invagination and major wound infection in 3.33% whereas in simple ligation group minor wound infection was noted in 10.00% of patients and major wound infection in 3.33%.

In this study out of four patients in simple ligation group with wound discharge two (50%) had positive culture. The organism isolated were *Escherichiac coli* and *streptococcus* in each patient (25%). In stump invagination group out of six patients with wound discharge three (50%) had positive culture and organisms isolated were *staphylococcus aureus* in two cases (33.33%) and *Escherichiac coli* in one case (16.67%).

In this study, majority of patients (76.67%) who underwent simple ligation had the hospital stay of less than five days while, in patients who underwent stump invagination majority had hospital stay between six to ten days

(43.33%). The mean hospital stay in simple ligation group was significantly less (5.23 ± 3.40 days) compared to stump invagination (7.00 ± 3.03 days) ($p=0.046$).

Similar findings were reported in a study showing average hospital stay of 4.9 days in stump invagination compared 4.6 in simple ligation group.⁸

The significant difference in the duration of hospital stay could be due to the comorbid conditions such as diabetes, malnutrition, increased duration of time taken for wound healing and most of the patients were from nearby villages where health care system is not developed, hence they preferred staying in the hospital till the wound healed completely.

The limitations of the study were smaller sample size and nutritional status was not considered.

Further studies on larger sample size with homogenous nutritional status may add strength to the study.

CONCLUSION

The study showed reduced incidence of wound infection with simple ligation (13.33%) compared to stump invagination (20%) during appendectomy done on non perforated appendicitis. However this reduction in the incidence was not statistically significant.

The mean post operative hospital stay in simple ligation group was significantly less (5.23 ± 3.40 days) compared to stump invagination (7.00 ± 3.03 days).

SUMMARY

Appendicectomy is one of the commonest operations in abdominal surgery. The most common method is to crush and ligate the stump and then invaginate into caecal wall by means of purse string suture. The present study was undertaken to compare simple ligation appendicular stump versus stump invagination in treatment of appendicectomies done on nonperforated appendicitis in terms of post operative wound infection.

The present one year randomized clinical trial was conducted in the Department of General Surgery, KLES Dr. Prabhakar Kore Hospital and Medical Research Centre, Belgaum over a period from January 2009 to December 2009 on 60 patients with non perforated appendicitis. A total of 30 patients in each group that is simple ligation and stump invagination were allotted by simple randomization. A thorough clinical examination was conducted and the findings were also recorded. Routine investigations such as complete blood count and special investigation such as ultrasound and X-ray abdomen was done. Wound infection was identified as incisional superficial and deep surgical site infection according to the NNIS program definition.

In the present study 43.33% were males and 56.67% were females in simple ligation and in stump invagination group males and females were equally distributed. The mean age in the simple ligation group was 27.73 ± 11.15 years compared to stump invagination group 27.40 ± 11.99 years. All the patients (100%) in this study presented with pain in right lower abdomen. On day 3 minor wound infection was seen in 13.33% of the patients who underwent stump

invagination and 6.67% of patients who underwent simple ligation. On day 7 minor wound infection was noted in 16.67% of patients who underwent stump invagination and major wound infection in 3.33% whereas in simple ligation group minor wound infection was noted in 10.00% of patients and major wound infection in 3.33%. The mean hospital stay in simple ligation group was significantly less (5.23 ± 3.40 days) compared to stump invagination (7.00 ± 3.03 days) ($p=0.046$).

The study showed reduced incidence of wound infection and significantly reduced hospital stay with simple ligation compared to stump invagination during appendectomy done on non perforated appendicitis.

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ANNEXURE I - CONSENT FORM

Mr./Mrs. _____ we are requesting you to enroll yourself in study titled **“A COMPARISON OF SIMPLE LIGATION APPENDICULAR STUMP VERSUS STUMP INVAGINATION IN APPENDICECTOMIES DONE ON NONPERFORATED APPENDECITIS IN TERMS OF POST OPERATIVE WOUND INFECTION”** conducted by **Dr. **** *******, postgraduate student in MS GENERAL SURGERY under the guidance of **Dr **** ******* Professor, Department of Surgery, Jawaharlal Nehru Medical College, Belgaum.

Objective / purpose of this study

You have been requested to participate in research because your profile matches with the study group.

Your participation in the research is absolutely voluntary. Your decision to participate in the study or otherwise will not affect your relationship with Jawaharlal Nehru Medical College, Belgaum. If you decide not participate you are free to withdraw at any time.

This study is being done to compare two techniques used in Open Appendectomy which has been widely practiced all over the world. Patients who are diagnosed pre-operatively as Non-perforated appendicitis are recruited to this study to learn their post operative outcomes in terms of wound infection.

Procedures

Two commonly performed techniques of stump management in cases of appendectomy are compared in this study.

Risk and benefits

There is no increased risk involved in becoming a part of this study and the complications are those which are normally anticipated. The study helps to identify the incidence of post operative wound infection in comparison with the two techniques involved. The results deduced at the end of study will help all similar patients admitted in the hospital.

Alternatives

The standard treatment for the management of Appendicitis is Appendectomy with proper antibiotic regimens. A very few percentage responds initially to conservative management but are advised for interval appendectomy.

Withdrawing / Removal from the study

The participant has full freedom to withdraw from the study when ever he wishes and without prior notice. . Even if you decline to participate, there will not be any change in the line of your management or the relationship with your doctor. You will be told about all the new information that may affect your decision to participate in the study. The Investigator can also remove the participant from the study.

Privacy and Confidentiality

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

1. In emergency to protect your rights and welfare.
2. If required by law.

Institutional / Sponsors policy

If any unforeseen complications or injury occurs during the period of study the participant will be given treatment within the limitations of General ward, KLES Dr. Prabhakar Kore Hospital and Medical Research Centre, Belgaum.

Financial incentives for participation

The participant will neither get any financial incentives during the period of study nor will be asked to pay for the purpose of this study. The expense for coming for follow up should be met by the participant.

Contact details

The participant can contact me any time during the study period for clarification of doubts or any questions.

Dr ***** (P.G. General Surgery), J. N. M. C., Belgaum.

Authorization to Publish Results

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

Consent Statement

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

Signature or the left thumb impression of the participant or legally authorized representative.

Participant's name _____ Signature _____

Witness name _____ Signature _____

Experimenter's name _____ Signature _____

Place _____

Date _____

ANNEXURE II – PROFOMA

Patient Details

Name: _____ Age: _____
Sex: M / F _____ Registration no: _____
Date of Admission: _____ Address: _____
Date of Discharge: _____

Brief History

Chief Complaints:

- 1)
- 2)
- 3)

Other relevant history:

Examination

General Examination

Vitals

Pulse rate: _____
BP: _____
Temp: _____
Respiratory Rate: _____

Systemic Examination

P/A:

Mc Burney`s point Tenderness:

Rigidity / Guarding:

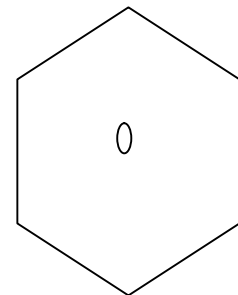
Hyperesthesia in Sherren`s triangle:

Bowel Sounds:

C.V.S:

R.S:

Other relevant examination:



Alvarado Score

Migration of pain	1
Anorexia	1
Nausea/ vomiting	1
RLQ tenderness	2
Rebound tenderness	1
Elevated temperature	1
leukocytosis	2
Left shift	1
Total score	

Provisional Diagnosis:

Investigations

TC/DC:

USG :

Other :

Operation Details

Name of Surgery: Open Appendectomy

Date of Surgery:

Anesthesia:

Intra-Op findings:

Gross appearance:

Length of appendix(in mm):

Position of appendix:

Signs of Peritonitis : Yes / No

Type of stump management: Simple Ligation / Stump Invagination

Post-op period:

Passing of flatus:

Bowel sounds:

Oral feeds:

Duration of hospital stay:

Histopathology of the appendicular specimen:

Wound infection: Absent / Minor / Major

Culture report of wound discharge

Date of Suture Removal:

Follow up for wound infection

3rd post-operative day – Yes / No

7th post-operative day – Yes / No

ANNEXURE III – PHOTOGRAPHS



Photograph 1. Simple ligation



Photograph 2. Purse string suturing



Photograph 3. Stump invagination



Photograph 4. Infected wound

ANNEXURE IV - MASTER CHART

Simple Ligation (Group A)

Sl. No.	I.P. No.	Age (Years)	Sex	Symptoms				Signs				Alvarado Score	Investigations			Intraoperative findings			Postoperative findings			
				Pain	Vomiting/nausea	Fever	Others	Mc Burney's tenderness	Rigidity/Guarding	Hyperaesthesia/Sherren's trg	Bowel sounds		Diagnosis	Total count (/mm ³)	Ultrasonography	Gross appearance	Length (Cms)	Position	Wound infection POD 3	Wound infection POD 7	Culture of wound discharge	Hospital stay (Days)
A1	302734	18	F	+	+	+	-	+	-	-	+	8	SA	14,300	PT	INF	14	PEL	-	-	-	3
A2	304314	21	F	+	+	-	-	+	-	-	+	7	SA	12,250	PT	INF	6	RC	-	-	-	4
A3	306846	19	M	+	+	-	-	+	-	-	+	8	AA	14500	PT	INF	12	RC	-	-	-	4
A4	312714	45	M	+	+	+	-	+	-	-	+	5	SA	8000	PT	INF	8	RC	-	-	-	4
A5	318902	33	F	+	+	+	-	-	-	-	+	8	SA	12000	INF	INF	8	RC	-	-	-	5
A6	318816	12	M	+	+	+	-	+	-	+	+	8	CA	135000	PT	INF	8	RC	-	-	-	5
A7	318912	32	F	+	+	+	-	+	-	-	+	9	AA	24000	PT	INF	10	RC	-	-	-	4
A8	319838	35	F	+	+	-	-	+	-	+	+	8	AA	20000	PT	INF	9	RC	-	-	-	5
A9	320552	35	M	+	+	-	-	+	-	-	+	7	CA	15000	PT, Rt UC	FBR	10	RC	-	-	-	6
A10	325454	55	F	+	-	+	-	+	-	+	+	8	AA	18270	PT	INF	8	RC	-	-	-	4
A11	329452	25	F	+	+	+	-	+	-	-	+	9	AA	22760	PT	INF, FEC	14	RC	-	-	-	4
A12	329452	25	F	+	-	+	-	+	-	-	+	8	AA	14500	PT	INF	16	RC	-	-	-	5
A13	331154	36	M	+	+	+	-	+	-	-	+	8	AA	10500	PT	INF	13	RC	-	-	-	6
A14	331228	22	M	+	+	+	-	+	-	-	+	7	AA	9000	PT	INF	7	RC	-	-	-	5
A15	331956	10	M	+	+	-	-	+	-	-	+	8	AA	13050	PT	INF	8	RC	-	-	-	4

Sl. No.	I.P. No.	Age (Years)	Sex	Symptoms				Signs				Alvarado Score	Investigations			Intraoperative findings			Postoperative findings			
				Pain	Vomiting/nausea	Fever	Others	Mc Burney's tenderness	Rigidity/Guarding	Hyperaesthesia/Sherrren's trg	Bowel sounds		Diagnosis	Total count (/mm ³)	Ultrasonography	Gross appearance	Length (Cms)	Position	Wound infection POD 3	Wound infection POD 7	Culture of wound discharge	Hospital stay (Days)
A16	331834	23	F	+	+	+	MALN	+	-	-	+	8	AA	12500	PT	INF	6	PEL	-	MN	Strept	1
A17	331954	38	F	+	+	+	-	+	-	-	+	7	AA	12000	PT	INF, FEC	5	PEL	-	-	-	2
A18	333592	19	M	+	+	-	-	+	-	+	+	9	AA	18900	PT	INF	5	PEL	MN	MJ	E Coli	20
A19	333592	19	F	+	+	+	-	-	-	+	+	7	SA	12500	INF	INF	8	RC	-	-	-	6
A20	334420	40	F	+	-	-	-	+	-	-	+	8	SA	10000	PT	INF	7	RC	-	-	-	4
A21	325592	25	M	+	-	-	-	+	-	+	+	7	AA	12000	PT	INF	6	RC	-	MN	-	8
A22	325592	25	M	+	-	-	-	+	-	-	+	5	SA	5000	PT	INF	5	RC	-	-	-	4
A23	335449	40	M	+	+	+	-	+	-	+	+	8	AA	10500	PT, Rt UC	INF	9	RC	-	-	-	5
A24	336646	16	M	+	+	+	-	+	-	-	+	6	CA	8500	PT	FBR	14	RC	-	-	-	3
A25	338099	26	F	+	+	+	-	+	-	-	+	6	SA	7600	PT	INF	4	RC	MN	MN	-	11
A26	337428	32	F	+	+	+	-	+	-	-	+	8	AA	10500	PT	INF	5	RC	-	-	-	3
A27	339040	36	M	+	+	-	-	+	-	-	+	7	SA	12000	PT	INF	8	RC	-	-	-	4
A28	341762	43	F	+	-	-	-	+	-	-	+	8	AA	12550	PT	INF	6	PI	-	-	-	9
A29	342032	18	F	+	-	-	-	+	-	+	+	8	AA	12000	PT, RT OC	INF	6	PI	-	-	-	5
A30	344394	19	F	+	-	-	-	+	-	-	+	9	AA	13500	PT	INF	12	PEL	-	-	-	4

Stump Invagination (Group B)

Sl. No.	I.P. No.	Age (Years)	Sex	Symptoms				Signs				Alvarado Score	Investigations			Intraoperative findings			Postoperative findings			
				Pain	Vomiting/nausea	Fever	Others	Mc Burney's tenderness	Rigidity/Guarding	Hyperaesthesia/Sherrren's trg	Bowel sounds		Diagnosis	Total count (/mm ³)	Ultrasonography	Gross appearance	Length (Cms)	Position	Wound infection POD 3	Wound infection POD 7	Culture of wound discharge	Hospital stay (Days)
B1	306063	32	M	+	+	+	-	+	-	-	+	9	AA	8400	PT	INF	16	RC	-	-	-	6
B2	307395	35	F	+	+	+	-	+	-	-	+	7	AA	9450	PT	INF	15	RC	-	-	-	11
B3	310681	21	M	+	+	-	-	+	-	-	+	8	CA	6800	WNL	FBR	13	RC	-	-	-	4
B4	311787	15	F	+	+	-	-	+	-	-	+	8	AA	10200	PT	INF	7	PEL	-	-	-	5
B5	316625	28	M	+	+	-	-	+	-	-	+	7	SA	8200	INF	FBR	10	RC	-	-	-	6
B6	317657	32	M	+	+	-	-	+	-	-	+	8	AA	9200	INF	INF	10	RC	-	-	-	6
B7	318387	9	M	+	-	+	-	+	-	-	+	9	AA	8900	PT	INF	10	RC	-	-	-	7
B8	318401	30	F	+	-	+	-	+	-	-	+	8	AA	10100	PT	INF, FEC	12	RC	-	-	-	8
B9	329283	30	M	+	+	-	-	+	-	-	+	9	SA	9100	PT	INF	11	RC	-	-	-	8
B10	319325	12	F	+	+	+	-	+	-	-	+	9	AA	11800	PT	INF	8	RC	-	-	-	5
B11	320191	30	M	+	+	+	DM	+	-	-	+	8	AA	9400	PT, Lt UC	INF	12	RC	MN	MN	Staph	11
B12	322019	20	F	+	+	+	-	+	-	-	+	8	AA	8200	PT	INF	13	RC	MN	MN	-	10
B13	326125	13	F	+	+	-	-	+	-	-	+	6	SA	7900	PT	INF, FEC	9	RC	-	-	-	7
B14	325459	55	F	+	-	-	-	+	-	-	+	8	AA	8200	PT, Rt UC	INF	10	RC	-	-	-	5
B15	329283	23	M	+	-	-	-	+	-	-	+	9	AA	8600	PT	INF	10	PEL	MN	MN	Staph	9

Sl. No.	I.P. No.	Age (Years)	Sex	Symptoms				Signs				Alvarado Score	Investigations			Intraoperative findings			Postoperative findings			
				Pain	Vomiting/nausea	Fever	Others	Mc Burney's tenderness	Rigidity/Guarding	Hyperesthesia/Sherren's trg	Bowel sounds		Diagnosis	Total count (/mm ³)	Ultrasonography	Gross appearance	Length (Cms)	Position	Wound infection POD 3	Wound infection POD 7	Culture of wound discharge	Hospital stay (Days)
B16	329961	26	F	+	+	-	-	+	-	+	+	7	AA	11000	PT	INF	11	RC	-	-	-	5
B17	332789	20	M	+	-	+	-	+	-	-	+	8	AA	8100	PT	INF	12	RC	-	-	-	4
B18	333681	45	F	+	+	+	DM	+	-	-	+	8	AA	7000	PT, Lt OC	INF, FEC	12	RC	-	MJ	E. Coli	12
B19	334901	15	F	+	+	+	-	+	-	-	+	8	AA	7900	PT	INF	11	RC	-	-	-	9
B20	338371	17	F	+	+	-	-	+	-	-	+	8	AA	8900	PT	INF	8	RC	-	-	-	4
B21	339189	19	M	+	+	-	-	+	-	-	+	9	AA	9200	PT	INF	9	RC	-	-	-	4
B22	339189	39	F	+	-	-	-	+	-	-	+	9	AA	7600	PT	INF	10	RC	-	-	-	4
B23	340785	28	F	+	+	-	MALN	+	-	-	+	8	AA	6900	PT	INF	12	RC	MN	MN	-	13
B24	342633	51	M	+	+	-	-	+	-	-	+	7	AA	7000	PT	INF, FEC	7	RC	-	-	-	5
B25	343187	25	F	+	+	-	-	+	-	-	+	8	AA	6900	PT	INF	10	PEL	-	MN	-	14
B26	344471	55	M	+	-	-	-	+	-	+	+	7	AA	9100	PT	INF	10	RC	-	-	-	9
B27	346683	27	F	+	-	-	-	+	-	-	+	8	AA	9200	PT	INF	11	PI	-	-	-	6
B28	348979	28	M	+	-	-	-	+	-	-	+	8	AA	8200	PT	INF	10	RC	-	-	-	7
B29	347483	21	M	+	-	-	-	+	-	-	+	7	AA	7900	PT	INF	11	RC	-	-	-	4
B30	347483	21	M	+	-	-	-	+	-	-	+	8	AA	7100	PT	INF	8	PI	-	-	-	2

ANNEXURE IV - KEY TO MASTER CHART

-	-	Absent
+	-	Present
AA	-	Acute appendicitis
CA	-	Chronic appendicitis
Cm	-	Centimeter
DM	-	Diabetes mellitus
E. Coli	-	Escherichia coli
F	-	Female
FBR	-	Fibrosed
FEC	-	Fecolith
INF	-	Inflammed
IP. No.	-	In patient number
Lt	-	Left
M	-	Male
MALN	-	Malnutrition
MJ	-	Major
mm	-	Millimeter
MN	-	Minor
OC	-	Ovarian cyst
PEL	-	Pelvic
PI	-	Preileal
POD	-	Post operative day

PT	-	Probe tenderness
RC	-	Retrocaecal
Rt	-	Right
SA	-	Recurrent appendicitis
Sl. No.	-	Serial number
Staph	-	Staphylococcus aureus
Strept	-	Streptococcus
Trg	-	Triangle
UC	-	Ureteric calculi