‘‘COMPARATIVE STUDY OF EFFICACY OF MONOPOLAR ELECTROCAUTERY AND ULTRASONIC SHEARS IN LAPAROSCOPIC APPENDECTOMY’’

BY

Dr. ATUL DUA

DISSERTATION SUBMITTED TO SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION AND RESEARCH, KOLAR, KARNATAKA In partial fulfilment of the requirements for the degree of

MASTER OF SURGERY
IN
GENERAL SURGERY

Under the Guidance of

Dr. KRISHNA PRASAD K

PROFESSOR & HOD

DEPARTMENT OF GENERAL SURGERY,
SRI DEVARAJ URS MEDICAL COLLEGE,
TAMAKA, KOLAR-563101

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SRI DEVARAJ URS MEDICAL COLLEGE, TAMAKA, KOLAR-563101

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Dr. ATUL DUA

SRI DEVARAJ URS MEDICAL COLLEGE, TAMAKA, KOLAR-563101

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Signature of the Guide

Date:

Place: Kolar

Dr. KRISHNA PRASAD K.
Professor & HOD
Department of General surgery,
Sri Devaraj Urs Medical College
Tamaka, Kolar.

SRI DEVARAJ URS MEDICAL COLLEGE,
TAMAKA, KOLAR-563101

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Dr. K. KRISHNA PRASAD
Professor & HOD
Department of General Surgery,
Sri Devaraj Urs Medical College
Tamaka, Kolar

Date:
Place: Kolar

Dr. P.N.SREERAMULU
Principal
Sri Devaraj Urs Medical College
Tamaka, Kolar

Date:
Place: Kolar

SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION AND RESEARCH CENTER, TAMAKA, KOLAR, KARNATAKA

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Dr. ATUL DUA
Post graduate student
Department of General Surgery
Sri Devaraj Urs Medical College
Kolar

Sri Devaraj Urs Academy of Higher Education and Research

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Prof. & HOD of Surgery
Sri Devaraj Urs Medical College,
Tamaka, KOLAR-563101.

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Signature of the Candidate

Dr. ATUL DUA

LIST OF ABBREVATIONS

ASIS	: Anterior superior iliac spine
CT	: Computed tomography
SSI	: Surgical site infection
VAS	: Visual analogue scale (pain score)
HIV	: Human immunodeficiency virus
i.e.	: That is
WBC	: White blood cells
Tc	: Technetium

ABSTRACT

Aim: To compare efficacy of monopolar electro cautery and ultrasonic shears for laparoscopic appendectomy in terms of operating time, intraoperative hemostasis, post-operative pain, surgical site infection and post-operative hospital stay.

Methods: In this prospective comparative study, conducted in R L Jalappa Hospital, Kolar, patients were divided into two groups using odd- even method (alternate method) to include similar type of cases in both groups. Each group included 22 patients, and underwent laparoscopic appendectomy using ultrasonic shears or monopolar electro cautery.

Results: Most of the patients were in the age group of 21 to 30 years. Majority were males. Significant differences were noted in terms of operating time, pain score on 24 hours postoperatively, intraoperative hemostasis and duration of post-operative hospital stay. These parameters were less in ultrasonic shears group compared to conventional Monopolar electro cautery group. Complications like surgical site infection were relatively same in both the groups.

Conclusion: Use of ultrasonic shears was found to be safe, effective and beneficial in reducing operative time and achieving better intraoperative hemostasis. Ultrasonic shears serves as an alternative to the Monopolar electro cautery in laparoscopic appendectomy. There is a decrease in the post-operative hospital stay in ultrasonic shear group. The intensity of pain perceived by patients in the ultrasonic shear group is less compared to monopolar electro cautery group. The cost of ultrasonic shear is more compared to monopolar electro cautery, which limits its regular use in laparoscopic appendectomy.

Keywords: Ultrasonic shears, Monopolar electro cautery, laparoscopic appendectomy

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INTRODUCTION

Acute appendicitis is commonest indication for abdominal emergency surgery with incidence of about 8%[1]. It is associated with significant morbidity (10%) and mortality (1-5%) despite advances in diagnosis and treatment[2].

It commonly occurs in age group of 10-20 years with male preponderance, male to female ratio (1.4:1)[3]. Appendicitis is caused due to obstruction of lumen which leads to stasis and bacterial proliferation, commonest cause being fecolith, other causes include lymphoid hyperplasia, worm infestation[3].

This remarkable laparoscopic surgery era has changed the approach for surgical diseases. Most of open surgeries are now being preferred for laparoscopic technique due to its advantages[4].

First Laparoscopic appendectomy was performed on 30th May, 1980 by Dr. Semm, a gynaecologist. Laparoscopy can be utilized to diagnose conditions coexisting with appendicitis, in females for gynaecology and pelvis pathologies and in obese patients[5].

Laparoscopic appendectomy is progressively accepted as treatment of choice for acute appendicitis. It offers advantages like faster recovery, less postoperative pain, reduced wound infection, short duration of stay in hospital and earlier return to work[6].

In appendectomy, the most important step is closure of stump. Inadequate closure may lead to complications such as faecal fistula, peritonitis leading to sepsis causing severe morbidity[7].

Newer methods for appendicular stump closure have been introduced like endoloop, double endoloop, ultrasonic shears, knotting, bipolar coagulation, slipknot tying, metal clip, hem o lock clip and linear endostaplers[8].

Energy sources are indispensable for laparoscopic appendectomy. Electro cautery is the most popular energy source and ultrasonic shears is one of the latest additions.

Monopolar electro cautery is utilized because of its easy availability, affordability and easy maintenance, but it is associated with distant thermal damage which may inadvertently lead to perforation of bowel.

Ultrasonic shears is the advanced and one of the latest energy sources which offers ease of usage like easy cut & coagulation and least complications but is expensive in terms of initial as well as maintenance costs.

Ultrasonic shears during laparoscopic surgery produces less lateral thermal damage and leads to a shorter duration of surgery. Ultrasonic shears produces bioaerosols or very small particles and produces no smoke and no electric energy passage through patient's body[9,10,11].

The contemporary study is being contemplate to compare the efficacy of monopolar electro cautery with ultrasonic shears in laparoscopic appendectomy, the results of which may aid the surgeons to make objective choices in choosing the right energy source.

OBJECTIVES

OBJECTVES OF THE STUDY

(A) To study the efficacy of Monopolar electro cautery (Group A) in laparoscopic appendectomy in terms of operating time, intraoperative bleeding, postoperative pain, surgical site infection and postoperative stay.

(B) To study the efficacy of Ultrasonic shears (Group B) in laparoscopic appendectomy in terms of operating time, intraoperative bleeding, postoperative pain, surgical site infection and postoperative stay.

(C) To compare the efficacy of (Groups A & B) Monopolar electro cautery with Ultrasonic shears in laparoscopic appendectomy in terms of above mentioned parameters.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Being a vestigial organ, the clinical importance of vermiform appendix results from its propensity from inflammation leading to “Acute appendicitis”.

In 1530, Erasmus a Greek scholar first documented a case of appendicitis with abscess formation.

In 1554, French physician Jean Fernal diagnosed first case of perforated appendicitis on autopsy who presented with pain abdomen and loose stools.

Vermiform appendix was first coined by Verneys in 1710.

1736: First appendectomy done by Claudius Amyand, surgeon at St George’s Hospital in London and sergeant surgeon Queen Ann, King George I and King George II[12].

1848: the first surgical treatment of appendicitis or peri typhlitis without abscess was

done by Hancock[13].

1880: Lawson Tait, a pioneer in abdominal surgery performed the first appendicectomy on a girl with gangrenous appendicitis[14].

Reginald Fitz in 1886 identified appendix as a primary source of right lower quadrant inflammation. Appendicitis was coined by him and he proposed timely surgical intervention for it[15].

In 1889, Charles Mcburney coined Mcburney’s incision and reported early operative intervention in acute appendicitis[16].

In 1902, Oschner sherren regimen was described by Albert Oschner for conservative management of appendicular abscess[17].

In 2004, a study conducted by Ngugen NT et al reported the increase in incidence of laparoscopic appendectomy from 20% to 43%from 1999 to 2003 especially in female patients with less severe symptoms[18].

A series of Laparoscopic appendectomy was first published by Pier A et al and they demonstrated that the procedure had a low complication rate and high operating speed compared to traditional open appendectomy[19].

EMBRYOLOGY

Appendix develops as a narrow diverticulum from distal end of caecal bud during descent of colon and appears as a small conical dilation of midgut caudal limb at around 6th week[20]. It forms due to growth of Caecum (right wall) resulting in appendix being pushed to inner side[21]. As gestation progresses, the appendix becomes more elongated and tubular as the cecum rotates medially and becomes fixed in the right iliac fossa of the abdomen. Diameter of colon is 4.5 times at birth and 8.6 times at maturity with respect to appendix.

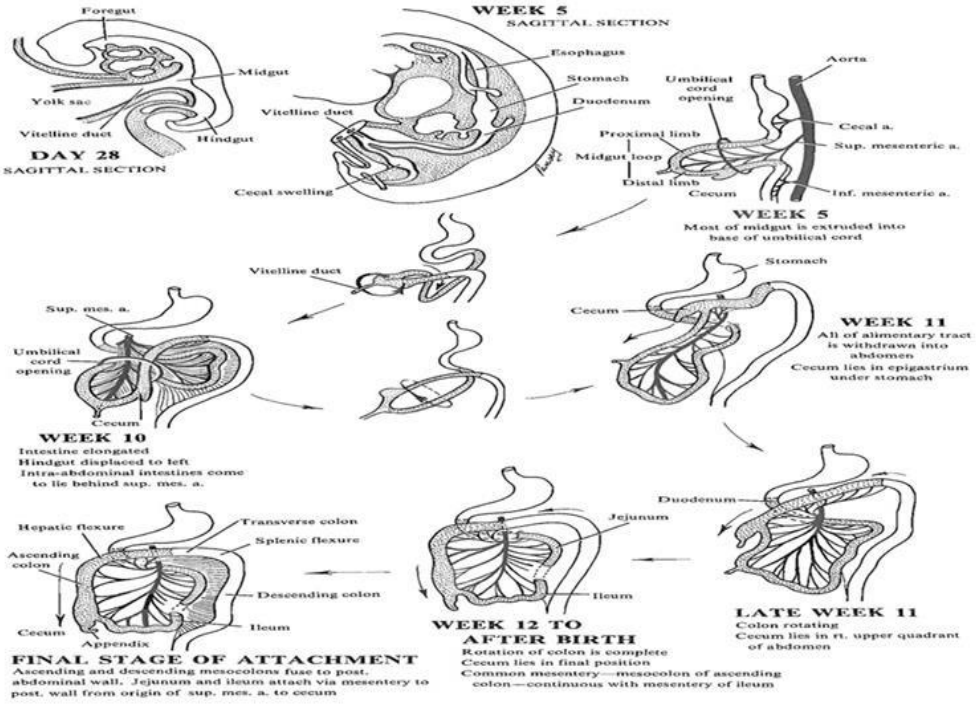


FIGURE 1:- EMBRYOLOGICAL DEVELOPMENT OF APPENDIX

Appendix lies at the apex of caecum in intrauterine life but gradually gets displaced medially towards ileocaecal valve due to increased growth at right terminal haustral[22].

ANATOMY

The size of Appendix varies from 5mm to 35mm in length (average 9mm length in adults). Its base can be identified at convergence of taeniae coli at the tip of caecum. These anatomic variations in position of tip of appendix may account for different clinical presentation and variable location of abdominal discomfort. Gerlach's valve is a mucous membrane fold, semilunar in shape which guards the appendicular orifice[23].

POSITIONS OF APPENDIX[17]

Retrocaecal: - seen in 74% individuals at 12 o clock position, lies behind caecum

Pelvic: - seen in 21% individuals at 4 o clock position

Sub-caecal: - seen in 1.5% individuals at 6 o clock position

Pre-ileal: - seen in 1% individuals at 1 o clock position

Paracolic: - seen in 2% individuals at 11 o clock position

Post ileal: - seen in 0.5% individuals at 2 o clock position

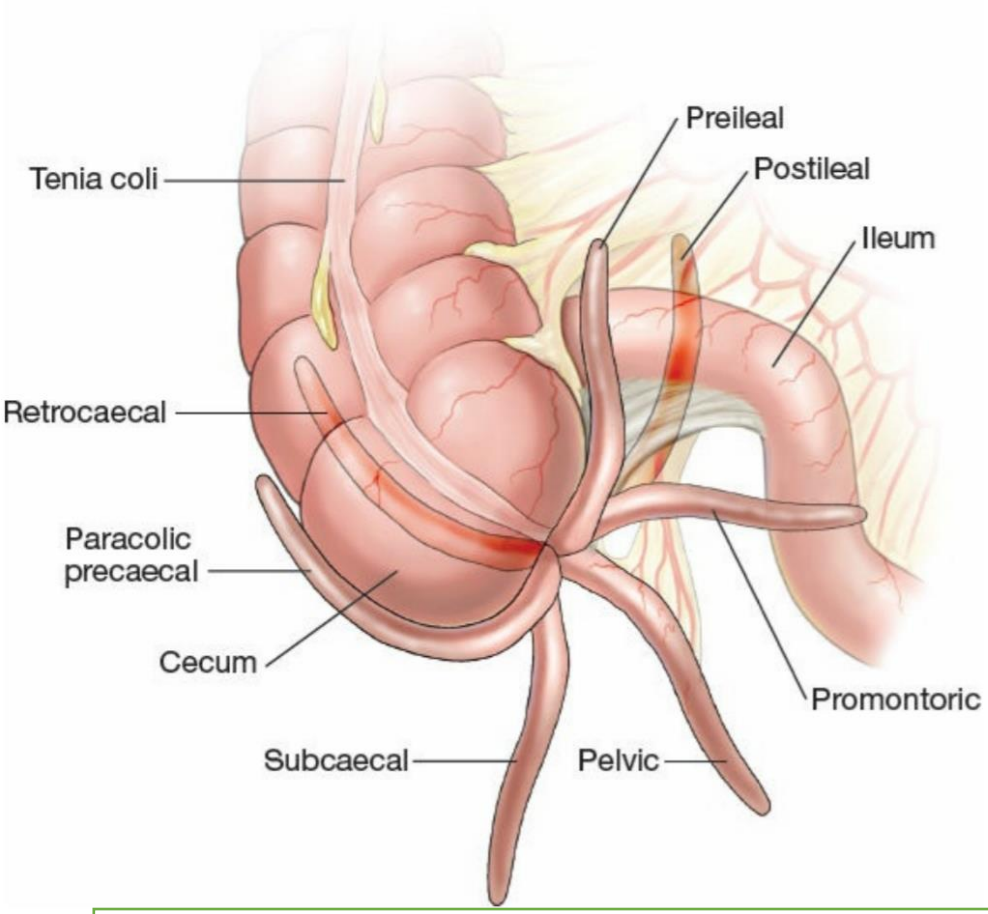


FIGURE 2:- POSITIONS OF APPENDIX

ARTERIAL SUPPLY

Appendix is supplied by appendicular artery which is a branch of lower division of ileocolic artery which itself is a branch of superior mesenteric artery. Appendicular artery descends posteriorly to end of ileum to enter mesoappendix near to base. Its recurrent branch anastomose with a branch of posterior caecal artery. It is an end artery hence inflammation cause thrombosis which progresses to gangrene and perforation. Accessory artery of Seshachalam may be present at times[24].

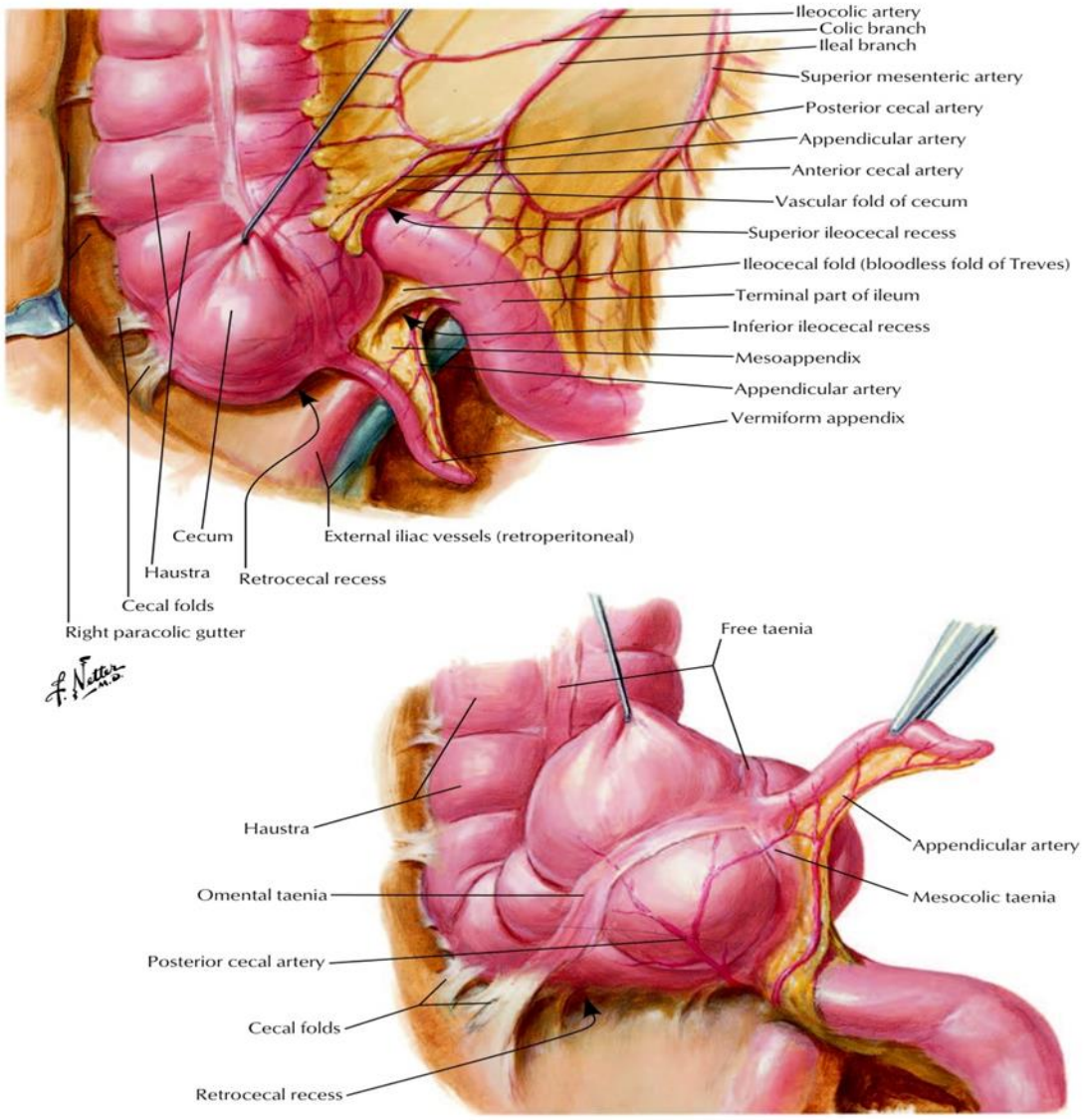


FIGURE 3:- ARTERIAL SUPPLY OF APPENDIX

VENOUS DRAINAGE

Appendicular vein follows the appendicular artery along free border of mesoappendix and joins ileocolic vein. Ileocolic vein further drains into inferior mesenteric vein and finally into portal vein[24].

LYMPHATIC DRAINAGE

Drainage of lymphatic vessels is from lymphatic follicles and pierces muscular coat to nodes in mesoappendix and then into paracolic nodes along ileocolic artery and finally into group of superior mesenteric lymph nodes[24].

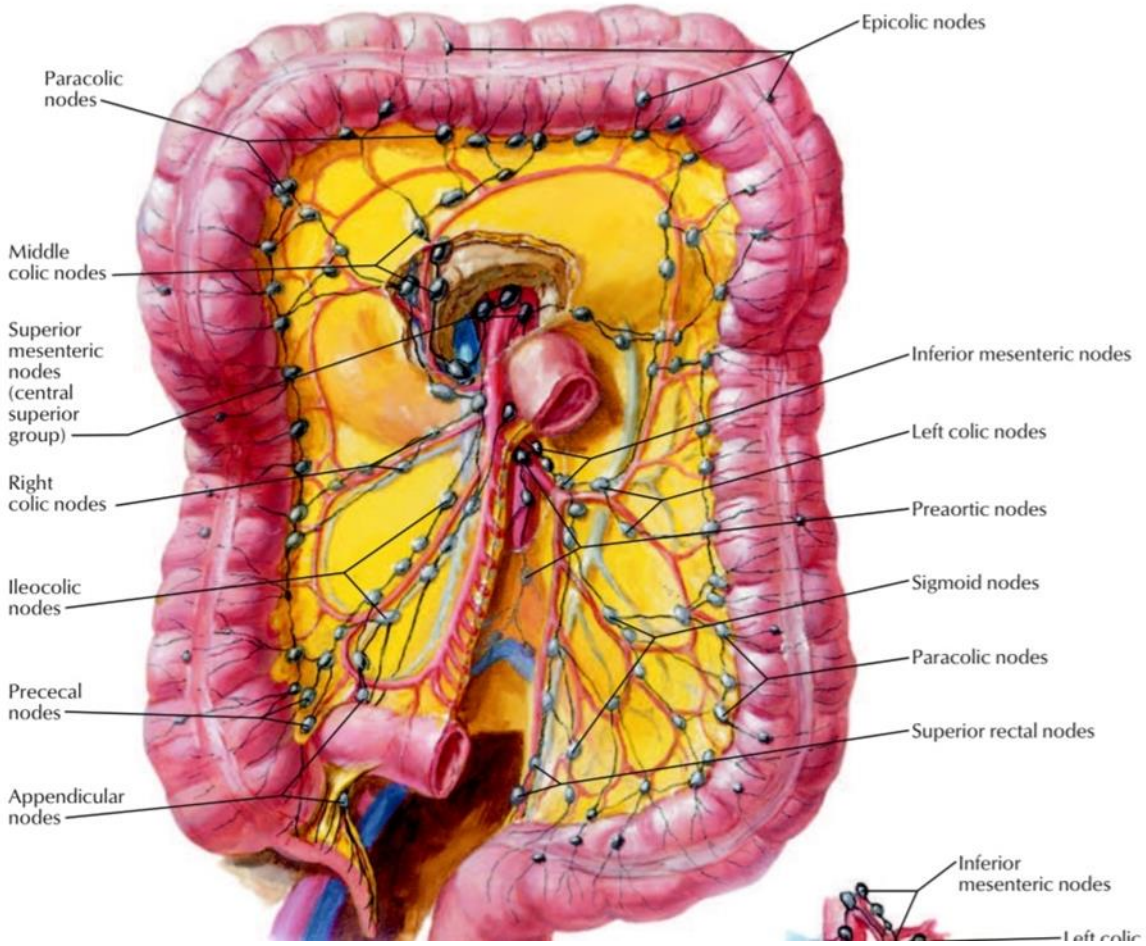


FIGURE 4:- LYMPHATIC DRAINAGE OF APPENDIX

NERVE SUPPLY

Parasympathetic supply is from vagus nerve whereas Sympathetic supply is from thoracic segments 9 and 10 through coeliac plexus. Hence, referred pain is felt around umbilicus (T9-T10)[24].

SURFACE MARKING

Mc Burney's point corresponds to base of appendix, at junction of medial two third and lateral one third of a line joining ASIS and umbilicus[16].

NORMAL HISTOLOGY

The layers of appendicular wall are same as rest of large intestine. Serosa forms a complete covering, except along the mesenteric attachment. The longitudinal muscular fibers from a complete layer of uniform thickness, except over a few small areas where both muscular layers are deficient. The sub mucosa typically contains many large lymphatic aggregates. Mucosa is covered by columnar epithelium, and M cell are present in the epithelium overlies the mucosal lymphoid tissue[25].

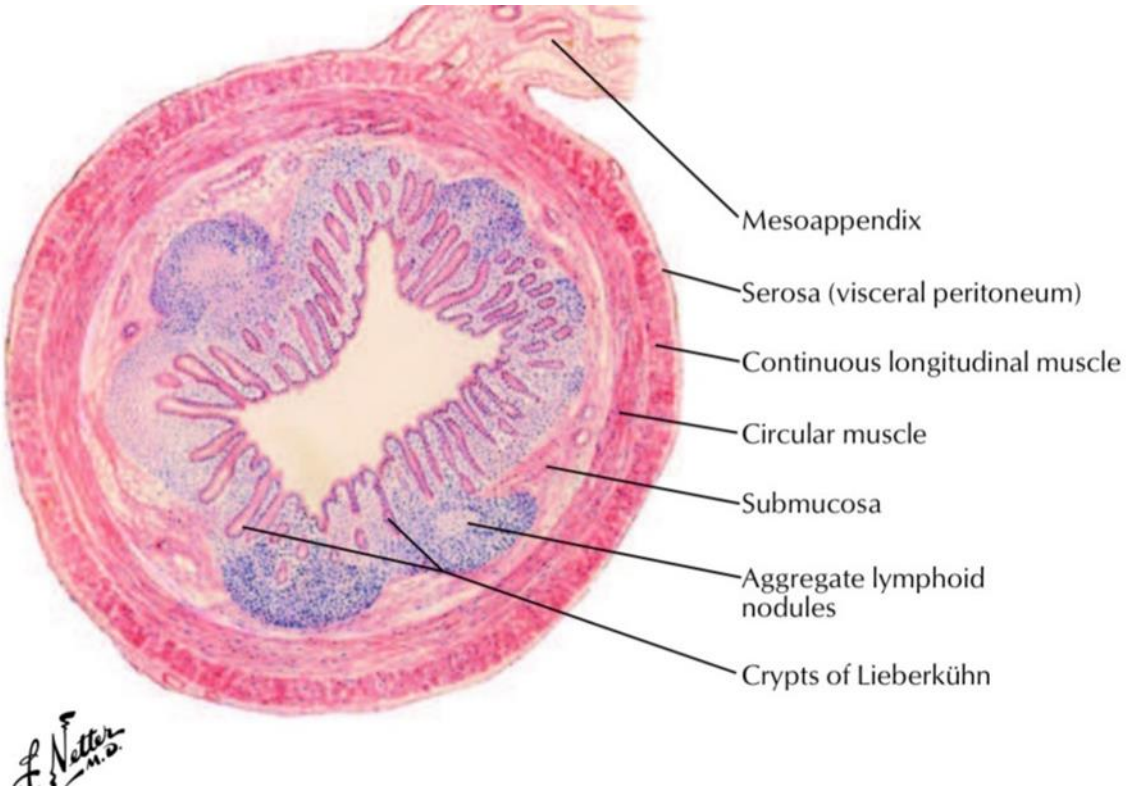


FIGURE 5:-NORMAL HISTOLOGY OF APPENDIX

FUNCTIONS

In mammals particularly herbivores, caecum and appendix are large and are important for cellulose digestion by symbiotic bacteria. The lymphoid follicles are a centre for B cell lymphocyte maturation. Appendix has very important immunological role in synthesis of immunoglobulins, especially immunoglobulin A[13].

ACUTE APPENDICITIS

Incidence:

The rate of appendectomies being done in a lifetime for men is 12% and for women is 25%. Mean age for appendicitis equals to 31.3 years and 22 years being the median age. Males are more prone to appendicitis than females (M:F ratio is 1.4:1)[26].

Geographic distribution:

Environmental factors play a key role in appendicitis rather than genetic factors, as appendicitis become prevalent when people migrate to western world or adapt a western diet. It is commonly seen among meat consuming white races and rarely with people who habitually consume bulk cellulose diet. Surgeons also believe that appendicitis is associated with familial tendency, explanation being inherited malformation seen with it[27].

PATHOPHYSIOLOGY:

The major causative factor for acute appendicitis is luminal obstruction. The appendix is vulnerable to this phenomenon because of its small luminal diameter compared to length. Obstruction of the proximal lumen of the appendix leads to increased pressure in the distal portion because of ongoing mucus secretion and production of gas by bacteria within the lumen. With progressive distention of the appendix, the venous drainage becomes impaired, resulting in mucosal ischemia. With continued obstruction, full-thickness ischemia ensues, which ultimately leads to perforation.

Bacterial overgrowth within the appendix is caused due to stasis of bacteria distal to the obstruction. This overgrowth leads to release of larger bacterial inoculum in cases of perforated appendicitis. The causes of the luminal obstruction are many and varied. These most commonly include faecal stasis and fecolith but may also include lymphoid hyperplasia, neoplasms, fruit and vegetable material, ingested barium, and parasites such as ascariasis. Pain of appendicitis has both visceral and somatic components[28]. Distention of the appendix is responsible for the initial vague abdominal pain (visceral) often experienced by the affected patient. The time from onset of obstruction to perforation is variable and may range from a couple hours to some days. The presentation after perforation is also variable. The commonest sequela is the formation of periappendiceal or pelvis abscess. On occasion, however, free perforation occurs that results in diffuse peritonitis[28].

TYPES OF APPENDICITIS:-

1) ACUTE NON-OBSTRUCTIVE APPENDICITIS:

This type of appendicitis has no luminal obstruction but has mucosal inflammation followed by secondary infection. Its sequelae are resolution, fibrosis, recurrent appendicitis or obstructive appendicitis[29].

Rapid progression of inflammation occurs if it reaches the submucosa. Appendix becomes turgid with haemorrhages into the mucosa. Finally, obstructive appendicitis occurs once the bacteria translocates from submucosa to muscularis propria. As appendicular artery is an end artery, inflammation may lead to its thrombosis which causes necrosis and gangrene starting at the tip of appendix. Lymphoid hyperplasia has also been seen to cause obstructive appendicitis.

This type usually progresses slowly for protective barriers to form, and if at all progresses it causes localised peritonitis. Also, sometimes the inflammation does not pass beyond the mucosa i.e. catarrhal inflammation. Due to chronic fibrosis the tip appears shrunken, which is a classical ultrasound finding in recurrent appendicitis.

2) ACUTE OBSTRUCTIVE APPENDICITIS

Commonest cause is fecolith, being 40% in acute appendicitis, 65% in gangrenous (without perforation) appendicitis and more than 90% in perforated cases[28].

Other causes include lymphoid hyperplasia, foreign bodies like seeds, worm infestation like pinworm or roundworm.

Following obstruction there occurs a cycle of events. Due to obstruction that is closed loop obstruction the normal mucosal secretions accumulate causing stasis which in turn causes distension. The normal mucosal capacity is 0.1ml, accumulation of 0.5ml of fluid increases the luminal pressure to 60cm of water. As a consequence of this distension the stretch receptors that are present in visceral peritoneum get activated. At this time the patients complain of vague and dull aching type of pain in the umbilical region. Due to stasis of secretions it causes bacterial proliferation. The stretch receptors leads to nausea and vomiting. Further progression of distension leads to firstly venous congestion and venous obstruction but arterial flow is still intact. The inflammatory process then involves the parietal peritoneum which causes shift of pain to right in iliac fossa region (migratory pain). As the distension further increases arterial supply is compromised due to thrombosis causing ellipsoidal infarcts at antimesenteric border. Since it is an end artery it will finally lead to necrosis causing gangrenous appendicitis which further progresses into rupture into the peritoneal cavity causing peritonitis.

The infection is usually polymicrobial with presence of both gram negative and anaerobes. Common isolates include Escherichia coli, Bacteroides fragilis, enterococci, Pseudomonas aeruginosa and others. The following figure shows the bacteriae commonly isolated and their incidence[23].

TYPE OF BACTERIA	PATIENTS (%)
Anaerobic	
Bacteroides fragilis	80
Bacteroides thetaiotaomicron	61
Bilophila wadsworthia	55
Peptostreptococcus spp.	46
Aerobic	
Escherichia coli	77
Viridans streptococcus	43
Group D streptococcus	27
Pseudomonas aeruginosa	18

TABLE 1:- INCIDENCE OF BACTERIA ISOLATED FROM APPENDIX

After several hours of perforation, it is body's reaction to seal off the perforation and confine the inflammation to the periappendiceal area. The greater omentum tries to seal off the perforation and prevents spread to the rest of the peritoneal cavity. An inflammatory mass formed of matted intestines and omentum is formed as a result (appendicular mass) with little or no pus. It may cause further suppuration leading to appendicular abscess.

If the appendicular abscess ruptures, it can lead to generalised peritonitis which is much more catastrophic event.

There may be ascending septic thrombophlebitis of portal venous system (pyelothrombophlebitis) which is very grave. Pyogenic abscesses may be formed in the liver due to septic emboli.

Obstructive appendicitis with resolution of infection leads to distension of appendix with mucous collection known as mucocele.

3) RECURRENT APPENDICITIS

Recurrent attacks of non-obstructive appendicitis lead to fibrosis and adhesions causing recurrent appendicitis.

4) SUBACUTE APPENDICITIS

Milder form of acute appendicitis.

5) STUMP APPENDICITIS

Infection of the left-out stump if a long stump is left behind after appendicectomy

CLINICAL FEATURES :

Appendicitis needs to be considered as a differential diagnosis for almost every patient with acute abdomen[28]. It's been observed that nothing can be so simple, nor yet as difficult as diagnosing acute appendicitis.

Typically two clinical syndromes of acute appendicitis are described.

Acute catarrhal (non-obstructive)

Acute obstructive appendicitis-dangerous type

Migratory abdominal pain:

Patients suffering from acute appendicitis typically complain of vague abdominal pain that is most commonly periumbilical in origin and reflects the stimulation of visceral afferent pathways caused by progressive distention of appendix. As the condition progresses it leads to inflamed tip of appendix, resulting in peritoneal irritation, the pain eventually localizes to its classic location in right lower abdominal quadrant. This phenomenon remains a reliable symptom of appendicitis and should serve to further increase the clinician's index of suspicion for appendicitis[30].

Anorexia:

Anorexia is a useful and constant clinical feature, particularly in children[31].

Nausea and vomiting:

Vomiting usually occurs in early stages of attack, but few hours following initial pain because of protective pylorospasm. Many patients have a sensation of vomiting, but do not actually vomit. Nausea and vomiting depends on mainly two factors – distension of the inflamed appendix, and reflux nervous susceptibility of the patient. The severity of distension of appendix and consequent, perforation risk to the patient may be indicated by severity and frequency of vomiting[32].

Bowel disturbance:

Constipation is common. Irritation of the distal ileum can be seen in either pre ileal or in post ileal position leading to diarrhoea. Tenesmus or frequent evacuation can be caused due to irritation of distal gut by pelvic abscess[32].

Urinary disturbance:

Retrocaecal appendix can cause ureteric irritation which mimics pain like ureteric colic. Patients can present with haematuria, increased micturition frequency, and dysuria due to the irritation by the inflamed pelvic appendix.

PHYSICAL EXAMINATION

On general examination patient may have a toxic look with fever, if more than 101F suggests perforation or abscess, tachycardia (PR >90bpm), hypotension (systolic bp <100mm Hg). Per Abdominally-tenderness will be present at the right iliac fossa, with rebound tenderness at the Mc Burney's point. Due to peritoneal inflammation patient will have guarding and rigidity. In patients with appendicular mass there will be presence of well localised mass with regular borders, not mobile, not moving with respiration, tender soft to firm consistency will be palpable. Per rectal examination-there may be tenderness on right side either due to pelvic appendicitis or pelvic abscess.

SPECIFIC SIGNS OF APPENDICITIS:

1)MC BURNEY'S SIGN-

Tenderness is elicited at Mc Burney's point during deep palpation.

2) BLUMBERG'S SIGN (REBOUND TENDERNESS)-

Patient cries in pain, when pressure over the Mc Burney's point is released. This indicates inflammation of parietal peritoneum caused by appendicitis. If there is guarding then this

test is not recommended. This test indicates peritoneal inflammation resulting from an inflamed organ underneath[33].

3) **COPE'S/PSOAS SIGN-**

This test has two parts: Cope's Psoas and Cope's Obturator tests

COPE PSOAS TEST-This test is positive in retrocaecal appendicitis. Inflamed appendix comes in contact with psoas muscle causing its inflammation and hence spasm. So, patient keeps the right hip in flexed position. In this test, passive hyperextension of the hip is done on supine position, which aggravates pain, indicating a positive test.

COPE OBTURATOR TEST-This test is positive in pelvic appendicitis. Inflamed appendix irritates the obturator internus muscle which goes into spasm, so on internal rotation of the hip joint there is exaggerated pain.

4) **POINTING SIGN-**

On asking with regard to the progression and radiation of pain, the patient points that pain initially was at the umbilicus and then has shifted to right lower abdominal quadrant at present. This migration of pain is called as Volkovich Kocher's sign.

5) **ROVSING'S SIGN-**

On deep palpation of left iliac fossa, patient complaints of pain in right iliac fossa. This is due to shift of coils of small intestine from left to right where there is localised peritonitis.

6) **HYPERESTHESIA IN SHERREN'S TRIANGLE-**

Sherren's triangle is a triangle formed by three points-umbilicus, right anterior superior iliac spine, symphysis pubis.

Hyperesthesia is checked by gently lifting a fold of skin in this triangle or by simply scratching the abdominal wall. Presence of hyperesthesia suggests gangrenous appendicitis. Loss of this hyperesthesia in course of gangrenous appendicitis suggests rupture.

Appendicitis in children:

Appendicitis is not usually seen before 2 years age due to relatively wider lumen of appendix. Its incidence increases beyond 2 years age, peaks at 11 years and gradually declines after 15 years.

Preschool children have higher mortality as well as morbidity rates compared to children beyond 5 years age. The cause being delay in diagnosing appendicitis in infants and many patients getting admitted with established features of peritonitis.

Young children have a very atypical clinical presentation of acute appendicitis, frequently complaining of generalized abdominal pain rather than a shifting pain.

In a previously healthy teenager, presence of localized tenderness and guarding in right iliac fossa should raise the suspicion of acute appendicitis[34].

Appendicitis in Elderly Persons:

Appendicitis can have more grave complications in elderly as compared to young people. According to Peltokallio and Juuhianen, elderly patients and young people with acute appendicitis have similar clinical picture in terms of symptoms, temperature changes and leukocyte responses.

However, older age patients have higher chances of gangrene and perforation due to widespread infection and reduced appendicular blood supply leading to rapid disease progression[34].

Elderly patients have a higher incidence of comorbidities which affect their general condition and because of their less complainant and stoic attitude, there is a delay in seeking surgical management[34].

Appendicitis in Pregnancy:

Pregnant and non-pregnant women are equally prone to appendicitis, though there is a great difficulty of diagnosing appendicitis in pregnant women. Appendicitis can be misdiagnosed as ruptured ectopic pregnancy in first trimester. Nausea/vomiting may mimic morning sickness. With progression of pregnancy, appendix gets pushed upwards and laterally due to enlargement of uterus, resulting in mid/upper abdominal pain, suspecting falsely to be pyelitis or cholecystitis. A case series of twenty nine appendectomies in pregnancy were reported by Doberneck where he reported no maternal and fetal mortality. However, in case of appendicular perforation, the maternal or fetal mortality risk increases[34].

APPENDICITIS IN THE APPENDICEAL STUMP:

The diagnosis of appendicitis cannot be ruled out, even if there is a previous history of appendectomy. Frencis described a 44 year old woman, who underwent appendicectomy and subsequently presented with perforation of appendicular stump. It occurs if appendix is adhered to caecum or obscured due to edema of caecum or kinked appendix, causing misinterpretation and resulting in subtotal appendectomy[34].

APPENDICITIS DUE TO PARASITIC INFECTIONS-

Appendicular luminal obstruction may happen due to parasites blocking it or due to local inflammation. Enterobius vermicularis is the most common parasite isolated.

APPENDICITIS WITH HIRSCHPRUNG'S DISEASE-

Large bowel obstruction in neonates can occur due to imperforate anus, meconium plug, Hirschprung's disease etc. As a result, caecum and appendix may over distend leading to perforation. Treatment includes addressing the primary disease with appendicectomy.

APPENDICITIS WITH AIDS/ HIV-

Incidence is 0.5 % (general population 0.1 -0.2%). Symptoms are similar but absolute leucocytosis is absent due to already low total counts. However, if the baseline leukocyte count is available in HIV patients, we can see relative leucocytosis.

Appendicular rupture commonly occurs (43%) due to delayed presentation (> 24hrs) and low CD4 count. The condition causing right iliac fossa pain in HIV patients include opportunistic infections like, cytomegalovirus (CMV), Kaposi Sarcoma, Tuberculosis, Lymphoma and infectious colitis (30). CMV causes vasculitis in submucosa which leads to thrombosis. This finally causes mucosal ischemia leading to ulceration, bowel gangrene and perforation.

Also, spontaneous peritonitis may be caused by opportunistic organisms like mycobacterium avium, intracellular complex, mycobacterium tuberculosis. Cryptococcus neoformans and Strongyloides, Kaposi Sarcoma and Non-Hodgkin's Lymphoma may also present with right lower quadrant pain and mass. Viral and Bacterial Colitis also occur commonly.

In an HIV patient, thorough examination is crucial and immediate appendicectomy is indicated. If there is complains of diarrhoea, colonoscopy should be considered. Post-operative morbidity and length of hospital stay are increased in the patients with perforated appendicitis.

DIFFERENTIAL DIAGNOSIS OF APPENDICITIS[31]

CHILDREN	ADULT	ADULT FEMALE	ELDERLY
Gastroenteritis	Regional enteritis	Mittelschmerz	Diverticulitis
Mesenteric adenitis	Ureteric colic	pelvic inflammatory disease	Intestinal obstruction
Meckel's Diverticulitis	perforated peptic ulcer	Pyelonephritis	Colonic carcinoma
Intussusception	Torsion of testis	Ectopic pregnancy	torsion appendix epiploicae
Henoch-Schonlein purpura	Pancreatitis	Torsion/rupture of ovarian cyst	Mesenteric infarction
Lobar pneumonia	Rectus sheath haematomas	Endometriosis	Leaking aortic aneurysm

INVESTIGATIONS:

A. Haemoglobin

B. Total and differential counts- mild leucocytosis 10000- 18000 cells/ cubic mm. is associated with uncomplicated appendicitis with left shift. Counts more than 18000 is associated with complicated appendicitis.

C. Random and fasting blood sugars (in diabetics)

D. Erythrocyte Sedimentation Rate- elevated levels found in perforation and abscess

E. Coagulation Profile

F. Renal function tests

G. HIV/ HbSAg

H. Complete urine analysis

I. ECG and Chest X ray

J. Erect X ray Abdomen – which may show a fecolith, ureteric calculus, increased soft tissue density in the right lower abdominal quadrant, distended small bowel loops.

K. Ultrasound:

Julien Puylaert in year 1986 described ultrasound examination by technique of graded compression for diagnosing acute appendicitis. Appendix is visualized over psoas muscle after bowel loops gets displaced, when graded compression is applied over tender right iliac fossa using a 7 MHz probe.

Ultrasound features[34]:

A non-compressible tubular structure having a blind end with a diameter equals to or greater than 7 mm noted over area of tenderness. There is no peristalsis, surrounding fat is highly echogenic, presence of collection with caecal pole oedema.

Though 90% sensitivity is claimed for ultrasound diagnosis of appendicitis, but there are scenarios for false negative and false positive examination. False negative examination include appendicitis with appendix in retrocaecal position, gangrenous appendicitis, perforated appendix. False positive examination include hydrosalpinx, pyosalpinx, inflammatory diseases of bowel and resolving appendicitis.

L. Computed Tomography:

In cases of suspected appendicitis, CT can reveal about appendicolith, diameter of appendix 6 mm or greater, wall enhancement of appendix with IV contrast and no filling of oral contrast in appendix. Other changes include increased attenuation of surrounding fat, inflammatory phlegmon, caecal thickening, abscess, extra luminal gas and lymphadenopathy. Arrow head sign can be seen where caecal lumen is pointing towards obstructed appendicular opening. CT can help in better visualization of appendix than ultrasound. Both Sensitivity/specificity is 100%[34].

FIGURE 6:- CT SCAN IMAGING FOR APPENDICITIS

M. Nuclear Medicine

A newer investigation technique for evaluation of patients with suspected appendicitis. This imaging study can be broadly classified into: Tc 99m WBC (radiolabeled wbc) and Tc 99 IgG (radiolabeled IgG). Scintigraphy is used to observe the inflamed tissue in the right lower abdominal quadrant[15].

N. Barium enema:

A relatively older technique to evaluate appendicitis. On imaging after barium enema, caecum is externally compressed, there is partial or no filling of barium in appendix, and terminal ileum and caecum are in spasm[35].

O. Diagnostic laparoscopy:

A useful investigation for equivocal cases of appendicitis. Though this technique can be used as a vital investigation for diagnosing and managing cases of acute abdomen, but it requires in depth knowledge and training to become laparoscopic surgeon[12].

ALVORADO SCORING SYSTEM:

Following investigations this scoring is done so as to plan the further treatment.

It has 3 symptoms, 3 signs and 2 investigations.

CLINICAL FEATURE		SCORE
Symptoms	Migratory RIF Pain	1
	Anorexia	1
	Nausea/vomiting	1
	Tender RIF	2
Signs	Rebound tenderness	1
	Elevated temperature	1
	Leucocytosis	2
	Total	9

TOTAL 10

SCORE <5 NOT SURE

5-6 COMPATIBLE

6-8 PROBABLE

>9 CONSTANT

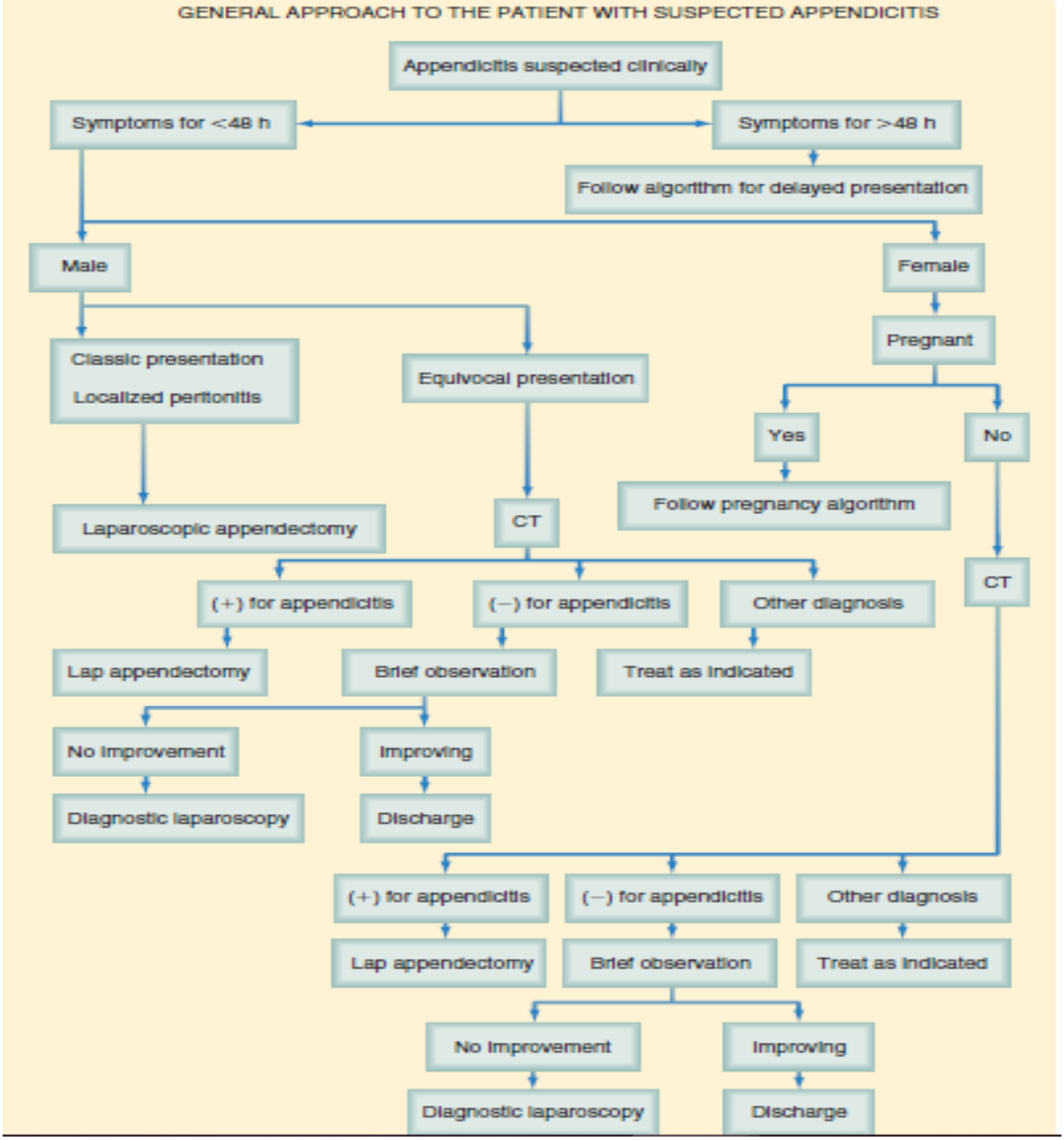


TABLE 2:- APPROACH TO A PATIENT WITH SUSPECTED APPENDICITS

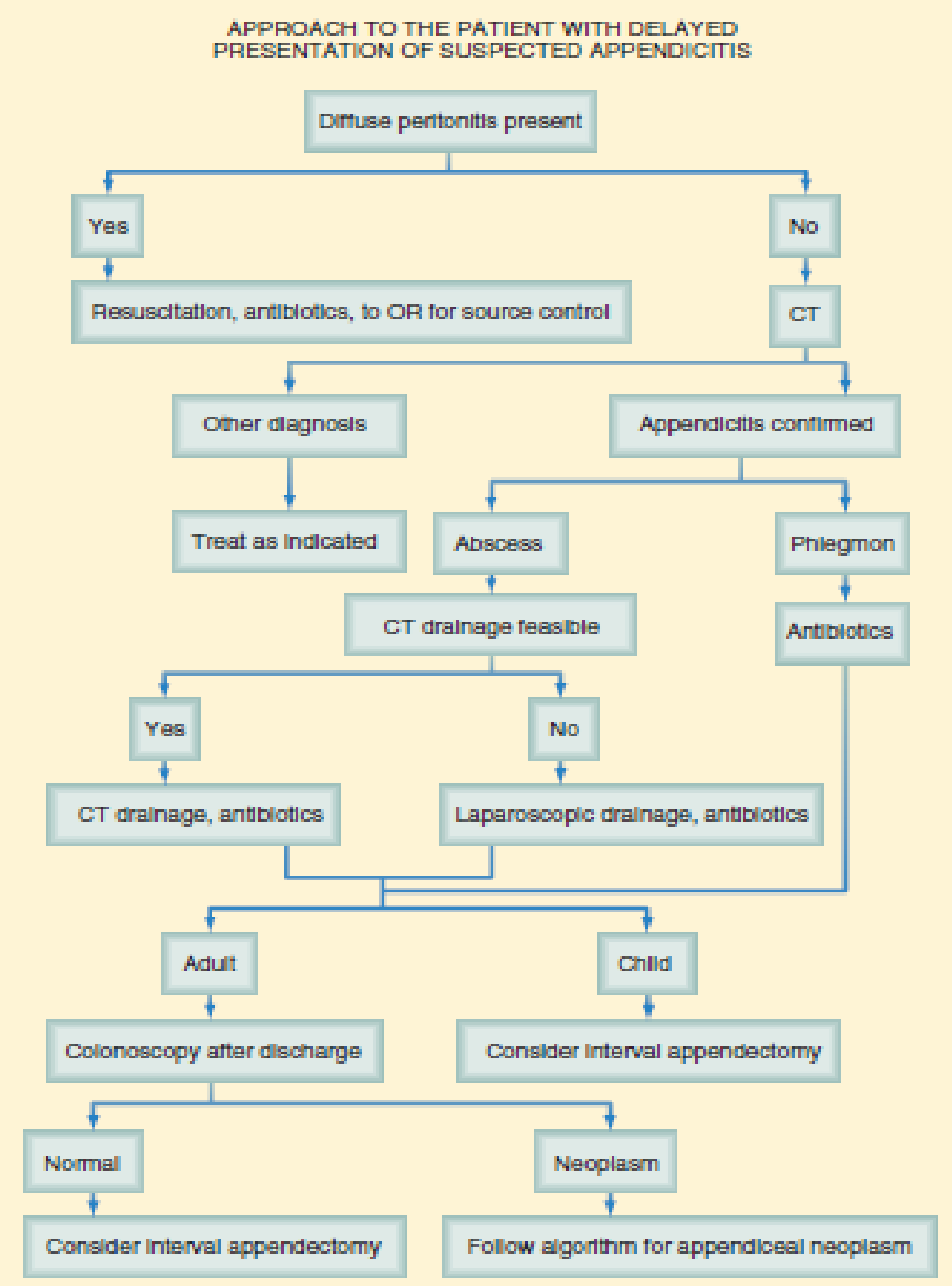


TABLE 3:- APPROACH TO A PATIENT WITH DELAYED PRESENTATION OF SUSPECTED APPENDICITIS

TREATMENT

Appendectomy is the standard treatment for acute appendicitis. Emergency surgery is usually advisable to prevent complications like peritonitis which can increase risk of morbidity and mortality. Preoperative management includes intravenous fluids to establish or maintain a good urine output, analgesics and single dose of antibiotic. Preoperative antibiotic has shown to reduce the incidence of postoperative SSI. Intravenous antibiotics covering both gram negative as well as gram positive organisms are started in case of suspected peritonitis[17].

Open Appendectomy:

Appendectomy performed under general or spinal anaesthesia with the patient supine on the operating table. . 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[17].

Incisions[17]:

1. **Gridiron incision**: (gridiron a frame of cross-beams to support a ship during repairs).

   The gridiron incision described first by McArthur 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.

2. **Lanz incision**: Transverse skin crease 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 2 cm below the umbilicus centered on the patient, is made approximately 2cm below the umbilicus centered on the midclavicular – midinguinal line.

3. **Rutherford Morison's 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.

4. **Lower midline incision**: When the diagnosis is in doubt, particularly in the presence of intestinal obstruction.

5. **Right lower paramedian incision**: It is difficult to extend more difficult to close and gives poorer access to the pelvis and peritoneal cavity.

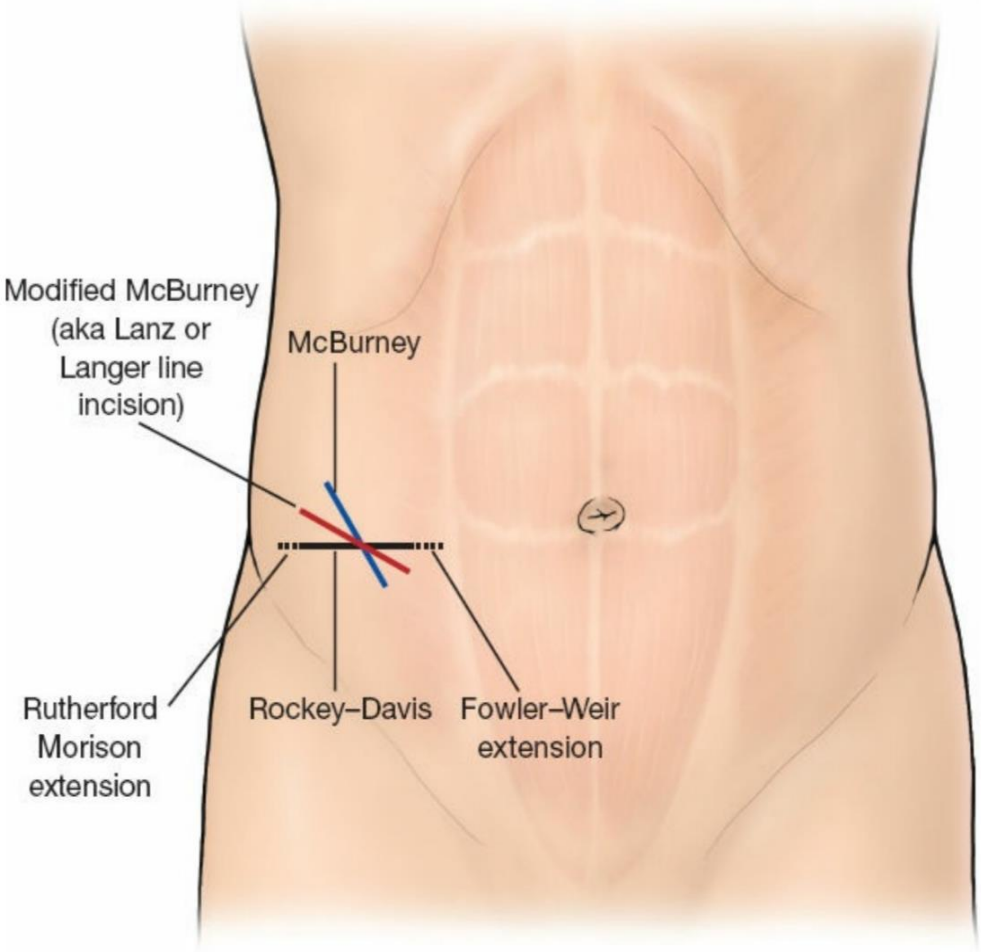


FIGURE 7:- INCISIONS FOR OPEN APPENDECTOMY

• PROCEDURE

ISOLATION OF APPENDIX

On entering the peritoneal cavity by tracing the anterior taenia coli appendix is identified. Another method is to identify fold of Treves, the only antimesenteric epiploic appendage which signifies the junction of caecum and ileum

DIVISION OF MESOAPPENDIX

The mesoappendix is pierced at the base with a mosquito forceps and the appendicular artery is ligated through this hole. The mesoappendix is divided in close proximity to the appendix.

REMOVAL OF APPENDIX

Appendix base is crushed with the help of a Kocher's forceps, it causes mucosal and muscular layers to occlude the lumen but peritoneal layer remains unaffected. Base is transfixed with suture. Appendix is cut in flush with this artery forceps[36].

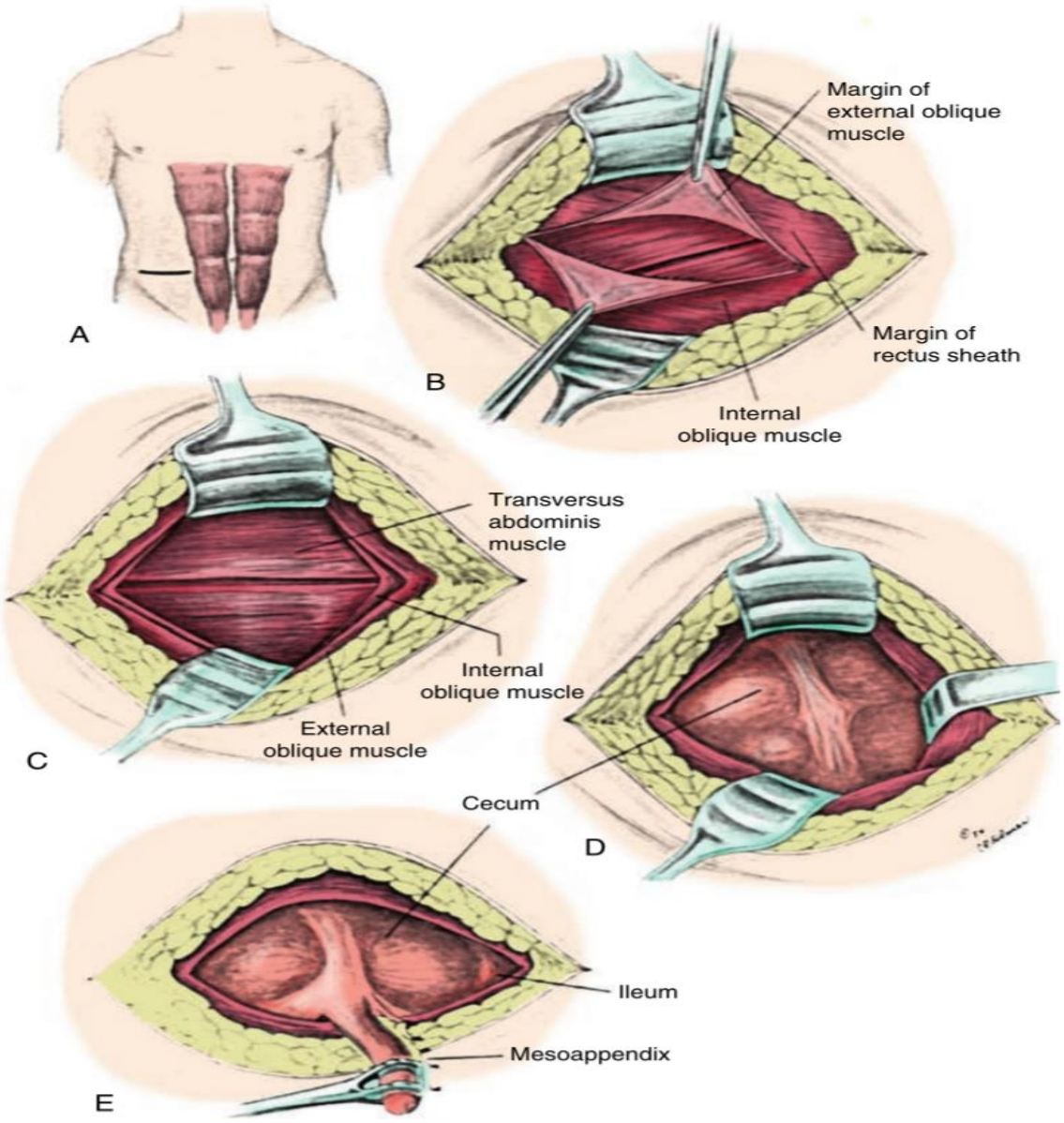


FIGURE 8:- STEPS OF OPEN APPENDECTOMY

LAPAROSCOPIC APPENDICECTOMY

It is more commonly used nowadays than open technique. Advantages include better visualisation of abdomen and pelvis, faster recovery, less hospital stay, less wound infections, reduced pain and analgesic use, cosmetically better scar. However, disadvantages include cost factor, and contraindicated in cardiac and pulmonary disease. Also, the operating surgeon should have sufficient expertise and skills for performing laparoscopy. Diagnostic laparoscopy can be beneficial in undiagnosed pain abdomen.

PROCEDURE

After giving general anaesthesia patient is kept supine. First port access can be done by two techniques, first method where first pneumoperitoneum is created using a Veress needle and then 10mm trocar is introduced and second by direct puncture in which directly 10 mm trocar is introduced without pneumo-peritoneum. For safe Veress needle insertion we should check for the stylet and needle patency by aspirating to rule out blood, bile or air. Saline is then injected if there is no aspirate and there should be free flow. The Veress is attached to an insufflator and gas pressure is maintained at 12mm Hg and 10mm flow rate. If the value is greater than this it means that the patient is not given GA properly and is contracting abdominal muscles.

After insufflation with carbon dioxide, a 10 mm port is created below umbilicus. Two more ports are created under vision through the 10mm umbilical port, both 5mm, one at the hypogastrium, care should be taken to avoid injury to bladder, and second one at the right or left iliac fossa. Depending on surgeon’s preference 5mm ports can be also created at right and

left iliac fossae. The angulation between the instruments should be between 60-90 degrees. Also, the instruments should be sufficiently far from one another to form an equilateral triangle. The operating Surgeon along with assistant stand on the left side, with monitor on the right side. The surgeon operates the two dissecting instruments while the assistant holds the telescope. The appendix is identified, adhesions are released from the base with electro cautery.

In case of retrocaecal appendix, then peritoneal attachments to the abdomen on the lateral side should be divided for better visualisation. Injury to the iliac vessels and ureter are avoided.

Appendix is grasped with Babcock forceps and retracted anteriorly. A window is created in the mesoappendix and appendicular artery is ligated with help of cautery. Appendix base is closed with suture or clips. This is followed by cutting the appendix in flush and appendix is removed with endobag though umbilical port. Port closure of 10 mm is done in 2 layers, whereas others in single layer.

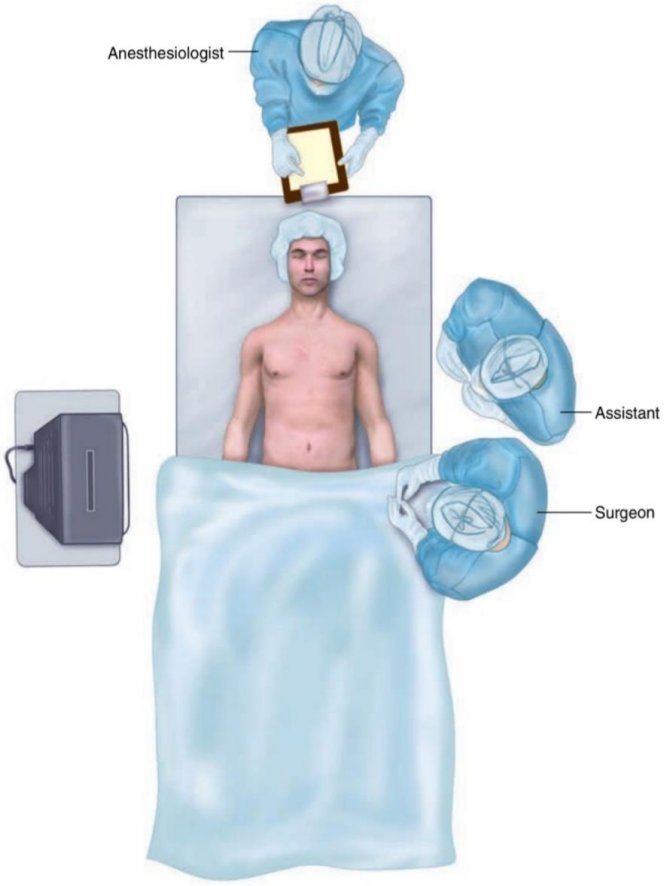


FIGURE 9:- POSITION OF SURGEON & ANESTHESIOLOGIST IN LAPAROSCOPIC APPENDECTOMY

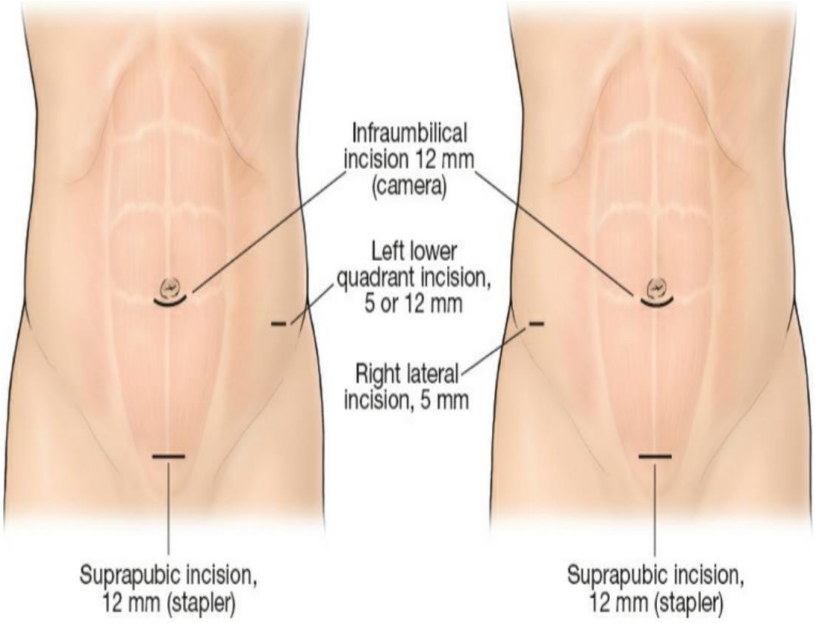


FIGURE 10:- INCISIONS FOR PORT PLACEMENT IN LAPAROSCOPIC APPENDECTOMY

FIGURE 11:- PORT PLACEMENT TECHNIQUE

POSTOPERATIVE COMPLICATIONS

Early- haemorrhage, diffuse peritonitis, pulmonary complications, retention of urine, neurogenic ileus.

Intermediate/secondary- residual abscess (pelvic, paracaecal, perinephric, subdiaphragmatic), wound infection, pyelophlebitis, femoral or iliac vein thrombosis, phlebitis and pulmonary embolism.

Late- incisional hernia, right sided indirect inguinal hernia, intestinal obstruction. Wound infection commonly occurs in complicated appendicitis. Cardiovascular and pulmonary complications most commonly are seen in older age group.

ENERGY SOURCES

1) **ULTRASONIC SHEARS**

   This device uses ultrasonic energy as its energy source for dissection and the dissection carried out using this is termed as ultracision. The device uses a high-power system which usually works at frequency ranging from 55.5 kHz to 55,000 vibrations/sec.

   Ultrasonic shear uses electrical current across paired negatively charged, disc shaped, ferroelectric ceramic crystals to produce ultrasonic wave form. The blade then cuts and coagulates tissue in precise and controlled manner[37].

   The inside curve of scalpel blade cut and dissects whereas the outer blunt edge coagulates. Blade is selected according to surgeon preference for the procedure being done[38].

There are five power levels for the apparatus, level 1 with 50 um amplitude the tip of instrument vibrated longitudinally, level has a pure cut with minimal coagulation[39]. Low power level has more hemostasis and lesser cutting. High power level has quicker speed during cutting[40].

The apparatus consists of a generator, blade and hand piece. The hand piece consists of an ultrasonic transducer which is made of piezoelectric crystals stacked and sandwiched under high pressure within the metal cylinders. Sealing of blood vessels can be achieved by protein denaturation and formation of coagulum which in turn occurs by tamponade and coagulation[41]. Ultrasonic energy is converted into mechanical energy by ultrasonic generator[42].

The scalpel part has 3 compatible probes which are shear, blade and hook. Shear will consist of opposite padding made of silicon, which is absent on the blade and hook. The shear will coagulate vessels up to diameter of 5mm, the hook and blade can coagulate vessels up to only 2mm in diameter. During the procedure, the probes can reach a temperature of 80 degree Celsius, and even on prolonged usage, the temperature of the device stays below 250 degree Celsius, which is very low when compared with different energy sources like laser and cautery.

This results in a decreased lateral thermal spread and avoids charring. Sticking of the coagulated tissue is avoided by the vibration of active probe. A reduced lateral thermal injury (<1.5 mm) at the surgery site is responsible for lesser pain in the post-operative period.

FIGURE 12:- ULTRASONIC SHEARS

2) MONOPOLAR ELECTRO CAUTERY

Monopolar electro cautery is used for several modalities like cutting, blending, desiccation, and fulguration. Here, the active electrode can be placed in the site of entry and can be used to cut tissue and coagulate bleeding. The return electrode pad is attached to the patient, so the flow of electrical current is from the generator to the electrode through the target tissue, to return to the generator. Monopolar electro cautery is commonly used because of its versatility and effectiveness.

FIGURE 13:- MONOPOLAR ELECTRO CAUTERY

TECHNIQUES FOR CLOSURE OF APPENDICULAR STUMP

Various newer techniques are been tried for the closure of appendix base during appendectomy. Some of which include endoloop, double endoloop, ultrasonically activated scalpel, instrument‑assisted knotting, bipolar coagulation, slipknot tying, metal clip, Hem‑o‑lock clip, and linear endostaplers.

Titanium clip application is a newer method for stump closure. Titanium has been proven biocompatible element having a high closing and continuous force of contact is proved advantageous. Also, it has been seen that the tissue adapts to the implant satisfactorily. It has 2 stems which are parallel to each other. Following its application over the base the base is crushed between the stems, thus preventing slippage. There is a pyramid shaped indentation on the inner surface which helps to increase the surface area of contact between the tissues. As a result, it helps in a good clasp. Also, the implant end ensures that there is no slipping[8].

Haem o lock clips

These are non-absorbable polymer structures which can be used for sealing of vessels, bile ducts and ureters. These can be used as a different novel technique for closure of the appendicular stump. Although they are costly but considered safe with lesser time for laparoscopy. They have less risk of slippage from the appendicular base. Due to presence of the locking device the clips sit at the base securely thus assuring the surgeon towards slippage. The clips should be applied at 90 degrees to the base of appendix[43].

ENDOSTAPLERS

Another alternative for stump closure is use of endostaplers. Main advantage is that it is fast and easy. Also, it has ability to seal and transect tissue at once. Its main disadvantage is its price. The wall of caecum can be tangentially transected using endostapler. It can also be used when base is thickened.

SINGLE INCISION LAPAROSCOPIC SURGERY (SILS)

Current advancement in the field of minimal access surgery includes the use of one incision for performing surgeries. Advantages include early healing, less scars, fewer surgical site complications, better cosmetic results. Although it has been seen that time duration of surgery is longer. Over the years SILS has been used for cholecystectomy, appendicectomy, bariatric surgeries, hernia repair, fundoplication, nephrectomy. For SILS, a 30 mm umbilical incision followed by insertion of a SILS port using shoehorn technique. 5 mm trocars inserted through the device. Rest of the procedure remains same as conventional three port laparoscopic appendectomy. Closure can be done in two layers[44].

MATERIALS AND METHODS

MATERIALS & METHODOLOGY

Patients who fulfill inclusion criteria will be included in the study.

Type of study: - Comparative study

Sample size: - Total: 44. Patients will be stratified into two groups based on Odd & Even method.

Group A (ODD) :- 22 patients will undergo laparoscopic appendectomy using monopolar electro cautery.

Group B (EVEN) :- 22 patients will undergo laparoscopic appendectomy using ultrasonic shears.

Informed written consent regarding the procedure being done, the alternative energy source, possible complications will be obtained from the patient.

Patients will be taken up for laparoscopic appendectomy after proper pre anaesthetic examination.

Various parameters will be studies:

Operating time: in terms of duration in minutes.

Intraoperative hemostasis: Weight and number of soaked gauge.

Post-operative pain: using visual analogue scale.

Surgical site infection: using Southampton wound scoring system.

Postoperative stay: in terms of duration in days.

Patients will be followed up for collection of postoperative outcome data for a period of 3 months for complications such as persistent port site infection, port site hernia and sinus formation.

SOURCE OF DATA:

Patients who satisfy inclusion criteria admitted to R.L. Jalappa Hospital and Research Centre, affliated to Sri Devaraj urs medical college, Tamaka, Kolar.

Study period: - December 2018 to June 2020 (1 year 7 months)

INCLUSION CRITERIA:

Patients suffering from appendicitis aged between 21 years and 60 years undergoing laparoscopic appendectomy

EXCLUSION CRITERIA:

1) Patients with appendicular mass/ appendicular abscess.
2) Patients with comorbidities like cirrhosis, bleeding diathesis, severe cardiac or pulmonary disease falling in ASA grade 3 & 4.
3) Patients with previous abdominal surgery (where pneumoperitoneum cannot be created)

Sample Size Estimation:

$$n=2S_P^2[Z_{1-\alpha/2}+Z_{1-\beta}]^2/\mu_d^2$$

$$\mathbf{S_p^2= [S_1^2 + S_2^2] / 2}$$

Where,

S_1^2 : standard deviation in the first group

S_2^2 : standard deviation in the second group

μ_d^2 : mean difference between the samples

α : significance level

$1-\beta$: power

The sample needed for our study was estimated and calculated by using mean difference in operating time from the study Alsayed A. Hamdy et.al.

Considering a power of 80% and alpha error of 5%, to detect a difference of 8% in duration of surgery between the groups, sample size of 22 were included in each group.

Statistical analysis:

Data was entered into Microsoft excel data sheet and was analyzed using SPSS 22 version software. Categorical data was represented in the form of Frequencies and proportions. **Chi-square test** was used as test of significance for qualitative data. Continuous data was represented as mean and standard deviation. **Independent t test or Mann Whitney U test** was used as test of significance to identify the mean difference between two quantitative variables and qualitative variables respectively [45,46,47].

Graphical representation of data: MS Excel and MS word was used to obtain various types of graphs such as bar diagram[45.46.47].

P value (Probability that the result is true) of <0.05 was considered as statistically significant after assuming all the rules of statistical tests[45.46.47].

Statistical software: MS Excel**,** SPSS version 22 **(**IBM SPSS Statistics, Somers NY, USA) was used to analyse data[45.46.47].

RESULTS

RESULTS

Table 4: Age Distribution among subjects

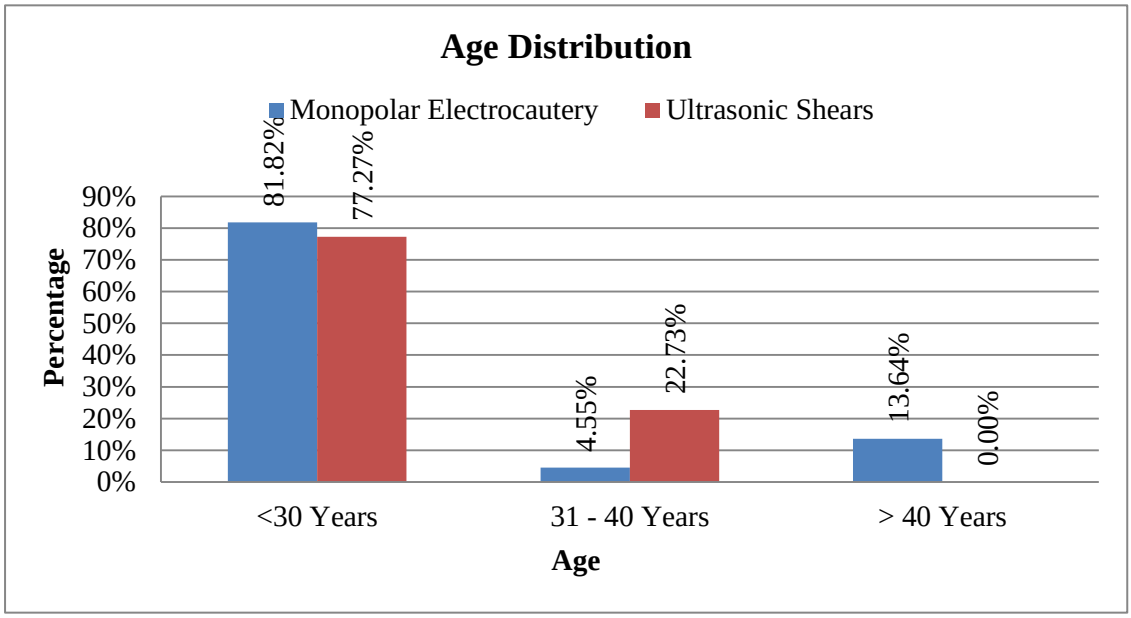
		Group			
		Monopolar Electro cautery		Ultrasonic Shears	
		Count	%	Count	%
Age	<30 Years	18	81.82%	17	77.27%
	31 - 40 Years	1	4.55%	5	22.73%
	> 40 Years	3	13.64%	0	0.00%

$\chi 2 = 5.695$, df = 2, p = 0.058

In Monopolar Electro cautery Group, 81.82% were < 30 Years, 4.55% were in 31 -40 Years and 13.64% were > 40 Years.

In Ultrasonic Shears Group, 77.27% were < 30 Years and 22.73% were in 31 -40 Years.

No significant variation in Age Distribution between two groups.



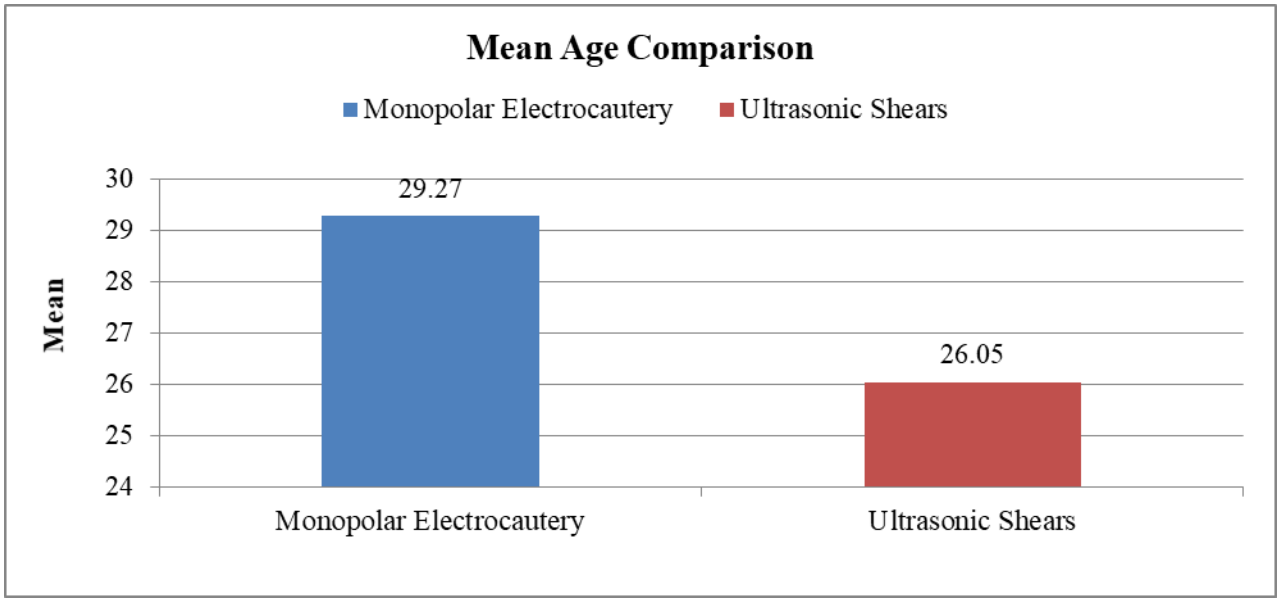
GRAPH 1: Bar Diagram depicting Age Distribution among subjects

Table 5: Mean Age Comparison between two groups

	Group						P value
	Monopolar Electro cautery			Ultrasonic Shears			
	Mean	Median	SD	Mean	Median	SD	
Age	29.27	27.50	8.19	26.05	25.00	4.87	0.120

Mean Age in Monopolar Electro cautery was 29.27 ± 8.19 and in Ultrasonic Shears was 26.05 ± 4.87.

No significant variation in Mean Age Comparison between two groups.



GRAPH 2: Bar Diagram depicting Mean Age Comparison between two groups

Table 6: Sex Distribution among two groups

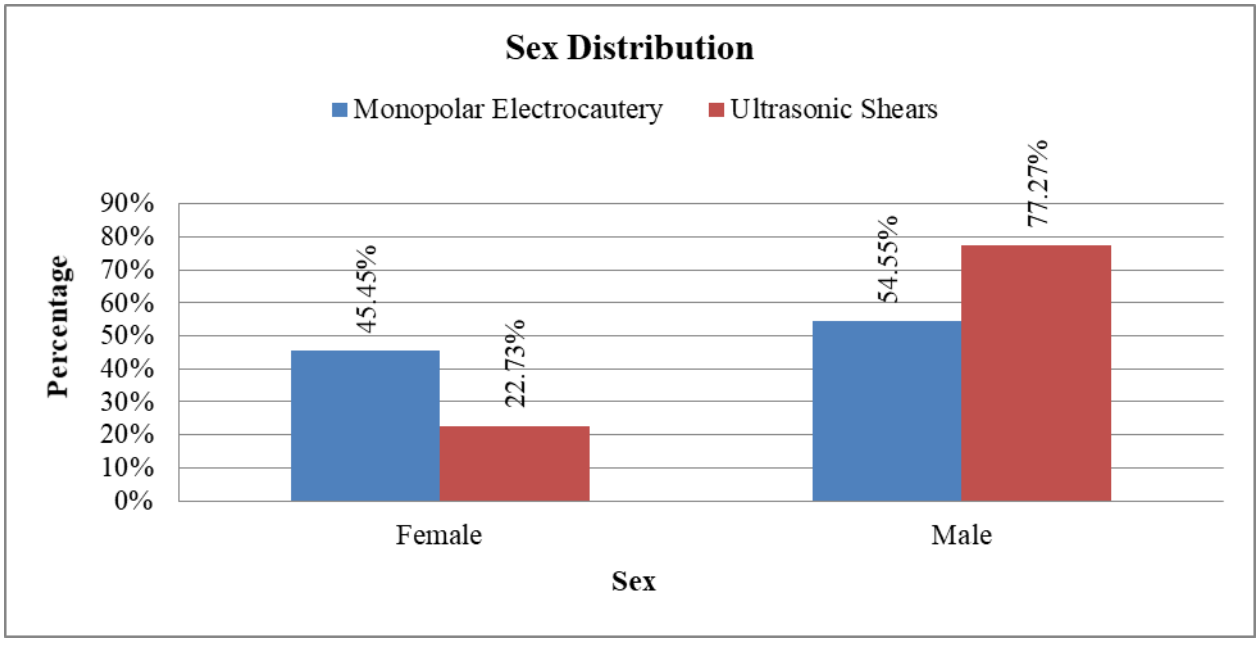
		Group			
		Monopolar Electro cautery		Ultrasonic Shears	
		Count	%	Count	%
Sex	Female	10	45.45%	5	22.73%
	Male	12	54.55%	17	77.27%

$\chi 2$ = 2.529, df = 1, p = 0.112

In Monopolar Electro cautery 45.45% were female and 54.55% were male.

In Ultrasonic Shears 22.73% were female and 77.27% were male.

No significant diaparity in Sex Distribution among two groups.



GRAPH 3: Bar Diagram Showing Sex Distribution among two groups

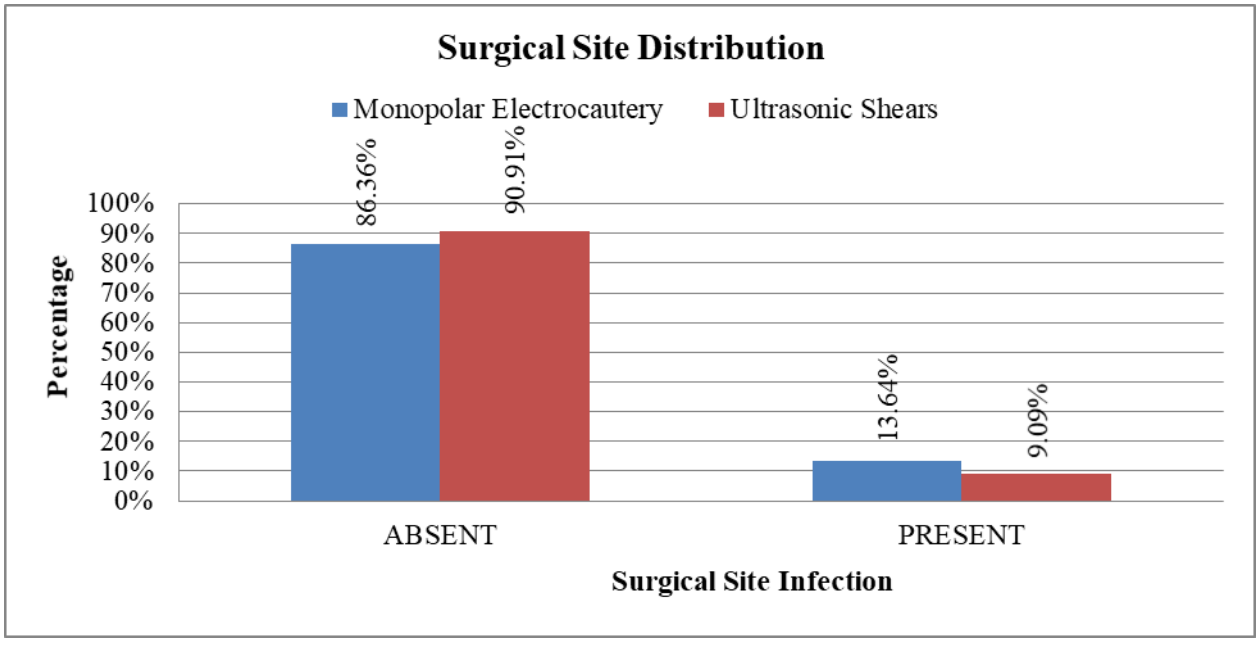
TABLE 7: Surgical Site Infection Distribution between two groups

		Group			
		Monopolar Electro cautery		Ultrasonic Shears	
		Count	%	Count	%
Surgical Site Infection	Absent	19	86.36%	20	90.91%
	Present	3	13.64%	2	9.09%

$\chi 2$ = 0.226, df = 1, p = 0.635

In Monopolar Electro cautery 13.64% had SSI and in Ultrasonic Shears 9.09% had Surgical Site Infection.

No significant variation in Surgical Site Infection Distribution between two groups.



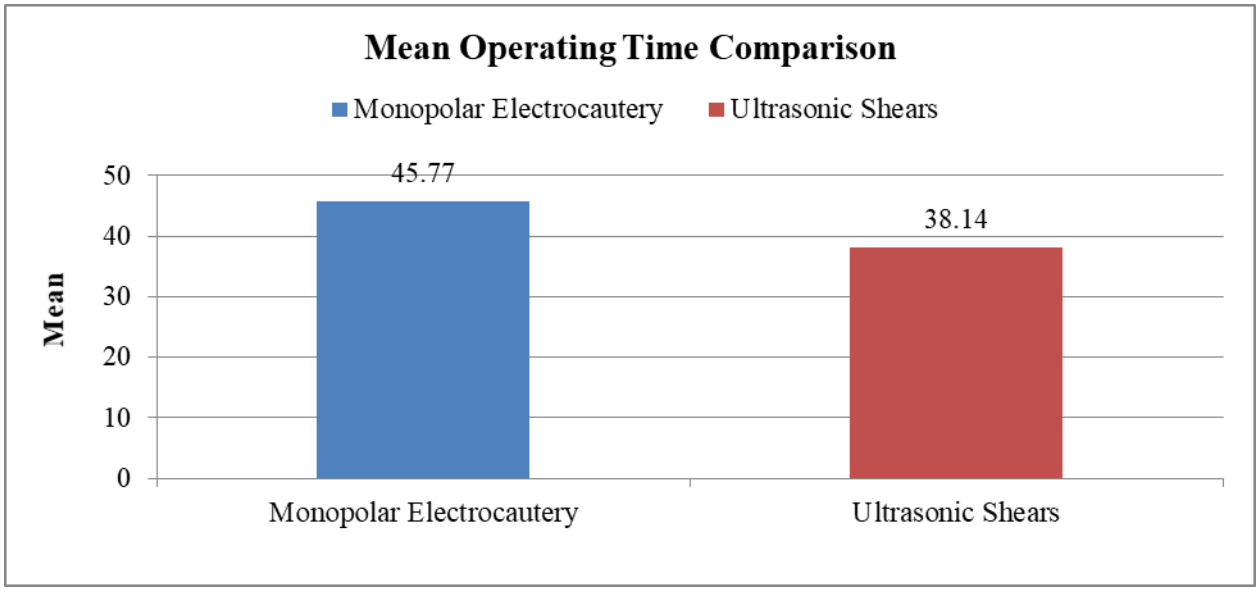
GRAPH 4: Bar Diagram Showing Surgical Site Infection Distribution between two groups

Table 8: Mean Operating Time in Mins Comparison between two groups

	Group						P value
	Monopolar Electro cautery			Ultrasonic Shears			
	Mean	Median	SD	Mean	Median	SD	
Operating Time in Mins	45.77	46.50	4.21	38.14	38.00	3.41	< 0.001*

Mean Operating Time in Mins in Monopolar Electro cautery was 45.77 ± 4.21 and in Ultrasonic Shears was 38.14 ± 3.41.

There was a significant difference in Mean Operating Time in Mins Comparison between two groups.



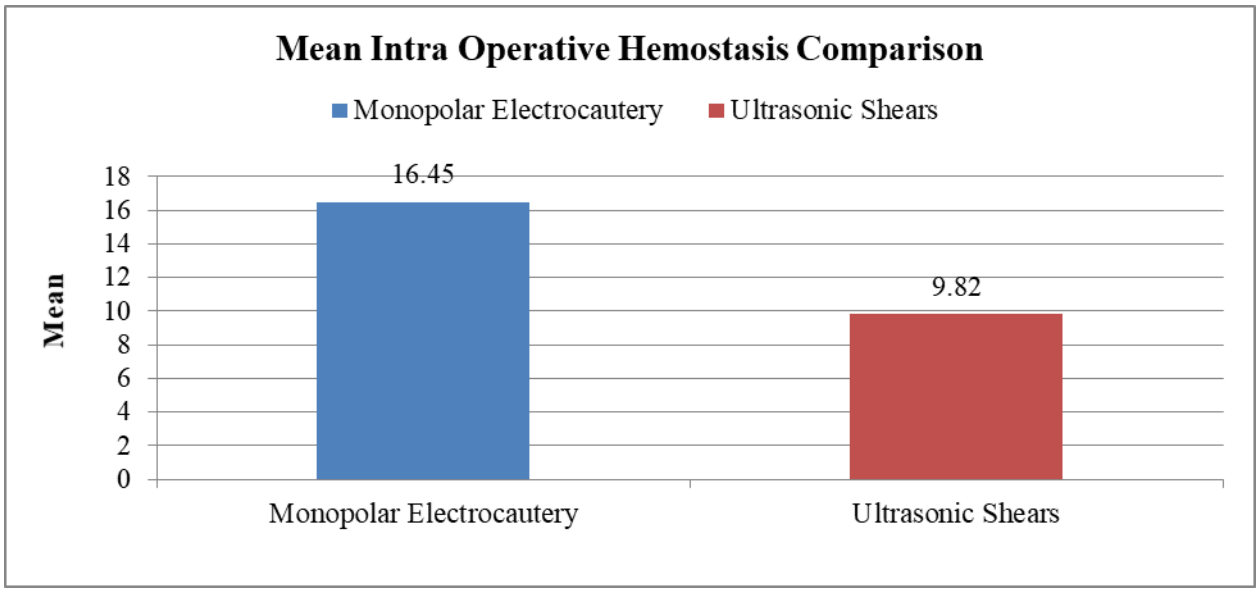
GRAPH 5: Bar Diagram Showing Mean Operating Time in Mins Comparison between two groups

Table 9: Mean Intra Operative Hemostasis Comparison between two groups

	Group						P value
	Monopolar Electro cautery			Ultrasonic Shears			
	Mean	Median	SD	Mean	Median	SD	
Intra Operative Hemostasis (ML)	16.45	16.00	6.05	9.82	10.00	3.03	< 0.001*

Mean Intra Operative Hemostasis (ML) in Monopolar Electro cautery was 16.45 ± 6.05 and in Ultrasonic Shears was 9.82 ± 3.03.

There was a significant difference in Mean Intra Operative Hemostasis Comparison between two groups.



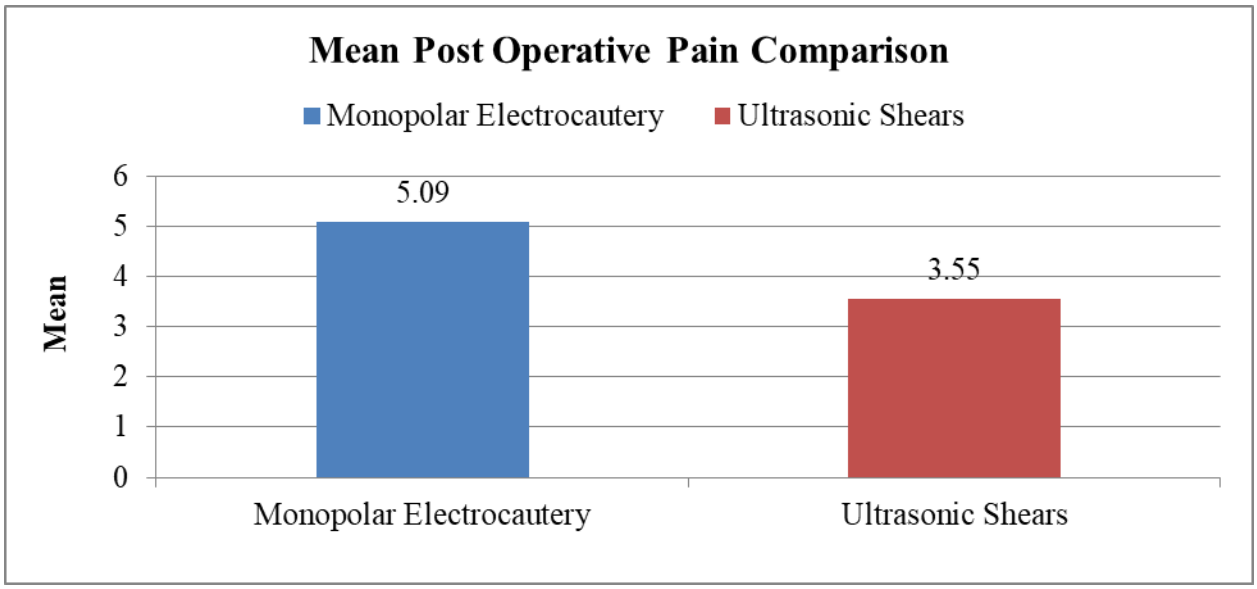
GRAPH 6: Bar Diagram Showing Mean Intra Operative Hemostasis Comparison between two groups

Table 10: Mean Post-Operative Pain Comparison between two groups

	Group						P value
	Monopolar Electro cautery			Ultrasonic Shears			
	Mean	Median	SD	Mean	Median	SD	
Post Operative Pain (VAS24 HR)	5.09	5.00	1.44	3.55	3.00	1.18	< 0.001*

Mean Post Operative Pain in Monopolar Electro cautery was 5.09 ± 1.44 and in Ultrasonic Shears was 3.55 ± 1.18.

There was a significant difference in Mean Post Operative Pain Comparison between two groups.



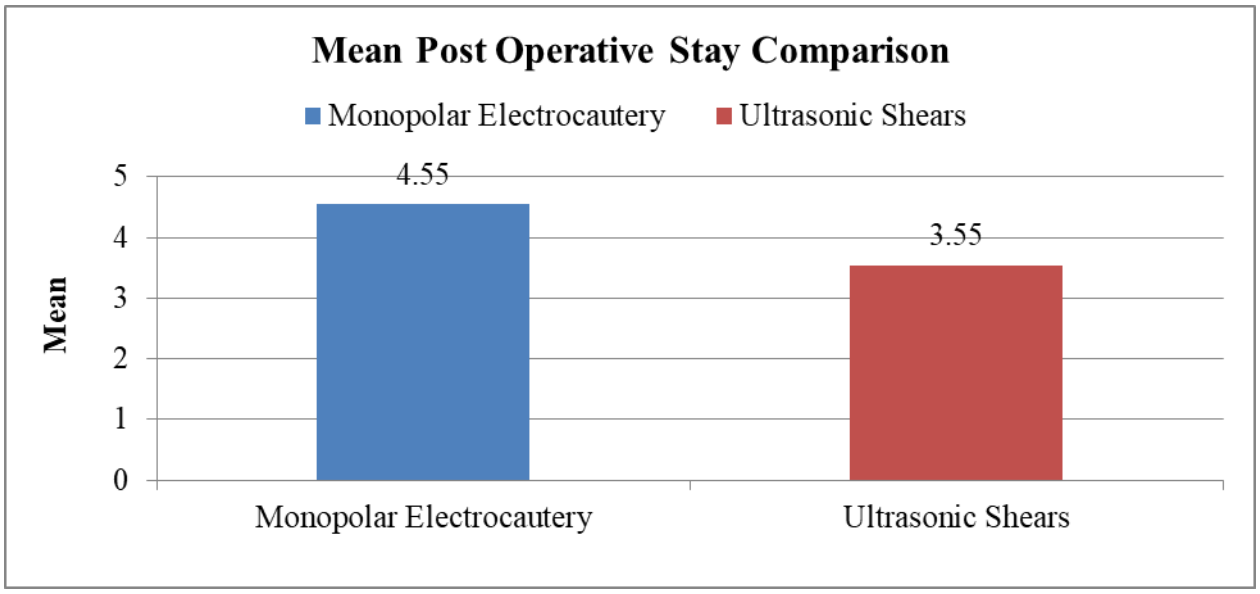
GRAPH 7: Bar Diagram Showing Mean Post Operative Pain Comparison between two groups

Table 11: Mean Post Operative Stay Comparison between two groups

	Group						P value
	Monopolar Electro cautery			Ultrasonic Shears			
	Mean	Median	SD	Mean	Median	SD	
Post Operative Stay in Days	4.55	4.00	1.74	3.55	3.00	1.18	0.031*

Mean Post Operative Stay in Days in Monopolar Electro cautery was 4.55 ± 1.74 and in Ultrasonic Shears was 3.55 ± 1.18.

There was a significant difference in Mean Post Operative Stay Comparison between two groups.



GRAPH 8: Bar Diagram Showing Mean Post Operative Stay Comparison between two groups

PHOTO GALLERY

PHOTO GALLERY

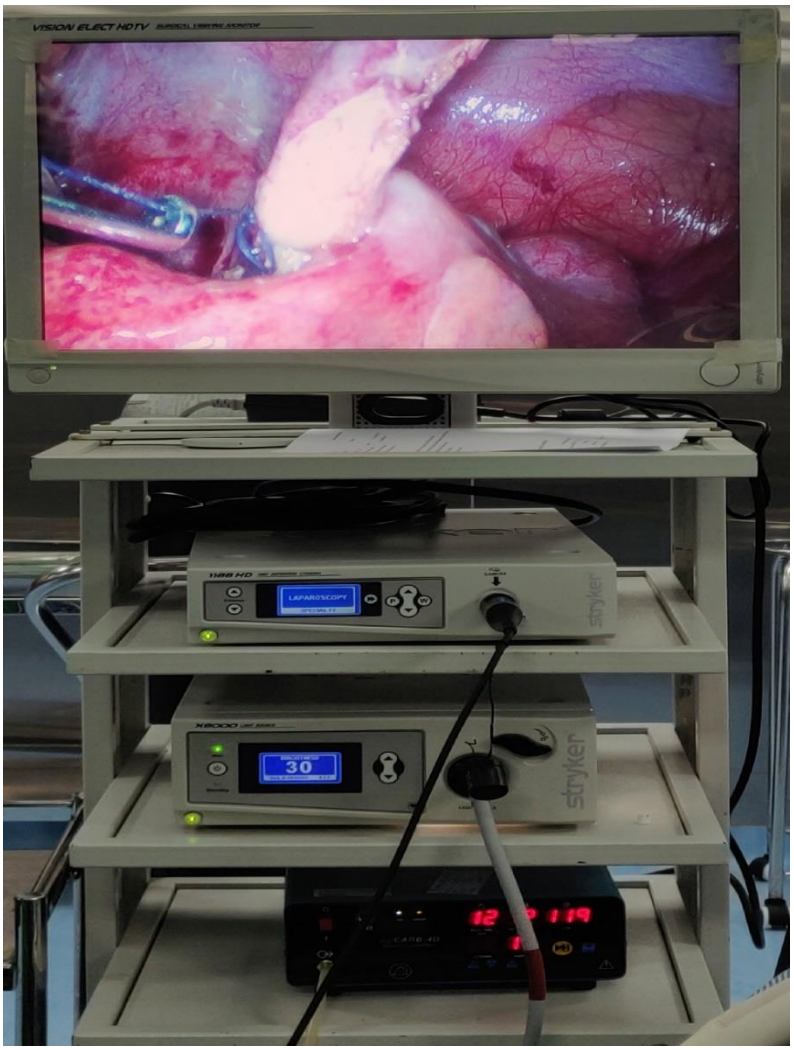
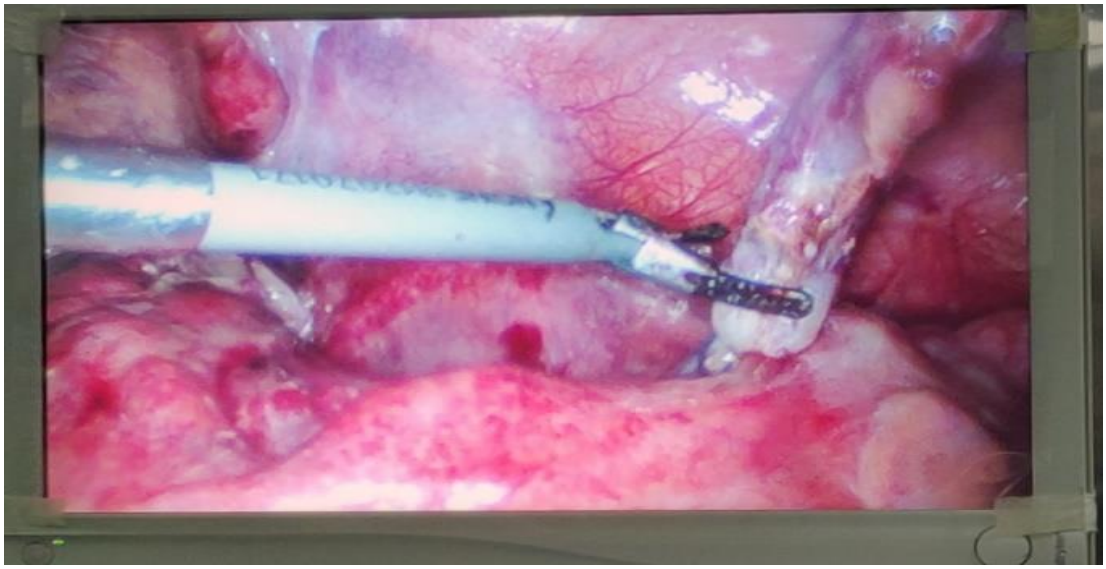
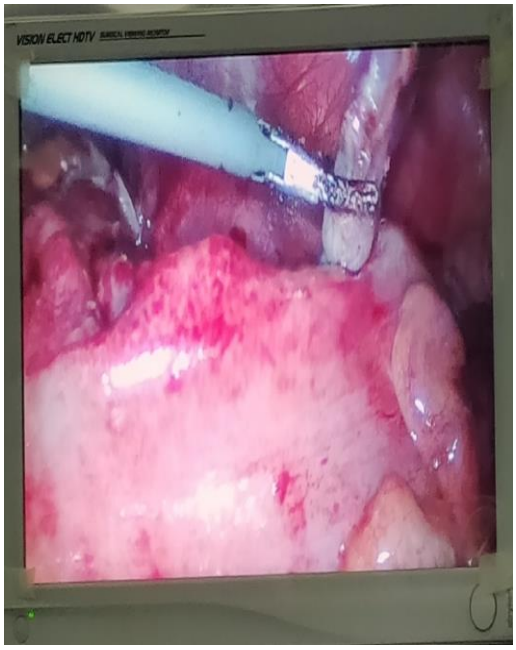


FIGURE 14- LAPAROSCOPIC MONITOR TROLLEY

FIGURE 15:- ULTRASONIC GENERATOR (ABOVE), MONOPOLAR GENERATOR (BELOW)

FIGURE 16:- PORTS USED IN LAPAROSCOPY





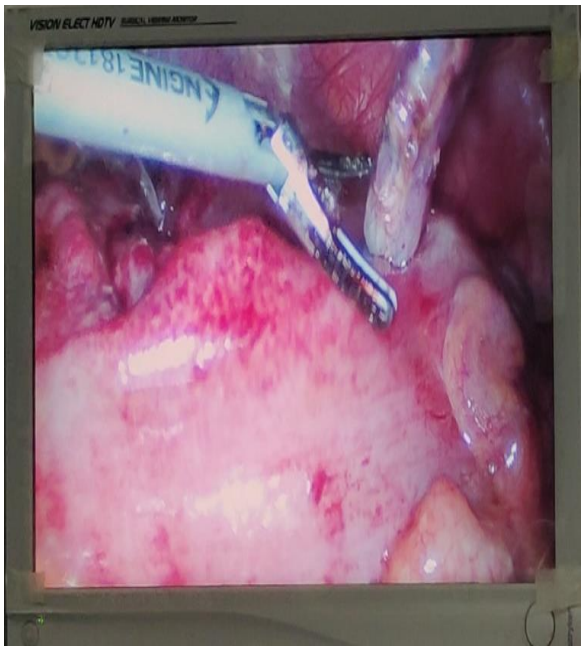


FIGURE 17:- LAPAROSCOPIC APPENDECTOMY USING ULTRASONIC SHEARS

DISCUSSION

DISCUSSION

The present study is a hospital based prospective comparative study undertaken to compare the outcomes of Laparoscopic appendectomy using two different energy sources i.e. monopolar electro cautery and ultrasonic shears, advantages and complications associated with their usage.

This study incorporated a total of 44 patients having appendicitis who underwent laparoscopic appendectomy in the Department of General Surgery at R.L. Jalappa hospital and research center attached to Sri Devaraj Urs Medical College, Kolar, during the period from December 2018 to July 2020.

The study was approved by the ethics committee of the institution. All the 44 patients were randomized using odd-even method (alternate method) and allocated for two groups equally (22 each) i.e. group A (Laparoscopic appendectomy using Monopolar electro cautery/odd group) and group B (Laparoscopic appendectomy using Ultrasonic shears/even group).

Patients suffering from appendicitis aged between 21 years and 60 years undergoing laparoscopic appendectomy are incorporated in study and patients with appendicular mass, appendicular abscess; comorbidities like cirrhosis, bleeding diathesis, severe cardiac or pulmonary disease falling in ASA grade 3 & 4; previous abdominal surgery (where pneumoperitoneum cannot be created) are excluded from the study.

The patients were assessed based on duration of surgery, intraoperative hemostasis, postoperative pain, surgical site infection and duration of hospital stay.

Demographic data of each patient was noted and all the patients were followed till three months after surgery.

1) AGE DISTRIBUTION:-

Each patient was comparable based on the demographic data studied, in both the groups. Patients studied with respect to age distribution showed no significant disparity in both groups. In our study, the mean age distribution in monopolar electro cautery group is 29.27 ± 8.19 years and ultrasonic shears group is 26.05 ± 4.87. No significant variation was seen in patient's mean age distributed among the two groups (p value of 0.120).

Similarly, in a study conducted by Jun Sun Lee et al the mean age among patients with ultrasonic shears was 22.1 ± 4.8 years where as with monopolar electro cautery was 22.5 ± 5.8 years, suggesting similar demographic data for age for acute appendicitis disease among patients[48].

In a study conducted by Saira Khalid et al, 74% patients were in age group of 15 to 25 years in both ultrasonic shears and monopolar electro cautery group[49].

2) GENDER DISTRIBUTION:-

When the gender distribution is noted, in both the groups, over all females are less affected compared to male population. In Monopolar Electro cautery group 45.45% were female and 54.55% were male whereas in Ultrasonic Shears group 22.73% were female and 77.27% were male. No significant variation in Sex Distribution between two groups was noted. (P value of 0.112).

In a study conducted by Jun Sun Lee et al, 98% patients were males similar to current study[48], whereas the study conducted by Saira khalid et al had majority (60%) of females presented with acute appendicitis[49].

3) MEAN OPERATING TIME:-

Mean operative time with ultrasonic shears is 38.14 ± 3.41 minutes and mean operative time with monopolar electro cautery is 45.77 ± 4.21 minutes. There is a significant difference (p value <0.001) in time of surgical procedure between the two groups. All these surgeries were performed by experienced surgeons and all were quite familiar with the instruments and the operative procedure and technique. There was a significant difference in the operative time among the two groups. However, the slightly longer operating time in the monopolar group might be due to extra time spent for hemostasis.

In the study conducted by Jun Sun Lee et al., which enrolled about 1178 patients, evaluated two laparoscopic appendectomy techniques: ultrasonic shears and monopolar electro cautery, the mean operating time was lesser with the ultrasonic shear group and it was statistically significant[48].

In a study done by Saira khalid et al., the mean operative time for ligation of mesoappendix laparoscopic appendectomy with monopolar electro cautery was 17.7±3.35 minutes; for ultrasonic shears patients, it was 17.6±3.28 and was statistically not significant[49].

4) INTRAOPERATIVE HEMOSTASIS:-

In Monopolar electro cautery group, mean intraoperative bleeding is 16.45 ± 6.05 ml where as it is 9.82 ± 3.03 ml in ultrasonic shears group as Ultrasonic shears coagulates the tissue before cutting and has vessel sealing property, which is not seen with conventional electro cautery. There was a significant difference in Mean Intra Operative hemostasis Comparison between two groups.

In a study done by Saira khalid et al., the mean operative time for ligation of mesoappendix laparoscopic appendectomy with monopolar electro cautery was 3.4±2.45 minutes; for Harmonic Scalpel (ultrasonic shears) patients, it was 3.3±2.45 and was statistically not significant[49].

5) POSTOPERATIVE PAIN:-

The post-operative pain is measured and quantified subjectively by using visual analogue scale (VAS), done 24 hours post-operatively i.e on post op day 1. The pain is not assessed on operative day, in our present study, as the post-operative pain can be altered or can be falsely low in the very immediate post-operative period. This can be due to the anaesthetic effect and time required for this effect to wear off. In our study, the ultrasonic shear group showed better pain score 3.55 ± 1.18 on 24 hours post operatively. Monopolar group showed pain score of 5.09 ± 1.44, 24 hours post operatively. The use of ultrasonic shear during laparoscopic appendectomy minimizes detriment to the surrounding tissues and closure with a stitch is not required for achieving hemostasis.

6) SURGICAL SITE INFECTION:-

SSI was noted in three patients (13.64%) with monopolar electro cautery group as compared to two patients (9.09%) in ultrasonic shear group. No significant disparity was in Surgical Site Infection Distribution between two groups.

Similarly in a study conducted by Jun Sun Lee et al, 5 patients has SSI with ultrasonic shear group where 4 patients with monopolar electro cautery group and showed no statistical difference[48].

7) DURATION OF HOSPITAL STAY:-

In general, the average hospital stay following a Laparoscopic appendectomy is 1-2 days. The average stay was slightly longer in our present study, 3.55 ± 1.18 days in the ultrasonic shear group and 4.55 ± 1.74 in the monopolar electro cautery group.

The reason for the longer hospital stay is due to the peculiarity that most of patients in the present study were rural population, who had to return to work and take part in their agricultural/household activities immediately after discharge, so they would not have been able to follow the postoperative instructions. There was a significant difference in Mean post-operative Stay Comparison between two groups.

In a study conducted by Jun Sun Lee et al, there was no statistical difference in duration of hospital stay between the two groups[48].

Laparoscopic appendectomy using ultrasonic shears virtually created a bloodless surgery field with a decreased damage to tissue, this has been associated with a significantly lesser operating time, reduced postoperative pain with a quicker recovery for patient's normal daily activities.

In ultrasonic shears, the ultrasonic energy at the active blade is converted to mechanical energy. The active blade delivers a high-grade frictional force, whereas the inactive upper arm holds the tissue in proximity. Precise dissection, reliable hemostasis, less charring and decreased lateral thermal spread are the prime advantages. This device mainly works by applying a firm pressure while sealing with a denatured protein coagulum. The vibration causes denaturation of hydrogen bonds and leads to vessel coagulation. The ultrasonic shears may be superior to electro surgery as it can cut through thicker tissue, creating lesser toxic surgical smoke, and may offer greater precision[30].

CONCLUSION

CONCLUSION

Use of Ultrasonic shears was found to be safe, effective and beneficial in achieving intraoperative hemostasis. Ultrasonic shears serves as an alternative to the conventional procedure (Monopolar electro cautery) in laparoscopic appendectomy. There is a decrease in the operating time, post-operative hospital stay in ultrasonic shear group. The intensity of pain perceived by patients in the ultrasonic shear group is less compared to monopolar electro cautery group. The high cost of ultrasonic shears as compared to monopolar electro cautery limits its regular use in laparoscopic appendectomy.

SUMMARY

SUMMARY

In this prospective comparative study conducted in R.L Jalappa Hospital attached to Sri Devaraj Urs Medical College, Tamaka, Kolar, 44 patients underwent ultrasonic shear assisted laparoscopic appendectomy and Monopolar electro cautery assisted laparoscopic appendectomy, 22 in each group were compared for the outcomes with respect to different parameters.

Most of the patients in age group of 21 to 30 years suffered appendicitis. Majority were males. Significant difference were observed in terms of operating time, 24 hours postoperative pain score, intraoperative hemostasis and duration of post-operative hospital stay. These parameters were less in ultrasonic shear group compared to conventional Monopolar electro cautery group.

Complications studied like surgical site infection were similar among the patients of Ultrasonic shear group and patients in whom Monopolar Electro cautery was used. Ultrasonic shear assisted laparoscopic appendectomy is modern, demands expertise, safe and effective in providing a bloodless and smokeless field with minimal tissue damage.

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BIBLIOGRAPHY

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ANNEXURES

PATIENT INFORMATION SHEET

Study title:- **'COMPARATIVE STUDY OF EFFICACY OF MONOPOLAR ELECTROCAUTERY AND ULTRASONIC SHEARS IN LAPAROSCOPIC APPENDECTOMY'**

GUIDE:- DR. KRISHNA PRASAD K.

STUDY CONDUCTED BY DR. ATUL DUA

STUDY LOCATION:- R. L. Jalappa hospital and Research centre attached to sri devaraj urs medical college, tamaka, kolar

This is to inform you that you have been diagnosed with inflammation of appendix. Surgery can be either by conventional open approach or laparoscopic approach. For laparoscopic appendectomy approach, two energy sources can be used either monopolar electro cautery or ultrasonic shears. This study is being conducted to compare the efficacy of monopolar electro cautery and ultrasonic shears. Following complications can be associated with it such as port site infection, port site hernia & sinus formation. If you are willing, you will be enrolled in this study. You will receive the standard care after laparoscopic appendectomy.

You are free to opt out of the study at any time, if you are not satisfied or apprehensive to be the part of the study. Your treatment and care will not be compromised, if you refuse to be part of the study. The study will not add any risk or financial burden to you if you are part of the study.

Your identity and clinical details will be confidential. You will not receive any financial benefit for being part of the study. You are free to contact Dr. Atul Dua or any other member of the research team for any doubt or clarification.

For further information contact:-

Dr. ATUL DUA (post graduate)
Phone no. 8130674930
Department of general surgery
SDUMC, Kolar

SIGNATURE/ thumb impression of Patient

ರೋಗಿಯ ಮಾಹಿತಿ ಪತ್ರ

ಅಧ್ಯಯನದ ಶೀರ್ಷಿಕೆ: – ' ತುಲನಾತ್ಮಕ ಎಲೆಕ್ಟ್ರೋಕಾರ್ಟರಿಯ ಫಲಪ್ರದತೆಯ ಅಧ್ಯಯನ ಮತ್ತು ಲ್ಯಾಪರೊಸ್ಕೋಪಿಕ್ ಆಪೆನ್ಡೆಕ್ಟೊಮಿನಲ್ಲಿ ಅಲ್ಟ್ರಾಸಾನಿಕ್ ಕತ್ತರಿಗಳು'

ಗೈಡ್: – ಡಿಆರ್. ಕೆ. ಕೃಷ್ಣ ಪ್ರಸಾದ್

ಅಧ್ಯಯನ *ನಡೆಸುವವರು* : ಅತುಲ್ ದುವಾ

ಅಧ್ಯಯನ ಸ್ಥಳ: – ಆರ್.ಎಲ್. ಜಲಪ್ಪ ಆಸ್ಪತ್ರೆ ಮತ್ತು ಸಂಶೋಧನಾ ಕೇಂದ್ರ ಶ್ರೀ ದೇವರಾಜ್...ವೈದ್ಯಕೀಯ ಕಾಲೇಜ್, ಟಮಕ , ಕೋಲಾರ ಜೋಡಿಸಲಾಗಿದೆ.

ನೀವು ಅನುಬಂಧದ ಉರಿಯೂತದಿಂದ ಬಳಲುತ್ತಿದ್ದಾರೆ ಎಂದು ನಿಮಗೆ ತಿಳಿಸುವುದು. ಸರ್ಜರಿಯು ಸಾಂಪ್ರದಾಯಿಕ ಮುಕ್ತ ವಿಧಾನ ಅಥವಾ ಲ್ಯಾಪರೊಸ್ಕೋಪಿಕ್ ವಿಧಾನದಿಂದ ಇರಬಹುದು. ಲ್ಯಾಪರೊಸ್ಕೋಪಿಕ್ ವಿಧಾನಕ್ಕಾಗಿ, ಎರಡು ಶಕ್ತಿಯ ಮೂಲಗಳನ್ನು ಏಕಸ್ವಾಮ್ಯದ ವಿದ್ಯುದ್ವಾಹಕ ಅಥವಾ ಅಲ್ಟ್ರಾಸಾನಿಕ್ ಕತ್ತರಿಗಳನ್ನು ಬಳಸಬಹುದು. ಏಕಸ್ವಾಮ್ಯ ಎಲೆಕ್ಟ್ರೋಕೌಟರಿ ಮತ್ತು ಅಲ್ಟ್ರಾಸಾನಿಕ್ ಕತ್ತರಿಗಳ ಪರಿಣಾಮಕಾರಿತ್ವವನ್ನು ಹೋಲಿಸಲು ಈ ಅಧ್ಯಯನವನ್ನು ನಡೆಸಲಾಗುತ್ತಿದೆ. ಇದರಿಂದ ತೊಡಕುಗಳು ಪೋರ್ಟ್ ಸೈಟ್ ಸೋಂಕು, ಪೋರ್ಟ್ ಸೈಟ್ ಅಂಡವಾಯು ಮತ್ತು ಸೈನಸ್ ರಚನೆ ಮುಂತಾದವುಗಳಿಗೆ ಸಂಬಂಧಿಸಿರುತ್ತವೆ.ನಿಮ್ಮ ಒಪ್ಪಿಗೆಯಿಲ್ಲದೆ ಅಧ್ಯಯನದಲ್ಲಿ ನೀವು ಸೇರಿಕೊಳ್ಳುತ್ತೀರಿ. ಲ್ಯಾಪರೊಸ್ಕೋಪಿಕ್ ಅಪಿಪೆಂಡೆಕ್ಟಮಿ ನಂತರ ನೀವು ಗುಣಮಟ್ಟದೆ ಆರೈಕೆಯನ್ನು ಸ್ವೀಕರಿಸುತ್ತೀರಿ.

ನೀವು ಅಧ್ಯಯನದ ಭಾಗವಾಗಿ ತೃಪ್ತಿಪಡಿಸದಿದ್ದರೆ ಅಥವಾ ಆತಂಕವಿಲ್ಲದಿದ್ದರೆ, ಯಾವುದೇ ಸಮಯದಲ್ಲಿ ನೀವು ಅಧ್ಯಯನವನ್ನು ಹೊರಗುಳಿಯಲು ಮುಕ್ತರಾಗಿದ್ದೀರಿ. ನೀವು ಅಧ್ಯಯನದ ಭಾಗವಾಗಿರಬೇಕೆಂದು ನಿರಾಕರಿಸಿದರೆ ನಿಮ್ಮ ಚಿಕಿತ್ಸೆ ಮತ್ತು ಕಾಳಜಿಗೆ ಧಕ್ಕೆಯುಂಟಾಗುವುದಿಲ್ಲ. ನೀವು ಅಧ್ಯಯನದ ಭಾಗವಾಗಿದ್ದರೆ ಅಧ್ಯಯನವು ಯಾವುದೇ ಅಪಾಯ ಅಥವಾ ಹಣಕಾಸಿನ ಹೊರೆಗಳನ್ನು ಸೇರಿಸುವುದಿಲ್ಲ.

ನಿಮ್ಮ ಗುರುತು ಮತ್ತು ವೈದ್ಯಕೀಯ ವಿವರಗಳು ಗೌಪ್ಯವಾಗಿರುತ್ತದೆ. ಅಧ್ಯಯನದ ಭಾಗವಾಗಿರಲು ನೀವು ಯಾವುದೇ ಆರ್ಥಿಕ ಪ್ರಯೋಜನವನ್ನು ಪಡೆಯುವುದಿಲ್ಲ. ಯಾವುದೇ ಸಂದೇಹ ಅಥವಾ ಸ್ಪಷ್ಟೀಕರಣಕ್ಕಾಗಿ ಡಾ ಅತುಲ್ ದುವಾ ಅಥವಾ ಸಂಶೋಧನಾ ತಂಡದ ಯಾವುದೇ ಸದಸ್ಯರನ್ನು ಸಂಪರ್ಕಿಸಲು ನೀವು ಮುಕ್ತರಾಗಿದ್ದೀರಿ.

ಹೆಚ್ಚಿನ ಮಾಹಿತಿಗಾಗಿ: –

ಡಾ. ಅತುಲ್ ದುಆ(ಪೋಸ್ಟ್ಡಾಜುಯೇಟ್) ಪಾಟಿಯಂಟ್ನ ಸಹಿ

ದೂರವಾಣಿ ಸಂಖ್ಯೆ. 8130674930

ಸಾಮಾನ್ಯ ಶಸ್ತ್ರಚಿಕಿತ್ಸೆ ಇಲಾಖೆ

ಸದುಂಕ್, ಕೋಲಾರ್

INFORMED CONSENT FORM

I Mr./Mrs. have been explained in my own understandable language, that I will be included in a study "COMPARATIVE STUDY OF EFFICACY OF MONOPOLAR ELECTROCAUTERY AND ULTRASONIC SHEARS IN LAPAROSCOPIC APPENDECTOMY'' , which is being conducted in R L JALAPPA HOSPITAL.

I have been explained that my clinical findings, investigations, intraoperative findings, post-operative course, will be assessed and documented for study purpose.

I have been explained my participation in this study is entirely voluntary, and I can withdraw from the study any time and this will not affect my relation with my doctor or the treatment for my ailment.

I have been explained about the follow up details and possible benefits and adversities due to interventions, in my own understandable language.

I have understood that all my details found during the study are kept confidential and while publishing or sharing of the findings, my details will be masked.

I in my sound mind give full consent to be added in the part of this study.

Signature/ thumb impression of the patient:

Name:

Signature/ thumb impression of the witness:

Name:

Relation to patient:

Date: Place

ತಿಳಿವಳಿಕೆಯ ಸಮ್ಮತಿ ಪಾತ್ರ

ನಾನು ಶ್ರೀ /ಶ್ರೀಮತಿ ನನ್ನ ಅರ್ಥವಾಗುವಂತಹ ಭಾಷೆಯಲ್ಲಿ ವಿವರಿಸಲಾಗಿದ್ದು, ನಾನು ಆರ್ ಎಲ್ ಜಲಪ್ಪಾ ಆಸ್ಪತ್ರೆಯಲ್ಲಿ ನಡೆಸಿದ "ಲ್ಯಾಪರೊಸ್ಕೋಪಿಕ್ ಅಪ್ಪೆಂಡೆಕ್ಟಮಿ ಮಾನೋಪೋಲರ್ ಕಾಟರಿಎಲೆ ಕ್ಯೂ ಮತ್ತು ಅಲ್ಟ್ರಾಸೋನಿಕ್ ಶೇಲಾರ್ಸ್ ಪರಿಣಾಮಗಳಅಧ್ಯಯನ" ದಲ್ಲಿ ಸೇರಿಸಲಾಗುವುದು.

ಅಧ್ಯಯನದ ಉದ್ದೇಶಕ್ಕಾಗಿ ನನ್ನ ವೈದ್ಯಕೀಯ ಸಂಶೋಧನೆಗಳು, ತನಿಖೆಗಳು, ಶಸ್ತ್ರಚಿಕಿತ್ಸೆಗೆ ಒಳಪಡುವ ಆವಿಷ್ಕಾರಗಳು, ಆಪರೇಟಿವ್ ಕೋರ್ಸ್, ಮೌಖಯ ಅಪಾನಗದನ್ನು ದಾಖಲಿಸಲಾಗುವುದು ಎಂದು ನನಗೆ ವಿವರಿಸಲಾಗಿದೆ.

ಈ ಅಧ್ಯಯನದಲ್ಲಿ ನನ್ನ ಪಾಲ್ಗೊಳ್ಳುವಿಕೆಯು ಸಂಪೂರ್ಣವಾಗಿ ಸ್ವಯಂಪ್ರೇರಿತವಾಗಿರುವುದನ್ನು ನಾನು ವಿವರಿಸಿದ್ದೇನೆ ಮತ್ತು ಯಾವುದೇ ಸಮಯದಲ್ಲಿ ನಾನು ಈ ಅಧ್ಯಯನದಿಂದ ಹಿಂತೆಗೆದುಕೊಳ್ಳಬಹುದು ಮತ್ತು ಇದು ನನ್ನ ವೈದ್ಯರೊಂದಿಗೆ ನನ್ನ ಸಂಬಂಧವನ್ನು ಅಥವಾ ನನ್ನ ಕಾಯಿಲೆಯ ಚಿಕಿತ್ಸೆಗೆ ಪರಿಣಾಮ ಬೀರುವುದಿಲ್ಲ.

ನನ್ನ ಸ್ವಂತ ಅರ್ಥವಾಗುವ ಭಾಷೆಯಲ್ಲಿ, ಮಧ್ಯಸ್ಥಿಕೆಗಳ ಕಾರಣದಿಂದಾಗಿ ಅನುಸರಣೆ ವಿವರಗಳು ಮತ್ತು ಸಂಭವನೀಯ ಪ್ರಯೋಜನಗಳು ಮತ್ತು ವಿಪತ್ತುಗಳ ಬಗ್ಗೆ ನನಗೆ ವಿವರಿಸಲಾಗಿದೆ.

ಅಧ್ಯಯನದ ಸಮಯದಲ್ಲಿ ಕಂಡುಬರುವ ನನ್ನ ವಿವರಗಳನ್ನು ಗೌಪ್ಯವಾಗಿರಿಸಲಾಗುವುದು ಮತ್ತು ಪ್ರಕಟಣೆ ಮಾಡುವಾಗ ಅಥವಾ ಆವಿಷ್ಕಾರಗಳ ಹಂಚಿಕೆಯ ಸಂದರ್ಭದಲ್ಲಿ ನನ್ನ ವಿವರಗಳನ್ನು ಮರೆಮಾಡಲಾಗುವುದು ಎಂದು ನಾನು ಅರ್ಥಮಾಡಿಕೊಂಡಿದ್ದೇನೆ.

ನನ್ನ ಧ್ವನಿ ಮನಸ್ಸಿನಲ್ಲಿ ನಾನು ಈ ಅಧ್ಯಯನದ ಭಾಗದಲ್ಲಿ ಸೇರಿಸಬೇಕಾದ ಪೂರ್ಣ ಸಮ್ಮತಿಯನ್ನು ನೀಡುತ್ತೇನೆ.

ರೋಗಿಯ ಸಹಿ / ಹೆಬ್ಬೆರಳು ಗುರುತು:

ಹೆಸರು:

ಸಾಕ್ಷಿಯ ಸಹಿ / ಹೆಬ್ಬೆರಳು ಗುರುತು:

ಹೆಸರು:

ರೋಗಿಗೆ ಸಂಬಂಧ: ದಿನಾಂಕ:

ಸ್ಥಳ:

PROFORMA

Name: **DOA:**

Age: **DOD:**

Sex: **IP/OP NO:**

Religion: **Unit No:**

Education: **Date of surgery:**

Occupation:

Address:

1. Chief Complaints:

Pain

Tenderness

Rebound tenderness

Vomiting/nausea

Fever

Diarrhea/constipation

Other complaints

2. Vomiting

Onset

Duration

Frequency

Character of onset

Amount

Content

Past history

Diabetes

Hypertension

T.B

Asthma / previous allergy

Previous surgeries

GENERAL PHYSICAL EXAMINATION

Appearance

Attitude

Build and Nourishment

Level of consciousness

Dehydration

Temperature

Pulse

Blood pressure

Respiration

INVESTIGATIONS:-

1) HB %
2) TOTAL LEUCOCYTE COUNT
3) RBS
4) BLOOD UREA
5) SERUM CREATININE
6) HIV and HbSAg
7) BLEEDING TIME and CLOTTING TIME
8) USG ABDOMEN AND PELVIS

Parameters

1) Operative time
2) Intraoperative hemostasis:- number and weight of soaked gauge.
3) Post operative pain:-visual analogue scale
4) Surgical site infection:- Southampton wound scoring system

5) Postoperative stay

Outcome of the patient

Patients are followed up for any post operative complication for a period of 3 months from the day of surgery.

KEY TO MASTER CHART

SL.NO: Serial number

UHID: Unique hospital identification number

M: Male

F: Female

ULTRASONIC SHEARS: Laparoscopic appendectomy using ultrasonic shears

MONOPOLAR: Laparoscopic appendectomy using monopolar electro cautery

OT(MIN): Operating time in minutes

IOH(ML): Intraoperative hemostasis in milliliter

POP: Post operative pain

VAS 24HR: Pain assessment using visual analogue scale at 24 hours post-operative

SSI: Surgical site infection

POS: Post operative stay in days

MASTER CHART

SL NO	UHID	AGE	SEX	PROCEDURE	OT(MIN)	IOH(ML)	POP(VAS 24hr)	SSI	POS (DAYS)
1	658911	26	M	MONOPOLAR	47	15	6	ABSENT	5
2	635175	35	M	ULTRASONIC SHEARS	38	8	4	ABSENT	3
3	670250	22	M	MONOPOLAR	50	18	7	ABSENT	4
4	674554	29	M	ULTRASONIC SHEARS	40	8	4	ABSENT	3
5	675906	56	F	MONOPOLAR	46	20	6	ABSENT	6
6	677488	21	M	ULTRASONIC SHEARS	36	10	3	ABSENT	4
7	682981	34	F	MONOPOLAR	52	24	4	ABSENT	3
8	681033	23	F	ULTRASONIC SHEARS	40	10	3	ABSENT	3
9	681470	25	M	MONOPOLAR	48	6	5	ABSENT	5
10	699583	22	M	ULTRASONIC SHEARS	41	8	3	ABSENT	3
11	701183	30	F	MONOPOLAR	49	17	4	ABSENT	5
12	713644	21	M	ULTRASONIC SHEARS	50	16	7	PRESENT	7
13	713100	24	M	MONOPOLAR	44	10	6	ABSENT	3
14	674416	25	F	ULTRASONIC SHEARS	36	6	4	ABSENT	4
15	715890	25	F	MONOPOLAR	45	13	3	ABSENT	4
16	338099	35	M	ULTRASONIC SHEARS	39	10	3	ABSENT	3
17	724438	29	F	MONOPOLAR	48	26	5	ABSENT	4
18	726274	25	M	ULTRASONIC SHEARS	37	8	4	ABSENT	2
19	725991	30	F	MONOPOLAR	52	30	7	PRESENT	9
20	734408	27	M	ULTRASONIC SHEARS	40	8	4	ABSENT	4
21	558320	23	F	MONOPOLAR	42	12	6	ABSENT	3
22	737039	25	M	ULTRASONIC SHEARS	35	10	3	ABSENT	3
23	742493	30	M	MONOPOLAR	48	18	4	ABSENT	3
24	742832	22	M	ULTRASONIC SHEARS	40	13	6	PRESENT	6
25	746944	29	M	MONOPOLAR	41	14	3	ABSENT	5
26	747788	31	M	ULTRASONIC SHEARS	36	6	3	ABSENT	3
27	747870	29	M	MONOPOLAR	48	12	5	ABSENT	3
28	742390	27	F	ULTRASONIC SHEARS	38	9	4	ABSENT	4
29	764679	29	M	MONOPOLAR	52	18	7	PRESENT	7
30	764726	23	F	ULTRASONIC SHEARS	33	5	4	ABSENT	3
31	779292	21	F	MONOPOLAR	42	13	4	ABSENT	4
32	800906	23	M	ULTRASONIC SHEARS	38	15	3	ABSENT	2
33	807073	43	F	MONOPOLAR	41	18	5	ABSENT	5
34	817266	21	M	ULTRASONIC SHEARS	38	13	2	ABSENT	4
35	833743	41	M	MONOPOLAR	44	10	4	ABSENT	3
36	832788	21	M	ULTRASONIC SHEARS	39	11	2	ABSENT	4
37	774172	25	M	MONOPOLAR	41	17	6	ABSENT	5
38	835077	33	M	ULTRASONIC SHEARS	38	12	3	ABSENT	4
39	832405	26	M	MONOPOLAR	49	27	8	PRESENT	8
40	564424	33	F	ULTRASONIC SHEARS	37	10	4	ABSENT	3
41	832450	21	M	MONOPOLAR	39	12	3	ABSENT	2
42	837573	21	M	ULTRASONIC SHEARS	37	14	2	ABSENT	4
43	833811	26	F	MONOPOLAR	39	12	4	ABSENT	4
44	841492	30	M	ULTRASONIC SHEARS	33	6	3	ABSENT	2