TRANSUMBILICAL SINGLE PORT LAPAROSCOPIC APPENDECTOMY VERSUS CONVENTIONAL LAPAROSCOPIC APPENDECTOMY:A PROSPECTIVE RANDOMISED STUDY

By

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ABBREVATIONS

1. DOA:DATE OF ADMISSION
2. DOD:DATE OF DISCHARGE
3. DOS:DATE OF SURGERY
4. PR:PULSE RATE
5. B.P: BLOOD PRESSURE
6. RR:RESPIRATORY RATE
7. TEMP:TEMPERATURE
8. HB:HEMOGLOBIN
9. TC:TOTAL COUNTS
10. DC:DIFFERENTIAL COUNT
11. ESR:ERYTHROCYTE SEDIMENTATION RATE
12. BT:BLEEDING TIME
13. CT:CLOTTING TIME
14. RBS:RANDOM BLOOD SUGAR
15. USG:ULTRA SONOGRAPHY
16. CT:COMPUTED TOMOGRAPHY
17. ECG:ELECTROCARDIOGRAPHY
18. VAS:VISUAL ANALOG SCALE
19. SPLA:SINGLE PORT LAPAROSCOPIC APPENDECTOMY
20. CTPLA:CONVENTIONAL THREE PORT LAPAROSCOPIC APPENDECTOMY
21. CLA:CONVENTIONAL LAPAROSCOPIC APPENDECTOMY

ABSTRACT

Purpose: Since laparoscopic appendectomy was first described, it has been modified various times and newer techniques were introduced. The most recent single port laparoscopy has been introduced as a improvised technique for appendectomy and also being used for other intra-abdominal surgeries. The main advantage of this technique being single small incision compared to three separate incisions for three ports in conventional laparoscopic appendectomy and virtually a scarlesssurgery.The aim of the study was to compare single-port laparoscopic appendectomy with conventional three port laparoscopic appendectomy for its efficacy and postoperative outcomes.

Methods :This study was conducted on 80 patients admitted in BLDEU's Shri B M Patil Medical College Hospital and Research Centre ,Bijapur from October 2011 to May 2013 who were diagnosed to have acute/chronic/recurrent appendicitis.The patients were divided into two groups of 40 each.Group A underwent Single Port Laparoscopic Appendectomy(SPLA)and Group B underwent conventional three port laparoscopic appendectomy(CTPLA).Both the group were compared for duration of surgery, duration of hospital stay, intraoperative complications ,postoperative pain ,post operativecomplications,cosmetic results in terms of satisfaction rate.

Results :.There was no age difference between both the groups.In SPLA group M:F was 25:15 wheras in CTPLA it was 21:19.Mean duration of surgery in SPLA group was 59.87+/-10.21 and for CTPLA was 54.4+/-16.64 suggesting both procedure took almost similar time and the difference was statistically insignificant.Duration of hospital stay in SPLA group was similar in both group.in SPLA group postoperative pain was less on first two days,4.8+/-1.2 and 2.4+/-0.2 and in CTPLA group 6.0+/-1.1 and 3.6+/-1.5 which was statistically significant difference.There was no difference

between SPLA and CTPLA group in terms of starting oral feeds.There were no difference between both the groups in terms of parenteral analgesics received and resuming work after surgery. SPLA group were more completely satisfied in terms of surgical scar 38(95%) in comparison to 28(70%) in CTPLA group. In our study conversion rate was 5% for SPLA and 2.5% for CTPLA. No surgical site infection was reported in CTPLA group on followup and in SPLA none.

Conclusion :This study shows that SPLA is a safe and effective technique for appendectomy and is superior to CTPLA in terms of postoperative scar, early resumption to work and less postoperative pain.

Key Words: single port laparoscopic appendectomy, SPLA, CTPLA, conventional three port laparoscopic appendectomy.

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INTRODUCTION

It is well known that abdomen is a pandora's box. Since the abdomen accommodates innumerable viscera and other anatomical structures, diseases of the abdomen arouse clinical curiosities. A meticulous examination of abdomen is one of the most rewarding and the diagnostic procedures available to a doctor, especially the surgeon, helps to plan an ideal treatment. Acute appendicitis is the most common cause of an 'acute abdomen' in young adults and, as such, the associated symptoms and signs have become a paradigm for clinicalteaching.[1]

Acute appendicitis is the most common acute surgical condition of the abdomen[2].Approximately 7% of the population will have appendicitis in their life time.[3]Acute appendicitis may occur at all ages but most commonly seen in the second and third decades of life[4].

Despite technological advances, the diagnosis of appendicitis is still based primarily on the patients history & the physical examination. Prompt diagnosis & surgical referral may reduce the risk of perforation & prevent complication.[5]The mortality rate in non-perforated appendicitis is less than 1%, but it may be as high as 5% and more in young & elderly patients in whom the diagnosis may often be delayed thus making perforation more likely. Preoperative diagnosis of acute appendicitis is sometimes challenging in young women, children & aged despite all round improvements in medical field & ultrasonography. Diagnostic scores are useful easy methods, which help in decision making[6]. Delay in diagnosis will lead to complication which increases morbidity, whereas overzealous diagnosis may lead to negative appendectomy .

Appendectomy continues to be one of the commonest procedures in general surgery with incidence of about 8%. Even with modern technologies, surgical skills,

antibiotics, fluids the morbidity associated with appendicitis is still 5 to 8 % mainly due to wound infection and delayed diagnosis and treatment. Laparoscopy has much to offer for the early diagnosis and treatment of appendicitis with least morbidity and gaining popularity as an alternative to open surgery.[55]

Now a days laparoscopic appendectomy is considered as the gold standard approach for removal of diseased appendix irrespective of its anatomical and pathological types . The main advantages of laparoscopic appendectomy includes excellent visualization ,decreased blood loss, diminished post-operative pain, early return to work, decreased wound infection and better cosmesis.[49]

Since laparoscopic appendectomy was first described, it has been modified various times and newer techniques were introduced. The most recent single port laparoscopy has been introduced as a improvised technique for appendectomy and also being used for other intra-abdominal surgeries.[47] The main advantage of this technique being single small incision compared to three separate incisions for three ports in conventional laparoscopic appendectomy and virtually a scarless surgery. Since this technique is new it needs to be investigated for its safety, outcomes of surgery.[49]

OBJECTIVES OF THE STUDY:

- To compare the outcomes of single port laparoscopic appendectomy with conventional three port appendectomy including

    1. Duration of surgery
    2. Complication rate.
    3. Satisfaction rate.(assessment of postoperative scar)
    4. Pain scale difference.
    5. Duration of hospital stay.

REVIEW OF LITERATURE

HISTORICAL REVIEW[7-10]

It seems appropriate to enlighten one's mind with historic moments of medicine, which are fascinating. Credit must be given to those who have contributed for the benevolence of mankind. Their pioneer works are an inspiration to the new generations.

Tiberius Caesar allowed Celsus to dissect on the executed criminals and he might have felt the presence of appendix. Aryateus of Cappedocia in 3rd century A.D is reputed to have described accurately appendicular abscesses and cured the patients by incision & drainage of the abscess through the abdominal wall.

In 1492,Leonardo de Vinci clearly depicted the organ in his anatomical drawings. He called it "Orchid" literally an ear to denote the auricular appendage of the caecum.

In 1521, Berengario D A Carpi, first described the organ.

In1530,VidoVidius,first named the worm- like organ as the vermiform appendix.

In 1530,Great scholar, Erasmus, was the first to record case of appendicitis with abscess formation.

In 1543, Andreas Vesalius ,illustrated the normal appendix in his 'De Humani corporis Fabrica'.

In 1554,Zeanfernel,French physician described a case of perforated appendix after an autopsy on 7 year girl who had suffered from diarrhea and was given large quince to stop her bowels.

In 1652,Hiden,a leading German surgeon gave detailed account of diseased inflamed appendix, after autopsy on a young man who died after several years of

progressive intestinal pain. The appendix was shrunken & drawn into a small bowel completely filling it, so that no contents could be forced into the colon, therefore such pain, appendix was inflamed & swollen throughout.

In 1710,Verneys was the first to coin the term appendix vermiformis, the first description of appendicitis.

In 1711,LorenzHiester gave the first good description of a case of acute appendicitis, postmortem on a executed criminal. Morganin (1719) illustrated beautifully in his 'Adversaria Anatomica'.

In 1755,LorenzHiester, professor at Helmstedt recognized that appendix might be the site of acute primary inflammation.

The first reported appendectomy was by Claudius Amyand, surgeon at St.George's Hospital London in 1735. It was the first occasion on which the appendix was successfully removed from the living subject. He removed from a hernial sac an appendix that had been perforated by pin. By the end of the 18^{th} century the appendix was recognized anatomically and that it could be become inflamed and cause serious, even fatal results. But symptoms were unrecognized and appropriate surgical treatment was a long way off.

John Parkinson in 1812, recorded a proven case of acute appendicitis. A 5 year old boy died, 48 hours after the onset of acute abdominal pain and vomiting. At autopsy an actually inflamed appendix which contained a faecolith, was found. He stated that no disease was present in the caecum or proximal appendix but was in the appendiceal tip.

In 1824, French physician Louyer Villermay was the first to prove that the appendix could be the site of inflammation based on study of 2 young men who died

shortly after onset of abdominal pain. Each was found to have a gangrenous appendix & normal caecum. Melier in 1827 confirmed these findings.

Baron Gullaume Dupuytren & Goldbeck (1830),promoted the theory that inflammation arouse in the cellular tissue surrounding the caecum known as typhlitis & perityphlitis.

In 1884, Samuel Fenwick in London exhorted the surgical community to operate upon a perforated appendix as soon as the diagnosis was always certain.

In 1886, Fitz, professor of medicine at Harvard who gave a lucid and logical description of the clinical feature & described in detail the pathological changes of the disease; was also the first one to use the term appendicitis.

In 1880,LawsonTait, a pioneer of abdominal surgery in Great Britain, performed first planned appendectomy on a girl with an appendiceal abscess. She had recurrent pain in right iliac fossa. This milestone in history of appendicitis was not reported by Tait till 1890. Later John Shepherd rediscovered Tait's important contribution. In 1887, Morton of Philadelphia successfully diagnosed & excised an acutely inflamed appendix within an abscess cavity.

In 1889, Charles McBurney described the pathological changes in appendicitis. In 1902, Albert Ochsner, surgeon from Chicago & Sherren at the London hospital recommended a conservative approach to patient with generalized peritonitis following perforated appendix, to allow the inflammatory process to localize before considering any operation.

In 1905, Rockey described a transverse skin incision which, Elliot had done in 1896.

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

In 1982, Semm is widely credited with performing the 1st successful laparoscopic appendectomy.[11]

Teicher I et al (1983), described problems related to the confusing diagnosis of acute appendicitis as evidenced by negative laparotomy rate.To assess the feasibility of decreasing the diagnostic error , scoring system was formed to aid in the diagnosis of acute appendicitis and concluded that the scoring system could have eliminated over 1/3rd of unnecessary laparotomies or appendectomies.[12]

Arnbjornsson E (1983), described the role of dietary fiber as the cause of acute appendicitis was evaluated. By means of food diaries, the average daily fiber consumption was determined in 31 patients with acute appendicitis & in 30 control patients, matched for age & sex. The average daily dietary fiber intake was 17.4 gms in the group with appendicitis and21 gmsin the control group,the difference is statistically significant the result which supports the hypothesis that diet in particular, lack of fiber may be an important factor in the pathogenesis of acute appendicitis.[13]

Alvarado A et al (1986), described practical scoring system which included localized tenderness in right lower quadrant, leukocytosis, migration of pain i.e. shifting of pain, temperature elevation ,nausea ,vomiting ,anorexia & direct rebound tenderness and the score helped in interpreting the confusing picture of acute appendicitis[14].

Puyleart JBCM et al. (1986),used ultrasonography as a tool to diagnose appendix. Ultrasonography was performed with 5 MHz or 7.5 MHz transducer using

graded compression technique appendix was visualized & diameter thickness, free fluid, ileus, tenderness at McBurneys point[15].

Abu - Yousef MM et al.(1989),used high resolution 5 to7.5MHz transducer to compress the bowels to displace the interfering gas in the right lower quadrant and directly visualized the inflamed appendix with the sensitivity that varies from 80 to 95%.A specificity of 95 to 100% & an accuracy of 91 to95%. It was also possible to differentiate acute appendicitis from the gangrenous & a perforated appendix. [16]

Addis et al. (1990) studied the lifetime rate of appendectomy and suggested as 21% for men & 25% for women , approximately 7% of all people undergoing appendectomy for acute appendicitis[3].

Fingerhut A et al.(1999), described diagnosis has been advocated as a potential tool to decide the number of negative appendicectomies performed. However the morbidity associated with laparoscopic and general anesthesia is acceptable only if pathology requiring surgical treatment present, and is amenable to laparoscopic techniques. The question of leaving a normal appendix in situ is controversial one 17% to 27% of normal appendices at exploration had pathological and histological findings.[17]

Sudhir Kumar Mohanty et al.(2000), quoted that modified Alvarado's score combined with ultrasound can be used as a cheap inexpensive way of confirming acute appendicitis ,thus reducing negative appendectomy rate[18].

Enochsson L et al(2001), quoted that laparoscopic appendectomy may be beneficial in obese patients in whom it may be difficult to gain adequate access through a small right lower quadrant incision. Additionally there may be a decrease in risk of postoperative wound infection after laparoscopic appendectomy in obese patients[19].

Bhattarcharjee PK et al (2002), did a study on modified Alvarado score and concluded that score was found to be a dependable aid both in pre-operative diagnosis of acute appendicitis and in the reduction of negative appendectomy[20].

De U De Krishna K (2004), reported a case having right lower quadrant abdominal pain in a 26 year old female who underwent appendectomy one year back. Recurrent appendicitis was noted in appendiceal stump. Although rare, stump appendicitis should be considered in the differential diagnosis of right lower quadrant abdominal pain.[21]

Nguyen NT et al.(2004), analyzed the outcomes of laparoscopic versus open appendectomy. He obtained data from the university health system consortium clinical data base for all patients who underwent appendectomy for acute and perforated appendicitis between 1999 and 2003(n=60236). Trends in utilization of laparoscopic appendectomy were examined over the 5 year period. Over all 41,085 patients underwent open appendectomy and 19,151 patients underwent laparoscopic appendectomy the percentage of appendectomy performed by a laparoscopy increased from 20% in 1999 to 43% in 2003 . Compared with patients who underwent open appendectomy, patients who underwent laparoscopic appendectomy were more likely female, more likely white, had a lower severity of illness and were less likely to have perforated appendicitis. Laparoscopic appendectomy was associated with a shorter length of hospital stay (2.5 days vs. 3.4 days) lower rate of 30 days re-admission (1.0%vs 1.3%) and a lower rate of overall complication (6.1%vs.9.6). There was no significant difference in the observed to expected mortality ratio between laparoscopic and open appendectomy (0.5 vs. 0.6). The mean cost per case was similar between the two groups[22].

Parveen Bhatia et al. Institute of Minimal Access, Metabolic and Bariatric Surgery, Sir Ganga Ram Hospital and Bhatia Global Hospital & Endosurgery Institute, New Delhi, India presented their initial experience of 17 cases of SILS appendectomy which were completed using conventional laparoscopic instruments. They utilised a single-incision multi-port laparoscopic appendectomy (SIMPLA) technique. At the end of study results were a) operative time was 63 ± 20 min, b) blood loss 6.5 ± 5 mL ,c)bowel movement (passing stool) occurred in 2.6 ± 0.6 days. d)Most patients were discharged on the first post-operative day on oral diet. e)The analgesic usage and pain scores were similar to multi-port laparoscopic appendectomy. No complications were noted at follow-up till 4 weeks and the surgical wound healed in all patients with an inconspicuous scar. They concluded that their initial experience with SILS appendectomy demonstrates its feasibility and supports the promise of minimising further the access of laparoscopic surgery. The clear advantage is its cosmetic benefit.

Jun Ho Park, et al.[49] compared the outcomes of of laparoscopic appendectomy with transumbilical single-port laparoscopic appendectomy(TUSPLA).This study was conducted in Hallym University of Medicine, Seoul, Korea between April 2009 to June 2009 and total of 40 patients were included in the study 20 in each group. They concluded that TUSPLA was technically feasible and safe in patients with non-complicated appendicitis and showed higher VAS score 24 hours postoperatively than the LA group.[53]

O Ates et al.[48] in 2005 conducted a comparative study between Laparoscopic appendectomy(LA) and Single-port intracorporeal laparoscopic appendectomy(SPI-LA) in children using transabdominal sling suture. Total of 38 patients were included in the study and 35 patients underwent SPI-LA and in 3 patients second port was inserted. Average duration of the procedure was 38+/- 5.6 min and no complications

were reported. This study concluded that SPI-LA is a safe, highly minimally invasive procedure with excellent cosmetic results.

E Khiangte et al. from Sept. 2009 to June 2010 at International Hospital Assam, ndia conducted 40 single-port surgeries using Glove port,27 cholecystectomies,11 appendectomies and 02 ovarian cystectomies. Study concluded that Glove port is simple, reusable, cost-effective and a reliable Gadget for single-port surgery, may be alternative to the costly commercially available single-port system.[47]

REGIONALANATOMY

GENERAL CONSIDERATION

Abdomen is divided into 9 quadrants by 2 vertical and 2 horizontal lines. The vertical lines pass through midclavicular line and midinguinal points. The horizontal lines are transpyloric and transtubercular. Transpyloric line is a horizontal line passing through the tip of 9^{th} costal cartilage on each side. Transtubercular is a horizontal line joining the both tubercles of the iliac crest.

Right iliac fossa is the right lateral and the lower most quadrant. The anterior wall if formed by external oblique, internal obliqus ,transverse abdominal muscles and is fascia transversalis. The psoas and quadrates lumborum muscles and thoraco lumbar fascia from posterior wall and inferiorly it is bounded by the posterior part of the ileum and iliacus muscles. Lateral wall formed by external oblique muscle , internal oblique muscle , transverse abdominal muscle, fascia transversalis and inferiorly by iliac bone covered by iliac muscles.

Appendix[26-29]

Vermiform appendix is found only in humans, certain anthropods, apes and the wombat. The appendix lies at the commencement of the large intestine into the right iliac fossa.

EMBRYOLOGY OF THE APPENDIX

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

As the small diverticulum the appendix appears in 6^{th} week of intrauterine life and is found at the apex of caecum at an early stage. The appendix is formed medially by excessive growth of the right wall of the caecum.

Position of the appendix:

The location of the base of the appendix is dependent on the position of the ceacum. The base is attached to the posterior medial surface of the caecum 2.5cm below the ileo-caecal junction at a site where the 3 tinea coli coalesce. The remaining portion is free .In relation to the anterior abdominal wall lies base which is situated $1/3^{rd}$ way up the line joining right anterior superior iliac spine to the umbilicus(Mc Burney's point).In incomplete rotation of the bowel, caecum may lie at the higher level beneath the liver in relation to duodenum and gall bladder, in this position signs & symptoms of acute appendicitis mimic acute cholecystitis. When the caecum is long and mobile the appendix may lie in the pelvis, in which case the tenderness in acute appendix is found maximally on pelvic examination. Very occasionally caecum and appendix lie in the left iliac fossa in which cases acute appendix mimic acute diverticulitis of sigmoid colon. The position of the tip of the appendix in relation to the caecum is variable. The various position are:

1. Retrocaecal-74%
2. Paracaecal -2%
3. Preileal -1% ,

4. Post ileal -5%
5. Pelvic -21%
6. Subcaecal- 1.5%

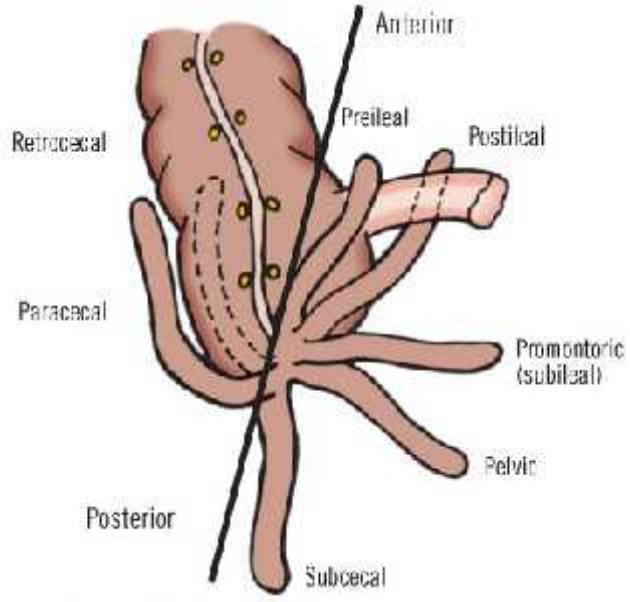


Fig 1 positions of appendix

The appendix varies considerably in length and circumference. The average length is between 7.5 to 10cms. Specimens of over 30cms in length have been recorded. The appendix in males average 0.5cms longer in length than in females.

Figure 2: Mesoappendix displayed demonstrating the appendicular artery.

The lumen which should admit a matchstick is irregular being encroached upon by the multiple longitudinal folds of mucous membrane. Appendix has short mesentery of its own. The mesoappendix that springs from lower surface of mesentery is subject to great variation. Some times as much as distal 1/3rd of the appendix is free from mesoappendix. Especially in childhood the mesoappendix is so transparent that the contained blood vessels can be seen. In many adults it becomes laden with the fat which obscures these vessels.

BLOOD VESSELS

The appendicular artery a branch of lower division of the ilieocolic artery passes behind the terminal ileum to enter the mesoappendix a short distance from the base of the appendix. It then comes to lie in the free border of mesoappendix but for a variable distance from the tip where the mesoappendix is lacking, the artery lies directly on the muscle wall beneath the peritoneal coat. An accessory appendicular artery, a branch of posterior caecal artery may be present but in most people once the appendicular artery reaches the wall of the appendix proper it becomes an end artery. Thrombosis of the artery as a result of appendicitis causes necrosis of appendix. The appendicular vein which follows the appendicular artery along the free border of the mesoappendix joins caecal veins to become ileocolic vein which is a tributary of superior mesenteric vein. Inflammatory thrombus may cause suppurativepyelophlebitis in case of gangrenous appendicitis.

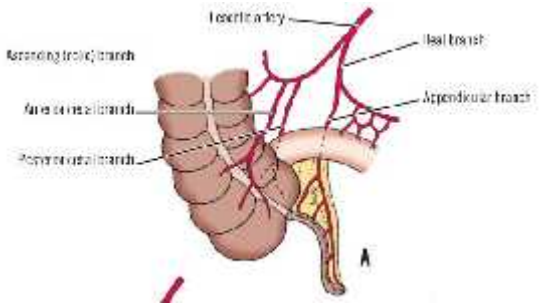


Fig 3:lood supply of appendix

LYMPHATIC VESSELS

Lymphatic vessels transverse the mesoappendix to empty into the iliececal lymph nodes through a number of mesenteric nodes they drain to superior mesenteric nodes.

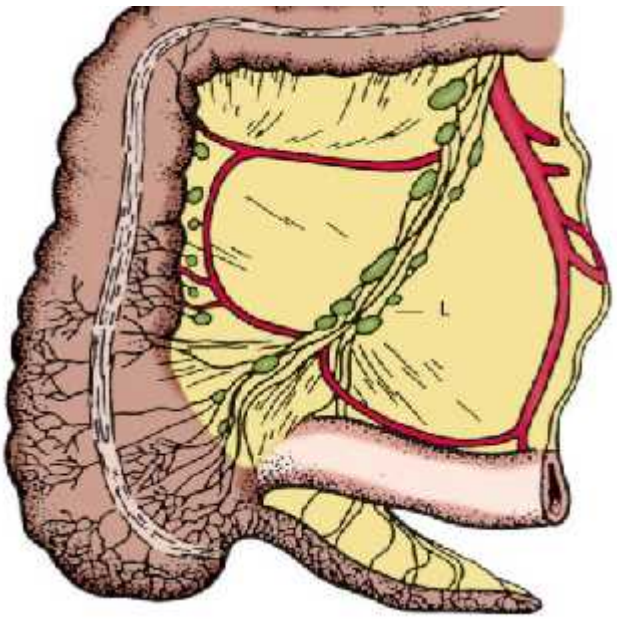


Fig 4:Lymphatic drainage of appendix

NERVE SUPPLY

Derived from sympathetic and parasympathetic nerves from superior mesenteric plexus. Afferent nerve fibers concerned with conduction of visceral pain from appendix believed to accompany the sympathetic nerve and enter the spinal cord at the level of 10^{th} thoracic segment.

MICROSCOPIC APPEARANCE[30-31]

Appendix is lined by columnar intestinal mucosa of colonic type. Crypts are present but not many. In the base of crypts lie the special cells Kulchitzky cells which give rise to carcinoid tumors. Appendicitis can be caused by them.

The submucosa contains numerous lymphatic aggregations(follicles). Those may be the cause for appendicitis. The muscular coat consists of 2 complete layers of smooth muscle inner circular and outer longitudinal. The latter is formed by the joining together of taenia-coli at the base of the appendix. The visceral layer of peritoneum envelops the appendix complete excepts for the narrow line of attachment of the mesoappendix.

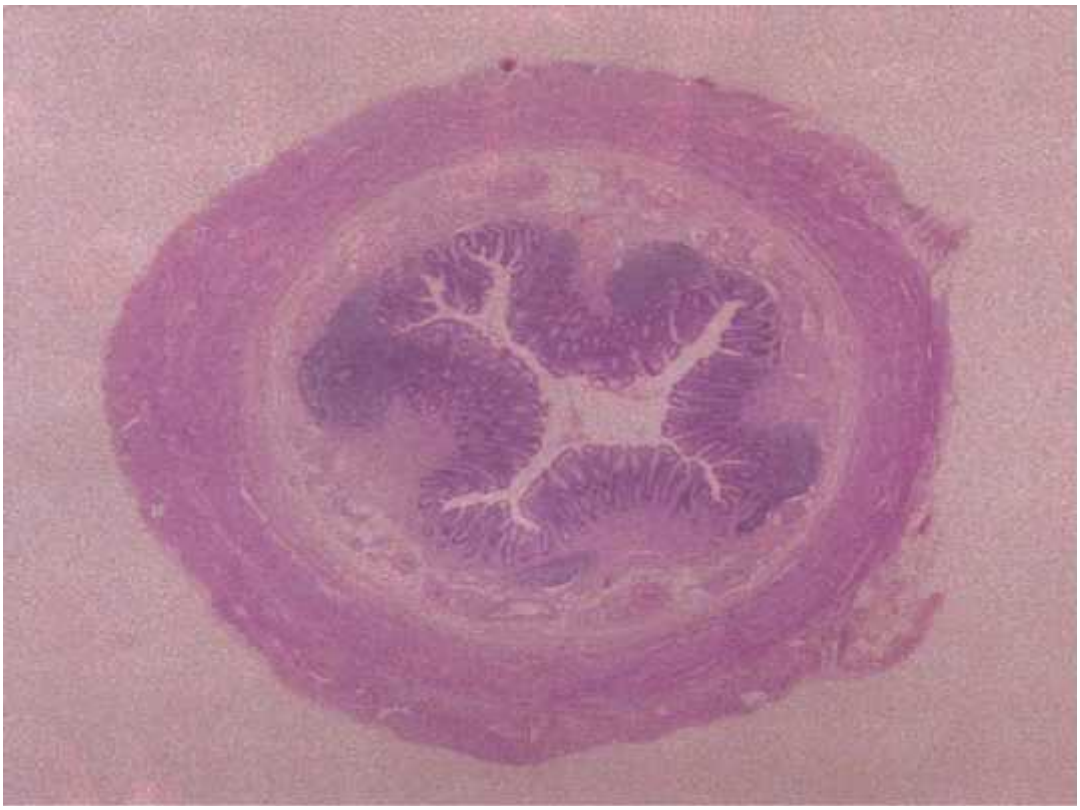


Figure 5: Normal vermiform appendix. The narrow lumen is bounded by mucosa which may be arranged in in folds. There is usually abundant lymphoid tissue in the mucosa, especially in younger individuals.This may encroach on and further narrow the lumen.The mucosa is bounded by a relatively thin muscularis mucosa.

CONGENITAL ANOMALIES[4]

1. Agenesis incidence 1 in 100000 persons
2. Duplication few cases of double appendix are reported.
3. Left sided appendix in situs inversus viscerum where there is complete transposition of thoracic and abdominal viscera. Occurs in 1 in 35000 persons.

FUNCTIONS OF HUMAN APPENDIX[32-35]

1. Embryological
2. Physiological
3. Microbiological
4. Biochemical
5. Immunological

1. Embryological

During the 5th fetal week , the appendix which develops from a bud at the junction of small and the large bowel and undergoes rapid growth into a pouch. In the 6th week there is transient nubbin surmounting the pouch indicating of being involved in the rapid development of the pouch . It is only after the 5th fetal month that the proximal end of this pouch starts growing differentially to give rise to the true caecum which continues to develop into infancy.

2. Physiology

The goblet cells lining the appendix and adjacent caecum and colon secrete a special type of mucus which can be regarded as an antibacterial paint controlling the organisms which develops in the bowel in the region. The mucous contains a high concentration of IgA immunoglobulin, secretory antibodies produced for mucosal surface immunity and forms the part of the bowel blood barrier.

3. Bacteriological

Through the cells within and cells over lining the lymphoid follicles and their production of secretory and humoral antibodies, the appendix would be involved in the control of bacterias growing in the caecum and colon in the neonatal life. As well it would be involved in the development of systemic tolerance to certain antigenic agent within the alimentary track whether they are derived from bacteria , food stuff or even the body's own proteolytic enzymes.

4.Biochemical

One in three hundred or so appendectomy specimen contain a carcinoid tumour composed of highly specialized type of cell rich in serotonin. The exact function of such agent in the entire bowel is still being elucidated but the fact is that majority of such tumours arises within the appendix.

5. Immunology

This the area where the appendix would seem to have its predominant function is due to its content of lymphoid follicle . Although it was thought the appendix itself would be the site for B lymphocytes induction.The appendix still have a role in this highly significant function but not alone and its lymphoid tissue is known to be involved in the antibodies production. These antibodies are of two types:

i) IgA type immunoglobulin - secretory or mucosal surface immunity.

ii) IgM and IgGimmunoglobulin -humoral or blood stream immunity.

The above type function have proven the appendix to be part of the G.A.L.T(Gut Associated Lymphatic Tissue).

ETIOLOGY[24-25]

The riddle of the appendicitis- its actual cause and its meteoric rise from an insignificant disease to the most common serious intraabdominal inflammatory

disease of western civilized races has been a matter for much speculation. So far no satisfactory explanation has been putforth. The following etiological factors are important but they are purely contributory:

AGE INCIDENCE:- Appendicitis is common in second decade

SEX:- males are affected more commonly than females

RACE AND DIET[4]:-

Appendicitis is common in the highly civilized European, American and Australian countries ,while it is rare in Asians, Africans and Polynesians.

Rendle short, showed that if individual from there later races migrate to countries where appendicitis is common they soon acquire the local susceptibility to the disease . This is contributed to diet rich in meat and scanty in cellulose.

SOCIAL STATUS

Acute appendicitis is more common between the upper and middle classes than those belonging to working class. The use of water closets instead of squatting position in defection has been said to increase incidence of appendicitis.

FAMILIAL SUSCEPTIBILITY

This can be accounted for by hereditary abnormality in position of the organ which predispose to infection. Thus the whole family may have long retrocaecal appendix with comparatively poor blood supply.

OBSTRUCTON TO THE LUMEN OF THE APPENDIX[4]

When an acutely inflammed appendix has been removed some form of obstructiontoits lumen can be demonstrated in 80% of cases. Obstructing agents are:

1) WITHIN THE LUMEN -faecolith and hyperplasia of submucosal lymphoid tissue .They are laminated, composed of inspissated faecal material, calcium, and magnesium phosphate and carbonates, Bacteria and epithelial debris. Rarely a foreign

body is incorporated in the mass. The presence of 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. Radiological demonstration of a stone is an absolute indication for surgery irrespective of signs and symptoms. Worms like round worm threadworm, pinworm and parasites can occlude the lumen and foreign body like pin, inspissated barium from previous studies also contribute.

2) IN THE WALL -Stricture due to fibrosis from earlier inflammation or neoplasm of which the carcinoid is the commonest cause.
3) Adhesions and kinking outside the wall

DISTAL OBSTRUCTION OF THE COLON

Acute appendicitis can result from an obstructing (colon) carcinoma usually of the right colon, usually in the elderly cases.

ABUSE OF PURGATIVES

Ingestion of purgatives especially castor oil by patients with 'stomach ache' and the violent peristaltic action which results, favors, and often determines, perforation of the inflamed appendix . "Purgation means Perforation" is a wise adage.

SEASONAL FACTORS

Particularly in children a possible association between respiratory tract infection and acute appendicitis exits. Involvement of lymphoid tissue in the tonsils and appendix may occur simultaneously. A blood borne infection may be present in these cases.

BACTERIAL FACTORS

While appendicitis is clearly associated with bacterial proliferation within the appendix no single organism is responsible, a mixed growth of aerobic and anaerobic organism are responsible. The most common organisms present are a mixture of E

Coli(85%) , enterococci(30%) , non hemolytic streptococci, anaerobic streptococci together with clostridium welchi (30%) and bacteroids.

VIRAL FACTORS

An acute viral infection at the time of or just before appendicitis might lead to lymphoid hyperplasia and subsequent healing might produce scarring, kinking etc. leading to acute obstruction. This it is the effect but not the direct cause.

Recently Cytomegalovirus appendicitis has been recognized in patients with HIV. Tucker and colleagues reported the 1st case which had perforated appendix with periappendicular abscess due to E coli .Intranuclear inclusions indicative of CMV infection were throughout the mucosa and submucosa of appendix. Davidson and colleagues reported 2cases.

TUBERCULOSIS OF THE APPENDIX[36]

It has been seldom reported after introduction of antitubercular drugs. Borrow and Fried men (1952) had reviewed 265 cases, but majority were diagnosed at post mortem examination of proved cases of tuberculosis. Two types have been described. Ulcerative and hyperplastic (Koster&Kosman1934) .Tuberculosis of appendix may present as mass in right iliac fossa indistinguishable from ileo-ceacal tuberculosis

OTHER RARE CAUSES

1. Appendicitis complicating regional ileitis (Crohn's disease)
2. Carcinoid tumour of the appendix
3. Primary adenocarcinoma of the appendix

These are diagnosed only by histological examination.

PATHOLOGY[29,37]

The menace of acute appendicitis lies in the frequency with which the peritoneal cavity is infected from the focus:

1. By perforation.

2. By transmigration of bacteria through the appendicular wall.

During the several hours between onset of acute appendicitis and rupture, natures walling off process is able to quarantine the inflammation in about 95% of patients and confine the spill to the periappendiceal area. The greater omentum attempts to seal off the spread of peritoneal invasion, while violent peristalsis from the ingested purgatives tend to spread it. Obviously if the inflammed appendix lies freely dangling ,the threat of peritonitis is increased and early perforation occurs and rapidly diffusing peritonitis is inevitable. An inflammatory mass consisting of matted intestine and omentum with little or no pus is formed if walling off process is completed. In some patients however a progressive suppurative process produces an expanding collection of pus contained by the walling off process- a periappendicular abscess.

Two types of appendicitis are known:

A. NON OBSTRUCTIVE ACUTE APPENDICITIS:

The inflammation mostly due to bacterial invasion usually commences in mucous 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 reaches the loose submucous tissues it progresses rapidly. The organ becomes turgid,dusky red and hemorrhages 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 by inflammation or thrombosis. This may lead to gangrene of the tip. In some cases, the swelling of the lymphoid tissue in appendix may lead to obstruction of the lumen proceeding to obstructive appendicitis.

Non-obstructive appendicitis may progress sufficiently slowly for protective barriers to form, and the resulting peritonitis is localized. In many instances the infection never progress beyond the mucous lining (i .e. catarrhal inflammation) but although the attack passes off, it is unlikely that a status quo ante is ever regained.Because the tip suffers most, after the resolution of the attack, fibrosis usually occurs there in and a shrunken tip is classical finding in recurrent appendicitis.

B. OBSTRUCTIVE ACUTE APPENDICITIS

When the appendix becomes obstructed the process of events begins with the accumulation of normal mucus secretion, proceeds to proliferation of contained bacteria and the pressure atrophy of the mucosa, which allows bacterial access to the deeper tissue planes and continues with inflammation of the walls of the appendix with the vessel thrombosis which because of end artery system leads to inevitably to gangrene and then perforation of the necrotic appendix wall. Often within 12 to 18 hours the appendix distal to the obstruction becomes gangrenous. Close examination of gangrenous appendices, directly after there removal shows conclusively that they usually belong to the obstructive group[30].

Perforation occurs most often at the site of impacted fecolith, before protective adhesions have had time to form. The escaping purulent and gaseous contents are under higher pressure and early wide spread peritonitis is liable to ensue. Subphrenic and pelvic abscesses are common later sequel, if the patient survives, the initial peritonitis. An even more lethal form of peritonitis is formed by secondary rupture of the intraabdominal abscess produced by rupture appendicitis. Ascending septic thromboplebitis of the portal venous system–pyelothrombophlebitis, is a very grave but unfortunately rare complication of gangrenous appendicitis. Septic clots from the involved mesenteric radicals embolise the liver producing multiple pyogenic abscesses. When acute inflammation subsides adhesions form an kinking of appendix leads to obstructive appendicitis. Fibrosis of the wall from previous attacks of appendicitis can contribute by narrowing the lumen and promoting fecolith impaction and rarely appendicitis accompanies ileoceacal Crohn's disease.

When the obstruction is partial and not complicated by infection "mucocele of the appendix" is formed.

Less common pathological conditions of the appendix

1 Mucocele of appendix

2 Diverticula of appendix

3 Intussusception of appendix

4 Endometriosis of appendix

5 Primary Crohn's disease of appendix

CLINICAL FEATURES AND DIAGNOSIS

AGE INCIDENCE:[25]

Rare before the age of two acute appendicitis becomes increasingly common during childhood and adolescence. The maximum incidence is between the age 20 and 30. Thereafter it gradually declines but no age is exempted. In infancy the lumen of the appendix is large in relation to intestine and its lumen opens freely into the caecum. In old age the appendix undergoes involution.

CLINICAL FEATURES[26,29,37]

NON OBSTRUCTIVE ACUTE APPENDICITIS:

There are typically 5 specific features

ABDOMINAL PAIN , WHICH SHIFTS:

Usually the first symptom is pain around the umbilicus, in the epigastrium or it may be generalized ,This is visceral pain and is therefore somewhat vague. It is due to distension of appendix . The pain is constant. After few hours the pain shifts to the point where the inflamed appendix irritates the parietal peritoneum ,which is sensitive. The pain is somatic or peritoneal, accurately localized and constant . Coughing causes local pain in acute appendicitis but not incase of a calculi in the ureter.

FEVER:

With corresponding increase in pulse rate 80-90 is usual . In severe cases temperature and pulse rate is even more.

Upset of gastric function: Protective pyloro-spasm occurs and anorexia ,nausea, infrequent vomiting, a brown furred tongue and a foul breath may manifest this. Typically the vomiting is of short duration and stops as soon the stomach is empty. In majority of instances the patient is constipated but occasionally diarrhea

occurs, especially in the very young or when the appendix lies in the post ileal or pelvic position.

LOCALIZED TENDERNESS AT THE SITE OF APPENDIX

As soon as the pain has shifted, there is localized tenderness either at McBurney point or elsewhere, as determine by the site of the appendix. These determine the operative approach.

McBurney (1889) has stated ,the seat of greater pain determined by the pressure of one finger, has been exactly between an inch and a half to 2 inches from the anterior superior iliac spine in a straight line drawn from that process to umbilicus (Shephard 1960)[38]. Now it is generally accepted as a point of junction between lateral 1/3rd and medial 2/3rd of a line drawn from umbilicus to right anterior superior iliac spine. These points suppose to correspond to the base of appendix.

Sir Z .cope(1959)[39] remarks that tenderness over the McBurney's point is not always constant. The pain he says seems to be actually located in the appendix itself and therefore depends on the position of the appendix and is obtainable when the viscus is not adhering to any surrounding part. Further the tenderness may be due to irritation of the adjacent peritoneum. Gentle percussion can also elicit this point of maximum tenderness according to Z.cope[39]over the region. It may lie in the flank also.

RIGIDITY IN THE RIGHT ILIAC FOSSA:

With the passage of time, accurate localization become more difficult as muscular rigidity becomes evident in addition to the tenderness. This is due to the irritation of parietal peritoneum.

OBSTRUCTIVE APPENDICITIS:

The sequence of clinical events occurs much more quickly. The onset is abrupt and there may be severe generalized abdominal colic from the start. Temperature may be normal, vomiting is common so that the clinical picture may mimic acute intestinal obstruction. Once recognized urgent surgical intervention is required because it rapidly progresses to perforation. In both types attack can commence at any time, but frequently it does so in the early hours of the morning ,awakening the patient from the sleep. Pain, anorexia ,nausea, vomiting and fever as classical syndrome is not complete in some cases and in certain cases the only relevant features is pain or tenderness in the right iliac fossa.

SPECIAL FEATURES

1. Cutaneous hyperaesthesia:

Presence of hyperaesthesia in Sherren's triangle (this is formed by lines joining the umbilicus, right anterior superior iliac spine and pubic symphysis)is a good sign in the diagnosis of gangrenous appendicitis . This is elicited by simply scratching the abdominal wall with the finger.

2. Rebound tenderness:

The suspected area is palpated with each expiration. The hand is now withdrawn suddenly as a result of this abrupt removal the abdominal musculature springs back into its original position. The patients will immediately cry or at least wince with pain. This is because the inflamed parietal peritoneum due to underlying inflammed organ also springs back along with abdominal musculature

3. Rovsing’s sign:

If the left iliac fossa is pressed pain is appreciated on the right iliac fossa in case of acute appendicitis. This is due to shifting of the coils or ileum to the right and pressing on the inflamed appendix

4. Signs on auscultation:

Activity of intestine may continue normally even in quite advance case of acute inflammation, eventually paralytic ileus supervenes and it is indicative of generalized peritonitis. Sometimes due to obstruction at the terminal ileum, exaggerated bowel sounds may be heard which confuses the surgeon to arrive at definitive diagnosis. Finally there is silent abdomen with long history of pain severe toxemia and abdominal distention.

STANDARD TECHNIQUESOF APPENDECTOMY[40]

A. ELECTIVE APPENDECTOMY:-

Removal of appendix will be described first , since it is usually a simple procedure and a relatively standardized technique employed.

INCISIONS:-

1. GRIDIRON INCISION:-

This muscle splinting muscle incision is commonly used for appendectomy the main advantage of this incision is that it does not damage any nerve & being muscle splinting it heals quickly. Inadvertently the sub costal nerve may be injured giving rise to inguinal hernias but this is very rare.

The incision an oblique one perpendicular to the right spino-umbilical line (which extends from the right anterior superior iliac spine to the umbilicus) through the Mc Burney's point that is junction between lateral 3^{rd}& medical $2/3^{rd}$ of 3 to 4 inches in length, whose $1/3^{rd}$ will be above the spinoumbilical line and $2/3^{rd}$below the same line.

Technique :-

The caecum may present as soon as the peritoneum has been opened ,or it may be have to be sought for by two fingers introduced into the peritoneal cavity and passed backwards round the lateral wall. It is easily distinguishable from small bowel by the presence of taenia coli. The caecum is grasped in a moist pack by the left hand and is gently withdrawn towards its lower end, when the appendix should follow it in the wound. Delivery of appendix is assisted if necessary by right index finger, which is introduced deeply into the lower part of the wound below the caecum. If the appendix cannot be readily found the operator should trace one of the taenia coli of the caecum leading to its base. The appendix is then freed by a finger passed along it

towards its tip, any firm adhesions being gently disrupted. If dense adhesions are present then these should be separated or divided under vision. Sometimes as a result of previous inflammation the appendix is sharply kinked and is bound down by adventitious bands to the right iliac fossa or to the brim of the pelvis. Such bands can be divided with safety and without risk of causing haemorrhage if the plane of dissection is on the lateral side of appendix.

The part of the caecum to which the appendix is attached is retained outside the wound, while the remainder is returned to the peritoneal cavity. The appendix is raised up and is held by a pair of Babcock's forceps applied near its tip. The mesoappendix is clamped with one or more pairs of artery forceps and is divided and ligatured. A forceps is momentarily applied to the base of the appendix exactly at the point of its junction with the caecum and a ligature is tied around the crushed area. It assists in the subsequent control of the stump if the ends of these ligature is kept long are retained in forceps. A purse string Lambert suture is inserted in the caecal wall around the base of the appendix. Forceps are then applied to the appendix 5 or 6mm distal to the ligature, the intervening lumen having been emptied by the pressure of the blades. A swab is placed underneath to absorb any escaping contents and the appendix is divided close to the forceps, the stump is invaginated with the slender forceps while the purse string suture is tightened. The appendix together with the knife, swab and forceps which have been contaminated by contact with the mucosa and placed in a bowl are removed from the field of operation.

Before the abdomen is closed, the ligated mesoappendix is reexamined for bleeding. The parts within reach are inspected or palpated particular attention being paid to the distal coils of the ileum for Meckel's Diverticulum and the ileocaecal lymph nodes. In the females the uterus, right ovary and tubes are palpated by two

fingers passed towards into the pelvis, the operation is completed by suture of the wounds in layers.

RETROGRADE REMOVAL OF APPENDIX:-

Frequently the base of the appendix is more accessible then the tip. This is the especially likely to occur when the appendix occupies the retrocaecal position when its inflamed distal end may be adherent to the posterior wall of the caecum or may even be buried within the serosa. In such cases the retrograde method of removal may often simplify the operation. Two pairs of artery forceps are insinuated through the mesoaappendix are applied to the base of the appendix 5-6 mm apart. The proximal forceps is removed and the appendix is ligatured in the groove that has been crushed. It is then divided close to the distal forceps and the proximal stumps is invaginated. The appendix with its cut end still occluded by the forceps is now freed by careful dissection and by successive clamping and clipping of its mesentery from base to tip it is removed.

2. LANZ'S TRANSVERSE INCISION:-

This incision is made at level of 2-3cm below the umbilicus and is centered on the mid-clavicular to midinguinal line. The structures incised in the direction of the skin incision. This incision lies in the direction of skin Langer's lines and is a better cosmetic incision the only disadvantage is rectal sheath is opened at the mid end of the wound.

3. PARAMEDIAN INCISION:-

Its chief advantage lies in the strong scar which results. The incision is made parallel to the mid line a distance of 2-3cm from it. The anterior rectus sheath is divided in line with the incision. Forceps are placed on the medial cut margins, which are retracted to expose the medial edge of the rectus muscle. The rectus is then

displaced laterally to expose the posterior sheath. The posterior sheath is incised together with the transversalis fascia and peritoneum.

4. RUTHERFORD MORRISON'S INCISION:-

It 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 & extending obliquely upwards & laterally as necessary.

5. BATTLES'S PARA RECTAL INCISION:-

This incision is mostly made on the lower abdomen over the lateral part of the rectus muscle. The skin & subcutaneous tissue are incised along the line of the incision the anterior rectus sheaths is also divided in the same line. The rectus muscle is retracted medially to expose the posterior rectus sheath in the upper part of the incision and fascia tranversalis in the lower major part of the incision, where the posterior rectus sheath is deficient below the arcuate line. The nerves should be retracted to get into the abdomen.

But it may be so happen that sacrifice of one or two nerves may be necessary this will cause some weakness of that segment of the rectus muscle supplied by the nerve.

This incision was previously used for appendectomy and for unilateral gynecological operations. But its popularity is on the wane as neither it gives proper access to the organs concerned nor it can be extended due to the presence of intercostal nerves.

Closure is carried out in the same manner as that of the paramedian incision.

6. LATERAL TRANSVERSE COSMETIC INCISION OPEN APPENDECTOMY[25,40,41,42]

Small transverse incision 2.5 to 3 cm long in the right lower abdomen starting just on the lateral border of rectus muscle and extended laterally in the line of Mc Burney's point. The only muscle in the operation field is rectus that was retracted medially. No other muscle was cut or split. Better cosmesis and almost invisible scar is the hallmark of small incision appendectomy.

7. LAPAROSCOPIC APPENDECTOMY[43]

The most valuable aspect of laparoscopic in the management of suspected appendicitis is as a diagnostic tool particularly in women of child-bearing age.

Essential Requirement for Laparoscopic appendectomy:-

Instruments for visualization:

i) Light source

ii) Telescope

iii) Video camera system

iv) Beam splitter

v) Monitor

vi) Video recorder

vii) Video printer

viii) Instruments for exposure & manipulation

ix) Insufflator

x) Puncture instruments

xi) Grasping & dissecting instruments

xii) Occlusion & ligation instruments

xiii) Electro surgical unit. Laser equipment is unnecessary

xiv) Irrigation & suction instruments

xv) Wound closure instruments

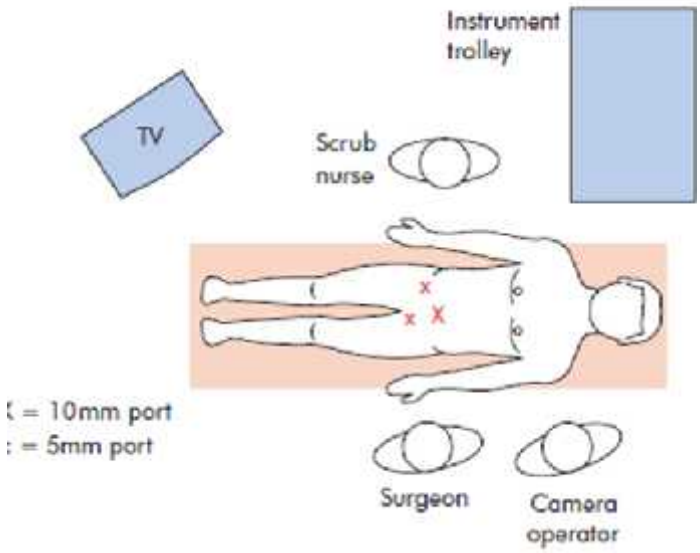


Fig 6:Position of surgeon, assistants and equipment for laparoscopic appendectomy

Preparation of the patient for laparoscopic appendectomy:-

Under the circumstances it is mandatory that the patient be totally prepared mentally and physically for the procedure. The steps of the laparoscopic procedure are explained to the patient. It is at all the times impressed that patients safety and the necessity of carrying out a complete & a through procedure may be terminated at any phase converted into a open surgery.It is made clear that open surgery if required would be done during the same anesthesia. Specific informed consent must be taken. A fully informed patients confidence acceptance & cooperation & vital for the smooth conduct of the procedure.

The preoperative evaluation of the patient is identical to that for open appendectomy. As every case is done under general anesthesia the routine evaluation of the patient for fitness for anesthesia is carried out.

The pneumoperitoneum:

The most important single step in the safe and efficient conduct of any laparoscopic procedure be it diagnostic or operative is the creation of a adequate generalized pneumoperitoneum. The pneumoperitoneum created with help of a spring loaded Veress needle. A small incision is made in the infraumbilical region. The Veress needle is held like a dart between the thumb and the index finger, with the little finger placed on the abdomen wall to act as a guard to prevent too deep or sudden penetration. The left hand elevates the abdominal wall as high as possible and with the gentle progressive pressure exerted by dorsiflexing the wrist the tip of the Veress needle is advanced through the various layers of the abdominal wall.

The fact that the needle tip is in the free peritoneal cavity has to establish carefully.

This is done by;

1. Injecting saline
2. Hanging drop test
3. Free movement of the needle tip
4. Once it is established that the needle tip is in the free peritoneal cavity, it is connected with the electronic pneumoinsufflator and carbondioxide insufflations is commenced at a flow rate of one liter per minute. These pressure readings on the insufflators , the tip of the needle and the intraabdominal cavity pressures are carefully monitored.
5. Percussions of the abdominal wall gives a resonant note & obliteration of liver dullness.

Open Technique: A small incision taken at lower margin of umbilicus and inciscion deepened till rectus sheath is reached. Once the rectus sheath is identified it is

carefully incised and incision is deepened under vision to open the peritoneum. Once the bowels are visualized a 10 mm port is inserted using blunt trocar and pneumoperitoneum is achieved by connecting CO2.Pneumoperitoneum is ascertained by obliteration of liver dullness on percussion.

Next 2 ports, either both 5mm ports or one 10 mm and other 5 mm port is introduced into the peritoneal cavity under vision using suitable incision on the abdominal wall.

Stapling techniques in laparoscopic appendectomy:-

An automatic stapling device, the multifire endo-gia30, is an instrument, which can passed through 12mm trocar sleeve, compresses the appendix as well as the resting stump, occluding its lumen with 3 lines of titanium staples and cutting between them. Using this stapler, the mean operation time is 35-95 min with no complications of mortality and morbidity.

This new stapling device offers a simple and safe method for use in laparoscopic appendectomy.

SILS[51][SINGLE INCISION LAPAROSCOPIC SURGERY]

The field of laproscopic or minimally invasive surgery has come a long way from Kelling's description of its use in a dog in 1901.Although laparoscopy was initially popularized by gynecologist, it did not gain wide spread use until the advent of the transistor chip and video camera was attached to the end of the laparoscope. As video imaging systems improved and new instruments were developed, applications of laparoscopy spread until essentially all operations performed with a larger laparotomy could be completed with minimally invasive surgery(MIS) tools.

As surgeons and industry continue to push the boundaries of MIS, new and controversial approaches such as natural orifice translumenal endoscopic

surgery(NOTES) and single-incision or single-port laparoscopic surgery are being explored with the goal of reduced surgical morbidity.

SILS aims at minimizing the number of abdominal wall incisions. The fundamental idea is to allow all of the laparoscopic instruments to enter through one skin incision. When compared with standard laparoscopy, the benefits of single-port laparoscopy seems similar to NOTES.SILS avoids the potential risk of intraperitoneal sepsis from internal organ perforation. SILS instruments are adapted from standard laparoscopic instruments.

First clinical use of a single incision laparoscopy was performed in humans as early as1969 by Wheeless who successfully performed single-puncture tubal ligation. First single-port appendectomy was done in 1992.With surgeons overcoming the learning of laparoscopy and advent of improved instrumentation, the concept of single-port laparoscopic surgery is gaining acceptance. Nowadays various procedure were done through single-incision such as cholecystectomy, colectomy, splenectomy, adrenalectomy, inguinal hernia repair, bariatric surgeries, prostatectomy,nephrectomy and pyeloplasty, hysterectomy, salphingectomy.

NOMENCLATURE

There is no consensus over nomenclature for the developing field of single-incision surgery.Some acronyms are as follows:

1. Single incision laparoscopic surgery(SILS)
2. Single site laparoscopy(SSL)
3. Single port access surgery(SPA)
4. One port umbilical surgery(OPUS)
5. Transumbilical endoscopic surgery(TUES)

6. Natural orifice transumbilical surgery(NOTUS)
7. Embryonic NOTES(E-NOTES)
8. Single laparoscopic port procedure(SLAPP)
9. Single-port laparoscopic surgery(SPLS)
10. Single port laparoscopy(SPL)
11. Single laparoscopic incision transabdominal surgery\
12. Single instrument port laparoscopic surgery(SIMPL)
13. Single-port incisionless conventional equipment-using surgery(SPICES)
14. Laparo-endoscopic single-site surgery(LESS)

DEVICES

Tools are similar to standard laparoscopic instruments. Ports are used to maintain pneumoperitoneum and a channel through which instruments inserted and exchanged.

PORTS

1.TriPort or QuadPort

Fig 7:Triport and QuadPort

It has two components: an outer multichannel valve and a fascial retractor with an inner and outer ring connected by a retractable sleeve. TriPort has two 5mm channels, one 12mm channel and two channels for insufflations and desufflation.

QuadPort has 4 legs :one 5mm,two 10mm,and one 15 mm in diameter.

2.Air Seal

Fig 8:Air seal

AirSeal ports use pressure barrier to prevent gas loss by using insufflated carbondioxide gas to create an invisible pressure barrier within the open lumen of the cannula. Since the air pressure is higher within the port, intrabdominal gas is prevented from leaking out.

Advantage :

a) improves visibility
b) increased freedom of movements.
c) permits extracorporeal knots without gas loss.

Disadvantages :not available for commercial use

3.SILS Port

- It is madeup of elastic polymer in a dumbbell shape. The port fits a 2.5cm incision and allows for three custom-made trocars of up to 12mm in size with one three way stop-cock. It conform to the shape of the abdominal wall to maintain pneumoperitoneum as well as access of multiple cannulas of different sizes.One benefit of the SILS port is the removable caps on the cannulas make small specimen retrieval easier. Larger specimen will require removal of entire device. The port is durable and can withstand significant torque .It has only one length and therefore has limited range of abdominal wall thickness that it will accommodate.

Fig 9:SILS Port

4.Uni-X port

- It consists of single multicannulaport. Port is cone shaped with a built-in port for insufflations and three 5mm cannulas for instrumentation. Fascial fixation suture are required to maintain it in position. Lack of larger cannulas limit the use of larger instruments such as staplers.

Fig 10:Uni-X Port

5.GelPoint

- Major advantage is that it provides a ‘flexible fulcrum” for manipulation of the laparoscope and instruments.

Fig 11 :Gel Point

6.SSL port

Low profile port with detachable cap and separate wound retractor. It accommodates two 5mm and one 10mm instruments and its unique 360 degree rotation allows for quick reorientation of instrumentation. It accommodates straight, bent, or curved instruments.

Fig 12:SSL Port

7.TransEnterix SPIDER

Fig 13:TransEnterix SPIDER

LAPAROSCOPES

- ✓ **Endo EYE**

  It minimises clutter and external instrument crowding. It comes in 5-mm and 10-mm sizes. The flexible tip option allows for adjustability in the positioning of the scope to improve visualisation and minimise sword-fighting effect.

Fig 14: EndoEYE

- ✓ **Flexible endoscopes**

  Flexibility afforded by the lack of rigidity also removes the ability to fine-tune the scope's postion and field of view.

INSTRUMENTATION

- ✓ **Roticulators**

  These are the instruments with articulating tip that has 80 degrees of articulation and 360 degrees of rotation of jaws.These are 5mm instruments that include graspers, dissectors, and scissors of standard length(31cm).

Fig 15:Roticulators

- ✓ **Real hand**

  This instrument offers seven degrees of freedom of movement and greater control and instrument dexterity.They are designed to mirror surgeon's hand movements.Working at an angle requires continues deflection of the wrist leading to surgeon fatigue.

- ✓ **Autonomy Laparo-Angle**

  In these instruments the distal tips have near 90 degrees of articulation and 360 degrees of axial rotation controlled by a knob.All these instruments are 5mm with varying length.

Fig 16:AutonomyLaparo Angle

✓ **S-Portal single-port access**

These instruments consists of either a rigid shaft with bends at predertermined locations or a completely malleable shaft that can take any configuration and maintain an element of rigidity once placed in a specific form.

Technical challenges

➢ **Triangulation**

It is considered one of the cardinal rules of standard laparoscopy,instrument triangulation allows for effective retraction and tissue dissection along proper anatomical plane.With single-port,this becomes much more difficult even with flexible tip and curved instruments.So crossing of instruments becomes necessary and such deviations from traditional laparoscopy have curbed surgeon's enthusiasm for adopting this new approach.

➢ **Retraction and exposure**

Effective traction and counter traction is reduced by the lack of triangulation.Certain laparoscopic procedures require two or more retractors,requiring modification oftechnique.This can be in the form of intrabdominal suture used as a sling,percutaneous suture affixed to an intra-abdominal object.

- **Inline vision**

  In laparoscopy,depth perception is removed by reduction of two convergent optical fields into one,and is compensated by the coupling of action and perception of depth.This not only requires mental rewiring and altered hand-eye coordination,uninhibited movements of the instruments are also essential.Flexible laparoscopes have been used to combat this problem.

- **Instrument crowding**

  Inserting four instruments through the same incision creates interference of instruments with one another.This difficulty can be overcome by either using instruments of different length,or alternate standard and flexible instruments or by intracorporeal crossing of instruments.

- **Ergonomics**

  With standard laparoscopy,part of the port site selection is determined by location that will allow comfortable hand position during the case.This flexibility is taken away in Single-port laparoscopy.Technical adjustments to avoid instrument crowding and lack of triangulation sometimes require the surgeon and the assistant to maintain uncomfortable position throughout the procedure.These factors affect the durability of the surgeon in performing the procedure, and may ultimately affect the safety of the approach.

- **Patient related limitations**

  The site of entry in single-port laparoscopic surgery is through umbilicus. Patients with previous incision at the umbilicus, tall or obese patients with surgical site distant from umbilicus will have technical difficulty in the procedure.

- **Instrumentation**

  Development of instrumentation is in its infant stage.Newer technology is also required to minimise external maneuveringnecessary for internal movements.Flexible instruments tend to dissipate retraction or dissection at the tip,hence reducing their effectiveness.

- **Cost and safety**

  With the development of new technology ,there comes the expected increase in price associated with purchase of new instruments and training.As instruments become more sophisticated,they become more expensive.Also safety of this approach must be studied as the safety of patient is of paramount importance.

MANAGEMENT OF APPENDIX MASS[26]

If an appendix mass is present and the condition of the patient is satisfactory, the standard treatment is conservative Ochsner- Sherren regimen. This strategy is based of the premises that the inflammatory process is already localized & that inadvertent surgery is difficult and may be dangerous. It may be impossible to find the appendix & occasionally, a fecal fistula may form for these reasons it is wise to observe a non operativeprogramme but to be prepared to operate , should clinical deterioration occurs i.e. rising temperature,pulse rate ,increasing or spreading abdominal pain or increase in the size of the mass.

Careful record of the patient's condition and the extent of the mass should be made and the abdomen regularly reexamined. It is helpful to mark the limits of the mass on the abdominal wall using the skin pencil. A contrast enhanced CT examination of the abdomen should be performed and antibiotic therapy instigated. An abscess if present should be drained under radiological control i.e. either USG or CT guided. Temperature & pulse rate should be recorded. 4^{th} hourly and a fluid

balance record maintained. Clinical deterioration and evidence of peritonitis &is indication for early laparotomy. Clinical improvement is usually evident within 24-48hrs. Failure of the mass to resolve should rise suspicion of carcinoma or Crohn's disease. Using this regimenapproximately 90% of the cases resolve without incident. It is advisable to remove the appendix after an interval 6-8 weeks.

POST OPERATIVE COMPLICATIONS [44]

Post-operative complication following appendectomy are relatively uncommon & reflects the degree of peritonitis that was present at the time of operation &intercurrent diseases that may predispose to complications.

i) Wound infection
ii) Intra abdominal abscess
iii) Paralytic ileus
iv) Respiratory complications
v) Venous thrombosis & embolism
vi) Portal pyaemia
vii) Faecal fistula
viii) Adhesive intestinal obstruction
ix) Right inguinal hernia

PROGNOSIS

Early diagnosis and the general recognition of the necessity of early operation ,improved anaesthesia, improved surgical techniques, improved management of general peritonitis and newer antibiotics, all have added toward better prognosis in these days. Mortality is negligible in cases which are operated within 48 hrs after appearing of symptoms. Peltokallio and Tykka[45](1981) reported 0.12% in non perforated& 0.18% in perforated group.

The morbidity & mortality rate for masses is the lowest if treated conservatively but high if early operation is done (Mcpherson & Kinmonth)[46].

MATERIAL AND METHODS

7.1 STUDY TYPE AND DESIGN

Study Type: Interventional

Study Design: Allocation: Randomized

Endpoint Classification: Safety/Efficacy Study

Intervention Model: Parallel Assignment

Primary Purpose: Treatment

SOURCE OF DATA

All cases of clinically diagnosed acute/chronic/recurrent appendicitis in B.L.D.E.U.'s Shri B M Patil Medical college Hospital and Research Centre, Bijapur, from October 2011 to May 2013 .

Method of collection of data

- Patients who gave consent for laparoscopic appendectomy are randomly allocated either of two groups[group A-patients undergoing single port laparoscopic appendectomy(SPLA), group B-patients undergoing conventional three port laparoscopic appendectomy(CTPLA).]
- Patients were given numbers according to the order of admission to the hospital, all odd numbered patients were grouped as group A and all even numbered patients were allotted group-B.
- Informed written consent was taken before surgery explaining them about the advantages and possible complications of both the procedures.
- Patients allocated to group 1 Underwent single port laparoscopic appendectomy.

Principle: Single port through the transumbilical incision was made, glove-port inserted and then 3 trocars were inserted. Laparoscopic instruments manipulation done through single port and resected appendix removed through it.

- Patients allocated to group 2 underwent conventional three port laparoscopic appendectomy.

Principle: According to standard protocol, 3 trocars were inserted in infraumbilical, left lower quadrant, and suprapubic area, laparoscopic instruments were manipulated through three separate ports and resected appendix was removed.

- **Intra operatively**
    - Duration of the surgery is recorded.
    - Any complications or technical difficulties leading to conversion of single port laparoscopy into conventional laparoscopic appendectomy or open appendectomy noted.
- **Postoperatively**
    a) Postoperative pain was measured among both groups [Inj.diclofenac 3cc im or inj. Tramadol 50mg was given twice a day dose and when required along with iv fluids and antibiotics. Before giving the dose of pain killers patient is asked to grade his/her pain on Visual Anolog Scale. Once Injectable analgesics stopped oral NSAIDS were given on demand with VAS score .]
    b) Time of return of bowel sounds was noted.
    c) Duration of post-surgery hospital stay was noted
    d) Complications were recorded.

- Follow-up for one month followed by a questionnaire at the end of one month was done.

ELIGIBILITY:

- Age Eligible for Study: 8 Years to 75 Years
- Genders Eligible for Study: All[Male/Female/Transgenders]

INCLUSION CRITERIA:

All patients attending the Surgical O.P.D.or admitted in Surgery ward in whom the diagnosis of appendicitis is made.

EXCLUSION CRITERIA: Age less than 8 years or more than 75 years old

- Patients opting for open appendectomy..
- Gangrenous appendicitis diagnosed intra operatively.
- Any single port surgery getting converted into open appendectomy.
- Combined generalized peritonitis.
- ASA score more than 3.
- Pregnant women.

Procedure

1 .Single-Port Laparoscopic Appendectomy(SPLA)

The single port device was prepared before making a skin incision.It comprised of surgical glove and two 5mm and one 10 mm trocars .These trocars were inserted into first, fifth and third fingers of the glove respectively and then fastened with rubber bandage to prevent leakage of gas. The open end of the glove was passed through flexible ring and turned around it in the middle of the glove to form a double layer of glove with the flexible ring within it.

Under General anaesthesia ,patient in supine position with all aseptic precautions,20mm skin incision made in patient's umbilicus and carried down to

peritoneum.The inner flexible ring ,fitted with the glove was then introduced into the abdomen assisted by retractor.The open end of the glove was then wrapped around the outer larger ring.Pneumoperitoneum was introduced by carbon dioxide insufflations.We used conventional laparoscopic 5mm working instruments and 10mm scope. Patient was tilted left laterally 30 degrees,dissection of mesoappendix and appendicular artery was carried out using monopolarelectocautery.the appendicular base is ligated using extracorporeal knots with catgut no.1 and appendix transected using curved scissors ,irrigation done with Normal saline and suctioning done.After ascertaining the complete hemostasis the specimen is retrieved under vision along with glove port.The umbilical inscision closed with vicryl 2-0 and skin with the same.

2.Conventional Three Port Laparoscopic Appendectomy(CTPLA)

Under general anaesthesia,with all aseptic precautions,10mm curved skin inscision made in umbilicus and pneumoperitoneum is achieved using Veress needle using carbondioxide.a 10mm port is inserted or incision is deepened to open peritoneum and 10mm port inserted and then pneumoperitoneum is achieved and scope inserted.Under visual guidance two 5mm ports,one in left iliac fossa and one in suprapubicregion. Patient is put in left lateral tilt 30 degrees and mesoappendix is dissected using electrocautery.The base of the appendix is ligated using catgut no.1extracorporeal knot and excised using scissors irrigation done with normal saline and suctioning done and complete hemostasis ascertained.Specimen is retrieved under vision and incisions closed with vicryl 2-0.

RESEARCH HYPOTHESIS:

- Single port laparoscopic appendectomy is a safe, highly minimal invasive procedure with excellent cosmetic(No visible scar) results with minimal pain, shorter hospital stay and early return to work and with minimum post-operative complications as compared with conventional three port laparoscopic appendectomy.

SAMPLING:

The study period is from Oct. 2011 to May 2013.

Taking into consideration the incidence of appendicitis as 1.1 per 1000 (0.11%)population,sample size calculated using the formula

$$n = [(Z_\alpha^2 \times p \times q] / E^2$$

where Z_α=1.96 p=incidence rate in (0.0011)

q=(1-p) E=allowable-error(10%)

Allowable error is taken as 10%

The sample size comes out to be n = 40, in each group. Totally 80 patients were included in the study.

- Statistical Analysis was done using statistical tools like

  1. Z-test

  2. Correlation analysis and other tests as required

  3. For effective presentation data presentation tools like tables, charts were used

RESULTS AND ANALYSIS

The results and analysis of the outcome of the study are as follows.

Table no 1: Frequency and percentage Distribution of patients according to age

Age Group	SPLA	CTPLA
16-25	21	23
25-35	14	11
35-45	3	2
45-55+	2	4
Total	40	40

Graph No 1: percentage Distribution of patients according to age

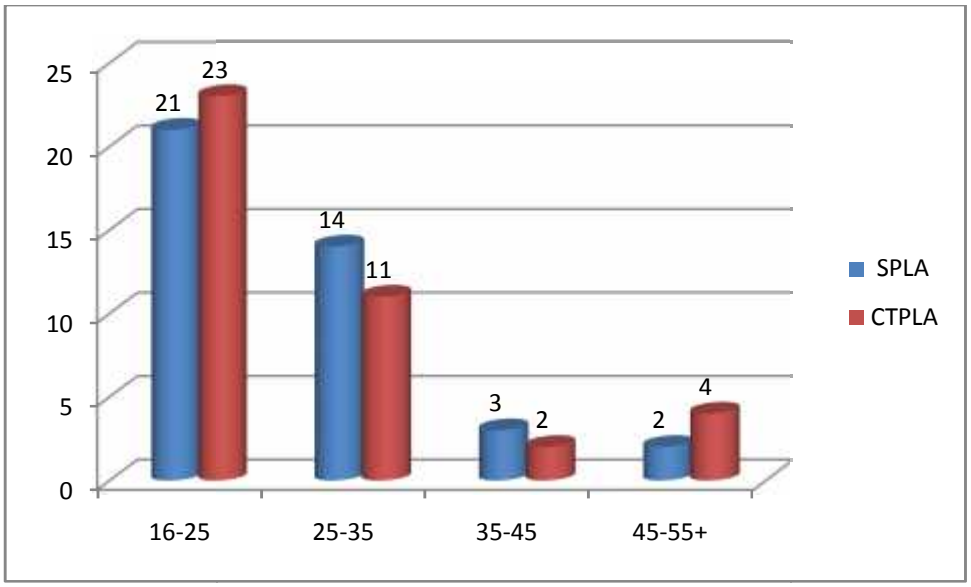


Table no 2: Distribution of patients according to sex

	SPLA		CTPLA	
Sex	Frequency	Percentage	Frequency	Percentage
Male	25	62.5	21	52.5
Female	15	37.5	19	47.5
Total	40	100.0	40	100.0

Graph No 2: Frequency and Percentage Distribution of patients according to sex

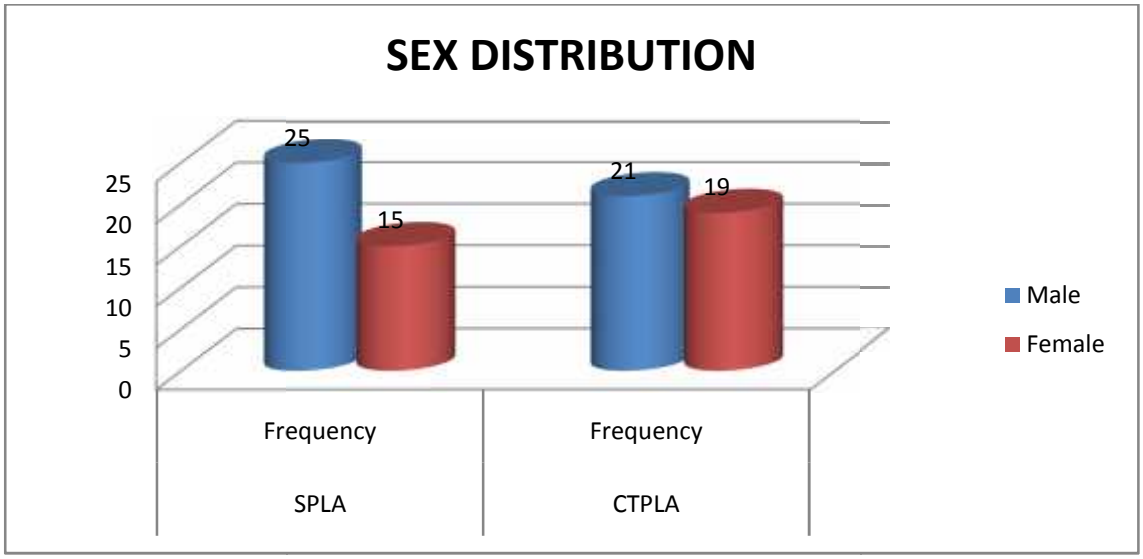


Table no 3: Distribution of patients according to Duration of surgery(in minutes)

Stat. Measures	SPLA	CTPLA	Z-Value	P-Value
mean	59.87	54.4	1.7	0.089
SD	10.21	16.64		
Max	75	90		
Min	30	30		

Graph No.3 : DURATION OF SURGERY

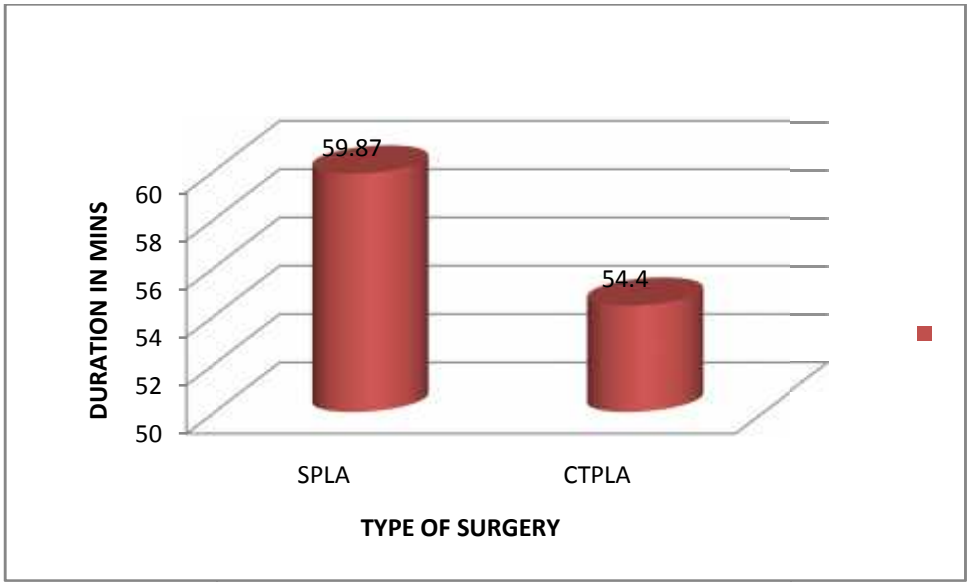
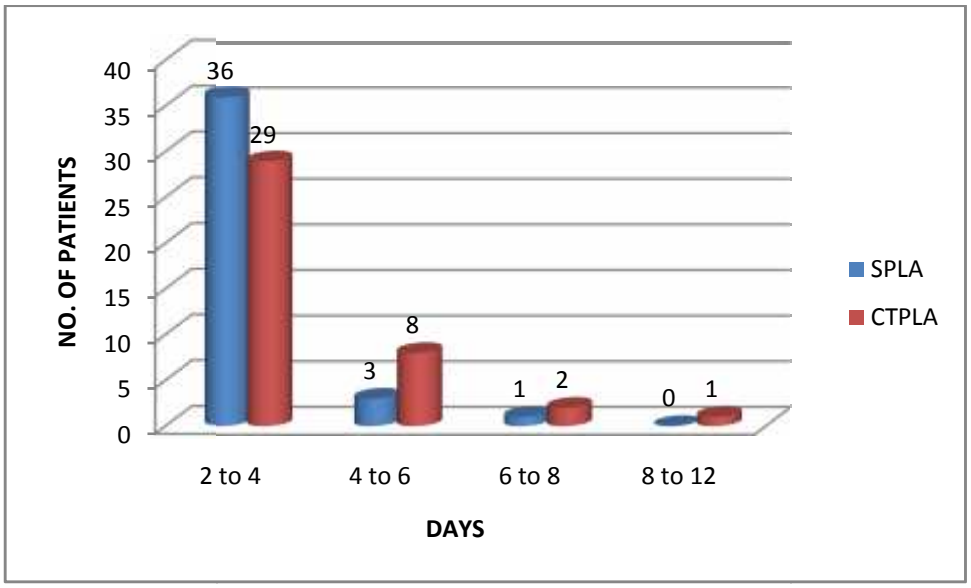


Table no 4: Distribution of patients according to Post surgery hospital stay (DOS-DOD)

	SPLA		CTPLA	
Post surgery hospital stay(in days)	Frequency	Percentage	Frequency	Percentage
2-4	36	90.0	29	72.5
4-6	3	7.5	8	20.0
6-8	1	2.5	2	5.0
8-12	0	0	1	2.5
Total	40	100.0	40	100.0

Graph No 4: Frequency and Percentage Distribution of patients according to post-surgery hospital stay (DOS-DOD)



Tableno.5 comparison of post surgery hospital stay(DOS-DOD)

Group	N	Mean	S.D	S.E	p-value
SPLA	40	3.5250	1.13199	0.17898	
CTPLA	40	4.1250	1.68230	0.26599	**0.128**

Table no 6: Frequency and percentage Distribution of patients according to Intra operative complications

	Group A(SPLA)		Group B(CTPLA)	
IOC	Frequency	Percentage	Frequency	Percentage
NO	39	97.5	38	95.0
YES	1	2.5	2	5.0
Total	40	100.0	40	100.0

Graph no 5: Frequency Distribution of patients according to Intra operative complications

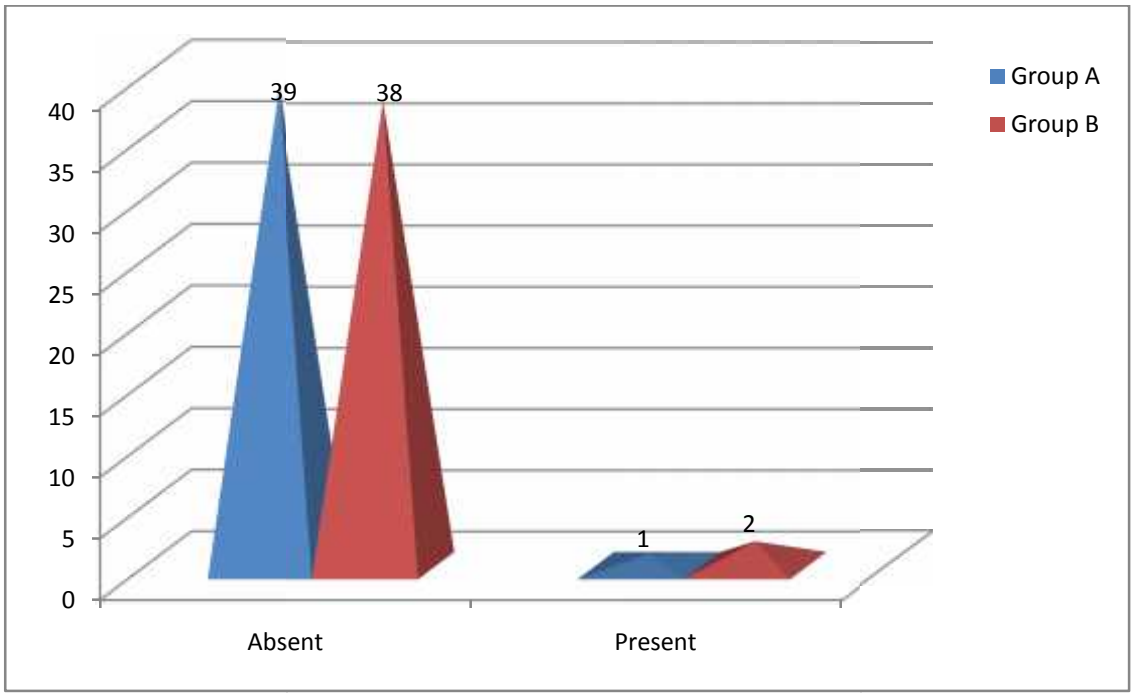


Table 7: Frequency and percentageDistribution of patients according to conversion

	Group A (SPLA)		Group B(CTPLA)	
Conversion	Frequency	Percentage	Frequency	Percentage
No	38	95	39	97.5
Yes	2	5	1	2.5
Total	40	100.0	40	100.0

Graph no 6: Frequency Distribution of patients according to conversion

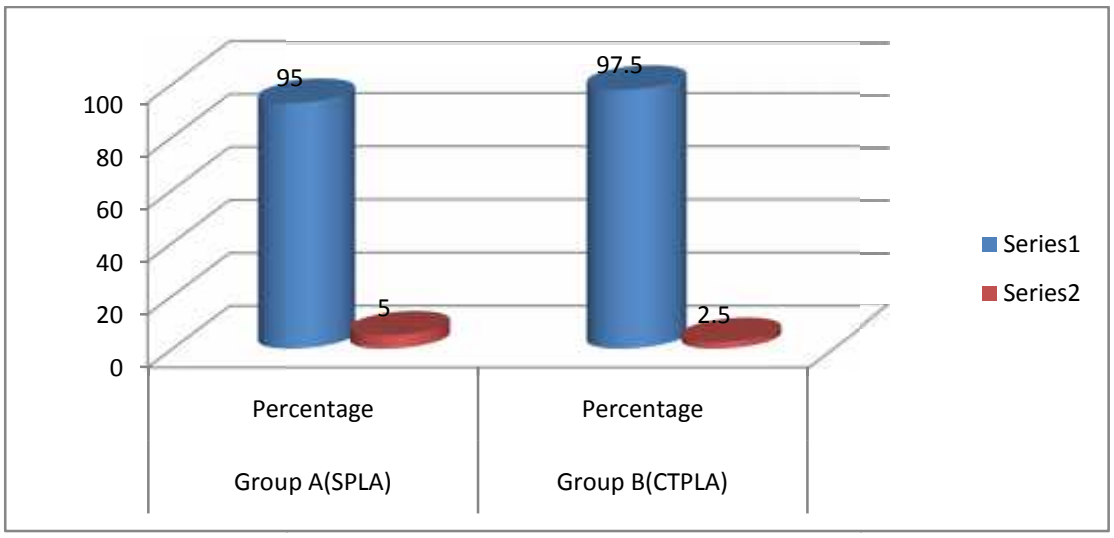


Table no 8: Frequency and percentage Distribution of patients according to No.of.days of Injectable analgesics received by patients.

	SPLA		CTPLA		Z-Value	P-Value
No. of. days	Frequency	Percentage	Frequency	Percentage		
1.00	14	35.0	9	22.5	1.24	0.215
2.00	24	60.0	26	65.0	0.46	0.645
3.00	2	5.0	5	12.5	1.19	0.234
Total	40	100.0	40	100.0		

Graph no 7: Frequency Distribution of patients according to No.of.days of injectable Analgesics received by patients.

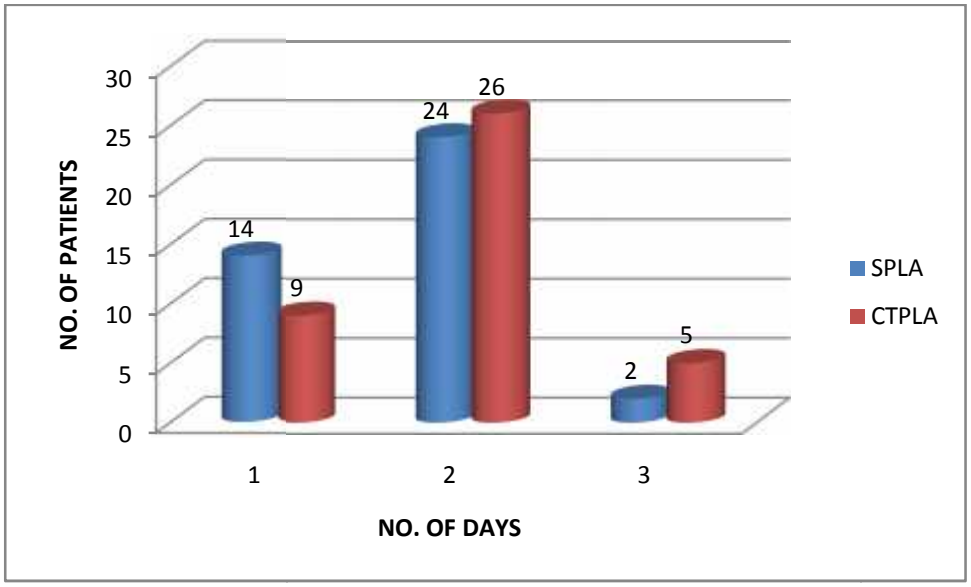
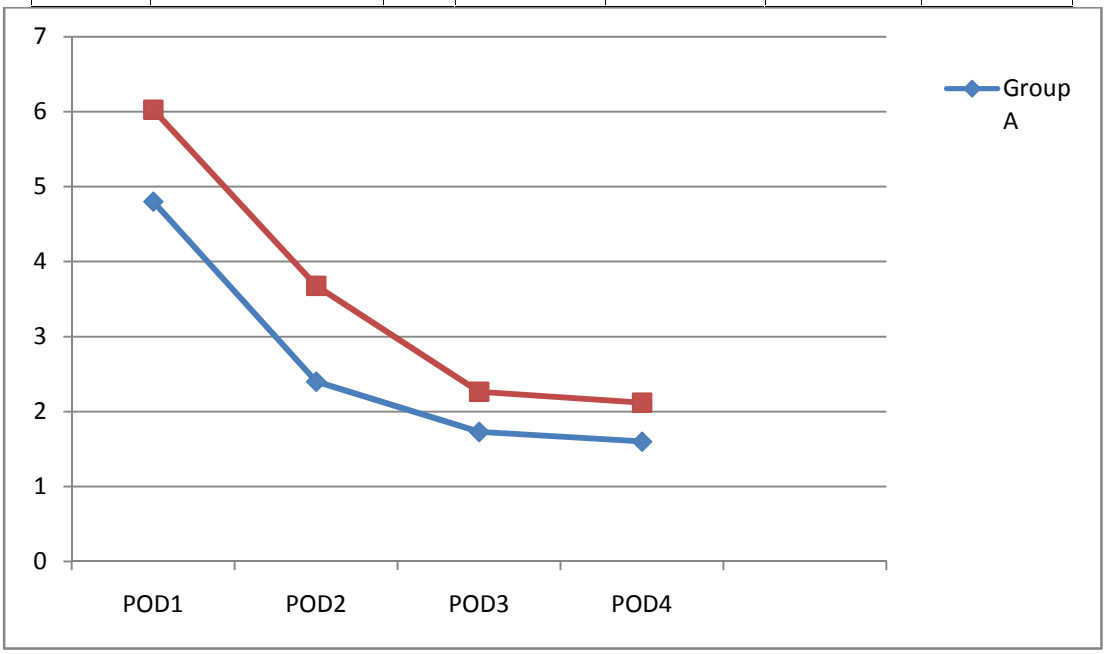


Table no 9: Comparison of pain scale on different days (VAS)

	Group	N	Mean	S.D	S.E	P-Value
POD1	GroupA(SPLA)	40	4.8000	1.24447	0.19677	0.025*
	Group B(CTPLA)	40	6.0250	1.18727	0.18772	
POD2	GroupA(SPLA)	40	2.4000	1.25678	0.19871	0.031*
	Group B(CTPLA)	40	3.6750	1.50874	0.23855	
POD3	GroupA(SPLA)	37	1.7297	0.99019	0.16279	0.421
	Group B(CTPLA)	38	2.2632	1.22329	0.19844	
POD4	GroupA(SPLA)	5	1.6000	0.54772	0.24495	0.211
	Group B(CTPLA)	17	2.1176	1.36393	0.33080	



Graph no.8:Showing difference in pain scale

Table no 10: Frequency and percentage Distribution of patients according to oral Feeds Started.

	GroupA(SPLA)		Group B(CTPLA)	
Feed started on POD	Frequency	Percentage	Frequency	Percentage
1.00	19	47.5	12	30.0
2.00	21	52.5	22	55.0
3.00	0	0	5	12.5
5.00	0	0	1	2.5
Total	40	100.0	40	100.0

Graph no9: Frequency and percentage Distribution of patients according to Feeds Started.

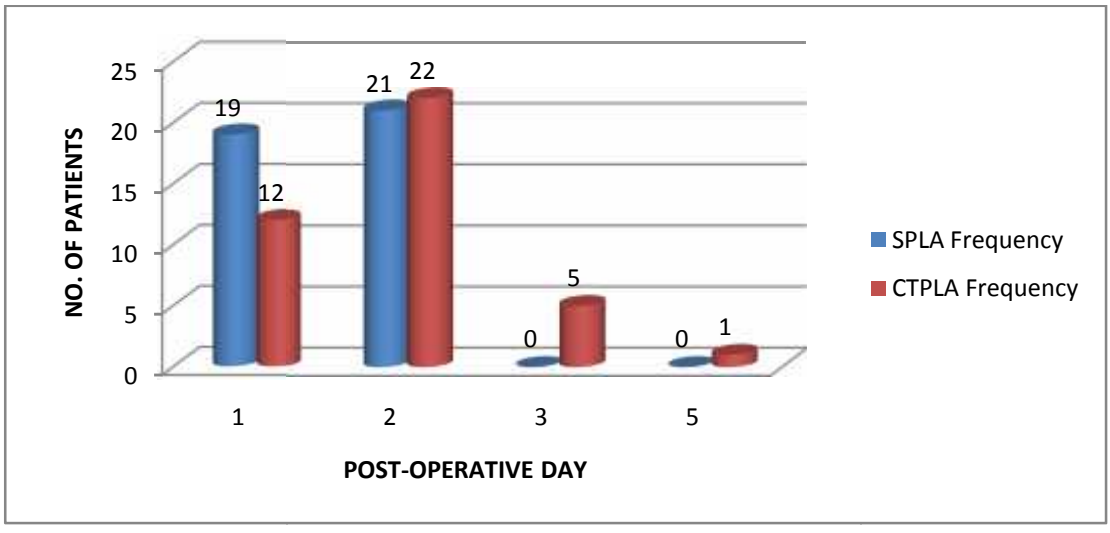


Table no 11: Frequency and percentage Distribution of patients according to surgical site infection.

	GroupA(SPLA)		Group B(CTPLA)	
Surgical site infection	Frequency	Percentage	Frequency	Percentage
Absent	40	100	39	97.5
Present	0	0	1	2.5
Total	40	100	40	100.0

Graph No.10:Distribution of patients according to surgical site infections.

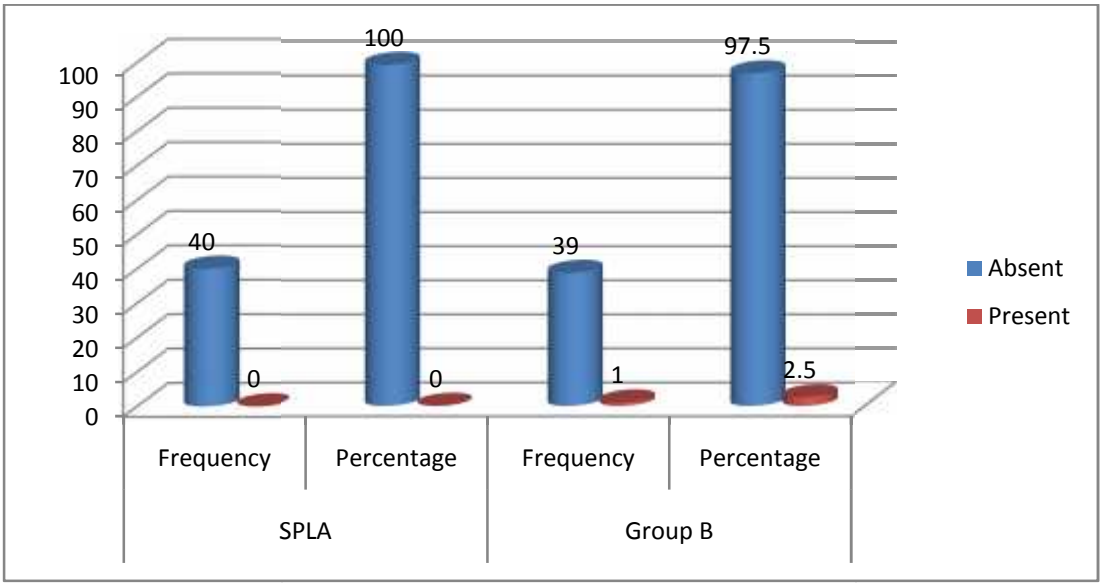


Table no 12: Frequency and percentage Distribution of patients according to resuming work.

	GroupA(SPLA)		Group B(CTPLA)	
Resume at work	Frequency	Percentage	Frequency	Percentage
2-7	36	90.0	26	65.0
7-12	4	10.0	10	25.0
12-17	0	0	4	10.0
Total	40	100.0	40	100.0

Graph no 11: Frequency and percentage Distribution of patients according to resume at work

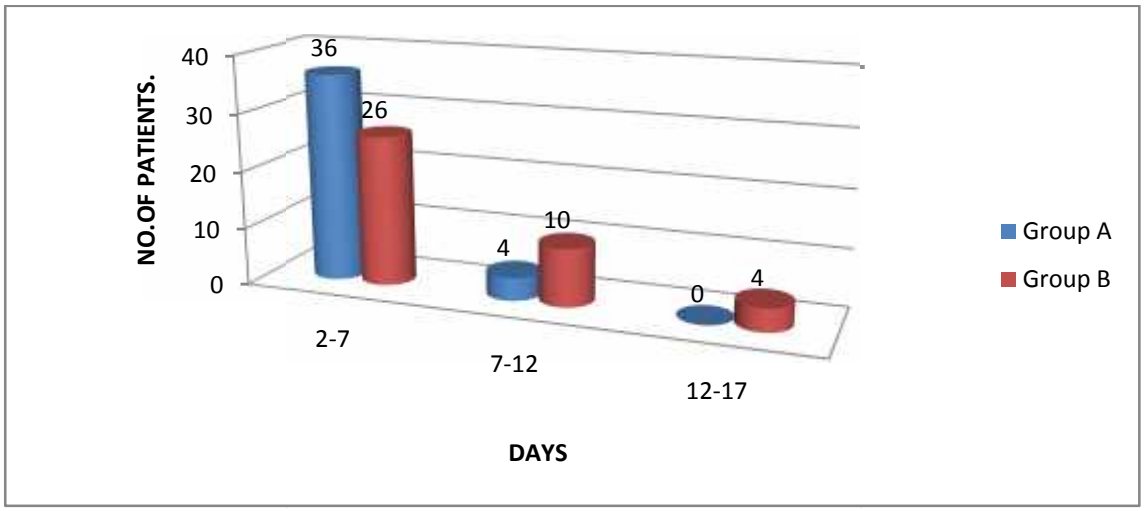


Table no.13:Comparison of days of resuming to work after surgery.

Group	**N**	**Mean**	**S.D**	**S.E**	**p-value**
GroupA(SPLA)	40	5.2500	1.42775	0.22575	< **0.0001***
Group B(CTPLA)	40	7.0750	3.58335	0.56658	

Table 14:Distribution of patients according to satisfaction rate

Satisfaction rate	SPLA	CTPLA	Z-Value	P-Value
0	38(95%)	28(70%)	3.11	0.0001
1	2(5%)	12(30%)	3.11	0.0001
Total	40	40		

0-Fully satisfied

1-Partially satisfied

2-can’t say

3-partially unsatisfied

4-fully unsatisfied

DISCUSSION

McBurney described open appendectomy in 1894, Since then, Semm introduced laparoscopic appendectomy for the first time in 1983; compared to open appendectomy, laparoscopic appendectomy has less postoperative pain and lesser doses of analgesics. It also has not only less tissue injury but also less irritation of the intestines so that the results in reduction of adhesion may occur after the sugery. It enables early ambulation and food intake and a short hospitalization period. Thus, patients can return early to normal lives and also have less cosmetic problems after surgery. For these reasons, laparoscopic surgery is now widely performed.

Over the last few years, the concept of Single-port Laparoscopic Surgery evolved tremendously in an attempt to reduce the number of incisions, to reduce post-operative pain and to provide cosmetically better scar(virtually no scar),and to reduce the risks of surgical site infection. It has further minimized the MIS(Minimally Invasive surgery).Here surgery is done through a single inscision intraumbilically.Single-port laparoscopic surgery can be performed using one of the many commercially available multichannel single-port device such as R-Port, Uni-X ,SILS port and many more using conventional laparoscopy instruments or advanced single-port surgical instruments. The main advantage of this technique being single small incision compared to three separate incisions for three ports in conventional laparoscopic appendectomy and virtually a scarless surgery.

In a country like India the commercially available ports are out of reach of common man, hence transumbilical glove port was tried to reduce the cost of surgery. It consists of a glove ,two rubber rings and conventional laparoscopic trocars. It has many advantages as it is very cheap, more cost-effective, a variety of instruments may be used to facilitate the procedure, it acts as a wound protector and avoids port-site

contamination or metastasis while retrieving infected or malignant specimen.This technique will definitely help the surgeons to take Single-port Laparoscopic surgery to the masses.

A total of 80 patients were included in the study and were divided into two .40 in each group.

Group A - Single Port Laparoscopic Appendectomy

Group B –Conventional Three Port Laparoscopic Appendectomy

- Age

In our study ,about 87.5%(35) patients in SPLA group were between 16-35 years of age and 85%(34) of CTLA group patients were between 16-35 years.Hence there was no significant age difference between both the groups.

Sex distribution

- ✓ In our study M:F in SPLA 25:15and CTPLA 21:19.
- ✓ Park et al.[50] shows M:F ratio was 14:28 in SPLA and 42:21 in CLA .
- ✓ Junhyun Lee et al shows M:F ratio 19:21 for SPLA and 11:21 for CLA.

  But Our study shows that in both the groups male patients were more than female patients as the incidence of appendicitis is more in males than in females. Also the young male preferred SPLA over CTPLA.

- Duration of surgery

  In our study duration of surgery was 59.87±10.21 min for Group A(SPLA) and 54.4 ±16.64 min for Group B (CTPLA) with P-value 0.089 shows that there is not significant difference between the time taken for both procedures. Our result is comparable to Jun Ho Park etal[49], in which duration of studying for SPLA was 63.5 min and CLA was 54.0 with no significant difference between the duration for both procedures. Initial few cases of SPLA took

longer time but gradually the duration reduced short learning curve for experienced Laparoscopic surgeon.

- Duration Post surgery hospital stay (days)

  In our study , in Group SPLA 36(90%) patients stayed for 2 to 4 days post surgery,3 (7.5%) for 4 to 6 days,1 (2.5%) for 6 to 8 days with mean stay of 3.5 days, where as in CTPLA group 29(72.5%) patients stayed for 2 to 4 days, 8(20%) patients stayed for 4 to 6 days ,2(5%) stayed for 6 to 8 days and 1 patient stayed for more than 8 days with mean post-surgery stay of the patient being 4.12 days.The difference between the mean post-surgery hospital stay among both groups was not statistically significant (P-Value 0.128). Our observation was in comparison to post op. hospital stay (days) Jun Ho Park etal[49] with CLA 3.9 and SPLA 3.6(P-value 0.441.)So it can be concluded that SPLA doesn't influence the duration of post op hospital study.

- Intra operative complications

  In our study, SPLA had 1(2.5%)patient had intraoperative complication in the form of appendicular tear and CTPLA had 2 (5%)patients had complications in the form of uncontrolled bleeding of appendicular vessels.

- In our study,conversion rate for SPLA group patients was 5%(2) whereas in CTPLA group it was 2.5%(1) due to complications and technical difficulties faced intraoperatively. In the study conducted by Jongkyung Park et al.[50] there were no conversions from single port surgery to either three port surgery or open appendectomy

- Number of days of Parenteral analgesics received

  In our study,SPLA group 14(35%) patients required parenteral analgesics only for one day,24(60%) patients received parenteral analgesics for 2 days post-surgery and only 2(5%) patients received continuously for 3 days. Whereas in CTPLA group only 9(22.5%) patients required parenteral analgesics for 1 day,26(65%) patients needed parenteral analgesics on 2nd day also and 5 patients required on 3rdday.Oncomparision there were no statistically significant difference between two groups.

  Our results are comparable to the results of Junhyun Lee et al[51].,in SPLA 0.86+/-1.3 and in CTLA 0.97+/-1.47.

- Pain scale(VAS)

  In our study the post operation pain was measured on visual Analogue scale. The mean score for SPLA on POD1 and POD2 was 4.8 ±1.2 and 2.4±1.2 and CLA on POD1 and POD2 was 6.0 $\pm$ 1.1 and 3.6 $\pm$ 1.5 with significant p-value of 0.025(POD-1) and 0.031(POD-2) suggesting that patient who underwent SPLA experienced lesser pain during POD-1 and POD-2 in comparison with CLA. But on POD-3 and POD-4 patient in both group experienced similar amount of pain irrespective of procedure they underwent, P-value 0.421 (POD-3) and 0.211 (POD-4). Park et al. shows VAS 2.92 $\pm$ 0.7 for CLA and 3.05 $\pm$ 0.9 SPLA group. P-value 0.312 which was statistically insignificant.

- Start of oral feeding

  In our study, all patients 100% (40)in group SPLA started on oral feeds within POD2,whereas in CTPLA group 12 (30%) started oral feed on POD1 22(55%)on POD2 and 5(12.5%) on POD3.Our results are comparable to the results of Park et al. in which oral feedings were started on 1.2+/- 0.6 days in

SPLA group and 1.6+/-0.9 days in CTLA group with no significant difference between the results.

- In our study ,there were no post-operative complication in the form of surgical site infections in SPLA group, but 1 patient had surgical site infection in CTPLA group. Our study result is comparable to results of the study of Jongkyung Park et al.[50]
- Resuming routine work.

  In our study,90%(36)of patients in SPLA group resumed their daily work within 7 days of discharge ,rest 10%(4) patients resumed work between 7 to 12^{th} day ,where as 65%(26)of patients in CTPLA group resumed their work within 7 days, 25%(10) patients resumed between 7 to 12^{th} day and remaining 10%(4) between 12 to 17^{th}day.This difference in the number of days patient took after discharge to resume to their routine work was found to be statistically significant (P-Value <0.0001).This shows that patients undergoing SPLA resumed their routine work much earlier than those patients who underwent CTPLA.

- Scar Satisfaction rate

  In our study,38(95%) patients in SPLA group were fully satisfied with the procedure , 2(5%) patients were partially satisfied. Where as in CTPLA group B 28(70%) were fully satisfied 12(30%) patients were partially satisfied , remaining and this difference is statistically significant(p-value=<0.0001).This study shown that more number of patients undergoing SPLA were fully satisfied when compared to CTPLA group patients and this difference was found to be statistically significant (P-Value 0.0001).

- In our study 2 patients in SPLA group was found to have ovarian cysts intraoperatively .and 3 patients in CTPLA group.
- On follow-up ,there were no wound infection or surgical site hernia or any readmissions among the patients in both SPLA and CTPLA group.

CONCLUSION

Laparoscopic surgery is now considered as the “gold standard”for many surgeries performed by general surgeons, especially appendectomy. Laparoscopic surgery has significantly advanced the concepts of minimally invasive surgery. With increased awareness and safety of laparoscopic surgeries and advancement in technology the newer concepts to further enhance the minimal invasive nature of surgeries emerged in the form of intraumbilical single incision laparoscopic surgeries.

This study showed that SPLA reduced postoperative pain, virtually scarless i.e excellent cosmetic results ,and early resuming work as compared to CTPLA. Also the duration of surgery, duration of hospital stay ,intraoperative complication rates, need for intravenous analgesics, and postoperative complications were similar in both study groups.

This study shows that SPLA is a safe and effective technique for appendectomy and is superior to CTPLA in terms of postoperative scar, early resume to work & less postoperative pain.

SUMMARY

This study was conducted to compare the safety and efficacy of SPLA with CTPLA in patients undergoing surgery for appendicitis.

This study was conducted on 80 patients admitted in BLDEU's Shri B M Patil Medical College Hospital and Research Centre ,Bijapur from October 2011 to May 2013 who were diagnosed to have acute/chronic/recurrent appendicitis.The patients were divided into two groups of 40 each.Group A underwent Single Port Laparoscopic Appendectomy(SPLA)and Group B underwent conventional three port laparoscopic appendectomy(CTPLA).Both the group were compared for duration of surgery, duration of hospital stay, intraoperative complications ,postoperative pain ,post-operativecomplications,cosmetic results in terms of satisfaction rate.

All data were collected and analyzedstatistically. There was no age difference between both the groups.In SPLA group M:F was 25:15 whereas in CTPLA it was 21:19.Mean duration of surgery in SPLA group was 59.87+/-10.21 and for CTPLA was 54.4+/-16.64 suggesting both procedure took almost similar time and the difference was statistically insignificant.Duration of hospital stay in SPLA group was similar in both group.in SPLA group postoperative pain was less on first two days,4.8+/-1.2 and 2.4+/-0.2 and in CTPLA group 6.0+/-1.1 and 3.6+/-1.5 which was statistically significant difference.There was no difference between SPLA and CTPLA group in terms of starting oral feeds.There were no difference between both the groups in terms of parenteral analgesics received and resuming work after surgery.SPLA group were more completely satisfied in terms of surgical scar 38(95%) in comparison to 28(70%) in CTPLA group.in our study conversion rate was 5% for SPLA and 2.5% for CTPLA. No surgical site infection was reported in CTPLA group on follow-up and in SPLA none.

SPLA can be considered as an alternative to CTPLA with better cosmetic outcome, less postoperative pain ,early reume to work with no increase in complication rates.

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ANNEXURE

SAMPLE INFORMED CONSENT FORM

B.L.D.E.A.U.'s SHRI B.M. PATIL MEDICAL COLLEGE HOSPITAL AND RESEARCH CENTER, BIJAPUR – 586103, KARNATAKA

TITLE OF THE PROJECT— **Transumbilical Single Port Laparoscopic Appendectomy Versus Conventional Laparoscopic Appendectomy in Patients: A Prospective Randomized Study**

PRINCIPAL INVESTIGATOR— Dr Supreet Ballur
Dept. of General Surgery
Email:bsupreet007@hotmail.com

GUIDE: Dr.S. N. Khairatkar
Associate Professor
Department of surgery
Ph-no. (08352) 262770 **Ext.**2009

Purpose of research:-

I have been explained about the reason for doing this study and selecting me as a subject for this study. I have also been given free choice for either being included or not in the study.

This study is to evaluate the safety and efficacy and advantages of single port laparoscopic appendectomy in comparison with conventional three port laparoscopic appendectomy .

Procedure:-

I have been explained that depending upon the group allocated to me, I'll either undergo single port laparoscopic appendectomy or conventional laparoscopic appendectomy; and that before surgery I'll be subjected to certain routine blood and urine investigations and chest x-ray and USG Abdomen, and other necessary investigations if needed.

Risks and discomforts:-

I understand that I may experience some pain or discomfort while examination or during my treatment. This is mainly the result of my condition and the procedure of this study is not expected to exaggerate these feelings that are associated with the usual course of treatment. I understand that analgesic will be given to me depending on the need.

Benefits:-

I understand that my participation in the study will have no direct benefit to me other than potential benefit of the treatment.

Confidentiality:-

I understand that the medical information produced by this study will become a part of hospital records and will be subject to confidentiality. Information of sensitive personal nature will not be part of medical record, but will be stored in the investigation research file.

If the data are used for publication in the medical literature or for teaching purpose no name will be used and other identifications such as photographs will be only with special written permission. I understand that I may see the photograph before giving permission.

Request for more information:

I understand that I may ask more questions about the study at any time, Dr Supreet Ballur at the department of surgery is available to answer my questions or concerns. I understand that I will be informed of any significant new findings discovered during the course of the study, which might influence my continued participation. A copy of this consent form will be given to me to keep for careful reading.

Refusal or withdrawal of participation:

I understand that my participation is voluntary and that I may refuse to participate or may withdraw consent and discontinue participation in the study at any time without prejudice. I also understand that Dr. Supreet Ballur may terminate my participation in the study after he has explained the reasons for doing so and helped arrange for my continued care by my doctor,if this is appropriate.

Injury statement:

I understand that in the unlikely event of injury to me resulting directly from my participation in this study, if such injury were reported promptly, the appropriate treatment would be available to me. But, no further compensation would be provided by the investigator/hospital. I understand that by my agreements to participate in this study I am not waiving any of my legal rights.

I have explained to _____ the purpose of research, the procedures required and the possible risks to the best of my ability.

DATE: _____ _____

Dr . Supreet Ballur Dr.S.N.Khairatkar

(Investigator) (Guide)

Study subject consent statement:

I confirm that Dr.Supreet Ballur has explained to me the purpose of research, the study procedure, that I will undergo and the possible discomforts as well as benefits that I may experience in my own language. I have been explained all the above in detail in my own language and I understand the same . Therefore I agree to give consent to participate as a subject in this research project.

_____ _____

(Participant) Date

_____ _____

(Signature of witness) Date

SCHEME OF CASE TAKING:

1) Name: CASE NO:

2) Age: IP NO:

3) Sex: DOA:

4) Religion: DOS:

5) Occupation: DOD:

6) Residence:

7) CHIEF COMPLAINTS:

8) HISTORY OF PRESENTING ILLNESS:

9) PAST HISTORY:

- Diabetes mellitus
- Hypertension
- History of any drug intake
- Allergy to any drugs
- Renal disease
- Jaundice

10) FAMILY HISTORY:

11) GENERAL PHYSICAL EXAMINATION:

Pallor:	present/absent
Icterus:	present/absent
Clubbing:	present/absent
Generalized Lymphadenopathy:	present/absent
Build:	Poor/Moderate /Well
Nourishment:	Poor / Moderate / Well

12) VITALS

PR:

BP:

RR:

Temp:

Weight:

13) OTHER SYSTEMIC EXAMINATION:

- Per Abdomen examination
- Respiratory System
- Cardiovascular System
- Central Nervous System

14) INVESTIGATION:

BLOOD: Hb	URINE: Albumin
TC	Sugar
DC	Microscopy
ESR	
BT, CT	

BLOOD UREA, SERUM CREATININE

RBS

USG Abdomen

CT abdomen

ECG

16) FINAL DIAGNOSIS:

17)SURGICAL PROCEDURE:

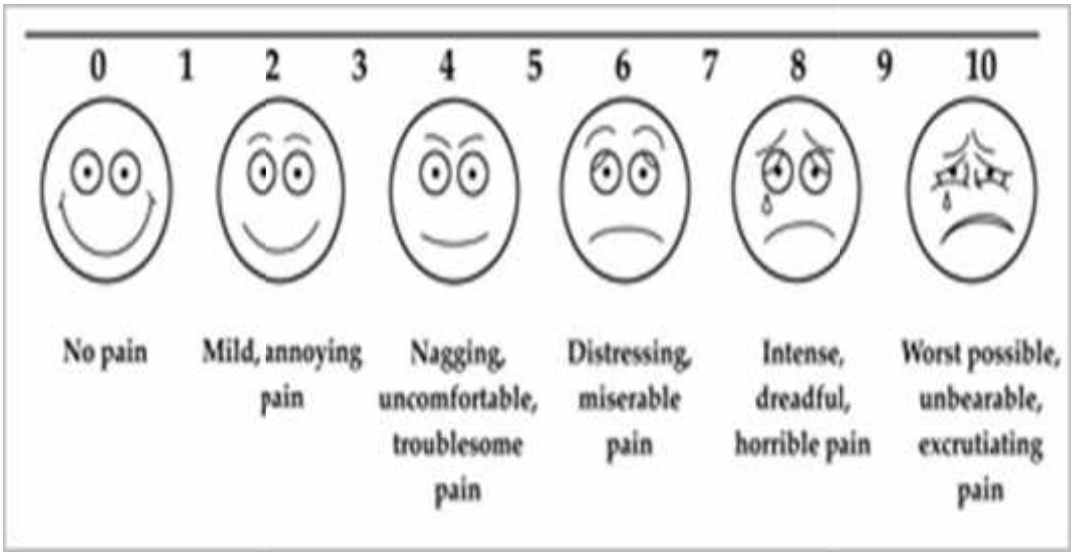
18)DURATION OF SURGERY(IN MIN.):

19)INTRAOPERATIVE COMPLICATONS IF ANY:

17) POSTOPERATIVE FOLLOW-UP:

	POD1	POD2	POD3	POD4	POD5
TEMPERATURE					
PULSE RATE					
BLOOD PRESSURE					
NAUSEA/VOMITTING					
PER ABDOMEN					
CVS					
RESPIRATORY SYSTEM					
INCISION SITE					
PAIN SCORE(VAS)					
INJECTABLE ANALGESICS					
ORAL FEEDS STARTED					

VISUAL ANALOG SCALE FOR PAIN



FOLLOW UP QUESTIONNAIRE

1.On which day from the day of surgery did you resume your daily work.?

2.Are you satisfied with the surgical procedure you underwent for the treatment for appendicitis? Please rate your satisfaction on scale from 0 to 4…[0-satisfied and 4-dissatisfied].

3.Any complications?

ETHICAL CLEARANCE

B.L.D.E.UNIVERSITY'S
SHRI.B.M.PATIL MEDICAL COLLEGE, BIJAPUR-586 103
INSTITUTIONAL ETHICAL COMMITTEE

INSTITUTIONAL ETHICAL CLEARANCE CERTIFICATE

The Ethical Committee of this college met on 20-10-2011 *at* 10-30 am *to scrutinize the Synopsis/Research projects of postgraduate/undergraduate student/Faculty members of this college from Ethical Clearance point of view. After scrutiny the following original/corrected & revised version synopsis of the Thesis/Research project has been accorded Ethical Clearance.*

Title Transumbilical Single port laparoscopic appendectomy versus conventional laparoscopic appendectomy in patients: A prospective randomized Study.

Name of P.G./U.G. student/Faculty member Dr Supreet Ballur
Dept of Surgery

Name of Guide/Co-investigator Dr. S.N. Khairatkar Asst prof Surgery

DR.M.S.BIRADAR,
CHAIRMAN
INSTITUTIONAL ETHICAL COMMITTEE
BLDEU'S, SHRI.B.M.PATIL
MEDICAL COLLEGE, BIJAPUR.
Chairman
Ethical Committee
BLDEA'S Shri. B.M. Patil
Medical College
Bijapur-586103

Following documents were placed before E.C. for Scrutinization
1) Copy of Synopsis/Research project.
2) Copy of informed consent form
3) Any other relevant documents.

25

B.L.D.E. UNIVERSITY

(Declared vide notification No. F.9-37/2007-U.3 (A) Dated. 29-2-2008 of the MHRD, Government of India under Section 3 of the UGC Act,1956)

The Constituent College

SHRI. B. M. PATIL MEDICAL COLLEGE, HOSPITAL AND RESEARCH CENTRE

SYNOPSIS REVIEW REPORT OF 2011-12 BATCH

Name of the Candidate : Suprit Bellur

Name of the Subject : Gen. Surgery.

Title of the Synopsis : Transumbilical Single port Lap. appendicectomy Vs conventional Lap appendicectomy.

OBSERVATIONS:

Remove "in patients" from the title

REMARKS:

Accepted Subject to the above mentioned corrections

Date: 6-12-11

Signature of the reviewer

Name: DR. Gadhi AS

Designation: Prof Vice Principal

College: JNMC

(Note: if required, use the overleaf space)

Smt. Bangaramma Sajjan Campus, Sholapur Road, Bijapur – 586103, Karnataka, India.

University: Phone: +918352-262770, Fax: +918352-263303 , Website: www.bldeuniversity.org, E-mail: office@bldeuniversity.org

College: Phone: +918352-262770, Fax: +918352-263019, Website: www.bldea.org, E-mail: bmpmc1@yahoo.co.in

SURGICAL PHOTOGRAPHS

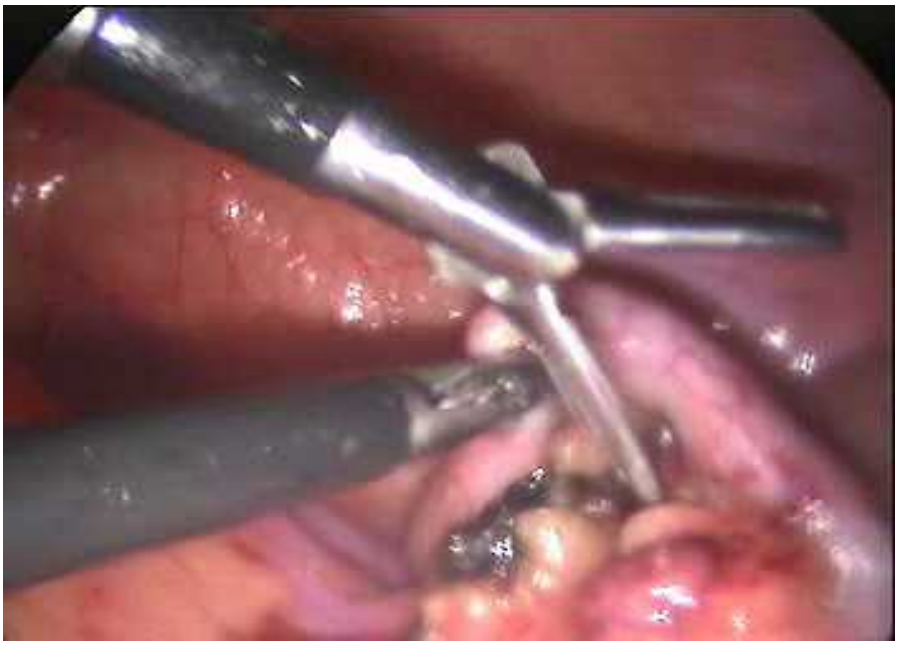
Materials for preparing glove port

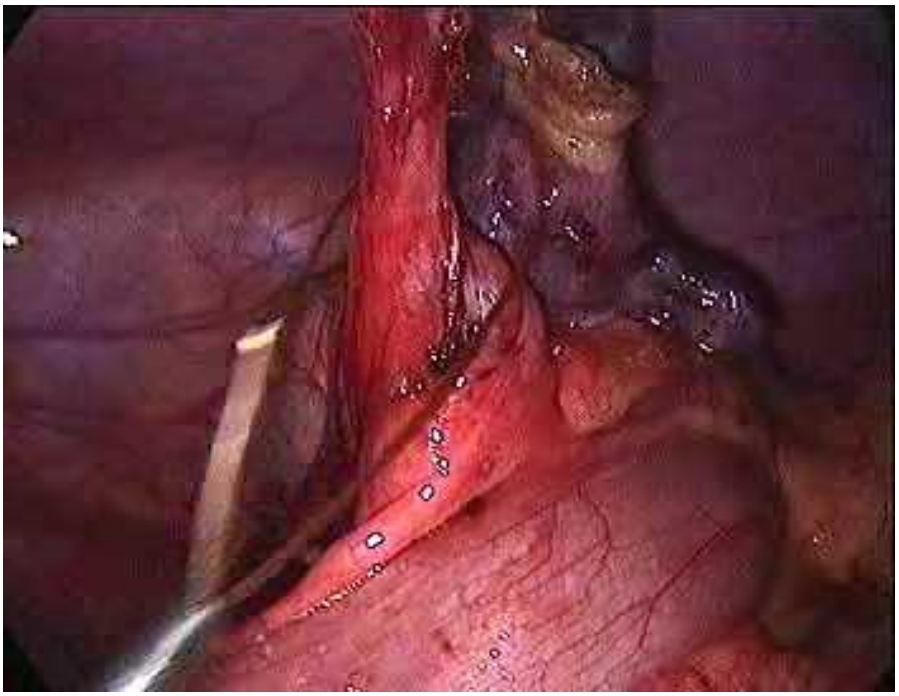
Glove port inserted through intraumbilical incision

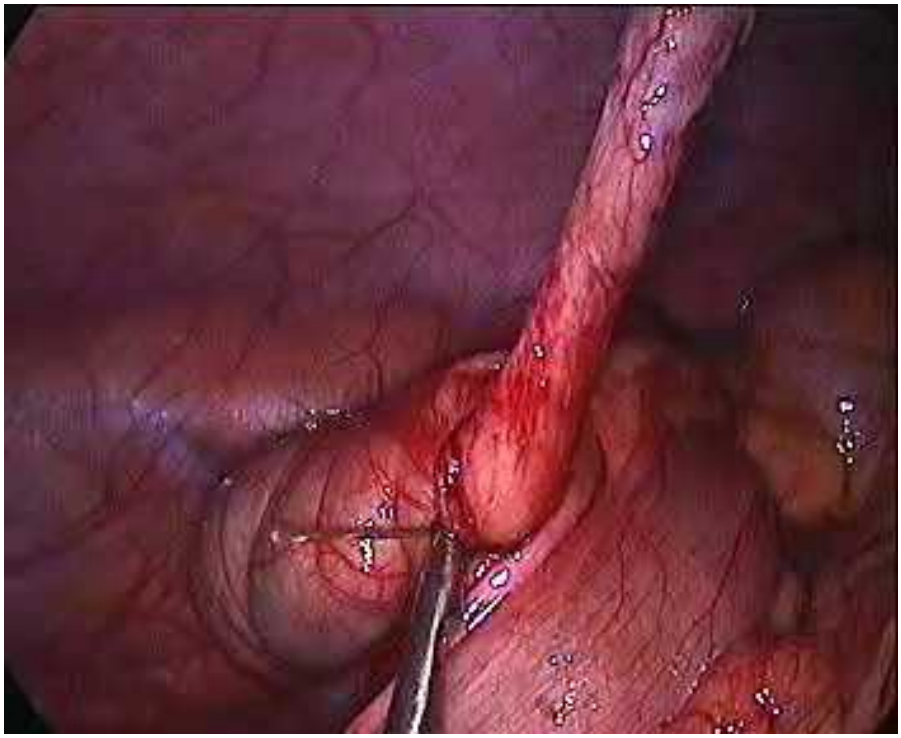
Scope being inserted through glove-port

Intra-operative pictures

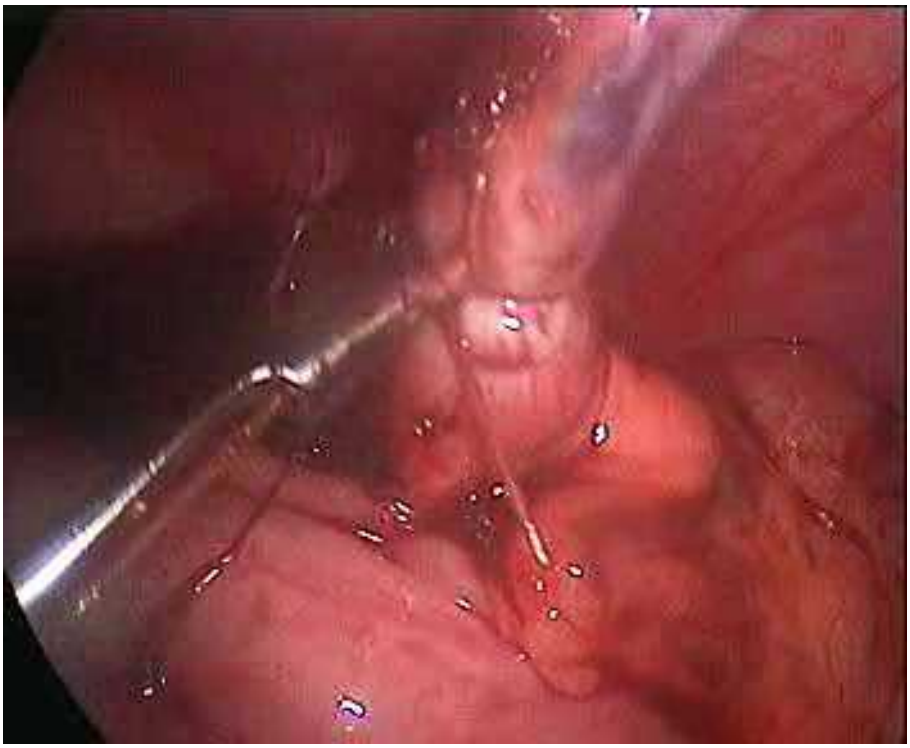
Intra-operative dissection of appendix







Intr-operative pictures



Retrieved appendix


07 01 2012

Post-operative scar from Conventional Three Port Laparoscopic Appendectomy

Post –operative scar from Single-Port Laparoscopic Appendectomy

Post –operative scar from Single-Port Laparoscopic Appendectomy

THREE PORT LAPAROSCOPIC APPENDECTOMY -CTPLA(GROUP B)

Sl.No	IP No.	Age	Sex	Duration of postsurgery hospital stay DOS - DOD	Duration Of Surgery(Min)	Intra operative Complication Yes/No	OTHER FINDINGS	CONVERSION TO OPEN APPENDECTOMY	VISUAL ANALOGUE SCALE				SURGICAL SITE INFECTION	ORAL FEEDS STARTED ON POD	TOTAL NUMBER OF DAYS OF PARENTERAL ANALGESICS GIVEN	FOLLOW UP		
									POD 1	POD2	POD3	POD4				RESUME TO WORK(POD)	SATISFACTION RATE	ANY COMPLICATIONS /READMISSION
1	27480	19	M	5	75	N	-	NO	6	4	2	-	NO	3	2	10	0	NIL
2	23216	25	F	4	50	N	-	NO	6	3	3	2	NO	3	3	15	1	NIL
3	24420	26	M	3	35	N		NO	6	4	2	1	NO	2	2	15	1	NIL
4	1322	24	F	4	60	N	RIGHT OVARIAN CYST	NO	5	4	2	-	NO	2	1	6	1	NIL
5	1467	19	F	3	52	N		NO	6	4	2	2	NO	2	2	8	1	NIL
6	4381	48	M	5	60	N		NO	6	4	2		NO	2	2	10	0	NIL
7	375	68	F	5	60	N		NO	6	2	2	2	NO	1	1	7	1	NIL
8	4379	28	M	6	48	N		NO	6	4	3	1	NO	3	2	10	1	NIL
9	20756	48	M	4	60	N		NO	8	6	2	-	NO	2	2	8	1	NIL
10	6490	35	M	4	70	N	LEFT OVARIAN CYST	NO	4	2	1	-	NO	2	1	7	0	NIL
11	25454	33	M	3	64	N		NO	6	2	-	1	NO	1	2	5	0	NIL
12	16065	28	F	4	45	N	FLIMSY ADHESIONS	NO	6	2	2	4	NO	2	2	12	1	NIL
13	11788	24	F	5	56	N		NO	8	6	4	5	NO	3	2	15	1	NIL
14	10764	17	M	5	90	Y		NO	7	6	6	4	NO	2	3	12	1	NIL
15	772	20	M	11	48	N		NO	8	7	4	4	YES	3	2	15	1	NIL
16	1467	19	F	3	65	N		NO	6	4	2	-	NO	1	2	6	0	NIL
17	4939	30	F	4	50	N		NO	4	2	1	2	NO	2	2	5	0	NIL
18	7957	12	F	5	80	N		NO	8	6	4	-	NO	2	2	7	1	NIL
19	7223	21	M	3	86	N		NO	6	4	2	-	NO	1	2	4	0	NIL
20	5053	34	F	3	60	N		NO	6	4	2	-	NO	2	1	6	0	NIL
21	4611	19	M	4	35	N		NO	8	6	2	-	NO	2	2	5	0	NIL
22	6689	17	M	3	75	N		NO	4	1	-	2	NO	1	3	4	0	NIL
23	6857	18	F	4	65	N	FLIMSY ADHESIONS	NO	8	4	2	1	NO	2	2	8	0	NIL
24	27630	17	M	7	54	N		NO	6	4	3	2	NO	2	2	4	0	NIL
25	26750	25	M	3	45	N		NO	6	4	3	2	NO	2	2	5	0	NIL
26	24360	24	F	4	46	N		NO	6	4	4	-	NO	1	3	3	0	NIL
27	782	35	F	4	35	N		NO	6	4	2	-	NO	2	2	4	0	NIL
28	27292	18	F	8	40	N		NO	6	2	2	-	NO	2	2	5	0	NIL
29	6270	46	M	3	35	N		NO	4	2	2	-	NO	2	2	6	0	NIL
30	4611	19	M	4	50	N		NO	6	4	4	-	NO	1	2	4	0	NIL
31	24072	18	F	3	64	N		NO	6	6	2	-	NO	1	1	4	0	NIL
32	23297	18	F	3	65	N		NO	6	4	4	-	NO	2	2	4	0	NIL
33	23040	22	M	6	54	N		NO	8	4	2	0	NO	1	1	5	0	NIL
34	26008	22	M	3	80	Y	APPENDICULAR TEAR	YES	6	4	2	1	NO	5	3	10	0	NIL
35	26468	32	M	4	45	N		NO	4	2	1		NO	2	2	5	0	NIL
36	27292	19	F	3	35	N		NO	5	2	1		NO	1	1	4	0	NIL
37	28291	25	M	2	60	N		NO	4	1	0		NO	2	1	6	0	NIL
38	23297	20	F	3	58	N		NO	6	3	1		NO	1	2	8	0	NIL
39	29473	28	M	3	60	N		NO	6	2	0		NO	1	1	4	0	NIL
40	26082	23	F	2	52	N		NO	6	4	1		NO	2	2	2	0	NIL

MASTER CHART

SINGLE PORT LAPAROSCOPIC APPENDECTOMY-SPLA (GROUP A)

Sl.No	IP No.	Age	Sex	DOS - DOD	Duration Of Surgery(Min)	Intra operative Complication Yes/No	OTHER FINDINGS	CONVERSION TO THREE PORT LAP.APPENDECTOMY YES/NO	VISUAL ANALOGUE SCALE				SURGICAL SITE INFECTION	ORAL FEEDS STARTED ON POD	TOTAL NUMBER OF DAYS OF PARENTERAL PAIN KILLERS GIVEN	FOLLOW UP		
									POD 1	POD2	POD3	POD4				RESUME TO WORK(POD)	SATISFACTION RATE	ANY COMPLICATIONS/READMISSION
1	27798	32	M	3	75	N	-	NO	6	2			NO	1	1	4	0	NO
2	7246	21	M	6	60	N	ADHESIONS	NO	6	4	4	2	NO	2	3	7	0	NO
3	25142	45	M	2	65	N		NO	4	1			NO	1	1	4	0	NO
4	26287	20	F	3	60	Y	DENSE ADHESIONS,	YES	6	6	2		NO	1	2	6	0	NO
5	8760	24	M	3	55	N		NO	3	3	1	1	NO	2	1	8	0	NO
6	16543	23	M	3	60	N		NO	6	4	2		NO	1	2	5	0	NO
7	491	23	M	4	66	N		NO	4	1	0		NO	2	2	6	0	NO
8	7679	29	F	3	70	N	LEFT OVARIAN CYST	NO	8	4	3	2	NO	2	2	8	0	NO
9	13568	35	F	2	45	N		NO	6	4	4		NO	2	2	5	0	NO
10	530	23	M	3	50	N		NO	6	1	1		NO	1	2	4	0	NO
11	7656	30	F	3	50	N		NO	6	4	2	1	NO	2	1	8	1	NO
12	16611	19	M	4	70	N		NO	6	3			NO	1	2	4	0	NO
13	21211	20	F	4	45	N		NO	4	2	1		NO	2	1	5	1	NO
14	28680	22	M	8	52	N		NO	4	2	1		NO	1	2	4	0	NO
15	5085	21	M	3	56	N		NO	4	2	1		NO	2	1	6	0	NO
16	27292	18	F	4	70	N	FREE FLUID AND ADHESIONS	YES	6	4	2	2	NO	2	2	7	0	NO
17	16543	18	M	3	60	N		NO	4	2	1		NO	1	2	5	0	NO
18	15787	30	F	4	58	N		NO	3	2	1		NO	2	2	7	0	NO
19	15228	23	M	3	52	N		NO	4	1	1		NO	1	1	4	0	NO
20	17261	36	F	4	45	N		NO	4	2	2		NO	2	1	5	0	NO
21	6813	21	M	5	40	N		NO	4	1	1		NO	1	1	3	0	NO
22	1910	36	M	4	50	N		NO	4	2	2		NO	2	1	8	0	NO
23	1908	20	M	3	52	N		NO	4	1	1		NO	1	1	5	0	NO
24	2561	26	M	3	60	N		NO	6	4	2		NO	2	1	4	0	NO
25	4611	32	M	4	50	N		NO	6	2	2		NO	2	2	6	0	NO
26	5338	19	M	4	65	N		NO	4	1	1		NO	1	2	4	0	NO
27	23402	30	F	4	70	N		NO	4	1	1		NO	1	2	5	0	NO
28	25258	26	M	5	40	N		NO	4	2	2		NO	1	2	6	0	NO
29	26606	16	F	2	42	N		NO	4	2	2		NO	2	2	5	0	NO
30	27338	25	M	3	48	N		NO	6	4	2		NO	1	1	6	0	NO
31	27097	30	F	4	52	N		NO	2	1	1		NO	2	2	5	0	NO
32	28098	22	F	4	60	N		NO	4	2	1		NO	2	1	4	0	NO
33	30232	18	F	3	66	N		NO	4	2	2		NO	1	2	7	0	NO
34	22533	26	M	3	70	N		NO	6	4	4		NO	2	2	6	0	NO
35	22555	32	M	4	80	N		NO	4	2	2		NO	2	2	3	0	NO
36	22557	45	M	2	70	N		NO	4	1	1		NO	2	2	5	0	NO
37	24370	28	F	4	55	N	RIGHT OVARIAN CYST	NO	4	2	2		NO	1	2	4	0	NO
38	25141	30	M	3	56	N		NO	6	4	4		NO	1	2	5	0	NO
39	26287	22	F	2	48	N		NO	6	2	1		NO	1	2	4	0	NO
40	7246	21	M	3	80	N		NO	6	2	1		NO	2	3	3	0	NO