"IS ULTRASONIC SHEARS A SAFE ALTERNATIVE TO MONOPOLAR ELECTROCAUTERY IN LAPAROSCOPIC CHOLECYSTECTOMY - A COMPARATIVE STUDY"

BY

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DISSERTATION SUBMITTED TO SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION AND RESEARCH, TAMAKA, KOLAR, KARNATAKA.

In partial fulfilment of the requirements for the degree of

M.S. GENERAL SURGERY

UNDER THE GUIDANCE OF

Prof. DR. P. N. SREERAMULU
PROFESSOR
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APRIL/MAY - 2023

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I hereby declare that this dissertation entitled **"IS ULTRASONIC SHEARS A SAFE ALTERNATIVE TO MONOPOLAR ELECTROCAUTERY IN LAPAROSCOPIC CHOLECYSTECTOMY - A COMPARATIVE STUDY"** is a bonafide and genuine research work carried out by me under the guidance of **Dr. P N SREERAMULU,** Professor, Department of General Surgery, Sri Devaraj Urs Medical College, Kolar, in partial fulfilment of University regulation for the award **"M. S. DEGREE IN GENERAL SURGERY",** the examination to be held in April 2023 by SDUAHER. This has not been submitted by me previously for the award of any degree or diploma from the university or any other university.

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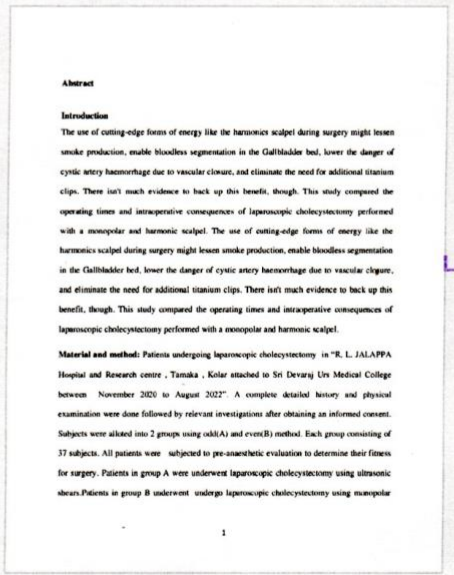

Abstract

Introduction

The use of cutting-edge forms of energy like the harmonics scalpel during surgery might lessen smoke production, enable bloodless segmentation in the Gallbladder bed, lower the danger of cystic artery haemorrhage due to vascular closure, and eliminate the need for additional titanium clips. There isn't much evidence to back up this benefit, though. This study compared the operating times and intraoperative consequences of laparoscopic cholecystectomy performed with a monopolar and harmonic scalpel. The use of cutting-edge forms of energy like the harmonics scalpel during surgery might lessen smoke production, enable bloodless segmentation in the Gallbladder bed, lower the danger of cystic artery haemorrhage due to vascular closure, and eliminate the need for additional titanium clips. There isn't much evidence to back up this benefit, though. This study compared the operating times and intraoperative consequences of laparoscopic cholecystectomy performed with a monopolar and harmonic scalpel.

Material and method: Patients undergoing laparoscopic cholecystectomy in "R. L. JALAPPA Hospital and Research centre , Tamaka , Kolar attached to Sri Devaraj Urs Medical College between November 2020 to August 2022" A complete detailed history and physical examination were done followed by relevant investigations after obtaining an informed consent. Subjects were alloted into 2 groups using odd(A) and even(B) method. Each group consisting of 37 subjects. All patients were subjected to pre-anaesthetic evaluation to determine their fitness for surgery. Patients in group A were underwent laparoscopic cholecystectomy using ultrasonic shears.Patients in group B underwent undergo laparoscopic cholecystectomy using monopolar

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Dr. BANGARU VENKATA NAVEEN KUMAR YADAV

Abstract

Introduction

The use of cutting-edge forms of energy like the harmonics scalpel during surgery might lessen smoke production, enable bloodless segmentation in the GB bed, lower the danger of cystic artery haemorrhage due to vascular closure, and eliminate the need for additional titanium clips. There isn't much evidence to back up this benefit, though. This study compared the operating times and intra-operative consequences of laparoscopic cholecystectomy performed with a monopolar and harmonic scalpel. The use of cutting-edge forms of energy like the harmonics scalpel during surgery might lessen smoke production, enable bloodless segmentation in the GB bed, lower the danger of cystic artery haemorrhage due to vascular closure, and eliminate the need for additional titanium clips. There isn't much evidence to back up this benefit, though. This study compared the operating times and intra-operative consequences of laparoscopic cholecystectomy performed with a monopolar and harmonic scalpel.

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electrocautery. All the parameters were compared the two techniques will be recorded and analysed.

Results: The cohort was divided into 2 groups, with 50% each (n=37) subjects in ultrasonic energy group and to monopolar electrocautery group. The mean intra operative blood loss (ML) was 10.81 ± 4.49 in ultrasonic energy group and it was 24.27 ± 6.64 in monopolar electrocautery group, the difference between 2 groups was substantially significant (p value <0.001). The mean operating time in minutes for the monopolar electrocautery group was 62.03 9.39 and for the ultrasonic energy group it was 41.49 ±7.72; this difference was highly significant. P value 0.001 The mean stay in hospital (days) was 5.78 days for the monopolar electrocautery group and 8.27 days for the ultrasonic energy group; this difference was statistically significantly different between the two groups. P value 0.001 The mean score VAS ON POD 1 was 3.89 ±1.05 for the monopolar electrocautery group and 5.41± 1.19 for the ultrasonic energy group; this difference was highly significant. (0.01 p value).

Conclusions: Ultrasonic energy was found to significantly more efficient in terms of intra-operative and post- operative and intra-operative outcome compared to monopolar group.

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ABBREVIATIONS

Glossary	Abbreviations
GB	GallBladder
BMI	Body Mass Index
LC	Laparoscopic Cholecystectomy
LS	LigaSure V
GP	Gyrus PK
HS	Harmonic Scalpel
ES	EnSeal
ELC	Early Laparoscopic Cholecystectomy
HSLC	Compared Harmonic Scalpel Aided Laparoscopic Cholecystectomy
CLC	Laparoscopic Cholecystectomy
HSG	Harmonic Scalpel Clipless
ME	Monopolar Electrocautery

INTRODUCTION

INTRODUCTION:

Gallbladder disease is a serious and widely prevalent condition. Distinct populations across the world have different rates of gallstone development.[1] In wealthy nations, 10% to 15% of the populace grieve from gallstone ailment. Approximately 2-3% of patients have a risk of symptomatic condition each year, and that risk rises to 10% after five years.[2] Increase in body mass index (BMI), symptomatic cholelithiasis, and dietary changes all have a significant association.[3] The illness burden in the "United States" has grown by more than 20% during the past thirty years.[1] Increases in BMI have been associated to this rise in the paediatric population. In population-based research, higher BMI has also been linked to a greater risk of cholecystectomy in the long term.[4] As a result, more individuals are opting for treatments for gallstone disease, with cholecystectomy emerging as the most frequently chosen surgical surgery in the US.

Laparoscopic cholecystectomy (LC) is the "gold standard" for treating gallstone disease symptoms. the most frequent complication of this procedure is that; the gallbladder perforation while dissection from the liver bed, often results bile leakage and stone disposal in the peritoneum.[5]

In India, cholecystectomy is among the most frequently elective surgical operations. The majority of cholecystectomies are done to alleviate Cholelithiasis - related biliary colic symptoms, to treat complications from gallstones (such as acute cholecystitis and biliary pancreatitis), or as unintentional cholecystectomies done during other open abdominal operations. The majority of cholecystectomies are now carried out laparoscopically in urban settings, although open surgery is still necessary in places without adequate facilities or skilled staff. The surgical removal of the gallbladder is known as a cholecystectomy. In India, gall stones afflict around 6% of the population. 10% of women and 3% of males are affected. In the elderly, it might reach 20%.[6]

Laparoscopy has incorporated several innovative technologies during the past few years. Physical haemostasis methods include endovascular staples topical sealants, bipolar coagulation, and sutures. Thermal haemostasis methods include Ultra - sonic or laser dissectors (e.g., either gelatin matrices or fibrin adhesive).[7] With the main objective of lowering technical requirements during minimally invasive surgery, developments in the evolution of based on energy haemostasis equipment for dissection and retraction of tissue has been developed in recent decades. Using high resolution digital imaging in tandem with surgery has greatly shortened recovery time. Using high resolution digital imaging in tandem with surgery has greatly shortened recovery time. These tools offer plenty of movement, quick and simple tissue dissection, and most significantly, safety during haemostasis, however they are also prone to problems.[8,9] Their effectiveness and drawbacks are affected by several factors such lateral heat dispersion, smoke emission, vessel burst stress, and closure time.[10]

It has been hypothesised that ultrasonic dissection can take the place of monopolar electrocautery during cholecystectomy. Because it causes less thermal damage, less trauma overall, and more precise dissection.[11,12] Compared to monopolar electrocautery, ultrasonic dissection has also been found to lower the risk of gallbladder perforation during laparoscopic cholecystectomy. While performing a LC, monopolar electrocautery has been proven to be useful in reducing bleeding and sealing the cystic artery.[14,15] It has been demonstrated that the laparoscopic cholecystectomy ultrasonic method of dissection is preferable than the monopolar approach. Since it does not increase the surgery time and reduces perforation. Additionally, this technique enables surgeons with less training to work easily in difficult situations. [16,17]

Need of the Study

The most frequent abdominal operations are those involving the biliary system. In 1987, Mouret became the first to perform a LC. The most common laparoscopic operation is this one. It is the most frequently accepted laparoscopic operations by general surgeons worldwide and has swiftly supplanted open cholecystectomy as the preferred procedure. Laparoscopic cholecystectomy advantages include less hospitalisation, decreased morbidity, quicker recovery, and improved functional capacity.[18]

In terms of intraoperative bleeding, postoperative recovery, and complications, cholecystectomy with ultrasonic shears is a more affordable option than traditional laparoscopic surgery.[18]

Monopolar electrocautery has often been employed. Electrocautery produces smoke that makes the operating area difficult to see, extending the procedure and raising the possibility of complications including haemorrhage and gallbladder perforation.

In addition to reducing smoke, enabling quick and painless surgical resection in the gall bladder bed, decreasing the likelihood of haemorrhage due to effective vascular closure, from the cystic artery and preventing the use of more titanium clips are the advantage of using advanced energy sources like ultrasonic shears, sonosicion, sonosurg, and thunder beat.[19] Slippage of the titanium clips used to clip the cystic artery and cystic duct increases the risk of bleeding and bile leakage. It could also act as a nidus for the creation of stones.[20] Hence this study aimed to compare the operating time, intra-operative blood loss, duration of hospital stays and post - operative pain using ultrasonic shears vs. monopolar electrocautery in laparoscopic cholecystectomy.

AIMS AND OBJECTIVES

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- "To compare the operating time, intra-operative blood loss, duration of hospital stay and post-operative pain using ultrasonic shears vs. monopolar electrocautery in laparoscopic cholecystectomy".

RESEARCH HYPOTHESIS:

"Ultrasonic Shears is better than Monopolar Electrocautery in Laparoscopic Cholecystectomy, in terms of less operating time, less intra-operative blood loss, less duration of hospital stay and less postoperative pain".

REVIEW OF LITERATURE

REVIEW OF LITERATURE:

Anatomy of Gall Bladder

The gallbladder is a pear-shaped organ that is situated in the upper right quadrant of the belly. Its breadth is 4 cm, and its length is between 7 and 10 cm. Despite being tiny, the organ usually results in stomach discomfort from gallstones, necessitating surgical excision of the organ. Anatomically, the gallbladder is situated underneath segments IV and V of the liver, anteriorly. When performing gallbladder and biliary surgery, detailed awareness of these anatomic possibilities is crucial due to the complexity of the bile system's architecture. There is an inferior peritoneal surface and a superior liver surface on the gallbladder. Although some writers claim that the gallbladder body's exposed surface is covered by an extension of the "Glisson's capsule" (liver capsule), the gallbladder does not have a capsule. The fundus of the gallbladder is initially wide before becoming more elongated as it enters the body. The infundibulum, which the gallbladder body narrows to connect to, then joins the cystic duct and neck. Heister spiral valves are located in the cystic duct and at the distal end of the gallbladder. These valves may facilitate gallbladder emptying by aiding neurological and hormonal stimulation. In the majority of persons, "Hartmann's Pouch" is a poor outpouching of the gallbladder neck or infundibulum. At the apex of the gallbladder fundus, there may occasionally be a shortage. It is not pathologic or surgical in nature and is referred to as a "Phrygian cap".[21]

Figure 1: The Liver The bile ducts and gallbladder are exposed, Spiral valves, spiral ducts, and a common bile conduit. Gray's Anatomy Contributed Plates [22]

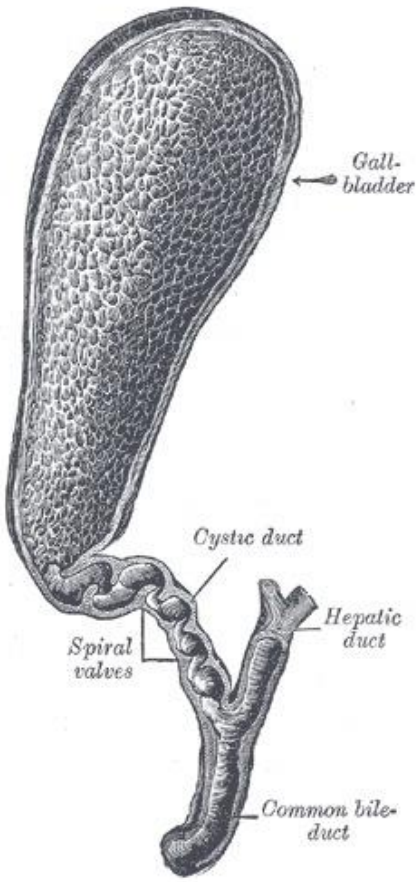
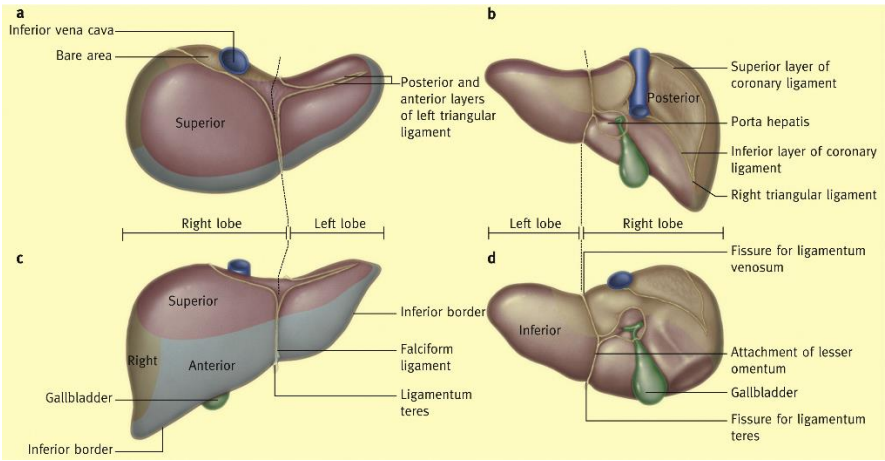


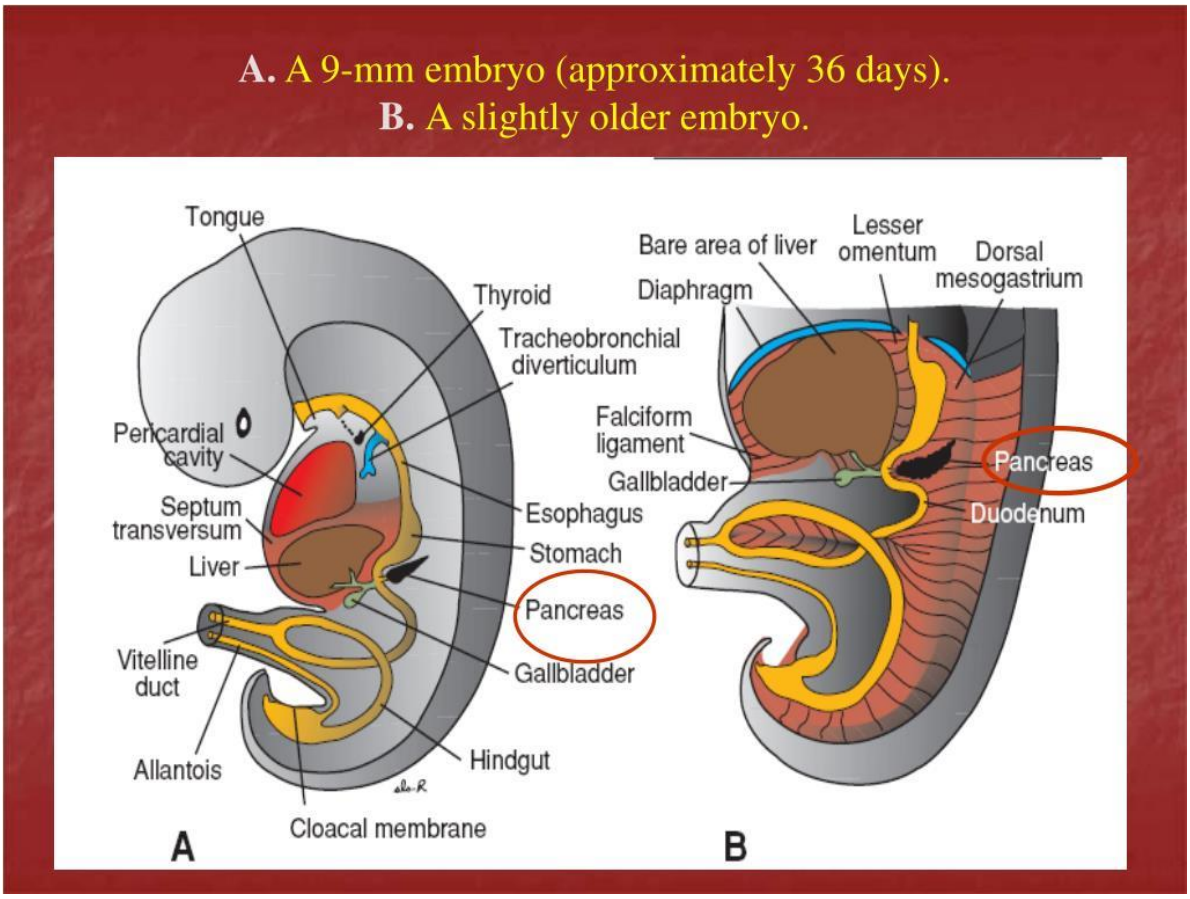
Figure 2 : Anatomy of Gallbladder and Ducts[23]



Embryology

By the conclusion of the 4th week of embryogenesis, pouches of the developing duodenum give way to the hepatic diverticulum. The hepatic volvulus forms the biliary tree, while the cystic volvulus, the 2nd outpouching, develops into the gallbladder. There are many different biliary systems in humans due to the tremendously variable biliary tree growth.[24]

Figure 3: "Embryo of 36 Days Old Showing Development of Gall Bladder and Pancreas". [24]

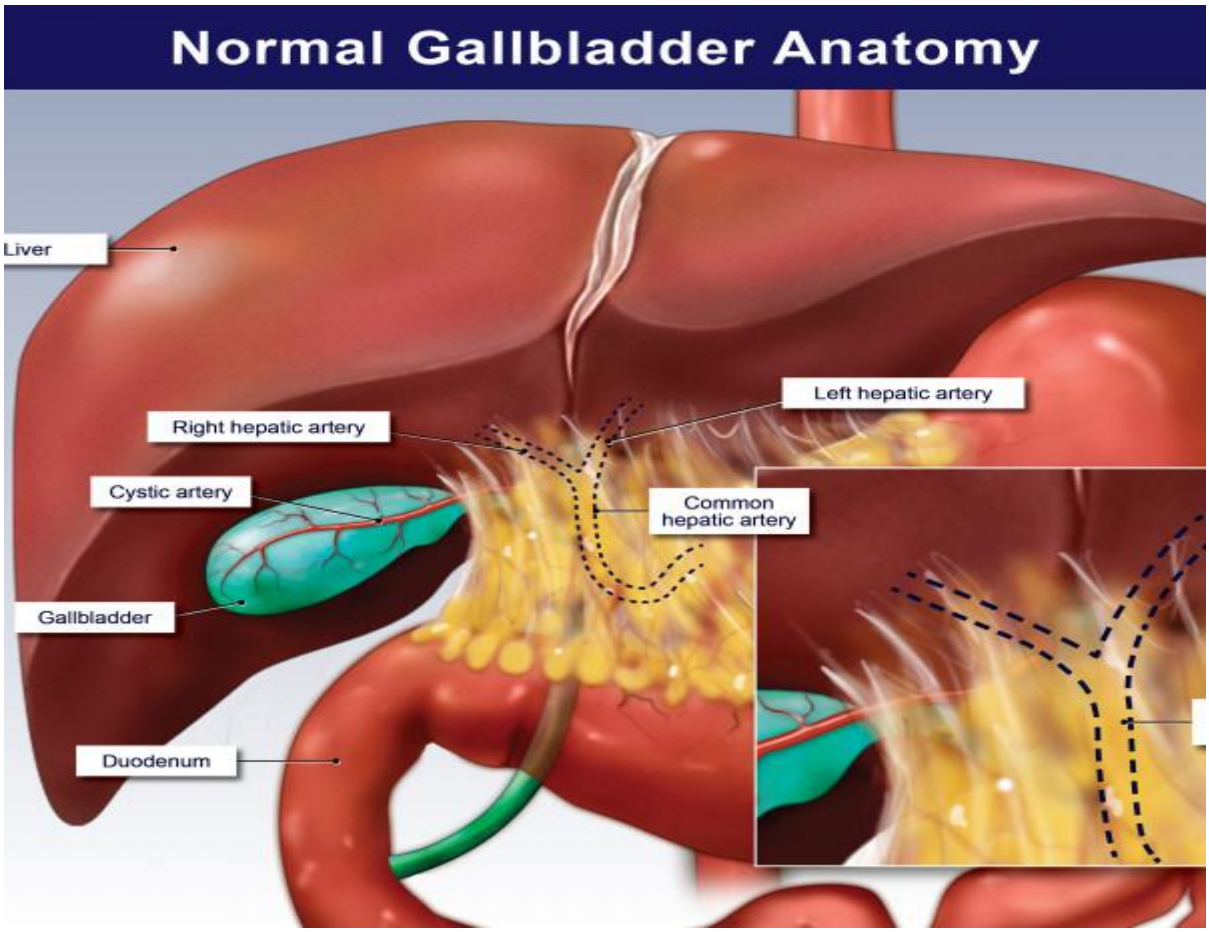


Lymphatics and Blood Supply

"The gallbladder receives the majority of its blood flow via the cystic artery". The cystic artery is a right hepatic artery branch that arises from the common hepatic artery. There are several anatomical variants of this vascular supply. Right hepatic, gastroduodenal, right gastric, and

superior in the back of pancreaticoduodenal arteries all provide blood to the common bile duct. These tiny veins need to be protected during surgery in order to guarantee proper common and cystic bile ducts are vascularized. Increased duct ischemia and leaks will ensue from the disruption of these vessels. The term "cystic vein" is untrue, the gallbladder's small venules empty into the liver's gallbladder bed, causing venous outflow. Larger hepatic venous sinuses may be observed during cholecystectomy, which can make it difficult to manage bleeding. Gallbladder lymphatics flow to the Calot triangle's cystic lymph node, also known as the lymph node of Lund. Often, gallbladder cancer spreads to nodes in the liver port without going via this lymph node.[25]

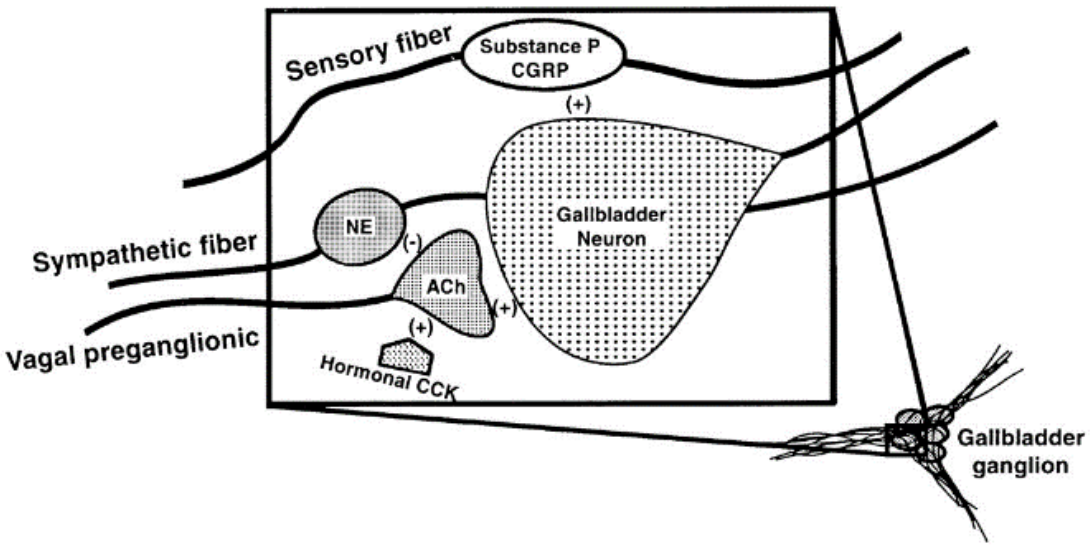
Figure 4: Blood Supply of Gallbladder



Nerves

The three main nerves innervate the gall and duct: Tactile information is transmitted through the right phrenic nerve, parasympathetic information is sent by the "hepatic branch of the right vagus nerve, and sympathetically input is sent by the celiac ganglia". The gallbladder becomes unresponsive after gastric operations like gastrectomy as well as after vagotomy for peptic ulcer disorder. Gallstones and cholecystitis will then develop as a result of this. Prophylactic cholecystectomies are frequently performed concurrently with such surgeries to prevent cholecystitis.[22]

Figure 5: Diagrammatic Representation of the Modulatory Activities That Take Place in the Gallbladder's Ganglia



"Gallbladder neurons are primarily propelled by vagal preganglionic inputs, which activate nicotinic receptors to cause rapid excitatory postsynaptic potentials (EPSPs). Cholecystokinin (CCK) and sympathetic inputs, which operate on presynaptic CCK-A and 2-receptors to change the quantity of acetylcholine (ACh) produced by vagus neurons, can up- or down-regulate the effectiveness of this relationship. It is possible for sensory fibres in the gallbladder ganglia to act as an axon reflex by directly releasing tachykinins and calcitonin gene-related

peptide (CGRP) onto gallbladder neurons. This causes the neurons to become depolarized and more excitable. Tachykinins are released from gallbladder ganglia and neurokinin-3 receptors are activated as a result of slow EPSPs."[26]

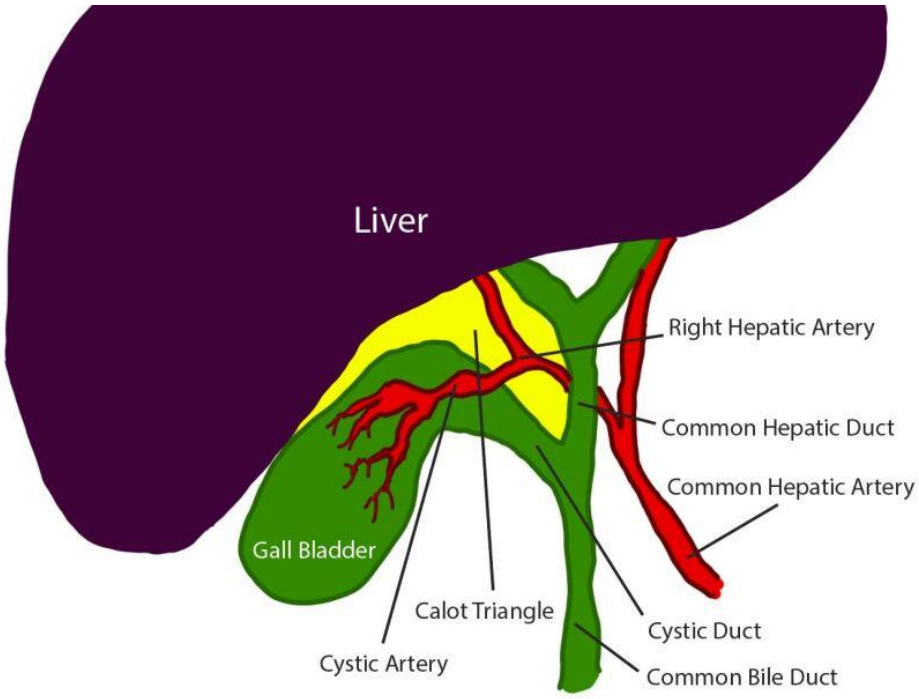
Relevant clinical anatomy and physiology – biliary tract

One of the body's anatomical structures with the most variation is the biliary tree. The gallbladder is a pear-shaped body part that is connected to the IVB and V sections of the liver. It is devoid of a capsule. The distal gallbladder's small outpouching, known as "Hartman's pouch", and the "Valve of Heister" are tapered proximal to the cystic duct. "At the junction of the hepatic artery (proximal) and common bile (distal) ducts, the cystic duct joins the bile duct". The "Ampulla of Vater" is where the bile duct common enters the duodenum. The Oddi sphincter regulates the quantity of bile that enters the duodenum.[27]

The left and right hepatic radicals are formed when the distal common hepatic duct splits in the liver. Smaller intrahepatic channels are subsequently formed by these radicals. If the ducts of "Luschka", which are small ducts that lead directly from the liver's gallbladder bed into the gallbladder, are not recognized and treated throughout the procedure, they may result in postoperative bile leakage.[28]

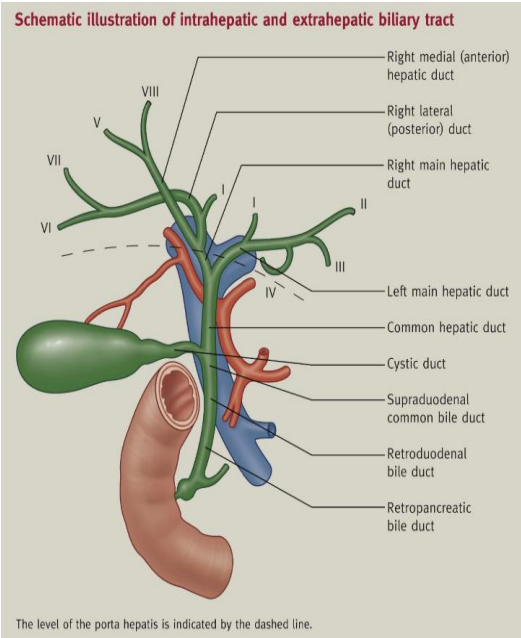
"The cystic duct, the common hepatic duct, and the underside of the liver are the three structures that make up Calot's triangle. The cystic artery, which is situated in the triangle under the Calot lymph node, may be found using the latter description. The common bile duct lies just below the portal vein. The surgeon must continuously be aware of the high prevalence of variability in this area of the body since there is no such thing as normal biliary architecture. Anatomical variants include choledochal cysts, fusiform gallbladders, auxiliary ducts, intrahepatic gallbladders, and duplications. In 15% to 20% of individuals, the anatomy will have altered."

Figure 6: "Diagram of the Calot Triangle and Local Anatomy".[22]



Short cystic ducts and their corresponding short cystic arteries are among the most deadly diseases. Due to the possibility that it may be confused for the cystic duct, the bile duct common is vulnerable to transection. Right hepatic artery injury or transection might result from a short cystic artery.[29]

Figure 7: Schematic Representation of Bile Ducts[30]



Technique

After the patient has been appropriately anaesthetized and prepared, a subcostal right (Kocher) or superior middle incision is performed. Retractors and packs offer sufficient exposure. It is essential to have a clear visual of the bile ducts, Calot triangle, and gallbladder. Retractors should only be used carefully to prevent liver injury. The gallbladder is constricted and moved to provide for the greatest visibility once the specialist has recognised all the features of the hepatis porta. The choice is taken whether to remove the gallbladder from the triangle of Calot up, or from above. Hemoclips are used to initially locate and separate the cystic duct and artery. It is crucial to recognise these structures. "The gallbladder is subsequently cut out of the liver's gallbladder bed using a harmonic scalpel or electrocautery. The gallbladder bed is examined to identify and treat any haemorrhage or bile leakage from the Luschka duct. The decision to do a surgical cholangiogram or typical bile duct exploration depends on factors related to typical bile duct stones, such as elevated bilirubin and a distended common bile duct (diameter greater than 8 mm). The standard multilayer method is then used to seal the abdomen".[31]

Before continuing with the case, the gallbladder may need to be emptied using a decompression needle if it is stiff and enlarged as a result of inflammation. Similar to laparoscopy, the method is based on the surgeon's comfort level and expertise. The surgeon should work to have a great critical picture of safety before clipping or cutting. Hartmann's pouch may be so fibrotic or exhibit considerable inflammation in some situations, necessitating the back wall or requiring "bailout" procedures like a cholecystostomy tube or partial cholestectomy.[32,33] The surgeon may choose to use closed vacuum drains.[34]

Cholecystectomy

In individuals with characteristic gallstone disease, LC is the typical of care.[35] In individuals with simple gallstone disease, this method has nearly entirely replaced open cholecystectomy due to all of its benefits. While there are many other cutting and coagulation techniques utilised

during laparoscopic cholecystectomy, monopolar electrocautery is now the favoured cutting technique. The use of "monopolar electrocautery" is often linked to unintentional tissue harm because it produces strong collateral heat that causes tissue hypoxia and death. Most electrocautery injuries are either missed while operation or appear much afterwards.[36] The surgical technique, however, might be considerably hindered by injuries such gallbladder perforation during laparoscopic cholecystectomy that cause bile and stones to leak into the peritoneal cavity. This might make the surgery take longer and have negative effects. Laparoscopic cholecystectomy is performed more quickly and with a lesser risk of gallbladder perforation because to the use of ultrasonic dissection. Ultrasound slicing is most useful for trainee surgeons, particularly in difficult intraoperative situations.[35]

Indications

Since the invention of laparoscopic cholecystectomies, there are fewer chances to do an "open cholecystectomy". Translating from a laparoscopic to an open cholecystectomy is the most frequent reason for an open cholecystectomy (2% to 10%). There are various factors at play in the implementation of this modification. Surgeons may use an open method if there is a doubt regarding the anatomy. "An open operation should be carried out if there is severe inflammation, adhesions, anatomical abnormalities, bile duct injuries, retained bile duct stones, or uncontrolled bleeding. Because laparoscopy bile duct investigation can be difficult, the need for a bile duct exploration may also be a basis for converting to an invasive procedure. Cirrhosis, gallbladder cancer, extensive upper abdominal surgeries with scar tissue, and other concurrent conditions, most notably diabetes, may all necessitate an open cholecystectomy".[37,38] Critically ill individuals may also require a planned open laparoscopic procedure since an open procedure could be less distressing for these individuals and minimise the physiological alterations brought on by a laparoscopic pneumoperitoneum.

Common justifications for switching from laparoscopic to open surgery include poor visualisation and ambiguous anatomy. It is more appropriate to think of conversion to open cholecystectomy as a success than a problem. By performing the procedure in the safest way feasible, it exhibits excellent judgement.[39]

Contra-indications

There are no drawbacks to doing an open cholecystectomy as opposed to a laparoscopic one. However, the laparoscopic approach is the favoured one since it may be completed as a day-care procedure and cuts down the recuperation period from several weeks to only a few days. Open cholecystectomy generally falls within the general criteria for any surgical procedure. Relative contraindications to laparotomy include shock, severe cardiac and respirational illness, anticoagulation, a latest neurologic episode, and other life-threatening diseases. Additionally, excision of the gallbladder should be delayed if there is a possibility of cancer until a full examination, which includes a possible depth of invasion and metastases, is finished.[40]

Epidemiology – rates of surgery, global, Indian

"Cholelithiasis disease is a prevalent digestive condition that is expensive to treat and has regional and ethnic variations.[41] In comparison to Western populations, East Asians have a lower female preponderance and a higher prevalence of pigments crystals, crystals in the bile duct, and intrahepatic duct stones.[42] One of the most common complications of gallstone disease is acute cholecystitis, which occurs at a rate of 1% per year. Gallbladder stones are more common in some regions of the world than others. In India, it is thought to be roughly 4%, compared to 10% in the West".[43]

Gallstones are commonly unintentionally found during laparotomies, abdominal radiographs, computed tomography scans, and ultrasonography in patients who have no biliary symptoms. About 3% of asymptomatic individuals have symptom development each year. Nearly two thirds of people with asymptomatic gallstones continue to be side effect after 20 years.[43]

Most of the gall stone condition is treated by cholecystectomy. In the years following the advent of laparoscopic surgery, the rates of gallbladder removal grew and stayed steady at a higher level. Laparoscopy surgery completion rates climbed from 8percent in 1992 to 99percentage in 2011.[44]

Using a case study in Ontario, where frequencies of elective cholecystectomy rose by 35% in 1991 as a result of the adoption of laparoscopic surgery, researchers examined the impact of rising rates of elective cholecystectomy on the incidence of severe consequences of gallstone disease. Acute cholecystitis sufficient to stop by 18% starting in 1991 as a result of greater laparoscopic procedure use. Despite not declining in 1992, the occurrence of acute pancreatitis and cholangitis had risen from 1988 to 1991.[45] It has been hypothesised that the development of laparoscopic may have led to an overuse of the procedure.

Open vs laparoscopic cholecystectomy

The 2nd most common gut procedure in general surgery is a cholecystectomy.[46] "LC has some advantages over traditional cholecystectomy, such as Improved aesthetic outcomes, less surgical discomfort, a reduced hospital stay, and an earlier return to normal activities".[47] Furthermore, cholecystectomy is a risky procedure that can result in serious consequences such as bile duct injury, bleeding, abscess, and pancreatitis.

Nguyenet al.[48, 49, 50] compared open and "laparoscopic Roux-en-Y sleeve gastrectomy" in a randomised experiment, doing thorough investigations on the physiology changes after laparoscopic surgery (LRYGB). "They observed that there was no substantial weight loss over (up to) three years of follow-up examination, and they did in fact confirm that LRYGB

decreased hospital stay, recuperation time, the amount of abdominal injuries, and operational time".[49] There have been reports of certain adverse effects, such as reduced intraoperative urine production, transitory postoperative increase of liver enzymes, and reduced femoral vascular flow.[50] [51]

Pneumoperitoneum-induced intra-abdominal hypertension, which may affect the function of the abdominal and respiratory organs, may have contributed to these physiologic abnormalities.[52] These results underline the need of avoiding lengthy operations in individuals who are elderly, over weight have variable hemodynamic, or have renal disease.

Laparoscopic surgery has been shown to be superior to open surgery in a number of procedures, including hepatectomy, distal pancreatectomy, and damaged peptic ulcer the decreased chance of subsequent venous thrombosis is another benefit of laparoscopy.[53, 54, 55, 56.]

Laparoscopic cholecystectomy

A much less aggressive surgical treatment for removing a damaged gallbladder is laparoscopic cholecystectomy. "Since the early 1990s, this procedure has largely supplanted the open method for cholecystectomies".[57] "In order to treat acute and chronic cholecystitis, symptomatic cholelithiasis, biliary dyskinesia, acalculous cholecystitis, gallstone pancreatitis, and gallbladder masses/polyps, laparoscopic cholecystectomy is currently advised".[58] The same justifications apply to an open cholecystectomy. An open cholecystectomy is usually the recommended treatment for gallbladder cancer. In the US, 20 million people suffer with gallstones. On this group, over 300,000 cholecystectomies are performed yearly. 10percent to 15percent of the people suffer from no symptom gallstones. Of them, 20% have symptoms ("biliary colic"). Of the 20% who have symptoms, 1% to 4% will experience problems.[59] "Gallstones become increasingly common as people age, and women are more likely than males to have them. Gallstones affect 5% of males and 20% of women between the ages of 50

to 65. Gallstones are typically made up of cholesterol 75percent of the times and pigment 25% of the time".[60]

Indications

- Chronic or acute cholecystitis
- Gallstone pancreatitis, acalculous cholecystitis, "biliary dyskinesia" (hypo- or hyperfunction), clinical cholelithiasis, and gall masses/polyps

Contra-indications

• Uncorrectable coagulopathy; inability to endure "pneumoperitoneum or general anaesthesia; metastatic disease like peritoneal deposits."

Please be aware that although a laparoscopic cholecystectomy was originally contraindicated in cases of gallbladder cancer, recent research supports this procedure.[61]

Procedure[62]

Equipment required

• "One laparoscope (5/10 mm, 0/30 degrees) with a camera wire and light source"

• Two laparoscopy monitors

• "5 mm to 12 mm trocars; carbon dioxide source; and insufflation tubing (average three 5 mm working trocars and one 10 mm to 12 mm trocar)"

• "Laparoscopic tools, comprising Maryland grasper, atraumatic graspers, clip appliers, hooks, spatulas, and retrieving bags".

• Forceps, a needle driver, an 11/15-bladed scalpel, and absorbable sutures

• Significant open set, for potential conversion

Preparation

- Before having surgery, the individuals should get medical improvement.

- According to protocol, prophylactic antimicrobials should be given within thirty min of incision.
- "An aseptic surgical area is created from just above the symmetrical costal borders to the pelvic tubercle and lateral to the right and left sides. The sterile operating room should allow for an open surgery, if necessary".

Technique[62]

"After anaesthesia induction and insertion, the laparoscopic cholecystectomy procedure may begin". First, carbon dioxide is inhaled into the belly at a 13 mmHg pressure. After that, trocars are inserted into the belly through four small incisions ("supraumbilical x1, epigastric x1, and right midclavicular x 1, right anterior axillary line x 1"). The gallbladder is stretched across the liver using extensive instruments and a monitor (laparoscope). This makes the region of the hepatocystic triangle that has been proposed visible. Careful deconstruction is done to provide a critical perspective on safety. There are just 2 tubular structures located at the gallbladder's base, the hepatocystic triad is free of fibrous and adipose tissue, and these are the sole findings supported by this theory. The operating surgeon can move on with complete confidence that cystic duct and cystic artery have been separated once this image has been obtained. Careful cutting and transecting have been applied to both structures. The liver bed and gallbladder are then totally separated using harmonic scalpel or electrocautery. Haemostasis should be attained after letting the abdomen to drop below 8 mmHg for 2 minutes. By using this technique, one can prevent missing possible venous haemorrhage brought on by increased "intra-abdominal tension". The gallbladder is taken out of the belly with the use of a specimen pouch. All trocars must be taken out during direct visualisation. "This expert advises fascial sealing of trocar locations larger than 5 mm in size to avoid incisional herniation during the healing process".

Different techniques involved like electrocautery, ultrasonic shears etc.

"Ultrasonic dissection technology works by generating a high-frequency ultrasound (eg, 55000 cycles/second) and applying such energy to the tissues producing 3 main "C" effects":

1. "Cavitation/tissue fragmentation (and dissection)- caused by cellular destruction secondary to intracellular fluid evaporation, and this occurs due to "low pressure at the blade".[63] Cavitation is an important effect of ultrasonic energy, because it causes separation of tissue planes facilitating dissection. This is particularly useful when looking for the "correct" plane of dissection between the liver and the gallbladder".[64]
2. "Coagulation: caused by conversion of ultrasonic energy into a localized heat, this has been reported to reach to 60°C to 100°C.[65] Denaturation of collagen in the walls of hollow structures (such as cystic artery and duct) can result in the occlusion or *sealing* of the lumen. The mechanism occurs when ultrasonic energy is transferred to tissue. This breaks the tertiary hydrogen bonds between the collagen and the proteins of extracellular matrix. These proteins denature and change from colloidal proteins into an insoluble gel that is able to seal the vessel walls.[66] This gel coagulation is specific to ultrasonic dissection, [67,67]and the airtight pressure of a sealed cystic duct was calculated to be" "higher than 320mm Hg[68]"
3. "Cutting—which is achieved by the "sharp" blade mode of the Harmonic scalpel".

According to reports, compared to monopolar electrocautery, which is linked to 15% of biliary tract injuries and 90% of visceral injuries during laparoscopic cholecystectomy, The danger of harm is reduced by ultrasonic energy's modest lateral propagation of vibrating energy in the surrounding structures..[65,69,70]

Several animal experiments supported the conclusion that compared to ultrasonic energy, unipolar electrocautery generates higher lateral heat energy distribution and tissue damage.[71,71,72] "If the insulation of the active electrode fails, causing electrically "coupling" with other surgical tools or tissue and the creation of stray electrical current, the safety of

electrosurgical equipment may also be compromised.[73] In contrast, a more effectively management animal research using monopolar electrocautery resulted in barely detectable thermal harm in the extramedullary biliary channels following laparotomy".[74]

Effect on tissue by ultrasonic and monopolar laparoscopic cholecystectomy

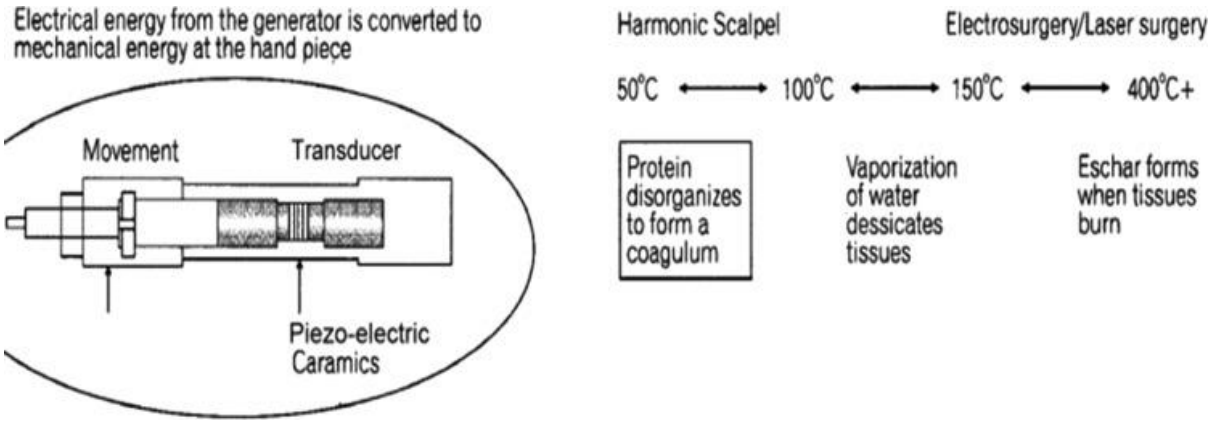
Because electro surgery allows for quick division of arterial structures while keeping the objective of haemostasis, it has contributed to the advancement of laparoscopy.[10, 75] to provide a safer and quicker haemostatic operating field, many technologies have been put into clinical practise. There is evidence, nevertheless, that highly sophisticated and operated devices can unintentionally injure adjoining structures owing to the transverse spread of heat energy, which could cause delayed injury to neighbouring structures.[75] Due to their relative lateral thermal dispersion, the older devices, which were predominantly electrosurgical in design, were shown to be relatively dangerous in abdominal surgery and may have damaged important tissues.[76,77,78]

"Monopolar electro surgery" carries familiar risks, including significant injury by heat to neighbouring tissues. In surgery, it is critical to minimise thermal damage to neighbouring tissues while maintaining safety and tissue integrity. Ultrasonic instruments are being tested to see if they are safer than traditional diathermy. [78,79,80] "Unlike large voltage or laser procedures, ultrasonic shears employ piezoelectric transducers to produce a vibration signals at the functional tip and convey less energy to the tissue, resulting in less transverse thermal damage and higher penetration depth because of lower temperatures.. [81]Ultrasonic energy regulates blood loss via the coaptive coagulation process".[10]

Ultrasonic shear devices use cutting mechanisms that are distinct from those used in electro surgery and laser surgery. Cavitational shearing and fragmentation is the initial step. At low temperatures, the vibrations of the blade tip's tip induce cellular moisture to vaporise, rupturing cells and allowing for very precise cutting and segmentation. "The genuine cutting power

offered by a sufficiently large blade vibrating 55,500 seconds at a time is the second type of cutting employed by "Ultrasonic shears." The blade edge shreds tissue on a microscopic level by stretching it past its breaking molecular bonds. Usually, tissue friction produces heat of 80°C.[7,10]

Figure 8: "The Physics of Thermal Damage with Laparoscopic Dissectors"[82]



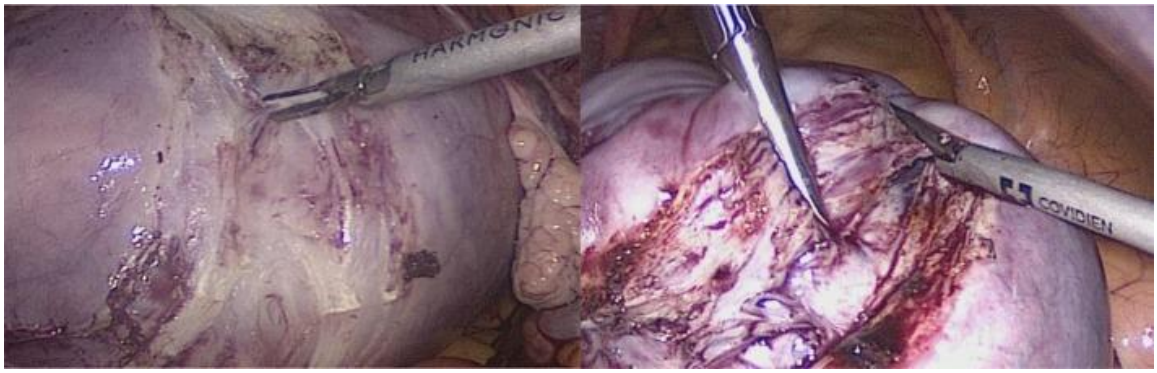
This technology's drawback is the creation of airborne particles lipid droplets from the region under treated, which can seriously obstruct laparoscopic visualisation.[83]

Laparoscopic and open surgery have both benefited from the use of radiofrequency and ultrasonic shears for a number of years. Both are highly developed technologically and have been demonstrated to deliver great outcomes with no lateral thermal harm.[78,79,80] the same coagulation and cutting objectives are met by laparoscopic ultrasonic devices in various ways. Ultrasonic shears stop bleeding at temperatures between 50 and 100 °C by tamponing the vessel and coagulating a protein solution to seal it.

The same coagulation and cutting goals are met by laparoscopic ultrasonic devices in various ways. Ultrasonic shears stop bleeding at temperatures between 50 and 100 °C by tamponing the vessel and sealing it with a protein coagulum. They run at lower heat than electrocautery devices because to much less heat being generated by tissue friction as a result of the blade pulsating at 55.5 kHz, mechanically shattering the hydrogen atoms in protein molecules.[77] "The

following evaluation analysed the degree of thermal damage caused by all energy-based laparoscopy devices in terms of length, output power, and tissue thickness.

Figure 9: "Far Less Mist Production with Thin Flaps vs Thick Flaps"[82]



A single 5-s treatment, a single 10-s administration, and a series of two successive 5-s applications were all used by Perko et al. to explore the Harmonic Scalpel's effects on tissues. Light microscopy and anthropometric imaging analyses were used to determine the breadth of material lateral heat deformation from the Harmonic Scalpel incision point. "The researchers measured lateral heat deformation with mean widths of 0.0522 0.0097 mm after a 5-s Harmonic Scalpel administration, 0.15440.0419 mm after a 10-s treatment and 0.10200.0430 mm after a 5-s implementation followed by 5 s of repose and another 5 s of action".[77]

In 2009, the "European Surgical Research" validated earlier research by Pogorelic and colleagues that coagulation necrosis is more common when the device is used continuously rather than disconnected/reconnected. The results showed that tissue lateral heat deformation following application of "Ultrasonic shears at conventional output power is larger when a prolonged sustained duration of application is utilized". The findings were based mostly on pig and rat abdomen walls. When the Ultrasonic shears are applied continuously as opposed to the same total period with a small middle break, lateral heat damage is also enhanced.[76]

A bipolar feedback-controlled vessel sealing system called LigaSure can efficiently seal vessels with a diameter of up to 7 mm while minimising thermal spread. The tool uses a correct number of application of pressure and radiofrequency radiation to fuse opposing tissue layers through the creation of a translatable seal of denatured collagen.[84,85] Because LigaSure achieves tissue union by protein denaturation as opposed to bipolar electrocautery, a genuine seal rather than a distal thrombus is produced. Less than 1 mm is the lateral thermal dispersion.[86]

"Following the recruitment of 100 patients for a comprehensive evaluation of Monopolar cauterization, Harmonic scalpel, and LigaSure, Druijani and coworkers used light microscopy and anthropometric imaging analysis to measure the thickness of tissue lateral heat damage from the juncture of the peritoneal incision. After a peritoneal incision, the mean lateral thermal damages caused by Harmonic scalpel, monopolar diathermy, and LigaSure comprised 215.79, 90.42, 127.48, and 144.18 m, respectively".[87]

In 2008, Lamberton et al proposed 4 laparoscopic vessel ligation equipment (2 bipolar sealing devices, "LigaSure V (LS) and Gyrus PK (GP), an ultra - sonic device, Harmonic Scalpel ACE (HS), and a novel device utilising nanotechnology, EnSeal PTC (ES)), with study end nodes including lateral thermal damage caused by various dissectors".[88]

Complications

The frequent side effects include bleeding, infection, and structural damage. The liver is a highly vascular organ, therefore complications like haemorrhage are prevalent. To avoid significant blood loss, skilled surgeons must be familiar of arterial anatomical anomalies. Iatrogenic injury to the typical bile/hepatic duct is the most serious effect. After injury to any of these tissues, additional surgery may be necessary to redirect the movement of bile into to the intestines. Typically, a pancreatic surgeon with appropriate experience is required for this therapy.[89]

The conversion to an open operation, while not a complication, has become less frequent as surgeons' experience has increased. A wider abdominal incision, severe postoperative pain management challenges, and an unsightly scar are all consequences of switching to an open operation. Take into consideration that deciding to have an open surgery is not a problem, but rather an informed decision taken by a trained surgeon to give the patient a safe course of treatment.[90]

In addition to complicating the surgery, bile leaks can result in fever, unexplained abdominal discomfort, or both, with or no signs and symptoms of "direct hyperbilirubinemia". Patients who are complicated frequently show up during the first week after operation. Treatment should start with a diagnostic abdominal CT scan or ultrasonography. Retained Choledocholithiasis necessitates biliary sphincterotomy. For the treatment of serious leaks, sphincterotomy and stenting should be employed. A HIDA scan to assess bile leakage is advised when CT or ultrasonography results are unclear.[90]

Morbidity and mortality in LC

"A singe center randomized controlled trial in Switzerland with 86 subjects were included to evaluate the morbidity in early LC and delayed LC. Early laparoscopic cholecystectomy (ELC) patients had lower overall morbidity. The ELC group had a shorter median total length of stay (4 vs 7 days, P 0.001) and duration of antibiotic therapy (2 vs 10 days, P 0.001). ELC had lower total hospital costs. The surgical time and postsurgical consequences were comparable. These findings indicated that early laparoscopic cholecystectomy (LC) for acute cholecystitis was safe even after 72 hours of symptoms and was associated with a shorter overall stay in the hospital, reduced period of antibiotic medication, and relatively low cost when compared to deferred cholecystectomy".[91]

In a systematic analysis by Coccolini, F et al observed that Laparoscopic cholecystectomy decreased post-surgical, death, mortality, and hospital stay in subjects with severe cholecystitis.

LC also reduced the rate of pneumonia and wound infection. This technique had no effect on the rates of severe haemorrhage or bile leakage. Hence, this analysis suggested Cholecystectomy in acute cholecystitis should be attempted laparoscopically first.[92]

Most relevant studies

"Retrospective research was done on patients who had had laparoscopic simultaneous cholecystectomy and surgical removal in 2018 by Liu, G. et al. Each laparoscopic combination cholecystectomy and appendectomy involved coagulation and sealing of the cystic and appendix arteries. Due to severe abdominal scar tissue or gallbladder puncture, 3 (5.3%) of the 57 individuals needed open surgery. The typical surgical procedure lasted 56 mins (range, 40–80 min). An average hospital stay following surgery was 3.0 days, and the average loss of blood was 12 mL (range: 5-120 mL) (range, 2–5 days). Post-Surgical hemorrhage, biliary rupture, infection, or mortality were non-existent. A safe, efficient, and affordable surgical technique was used to block the cystic and appendix vasculature during a laparoscopic simultaneous cholecystectomy and appendectomy".[93]

Ai, Xi et al. meta- analysis's from 2018 examined the efficacy and safety of US against clips for clamping the cystic duct during LC. 529 individuals were in the US cohort and 602 were in the clips group out of a maximum of 1131 patients, showing a substantial difference but no statistically significant heterogeneity. In terms of age or gender, there was insignificant difference between the two categories. In comparison to the clips group, the US group's hospital stay and operating time were significantly reduced. There was no significant difference between the two groups for conversion perforation, bile leakage, or total morbidity. In comparison to clips, the US permitted LC with a shorter hospital stay and operating time. In terms of conversion, rupture, bile spillage, and general morbidity, US was also equivalent to clips. This meta-analysis came to the conclusion that US is at least as safe and successful as

traditional clips in terms of cystic duct and vascular closure, or that it is clinically better than conventional clipping in some aspects.[94]

Rajnish, K. et al study's 2018 compared harmonic scalpel aided laparoscopic cholecystectomy (HSLC) to standard laparoscopic cholecystectomy (CLC) in terms of operating time and postoperative complications (HLC). As a consequence, HLC presented no discernible benefit over CLC in terms of surgical time, postsurgical discomfort, and intraoperative consequences.[19]

"Harmonic scalpel clipless (HSG) or traditional laparoscopic cholecystectomy (CLC) with electrocautery were the two treatment options given to 150 patients (75 in each group) who were randomly allocated to one of the two groups in the comparative research by Sanawan, E. et al.95, 2017. (CLC). HSG operated for a somewhat shorter period of time than CLC. Rather than 35 minutes (IQR 10), the median operating duration was 30 min (IQR 10). (p0.001). In the HSG group, the perforation rate was 5/75 (6.67%), while it was 16/75 (21.33%) in the CLC cohort (p=0.010). The ultrasonic shear group outperformed the traditional electrocautery group in every single main result".[95] A systematic meta-analysis by Jiang, H et al[96] 2107 found ultrasonic device with better performance with superior clinical outcomes compared to electrocautery device in laparoscopic cholecystectomy.

The 2014 study by Zangh, A., et al. looked at the potential advantages of ultrasonic segmentation and how well it worked to seal off the cystic artery and duct. Compared to the conventional group, the harmonic group's mean operation time was substantially lower in the conventional group had a substantially greater risk of gallbladder perforation than the harmonic group (20.66percent) of the respondents (25 individuals) vs. 6.98% (3 cases), respectively; p 0.05). Blood loss during surgery was substantially higher in the conventional group than in the HS cohort. "Between groups, there was no discernible difference in the mean postoperative

drainage volume. In neither group were there any serious visceral injuries. 14.02% was the overall morbidity rate".[20]

A prospective study by Ramzanali, S et al [17]2013 study involved 92 subjects with symptoms of gallstone indicated for laparoscopic and where randomly grouped to 2 groups: group A subjects who underwent LC with monopolar diathermy and group B with HS. Due to the low lateralization of heat energy, harmonic scalpels (HS) are used in surgery to reduce intraoperative blood loss, gallbladder damage, bile rupture, and stone spillage. The findings supported the use of a HS in operation since it reduced intraoperative blood loss, gallbladder damage, bile rupture, and stone seepage. This was because there was less lateralization of heat energy.

The efficiency and risk of 3 laparoscopic cholecystectomy tools were compared by Bulus, H. et al. [97] in There were 60 patients altogether in the research. "The individuals were split into 3 different groups. In Group A, the gall bladder was separated from the hepatic bed using electrocautery, and the cystic duct and artery were secured using laparoscopic clips. In Group B, Harmonic scalpel was used to separate the gall bladder from the hepatic bed and seal the cystic duct and artery. In Group C, a bipolar vascular sealer was used to separate the gall bladder from the hepatic bed and to seal the cystic duct and artery. Surgery took 31.5 minutes in Group B, 33.1 minutes in Group A, and 36.5 minutes in Group C. There was a substantial difference between Group B and Group C (P=0.04). Different energy source equipment used in LC may be safe to employ if the cystic duct is carefully dissected and sealed".

A prospective RCT by Mahabaleshwar, Vet al[5] 2012 compared the efficiency of the 2 methods in laparoscopic cholecystectomy. Final analysis included 60 subjects. "The results found Ultrasonic dissection is safe and effective, and it improves the operative course of laparoscopic cholecystectomy by reducing the incidence of gallbladder perforation".

“Katri, K. et al. 2012 sought to determine how well monopolar electrocautery reduced cystic artery bleeding after laparoscopic cholecystectomy. A total of 158 LC were included in the research. In 25 patients (15.8%), two arteries were controlled, as was one artery in 122 individuals (77.2%), however the cystic artery was missed in 11 individuals (7%). In 43, 72, and 32 individuals, the artery was classified as small, medium, or big, respectively. Monopolar electrocautery was used to regulate the artery in 114 individuals (77.5%) and metal clips were used in 33 patients (22.5%). In the majority of cases (68%), the cystic artery was managed laterally to the cystic lymph node. Injuries to the bile duct or bleeding were not observed at any point during the investigation. Therefore, during laparoscopic cholecystectomy, the electrocautery approach proved both safe and efficient for controlling the cystic artery”.[14]

A meta-analysis conducted in 2012 by Xiong, J. et al. compared the safety and benefit of monopolar electrical energy and ultrasonic energy in LC in RCT. According to the analysis's findings, Ultrasonic power is equally reliable and effective, as laser - assisted energy, and in certain cases it may even be safer.[98]

In a systematic review published in 2010, Sasi, W. et al. found that using ultrasonic LP resulted in a statistically significant decrease in operating time, stay in hospital, and sick leave as well as a lower risk of biliary perforation, particularly in serious complications, and lesser pain and nausea scores at numerous postsurgical time points. “However, many of these putative advantages are speculative and susceptible to selection and anticipation bias because the majority of the included studies were not blinded”. [16]

LACUNAE IN LITERATURE:

LC presently is the choice of treatment for gall bladder disease and has replaced open cholecystectomy. In developing countries like India too laparoscopic cholecystectomy has been vastly used. However, community based or multicentric hospital study regarding the morbidity and other outcomes in India has not being well established still. The comparison of "ultrasonic energy versus monopolar electrosurgical energy" in LC though has shown controversial results, all the literature has been done in past. Presently its comparison has been limited to few studies with less sample size and India is least studied.

A robotic surgery is a computer-controlled device that aids in the use and manipulation of surgical instruments by a surgeon. Originally intended for tele surgery, the surgical robot is now employed in the surgery room to ease laparoscopic surgery. Since the first robotic assisted system was authorised in the United States in 2000, practically every area of laparoscopic surgical intervention has seen extensive usage of surgical robots. However, this procedure India tough used in India is widely for upper socio-economical people, as it is very expensive.

MATERIALS AND METHODS

Materials and Methods:

Study site: "This study was conducted in the Department of Surgery at R.L.Jalappa Hospital and Research Centre attached to Sri Devaraj URS Medical College, Tamaka, Kolar".

Study population: individuals underwent laparoscopic cholecystectomy in at "R.L.Jalappa Hospital and Research Centre attached to Sri Devaraj URS Medical College, Tamaka, Kolar".

Study design: The current study was a Comparative Observational study.

Sample size:

Assuming the difference in operating time to be 6 minutes, with standard deviation of (n=20) and(n=20) in each group obtained from previous study Kumar Rajnish et al, and with 95% of confidence interval and 80% of power, the minimum sample size for the study was calculated to be 37 in each group with a total of 74.

The sample size formulae used are as follows:

$n_1= (\sigma_1^2 + \sigma_2^2/ \kappa) (z_{1-\alpha/2} + z_{1-\beta})^2 / \Delta^2$

$n_2= (\kappa* \sigma_1^2+ \sigma_2^2) (z_{1-\alpha/2} + z_{1-\beta})^2 / \Delta^2$

n_1= sample size of group 1

n_2= sample size of group 2

σ_1= standard deviation of group 1

σ_2= standard deviation of group 2

Δ= difference in group means

K= ratio = n2/n1

$z_{1-\alpha/2}$= two sided z value

$z_{1-\beta}$= power.

Sampling method: Until the desired sample size was obtained, all of the eligible participants were sequentially recruited into the research using easy sampling.

Study duration: The data collection for this study was from November 2020 to August 2022.

Inclusion Criteria:

1. Operable gallstone diseases

2. "American Society of Anaesthesiologists Grade I and Grade II"

Exclusion Criteria:

1. Immuno-compromised status

2. Chronic liver disease

3. Impaired liver function test

4. Proven malignancy

Ethical considerations: The institution's human ethics committee authorised the study. All research participants provided written informed consent, and only those who were prepared to sign it were allowed to take part in the investigation. Before getting agreement, it was mentioned to the participants the risks and advantages of the study as well as the volunteer nature of their involvement. Participants in the research were kept in the strictest of confidence.

Data collection tool: A well-organized research proforma contained documentation of all pertinent parameters.

Methodology:

- A complete detailed history and physical examination were done followed by relevant investigations after obtaining informed consent.
- Subjects were allotted into 2 groups using the odd (A) and even (B) methods. Each group consisted of 37subjects.
- All patients were subjected to pre-anesthetic evaluation to determine their fitness for surgery.
- Co morbidities if any, were appropriately corrected pre-operatively.
- Patients in group A underwent LC using ultrasonic shears.

- Patients in group B underwent LC using monopolar electrocautery.
- All the parameters to compare the two techniques were recorded and tabulated.

Statistical methods:

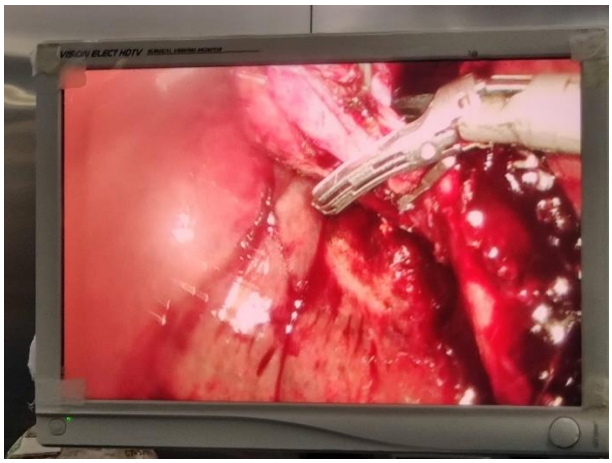
Used energy was regarded as the primary explanatory factor. The key outcome parameters were intraoperative blood loss (ML), operating duration in minutes, VAS ON POD1, and length of hospital stay in days. Age, gender, and other factors were regarded as pertinent research criteria.

All of the study's pertinent parameters were distributed in the right areas like counts, proportions, means, and standard deviations, and associated graphics like pie and bar charts were used to illustrate the results.

Continuous measurements are compared between study samples using the mean (central tendency) and SD (‘standard deviation’) in accordance with the normal distribution of the data, using an independent sample t-test (2 groups).

Significance as per the value of P was defined if the value was <0.05. Co-Guide software, version 1.01, was used to analyse the data.

Figure 10: LAPAROSCOPIC CHOLECYSTECTOMY USING HARMONIC SHEARS



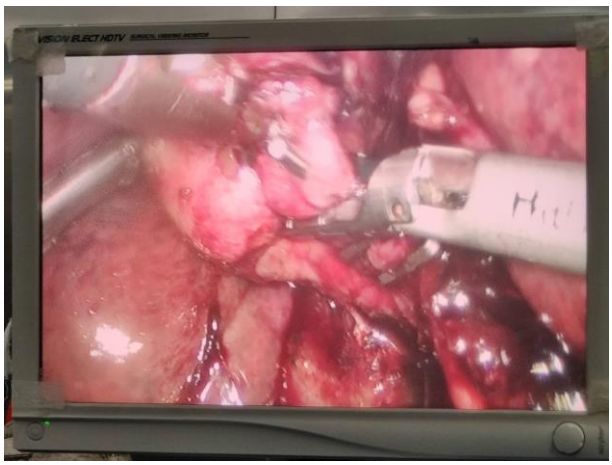
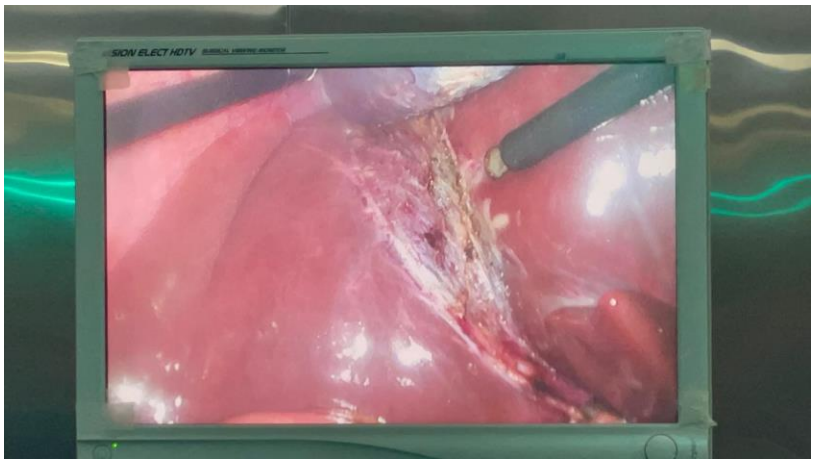


Figure 11: LAPAROSCOPIC CHOLECYSTECTOMY USING MONOPOLAR SPATULA



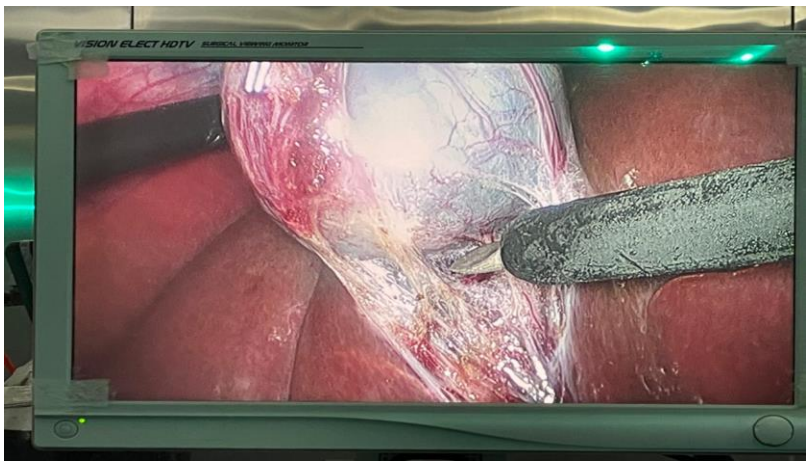
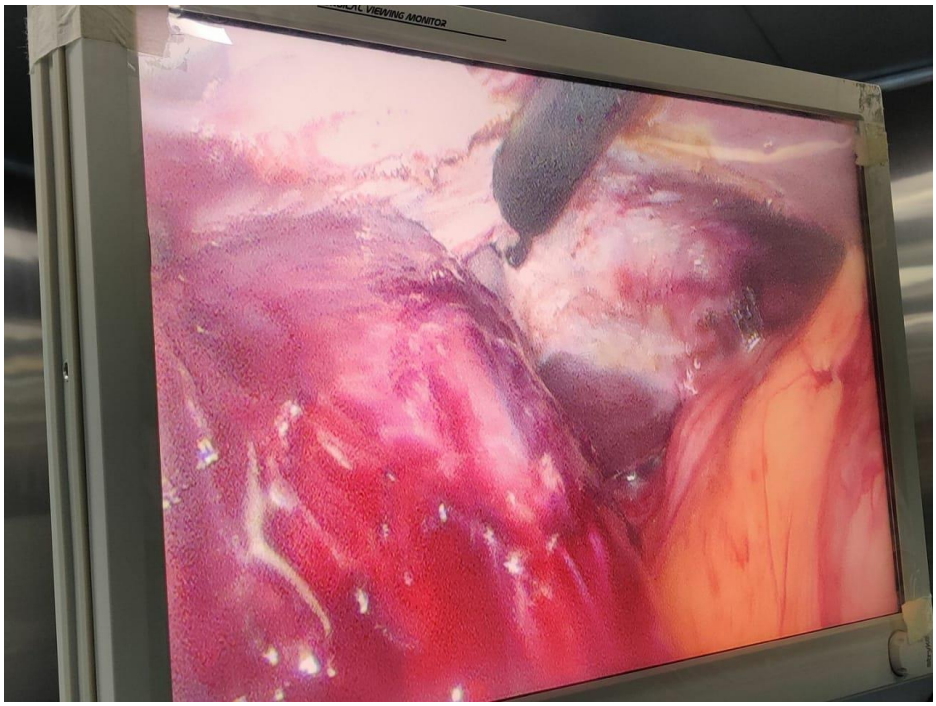
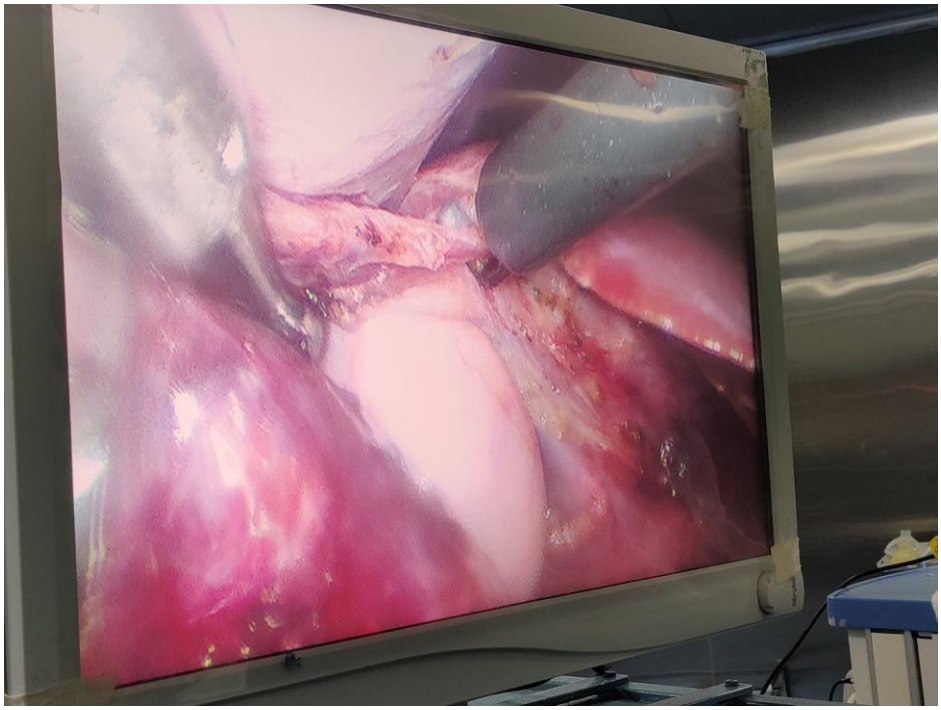


Figure 12: LAPAROSCOPIC CHOLECYSTECTOMY USING MONOPOLAR HOOK





RESULTS

RESULTS

A total 74 samples considered into the present study.

Table 1: Distribution of Age (years) in the study (N=74)

Name	Mean ± SD	Median	Minimum	Maximum	95% CI	
					Lower CI	Upper CI
Age (years)	44.23±14.67	41.50	20.00	80.00	40.89	47.57

The mean age (years) of samples studied was 44.23 ± 14.67, ranged as 20-80. (95% CI 40.89 to 47.57). (1st table)

Table 2: Summary of Gender (N=74)

Gender	Count	Percentage
Male	14	18.92%
Female	60	81.08%

There were 14 (18.92%) male and remaining 60 (81.08%) females in the study cases. (Table 2 & Figure 10)

Figure 13: Bars Indicating Distribution of Gender (N=74)

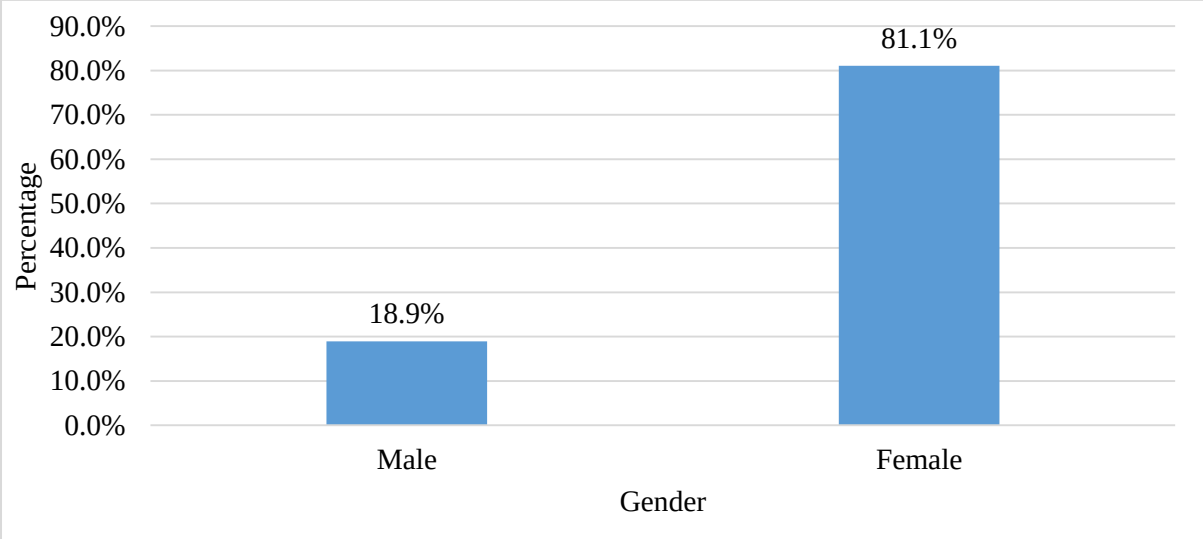


Table 3: Summary of Indication in the Samples Studied (N=74)

Indication	Frequency (N)	Proportion
Acute calculous cholecystitis	1	1.35%
Cholelithiasis post (ercp)	1	1.35%
Symptomatic cholelithiasis	1	1.35%
Porcelain gallbladder	1	1.35%
Gallbladder polyp	3	4.05%
Calculous cholecystitis	6	8.11%
Calculous cholelithiasis	8	10.81%
Cholelithiasis	53	71.62%

Among the study population, majority of 53 (71.62%) participants had cholelithiasis indication, followed by 8 (10.81%) participants had calculous cholelithiasis indication, 6 (8.11%) participants had calculous cholecystitis indication, 3 (4.05%) participants had gallbladder polyp indication and only 1 (1.35%) participant had acute calculous cholecystitis, symptomatic cholelithiasis, cholelithiasis post (ERCP) and porcelain gallbladder indication for each respectively. (Table 3 and Figures 11)

Figures 14: Indication of Study Cases Through Bar Chart (N=74)

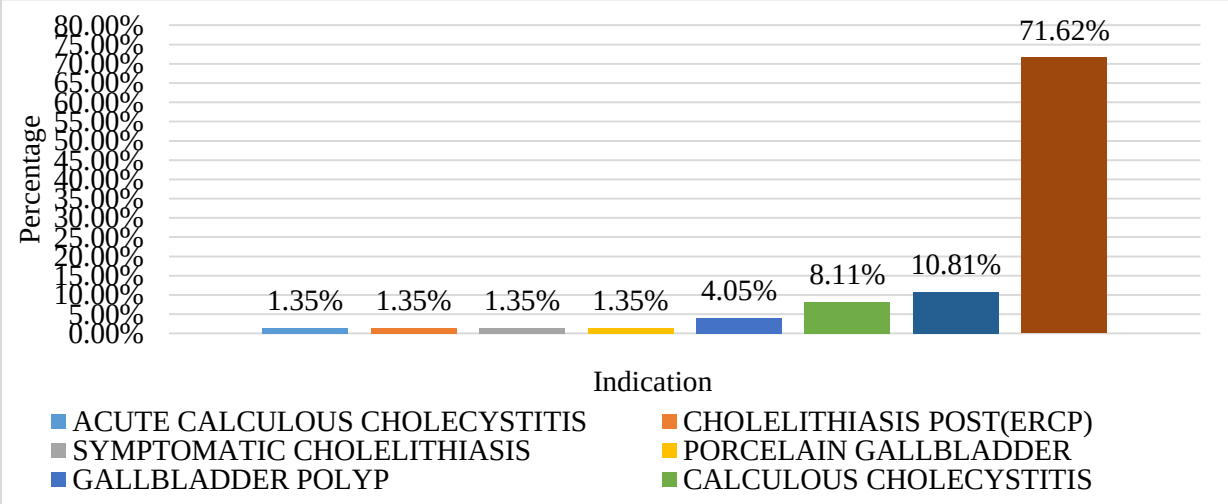


Table 4: Descriptive Stats for Energy Used (N=74)

Energy used	Summary (N)	Percentage
Ultrasonic energy	37	50.00%
Monopolar electrocautery	37	50.00%

In the present study, 37 (50.00%) were using ultrasonic energy and the same count were using monopolar electrocautery also. (Table 4 & Figures 12)

Figures 15: Depicting Energy Usage Using Graph of Pie (N=74)

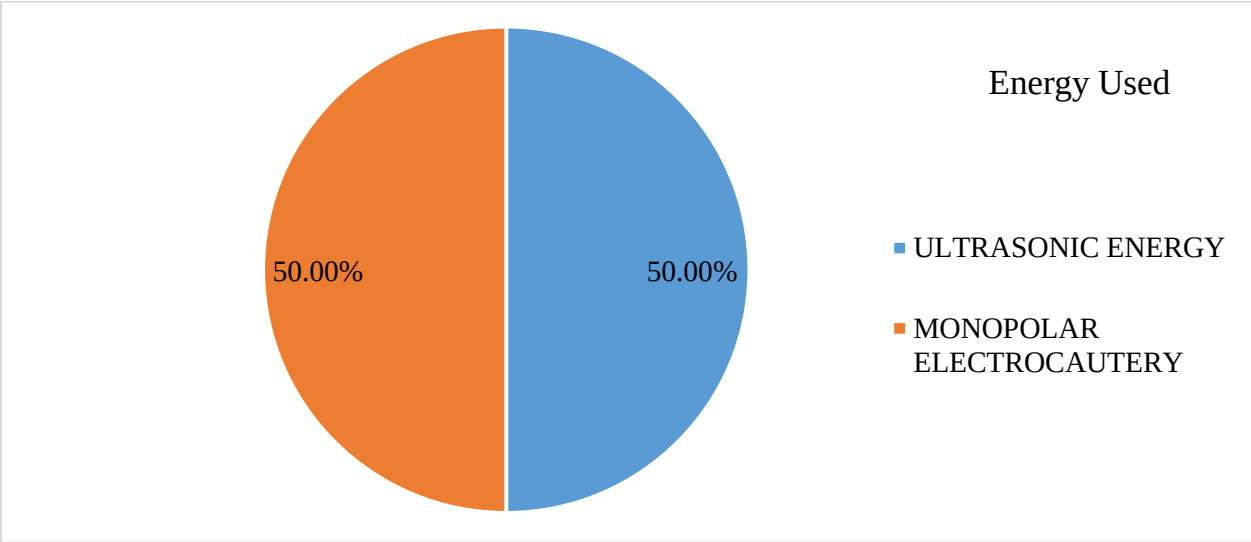


Table 5: Basic Summary of Intra Operative Blood Loss (ML) (N=74)

Name	Mean ± SD	Median	Minimum	Maximum	95% CI	
					Lower CI	Upper CI
Intra operative blood loss (ml)	17.54±8.81	15.00	5.00	35.00	15.53	19.55

The mean of intra operative blood loss (ml) was 17.54 ± 8.81, minimum level was 5 and highest level was 35 in the study cases (95% CI 15.53 to 19.55). (5th Table)

Table 6: Summary of Operating Time in Mins (N=74)

Name	Mean ± SD	Median	Minimum	Maximum	95% CI	
					Lower CI	Upper CI
Operating time (in mins)	51.76±13.41	50.00	30.00	75.00	48.70	54.81

The mean of operating time of study cases was 51.76 ± 13.41 in mins, minimum level was 30 and max value was 75. (95% CI 48.7 to 54.81). (Table 6)

Table 7: Distribution Indicating VAS ON POD1 in Our Study (N=74)

Name	Mean ± SD	Median	Minimum	Maximum	95% CI	
					Lower CI	Upper CI
VAS ON POD1	4.65±1.35	4.50	2.00	7.00	4.34	4.96

The mean VAS ON POD1 as per the study was 4.65 ± 1.35, range reported as 2 to 70. (95% CI 4.34 to 4.96). (Table 7)

Table 8: Descriptive Analysis of Length of Hospital Stay (days) (N=74)

Name	Mean ± SD	Median	Minimum	Maximum	95% CI	
					Lower CI	Upper CI
Length of hospital stay (days)	7.03±1.67	7.00	3.00	10.00	6.65	7.41

The Length of hospital stay (days) value of mean reported as 7.03 ± 1.67, min and max values were 3 and 10 days respectively. (95% CI 6.65 to 7.41). (Table 8)

Table 9: Comparison of Intra Operative Blood Loss (ML) with Energy Used in the Study Population (N=74)

Parameter	Energy used		IST P Value
	Ultrasonic energy (N=37) Mean ± SD	Monopolar electrocautery (N=37) Mean ± SD	
Intra operative blood loss (ML)	10.81 ± 4.49	24.27 ± 6.64	<0.001

The mean of intra operative blood loss (ML) was 10.81 ± 4.49 in ultrasonic energy group and it was 24.27 ± 6.64 in monopolar electrocautery group, the difference was significant statistically in the two study samples. (p value <0.001). (Table 9)

Figure 16: Bar picture of Intra Operative Blood Loss (ML) with Energy Used in the Study Population (N=74)

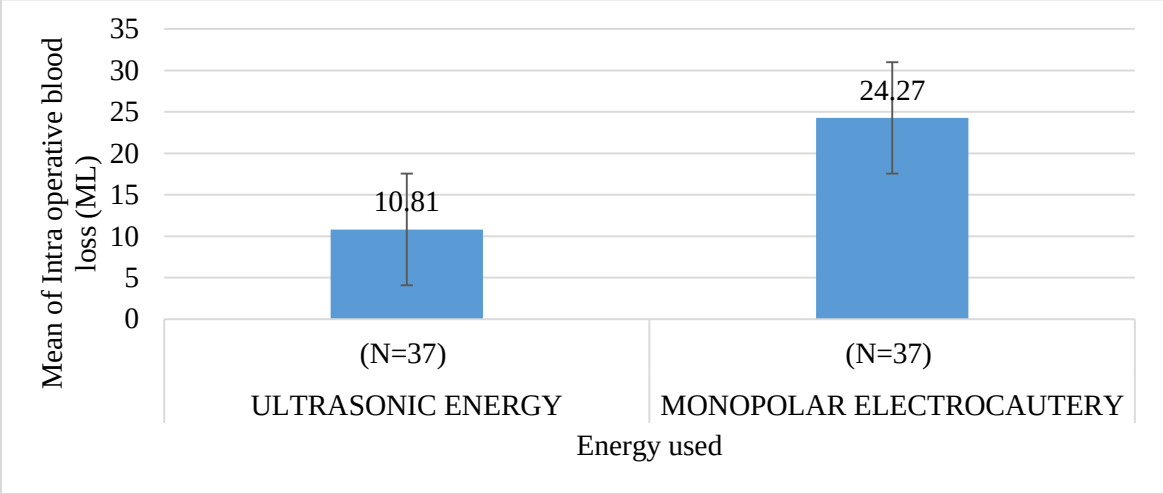


Table 10: Comparison of Operating Time in Mins with Energy Used in the Study Population (N=74)

Parameter	Energy used		IST P Value
	Ultrasonic energy (N=37) Mean ± SD	Monopolar electrocautery (N=37) Mean ± SD	
Operating time (in mins)	41.49 ± 7.72	62.03 ± 9.39	<0.001

The mean of operating time in mins was 41.49 ± 7.72 in ultrasonic energy group and it was 62.03 ± 9.39 in monopolar electrocautery group, the difference in operating time in two clusters of the study was reporting statistical significance with p value <0.001. (Table 10)

Figures 17: Bars depicting Operating time in mins with Energy used in the study population (N=74)

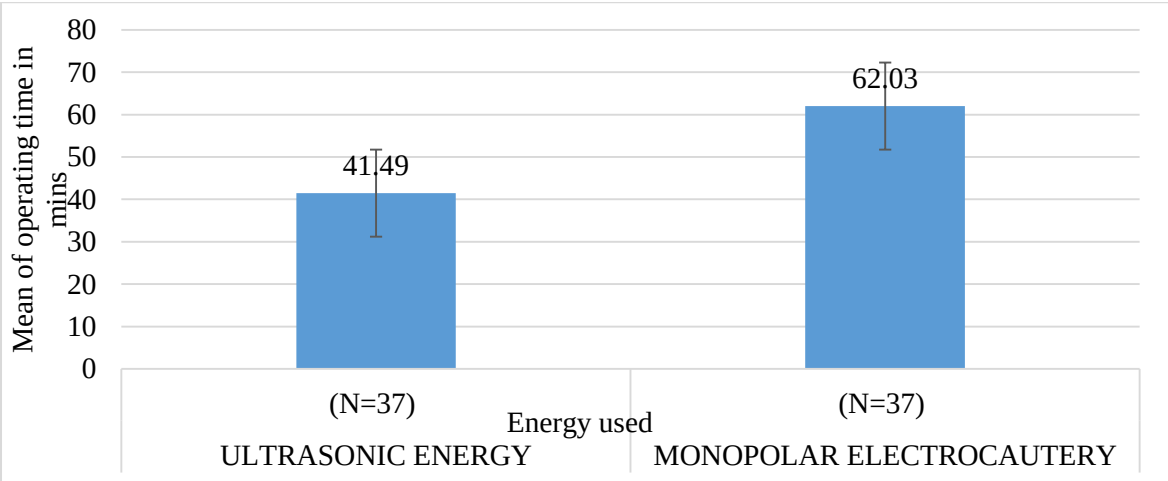


Table 11: Length of hospital stay (days) as per the Energy usage in the study population (N=74)

Parameter	Energy used		IST P Value
	Ultrasonic energy (N=37) Mean ± SD	Monopolar electrocautery (N=37) Mean ± SD	
Length of hospital stay (days)	5.78 ± 1.00	8.27 ± 1.22	<0.001

The mean (central tendency) of length of hospital stay (days) was 5.78 ± 1.00 in ultrasonic energy usage cases and it was 8.27 ± 1.22 in monopolar electrocautery, the difference of the measurement indicating significance statistically because the p value <0.001. (11th Table)

Figure 18: Bar chart of Length of hospital stay (days) with Energy used in the study population (N=74)

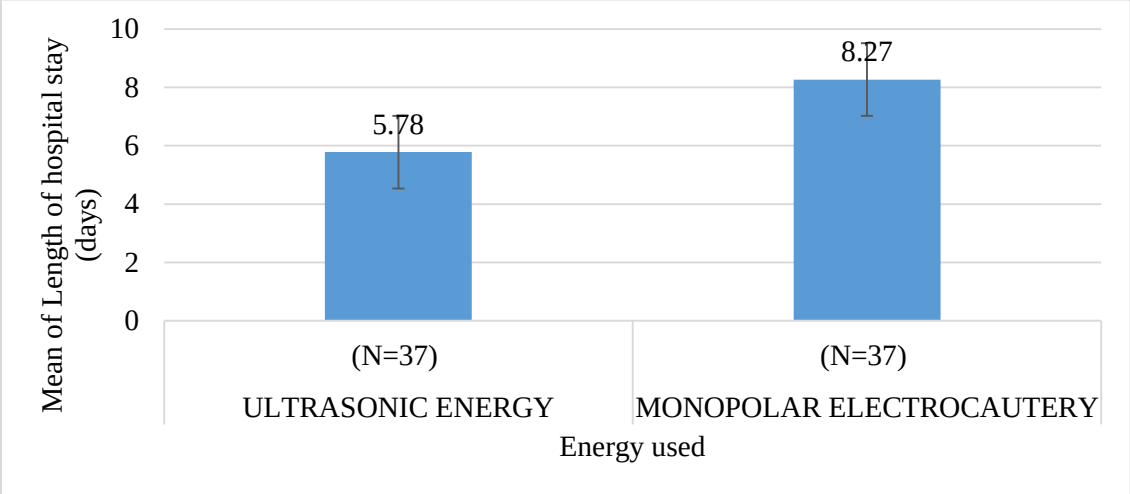
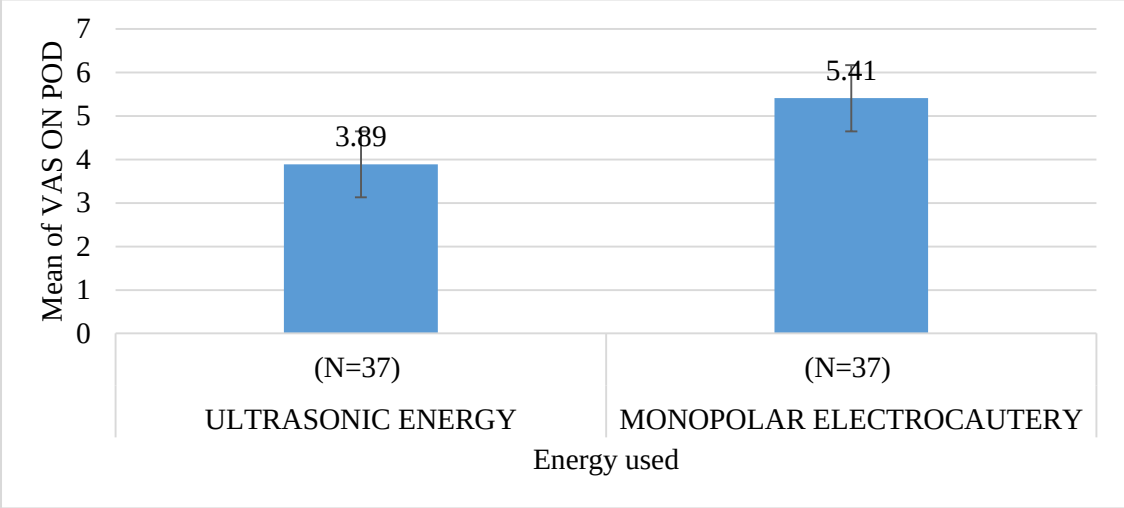


Table 12: Comparison of VAS ON POD1 with Energy used in the study population (N=74)

Parameter	Energy used		IST P Value
	Ultrasonic energy (N=37) Mean ± SD	Monopolar electrocautery (N=37) Mean ± SD	
VAS ON POD 1	3.89 ± 1.05	5.41 ± 1.19	<0.001

The mean of VAS ON POD 1 was 3.89 ± 1.05 in the cluster using ultrasonic energy and it was 5.41 ± 1.19 in monopolar electrocautery cluster, there was statistical significance since the significance value was <0.001. (12th Table)

Figure 19: Bar chart of VAS ON POD1 with Energy used in the study population (N=74)



DISCUSSION

DISCUSSION:

Due to contradictory information, this study set out to examine the possible benefits and drawbacks of using ultrasonic dissection during LC. The efficacy and safety of using an ultrasonically activated scalpel for gallbladder dissection have been supported by numerous studies. In order to separate and divide cystic ducts and arteries, ultrasonically actuated shears were first used in 1999.[63]

In contrast to monopolar electrocautery, which is linked to 15% of biliary tract injuries and 90% of visceral injuries during laparoscopic cholecystectomy, Injury risk is reduced by ultrasonic energy's little lateral propagation of vibration flow in the surrounding tissues. However, only a small number of authors have looked at its effectiveness in closing the cystic artery and duct.[36,99] This study compared the effectiveness of ultra -shear ultrasonic shears vs. monopolar electrocautery in laparoscopic cholecystectomy.

This comparative observational study included 74 subjects with mean age of the study population was 44.23 ± 14.67 yrs. Female predominance was observed in our study (81.08 %VS 18.92%). Majority (71.62%) of the study population had cholelithiasis indication, followed by 10.81% had calculous cholelithiasis indication, 8.11% had calculous cholecystitis indication, 4.05% had gallbladder polyp indication and only 1.35% participant had acute calculous cholecystitis, symptomatic cholelithiasis, cholelithiasis post (ERCP) and porcelain gallbladder indication for each respectively.

The study subjects was divided into 2 groups, with 50% each (n=37) subjects in ultrasonic energy group and to monopolar electrocautery group. Mahabaleshwar, V et al[5] compared the efficiency of electrocautery and ultrasonic involving 60 subjects (30 subjects in each group)for gall bladder dissection by laparoscopic surgery. Similarly, Zanghì, A et al[20] study involved 121 subjects in monopolar group and 43 subjects in ultrasonic group.

The mean "intra operative blood loss (ml)" was 17.54 ± 8.81, the "mean of operating time" was 51.76 ± 13.41, the mean VAS ON POD1 was 4.65 ± 1.35, and the "mean Length of hospital stay" (days) was 7.03 ± 1.67 among the study population.

Comparison of blood loss, hospital stay, operating time and vas score between the groups

The mean intra operative blood loss (ML) was 10.81 ± 4.49 in ultrasonic energy group and it was 24.27 ± 6.64 in monopolar electrocautery group, the difference between 2 groups was substantially noteworthy. (p value <0.001). Hence, we found a significantly less blood loss during surgery by ultrasonic energy group. Similar findings was supported by Zanghì, A et al[20] study where they found "Intraoperative volume blood loss significantly more in the monopolar group than in the HS group" ("29.32+14.21 vs. 12.41+8.22; p < 0.0001").

Table 13: Comparing the "Intraoperative Blood Loss" Among the two Groups Across Various Studies to Present Study

Studies	Monopolar	Ultrasonic / harmonic
Zanghì, A et al[20]	29.32+14.21	12.41+8.22
Sharma, N et al[18]	20.5±1.50 cc	16.10±2.22 cc
Present study	24.27 ± 6.64	10.81 ± 4.49

The mean of operating time in mins was 41.49 ± 7.72 in ultrasonic energy group and it was 62.03 ± 9.39 in monopolar electrocautery group, the variance among the 2 groups was substantial. (p value <0.001). Mahabaleshwar, V et al[5] found the mean duration of surgery was significantly less in ultra-sonics compared to electrocautery group ("electrocautery 34.37 minutes VS 27.20 minutes in the ultrasonic dissection group" (p = 0.001). In another study by Kandil, T et al[36] found significantly lesser duration of operating time with harmonic scalpel compared to conventional method ("33.21 + 9.6 vs. 51.7 + 13.79, respectively, p = 0.001").

Similar observation were found in Zanghì, A et al[20] study. In contrast to the present study by Rajnish, Kumar et al[19] found no significant (p0.03)difference between the mean operating time between harmonic scalpel and conventional laparoscopic group (conventional 67.3 ± 9.65 minutes, VS HLC group was 64.3 ± 8.5 minutes). Sharma, N et al[18] found significantly less duration of operative time in clipless harmonic scalpel group compared to conventional group (50 minutes 20 sec. VS 36 minutes 10 sec). Similar to this, the clipless LC group's operation took less time than the conventional LC group's in the study by Zaidi AH et al [100] and Gelmini R et al.[99] Patients who have clipless LC have shorter recovery times because only one instrument is used for cutting, coagulation, and the division of the cystic duct and cystic artery in this procedure. Because monopolar electrocautery produces intense collateral heat that causes tissue necrosis and ischemia, it is frequently linked to unintentional tissue damage.

The majority of electrocautery injuries present late or are not recognized during surgery.[36] However, an injury like a perforated gallbladder during a laparoscopic cholecystectomy can significantly complicate the surgical procedure by causing bile and stones to spill into the peritoneal cavity. This could make the surgery take longer and have negative effects. [36] There are a number of reasons why the ultrasonic dissection group's mean surgery time was shorter. "The dissector, clip applier, scissors, and electrosurgical hook or spatula are the four instruments commonly used in laparoscopic cholecystectomy that the Harmonic Ace replaces". The ultrasonic dissector's activation also doesn't cause smoke, which gives the surgeon a clear working space throughout the procedure.[5]

Table 14: Comparing the Mean Operative Time Among the two Groups Across Various Studies to Present Study

Studies	Monopolar	Ultrasonic / harmonic
Zanghì, A et al[20]	55.6+12.10	35.36 + 10.15 min
Mahabaleshwar, V et al[5]	34.37 minutes	27.20 minutes
Kandil, T et al[36]	33.21 + 9.6	51.7 + 13.79
Rajnish, Kumar et al[19]	67.3 ± 9.65 min	64.3 ± 8.5 min
Sharma, N et al[18]	46 min 50 sec	33 min 10 sec
Present study	62.03 ± 9.39	41.49 ± 7.72

The "mean of length of hospital stay" (days) was 5.78 ± 1.00 in ultrasonic energy group and it was 8.27 ± 1.22 in monopolar electrocautery group, hence a substantially more number of days in hospital spent was found in group 2. P value 0.001. According to Ai, Xi et al[94], findings, US clearly reduced operating time and hospital stay more than clips did, but there was no substantial difference among the 2 groups in terms of converting, puncture, biliary leakage during surgery, or general morbidity. It might be assumed that US is on par with, or even outperforms, ME (monopolar electrocautery) and clips with scissors in some respects. The cystic duct in LC can be blocked using US in an equally safe and effective manner, which makes it a viable alternative to traditional clips. In addition, contrast to our study findings Zanghì, A et al[20] found insignificant shorter duration of hospital stay in in harmonic group (monopolar electrocautery 48.15+4.29 vs. harmonic 49.06+2.94 hrs, $p > 0.05$). Similarly, Sharma, N et al[18] found significant lesser hospital stay in US group.

Table 15: Comparing the Mean Hospital Stay among the two Groups across Various Studies to Present Study

Studies	Monopolar	Ultrasonic / harmonic
Zanghì, A et al[20]	48.15+4.29 hrs	49.06+2.94 hrs,
Sharma, N et al[18]	2.40±0.13 days	1.70±0.13 days
Present study	8.27 ± 1.22	5.78 ± 1.00 days

The mean of VAS ON POD 1 was 3.89 ± 1.05 in ultrasonic energy group and it was 5.41 ± 1.19 in monopolar electrocautery group, hence the vas score in our study among the US group was substantially less compared to monopolar group. In Kandil, T et al[36] study the VAS score in harmonic scalpel was significantly less compared to conventional group at different time duration ("12 h postoperative was 3.25 + 1.84 vs 5.01 ± 1.2, p = 0.001) and at 24 h postoperative was 3.12 ± 1.64 vs. 4.48 ± 1.89,p = 0.001"). Rajnish, Kumar et al[19] study recorded insignificant variation in the pain scores between conventional and harmonic scalpel at 0 day and day1 (day 0: conventional 4.55 ± 0.51, VS ultra- sonic 4.65 ± 0.6, Day 1: 2.3 ± 0.8, VS 2.25 ± 0.78)

Table 16: Comparing the Vas Score among the Two Groups across Various Studies to Present Study

Studies	Monopolar	Ultrasonic / harmonic
Kandil, T et al[36]	5.01 ± 1.2	3.25 + 1.84
Rajnish, Kumar et al[19]	4.55 ± 0.51	4.65 ± 0.6
Sharma, N et al[18]	1.64	1.62
Present study	5.41 ± 1.19	3.89 ± 1.05

CONCLUSION

Conclusion

- The study populace was divided into 2 groups, with 50% each (n=37) subjects in ultrasonic energy group and to monopolar electrocautery group.
- "The mean intra operative blood loss" (ml) was 17.54 ± 8.81, the mean of operating time was 51.76 ± 13.41, the mean VAS ON POD1 was 4.65 ± 1.35, and the "mean Length of hospital stay" (days) was 7.03 ± 1.67 among the study population.
- The "mean intra operative blood loss" (ML) was 10.81 ± 4.49 in ultrasonic energy group and it was 24.27 ± 6.64 in monopolar electrocautery group, the variation between 2 groups was substantially significant. (p value <0.001).
- The "mean of operating time" in mins was 41.49 ± 7.72 in ultrasonic energy group and it was 62.03 ± 9.39 in monopolar electrocautery group, the variation between 2 groups was substantially significant. (p value <0.001).
- The "mean of length of hospital stay" (days) was 5.78 ± 1.00 in ultrasonic energy group and it was 8.27 ± 1.22 in monopolar electrocautery group, the variation between 2 groups was substantially significant. (p value <0.001).
- The "mean of VAS ON POD" 1 was 3.89 ± 1.05 in ultrasonic energy group and it was 5.41 ± 1.19 in monopolar electrocautery group, the variation between 2 groups was substantially significant. (p value <0.001).
- Hence our results found ultrasonic energy group more efficient compared to monopolar electrocautery group as the intraoperative blood loss, operating time, hospital stay and VAS score was less in ultrasonic shear group.

Limitations and recommendations

- The results of this study are more likely to contain type-II statistical errors, so our findings need to be verified by carrying out a larger, multi-centric randomized trial.
- This study found acceptance as a viable alternative to the conventional method. “There is still a need for more randomized trials with larger cohort populations”.
- Our study's implications could lead to the complete LC being performed with ultrasound in the future, removing all metal from the body and reducing the chance that nearby structures will sustain damage.

SUMMARY

Summary

The purpose of this study was to assess the operating time and intra-operative consequences between LC performed with a monopolar and harmonic scalpel. This comparative observational research was carried out between "November 2020 and August 2022 at the R. L. Jalappa Hospital and Research Center in Tamaka, Kolar, which is affiliated with Sri Devaraj Urs Medical College". Ultrasonic shears were used to perform LC on the patients in group A. Patients in group B had monopolar electrocautery-assisted LC.

The research population were divided into 2 groups, with 50% of the individuals (n=37) in each group receiving monopolar electrocautery and ultrasonic energy. In the study population, the mean VAS ON POD1 was 4.65 1.35, the mean operating time was 51.76 13.41, the mean intraoperative loss of blood (ml) was 17.54 8.81, and the average length of hospitalization (days) was 7.03 1.67. “The mean intraoperative loss of blood (ML) was 10.81 4.49 in the monopolar electrocautery group and 24.27 6.64 in the ultrasonic energy group; this difference was statistically significant. P value 0.001 The mean operating time in minutes for the monopolar electrocautery group was 62.03 9.39 and for the ultrasonic energy group it was 41.49 7.72; the difference between the two groups was statically significant”. “The mean hospitalisation (days) was 5.78 days for the monopolar electrocautery group and 8.27 days for the ultrasonic energy group. This difference between the two groups was substantial. P value 0.001 The mean VAS ON POD 1 for the groups using ultrasonic energy and monopolar electrocautery was 3.89 1.05 and 5.41 1.19, respectively. This difference between the two groups was substantial. P value 0.001”.Hence our results found ultrasonic energy group more efficient compared to monopolar electrocautery group as the intraoperative blood loss, operating time, hospital stay and VAS score was less in ultrasonic shear group.

BIBLIOGRAPHY

References:

1. Khan ZA, Khan MU, Brand M. Increases in cholecystectomy for gallstone related disease in South Africa. Sci Rep. 2020;10(1):1–5.
2. Stinton LM, Shaffer EA. Epidemiology of gallbladder disease: cholelithiasis and cancer. Gut Liver. 2012;6(2):172–87.
3. Stender S, Nordestgaard BG, Tybjaerg-Hansen A. Elevated body mass index as a causal risk factor for symptomatic gallstone disease: a Mendelian randomization study. Hepatology. 2013;58(6):2133–41.
4. Talseth A, Ness-Jensen E, Edna T-H, Hveem K. Risk factors for requiring cholecystectomy for gallstone disease in a prospective population-based cohort study. Br J Surg. 2016;103(10):1350–7.
5. Mahabaleshwar, VarunKaman L, Iqbal J, Singh R. Monopolar electrocautery versus ultrasonic dissection of the gallbladder from the gallbladder bed in laparoscopic cholecystectomy: A randomized controlled trial. Can J Surg. 2012;55(5):307–11.
6. Zahid H. Cholecystectomy: Govt. of India Standard treatment guidelines. [Internet]. Govt India. 2019; [cited August 20, 2022]. Available from: https://speciality.medicaldialogues.in/author/hina.
7. Lattouf J-B, Beri A, Klinger CH, Jeschke S, Janetschek G. Practical hints for hemostasis in laparoscopic surgery. Minim Invasive Ther Allied Technol MITAT. 2007;16(1):45–51.
8. da Silva RD, Sehrt D, Molina WR, Moss J, Park SH, Kim FJ. Significance of surgical plume obstruction during laparoscopy. JSLS J Soc Laparoendosc Surg. 2014;18(3).
9. den Boer KT, de Jong T, Dankelman J, Gouma DJ. Problems with laparoscopic instruments: opinions of experts. J Laparoendosc Adv Surg Tech A. 2001;11(3):149–55.

10. Emam TA, Cuschieri A. How safe is high-power ultrasonic dissection? Ann Surg. 2003;237(2):186–91.

11. Power C, Maguire D, McAnena OJ, Calleary J. Use of the ultrasonic dissecting scalpel in laparoscopic cholecystectomy. Surg Endosc. 2000;14(11):1070–3.

12. Wetter LA, Payne JH, Kirshenbaum G, Podoll EF, Bachinsky T, Way LW. The ultrasonic dissector facilitates laparoscopic cholecystectomy. Arch Surg. 1992;127(10):1195–9.

13. Tsimoyiannis EC, Jabarin M, Glantzounis G, Lekkas ET, Siakas P, Stefanaki-Nikou S. Laparoscopic cholecystectomy using ultrasonically activated coagulating shears. Surg Laparosc Endosc. 1998;8(6):421–4.

14. Katri KM, Bessa SS, Elnagah GA, El-Kayal E-SA. Is monopolar electrocautery safe and effective for control of the cystic artery during laparoscopic cholecystectomy? J Laparoendosc Adv Surg Tech A. 2012;22(6):557–60.

15. Davila D, Russek K, Franklin MEJ. Laparoscopic appendectomy: vascular control of the appendicular artery using monopolar cauterization versus clips. J Laparoendosc Adv Surg Tech A. 2012;22(2):165–7.

16. Sasi W. Dissection by ultrasonic energy versus monopolar electrosurgical energy in laparoscopic cholecystectomy. J Soc Laparoendosc Surg. 2010;14(1):23–34.

17. Ramzanali SAA, Zia-ul-Islam, Shah SSH. Monopolar electrocautery versus ultrasonic dissection of the gallbladder from the gallbladder bed in laparoscopic cholecystectomy. J Ayub Med Coll Abbottabad. 2013;25(3–4):16–8.

18. Sharma N, Chauhan A, Sharma V, Gupta A, Pathania S. Harmonic scalpel, the tool for new age laparoscopic cholecystectomy. Int Surg J. 2018;5(6):2324.

19. Rajnish K, Sureshkumar S, Ali MS, Vijayakumar C, Sudharsanan S, Palanivel C. Harmonic Scalpel-Assisted Laparoscopic Cholecystectomy vs. Conventional

Laparoscopic Cholecystectomy - A Non-randomized Control Trial. Cureus. 2018;10(Cdc):1–10.

20. Zanghì A, Cavallaro A, Di Mattia P, Di Vita M, Cardì F, Piccolo G, et al. Laparoscopic cholecystectomy: Ultrasonic energy versus monopolar electrosurgical energy. Eur Rev Med Pharmacol Sci. 2014;18(Suppl 2):54–9.
21. Hundt M, Wu CY, Young M. Anatomy, Abdomen and Pelvis, Biliary Ducts., Treasure Island (FL): 2022.
22. Vernon H, Wehrle CJ, Kasi A. Anatomy, Abdomen and Pelvis, Liver., Treasure Island (FL): 2022.
23. Ellis H. Anatomy of the gallbladder and bile ducts. Surg - Oxford Int Ed. 2011;29(12):593–6.
24. Salazar MC, Brownson KE, Nadzam GS, Duffy A, Roberts KE. Gallbladder Agenesis: A Case Report. Yale J Biol Med. 2018;91(3):237–41.
25. Lung K, Lui F. Anatomy, Abdomen and Pelvis, Arteries., Treasure Island (FL): 2022.
26. Mawe GM. Tachykinins as mediators of slow EPSPs in guinea-pig gall-bladder ganglia: involvement of neurokinin-3 receptors. J Physiol. 1995;485 (Pt 2(Pt 2):513–24.
27. Singh K, Singh R, Kaur M. Clinical reappraisal of vasculobiliary anatomy relevant to laparoscopic cholecystectomy. J Minim Access Surg. 2017;13(4):273–9.
28. Handra-Luca A, Ben Romdhane HM, Hong S-M. Luschka Ducts of the Gallbladder in Adults: Case Series Report and Review of the Medical Literature. Int J Surg Pathol. 2020;28(5):482–9.
29. Madni TD, Nakonezny PA, Imran JB, Taveras L, Cunningham HB, Vela R, et al. A comparison of cholecystitis grading scales. J Trauma Acute Care Surg. 2019;86(3):471–8.
30. Mahadevan V. Anatomy of the gallbladder and bile ducts. Surg - Oxford Int Ed.

2020;38(8):432–6.

31. Parra-Membrives P, Díaz-Gómez D, Vilegas-Portero R, Molina-Linde M, Gómez-Bujedo L, Lacalle-Remigio JR. Appropriate management of common bile duct stones: a RAND Corporation/UCLA Appropriateness Method statistical analysis. Surg Endosc. 2010;24(5):1187–94.

32. Tay WM, Toh YJ, Shelat VG, Huey CW, Junnarkar SP, Woon W, et al. Subtotal cholecystectomy: early and long-term outcomes. Surg Endosc. 2020;34(10):4536–42.

33. Elshaer M, Gravante G, Thomas K, Sorge R, Al-Hamali S, Ebdewi H. Subtotal cholecystectomy for "difficult gallbladders": systematic review and meta-analysis. JAMA Surg. 2015;150(2):159–68.

34. Ece I, Ozturk B, Yilmaz H, Yormaz S, Şahin M. The effect of single incision laparoscopic cholecystectomy on systemic oxidative stress: a prospective clinical trial. Ann Surg Treat Res. 2017;92(4):179–83.

35. Janssen IMC, Swank DJ, Boonstra O, Knipscheer BC, Klinkenbijl JHG, van Goor H. Randomized clinical trial of ultrasonic versus electrocautery dissection of the gallbladder in laparoscopic cholecystectomy. Br J Surg. 2003;90(7):799–803.

36. Kandil T, El Nakeeb A, El Hefnawy E. Comparative study between clipless laparoscopic cholecystectomy by harmonic scalpel versus conventional method: a prospective randomized study. J Gastrointest Surg Off J Soc Surg Aliment Tract. 2010;14(2):323–8.

37. Stanisic V, Milicevic M, Kocev N, Stanisic B. A prospective cohort study for prediction of difficult laparoscopic cholecystectomy. Ann Med Surg. 2020;60:728–33.

38. Quillin RC, Burns JM, Pineda JA, Hanseman D, Rudich SM, Edwards MJ, et al. Laparoscopic cholecystectomy in the cirrhotic patient: predictors of outcome. Surgery. 2013;153(5):634–40.

39. Gomes CA, Junior CS, Di Saverio S, Sartelli M, Kelly MD, Gomes CC, et al. Acute calculous cholecystitis: Review of current best practices. World J Gastrointest Surg. 2017;9(5):118–26.

40. Han H-S, Yoon Y-S, Agarwal AK, Belli G, Itano O, Gumbs AA, et al. Laparoscopic Surgery for Gallbladder Cancer: An Expert Consensus Statement. Dig Surg. 2019;36(1):1–6.

41. Shaffer EA. Gallstone disease: Epidemiology of gallbladder stone disease. Best Pract Res Clin Gastroenterol. 2006;20(6):981–96.

42. Park Y-H, Park S-J, Jang J-Y, Ahn YJ, Park Y-C, Yoon YB, et al. Changing patterns of gallstone disease in Korea. World J Surg. 2004;28(2):206–10.

43. Patel AM, Yeola M, Mahakalkar C. Demographic and Risk Factor Profile in Patients of Gallstone Disease in Central India. Cureus. 2022;14(5).

44. Talseth A, Lydersen S, Skjedlestad F, Hveem K, Edna T-H. Trends in cholecystectomy rates in a defined population during and after the period of transition from open to laparoscopic surgery. Scand J Gastroenterol. 2014;49(1):92–8.

45. Urbach DR, Stukel TA. Rate of elective cholecystectomy and the incidence of severe gallstone disease. Can Med Assoc J. 2005;172(8):1015–9.

46. Brockmann JG, Kocher T, Senninger NJ, Schürmann GM. Complications due to gallstones lost during laparoscopic cholecystectomy. Surg Endosc. 2002;16(8):1226–32.

47. Memon MA, Deeik RK, Maffi TR, Fitzgibbons RJJ. The outcome of unretrieved gallstones in the peritoneal cavity during laparoscopic cholecystectomy. A prospective analysis. Surg Endosc. 1999;13(9):848–57.

48. Nguyen NT, Lee SL, Goldman C, Fleming N, Arango A, McFall R, et al. Comparison of pulmonary function and postoperative pain after laparoscopic versus open gastric

bypass: a randomized trial. J Am Coll Surg. 2001;192(4):467–9.

49. Puzziferri N, Austrheim-Smith IT, Wolfe BM, Wilson SE, Nguyen NT. Three-year follow-up of a prospective randomized trial comparing laparoscopic versus open gastric bypass. Ann Surg. 2006;243(2):181–8.

50. Nguyen NT, Perez R V, Fleming N, Rivers R, Wolfe BM. Effect of prolonged pneumoperitoneum on intraoperative urine output during laparoscopic gastric bypass. J Am Coll Surg. 2002;195(4):476–83.

51. Nguyen NT, Cronan M, Braley S, Rivers R, Wolfe BM. Duplex ultrasound assessment of femoral venous flow during laparoscopic and open gastric bypass. Surg Endosc. 2003;17(2):285–90.

52. Hedenstierna G, Larsson A. Influence of abdominal pressure on respiratory and abdominal organ function. Curr Opin Crit Care. 2012;18(1):80–5.

53. Lunevicius R, Morkevicius M. Systematic review comparing laparoscopic and open repair for perforated peptic ulcer. Br J Surg. 2005;92(10):1195–207.

54. Ricci C, Casadei R, Taffurelli G, Toscano F, Pacilio CA, Bogoni S, et al. Laparoscopic versus open distal pancreatectomy for ductal adenocarcinoma: a systematic review and meta-analysis. J Gastrointest Surg. 2015;19(4):770–81.

55. Mirnezami R, Mirnezami AH, Chandrakumaran K, Abu Hilal M, Pearce NW, Primrose JN, et al. Short- and long-term outcomes after laparoscopic and open hepatic resection: systematic review and meta-analysis. HPB (Oxford). 2011;13(5):295–308.

56. Nguyen NT, Hinojosa MW, Fayad C, Varela E, Konyalian V, Stamos MJ, et al. Laparoscopic surgery is associated with a lower incidence of venous thromboembolism compared with open surgery. Ann Surg. 2007;246(6):1021–7.

57. Kapoor T, Wrenn SM, Callas PW, Abu-Jaish W. Cost Analysis and Supply Utilization of Laparoscopic Cholecystectomy. Minim Invasive Surg. 2018;2018:7838103.

58. Strasberg SM. Tokyo Guidelines for the Diagnosis of Acute Cholecystitis. J Am Coll Surg. 2018;227(6):624.

59. Blythe J, Herrmann E, Faust D, Falk S, Edwards-Lehr T, Stockhausen F, et al. Acute cholecystitis - a cohort study in a real-world clinical setting (REWO study, NCT02796443). Pragmatic Obs Res. 2018;9:69–75.

60. Kose SH, Grice K, Orsi WD, Ballal M, Coolen MJL. Metagenomics of pigmented and cholesterol gallstones: the putative role of bacteria. Sci Rep. 2018;8(1):11218.

61. Feng J-W, Yang X-H, Liu C-W, Wu B-Q, Sun D-L, Chen X-M, et al. Comparison of Laparoscopic and Open Approach in Treating Gallbladder Cancer. J Surg Res. 2019;234:269–76.

62. Hassler KR, Collins JT, Philip K, et al. Laparoscopic Cholecystectomy. [Updated 2022 Oct 24]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2022. Available from: https://www.ncbi.nlm.nih.gov/books/NBK448145/

63. Hüscher CGS, Lirici MM, Di Paola M, Crafa F, Napolitano C, Mereu A, et al. Laparoscopic cholecystectomy by ultrasonic dissection without cystic duct and artery ligature. Surg Endosc. 2003;17(3):442–51.

64. Tulikangas PK, Smith T, Falcone T, Boparai N, Walters MD. Gross and histologic characteristics of laparoscopic injuries with four different energy sources. Fertil Steril. 2001;75(4):806–10.

65. Amaral JF, Chrostek CA. Experimental comparison of the ultrasonically-activated scalpel to electrosurgery and laser surgery for laparoscopic use. Minim Invasive Ther Allied Technol. 1997;6(4):324–31.

66. Kanehira E, Kinoshita T, Omura K. Ultrasonically-activated devices for endoscopic surgery. Minim Invasive Ther Allied Technol. 1999;8(2):89–94.

67. Foschi D, Cellerino P, Corsi F, Taidelli T, Morandi E, Rizzi A, et al. The mechanisms

of blood vessel closure in humans by the application of ultrasonic energy. Surg Endosc. 2002;16(5):814–9.

68. Hüscher CG, Lirici MM, Anastasi A, Sansonetti A, Amini M. Laparoscopic cholecystectomy by harmonic dissection. Surg Endosc. 1999;13(12):1256–7.

69. Huang X, Feng Y, Huang Z. Complications of laparoscopic cholecystectomy in China: an analysis of 39,238 cases. Chin Med J (Engl). 1997;110(9):704–6.

70. Strasberg SM, Hertl M, Soper NJ. An analysis of the problem of biliary injury during laparoscopic cholecystectomy. J Am Coll Surg. 1995;180(1):101–25.

71. Lantis JC II, Durville FM, Connolly R, Schwaitzberg SD. Comparison of coagulation modalities in surgery. J Laparoendosc Adv Surg Tech A. 1998;8(6):381–94.

72. Antonutti R, Fontes-Dislaire I, Rumeau JL, Mutter D, Fourtanier G. [Experimental study of monopolar electrical and ultrasonic dissection]. Ann Chir. 2001;126(4):330–5.

73. Tucker RD, Voyles CR. Laparoscopic electrosurgical complications and their prevention. AORN J. 1995;62(1):51-53,55,57-58.

74. Portella AOV, Trindade MRM, Dias LZ, Goldenberg S, Trindade EN. Monopolar electrosurgery on the extrahepatic bile ducts during laparoscopic cholecystectomy: an experimental controlled trial. Surg Laparosc Endosc Percutan Tech. 2009;19(3):213–6.

75. Gözen AS, Teber D, Rassweiler JJ. Principles and initial experience of a new device for dissection and hemostasis. Minim Invasive Ther. 2007;16(1):58–65.

76. Pogorelić Z, Perko Z, Druzijanić N, Tomić S, Mrklić I. How to prevent lateral thermal damage to tissue using the harmonic scalpel: experimental study on pig small intestine and abdominal wall. Eur Surg Res. 2009;43(2):235–40.

77. Perko Z, Pogorelić Z, Bilan K, Tomić S, Vilović K, Krnić D, et al. Lateral thermal damage to rat abdominal wall after harmonic scalpel application. Surg Endosc. 2006;20(2):322–4.

78. Diamantis T, Kontos M, Arvelakis A, Syroukis S, Koronarchis D, Papalois A, et al. Comparison of monopolar electrocoagulation, bipolar electrocoagulation, Ultracision, and Ligasure. Surg Today. 2006;36(10):908–13.

79. Humes DJ, Ahmed I, Lobo DN. The pedicle effect and direct coupling: delayed thermal injuries to the bile duct after laparoscopic cholecystectomy. Arch Surg. 2010;145(1):96–8.

80. Newcomb WL, Hope WW, Schmelzer TM, Heath JJ, Norton HJ, Lincourt AE, et al. Comparison of blood vessel sealing among new electrosurgical and ultrasonic devices. Surg Endosc. 2009;23(1):90–6.

81. Druzijanić N, Perko Z, Kraljević D, Juricić J, Simunić MM, Bilan K, et al. Harmonic scalpel in transanal microsurgery. Hepatogastroenterology. 2008;55(82–83):356–8.

82. Devassy R, Gopalakrishnan S, De Wilde RL. Surgical Efficacy Among Laparoscopic Ultrasonic Dissectors: Are We Advancing Safely? A Review of Literature. J Obstet Gynecol India. 2015;65(5):293–300.

83. Kim FJ, Sehrt D, Pompeo A, Molina WR. Comparison of surgical plume among laparoscopic ultrasonic dissectors using a real-time digital quantitative technology. Surg Endosc. 2012;26(12):3408–12.

84. Smulders JF, de Hingh IHJT, Stavast J, Jackimowicz JJ. Exploring new technologies to facilitate laparoscopic surgery: creating intestinal anastomoses without sutures or staples, using a radio-frequency-energy-driven bipolar fusion device. Surg Endosc. 2007;21(11):2105–9.

85. Elemen L, Yazir Y, Tugay M, Akay A, Aydin S, Yanar K, et al. LigaSure compared with ligatures and endoclips in experimental appendectomy: how safe is it? Pediatr Surg Int. 2010;26(5):539–45.

86. Sartori PV, De Fina S, Colombo G, Pugliese F, Romano F, Cesana G, et al. Ligasure

versus Ultracision in thyroid surgery: a prospective randomized study. Langenbeck's Arch Surg. 2008;393(5):655–8.

87. Družijanić N, Pogorelić Z, Perko Z, Mrklić I, Tomić S. Comparison of lateral thermal damage of the human peritoneum using monopolar diathermy, Harmonic scalpel and LigaSure. Can J Surg. 2012;55(5):317–21.

88. Lamberton GR, Hsi RS, Jin DH, Lindler TU, Jellison FC, Baldwin DD. Prospective comparison of four laparoscopic vessel ligation devices. J Endourol. 2008;22(10):2307–12.

89. Schreuder AM, Busch OR, Besselink MG, Ignatavicius P, Gulbinas A, Barauskas G, et al. Long-Term Impact of Iatrogenic Bile Duct Injury. Dig Surg. 2020;37(1):10–21.

90. Chinnery GE, Krige JEJ, Bornman PC, Bernon MM, Al-Harethi S, Hofmeyr S, et al. Endoscopic management of bile leaks after laparoscopic cholecystectomy. S Afr J Surg. 2013;51(4):116–21.

91. Kao LS, Ball CG, Chaudhury PK. Evidence-based Reviews in Surgery: Early Cholecystectomy for Cholecystitis. Ann Surg. 2018;268(6):940–2.

92. Coccolini F, Catena F, Pisano M, Gheza F, Fagiuoli S, Di Saverio S, et al. Open versus laparoscopic cholecystectomy in acute cholecystitis. Systematic review and meta-analysis. Int J Surg. 2015;18:196–204.

93. Liu GB, Mao YY, Yang CP, Cao JL. Sealing of the cystic and appendix arteries with monopolar electrocautery during laparoscopic combined cholecystectomy and appendectomy. Med (United States). 2018;97(13).

94. Ai XM, Ho LC, Yang NY, Han LL, Lu JJ, Yue X. A comparative study of ultrasonic scalpel (US) versus conventional metal clips for closure of the cystic duct in laparoscopic cholecystectomy (LC): A meta-analysis. Med (United States). 2018;97(51).

95. Sanawan E, Qureshi AU, Qureshi SS, Cheema KM, Cheema MA. Effectiveness of Ultrasound Shear for Clipless Laparoscopic Cholecystectomy Versus Conventional Unipolar Electrocautery in Patients with Cholelithiasis. J Coll Physicians Surg Pak. 2017;27(10):611–5.

96. Jiang H-P, Liu Y-D, Li Y-S, Shen Z-L, Ye Y-J. Ultrasonic versus electrosurgical device for laparoscopic cholecystectomy: A systematic review with meta-analysis and trial sequential analysis. Int J Surg. 2017;40:24–32.

97. Bulus H, Basar O, Tas A, Yavuz A, Akkoca M, Coskun A, et al. Evaluation of three instruments for laparoscopic cholecystectomy: harmonic scalpel, bipolar vessel sealer, and conventional technique. Minerva Chir. 2013;68(6):537–42.

98. Xiong J, Altaf K, Huang W, Javed MA, Mukherjee R, Mai G, et al. A meta-analysis of randomized clinical trials that compared ultrasonic energy and monopolar electrosurgical energy in laparoscopic cholecystectomy. J Laparoendosc Adv Surg Tech A. 2012;22(8):768–77.

99. Gelmini R, Franzoni C, Zona S, Andreotti A, Saviano M. Laparoscopic cholecystectomy with Harmonic scalpel. J Soc Laparoendosc Surg. 2010;14(1):14–9.

100. Zaidi A, Haleem A, Rana S. Use of harmonic scalpel in laparoscopic cholecystectomy. PAFMJ. 2011;61(1).

ANNEXURES

PROFORMA

Name: **DOA:**

Age: **DOD:**

Sex: **IP/OP NO:**

Religion: **Unit No:**

Education: **Date of surgery:**

Occupation:

Address:

1.Chief Complaints:

Pain

Tenderness

Yellowish discolouration of eyes

Vomiting/nausea

Fever

Diarrhoea/constipation

Other complaints

2.Vomiting

Onset

Duration

Frequency

Character of onset

Amount

Content

Past history

Diabetes

Hypertension

T.B

Asthma / previous allergy

Previous surgeries

GENERAL PHYSICAL EXAMINATION

Appearance

Attitude

Build and Nourishment

Level of consciousness

Dehydration

Temperature

Pulse

Blood pressure

Respiration

INVESTIGATIONS:-

1) COMPLETE BLOOD COUNT
2) LIVER FUNCTION TEST
3) RBS
4) RENAL FUNCTION TEST
5) HIV and HBSAg
6) BLEEDING TIME and CLOTTING TIME
7) USG ABDOMEN AND PELVIS

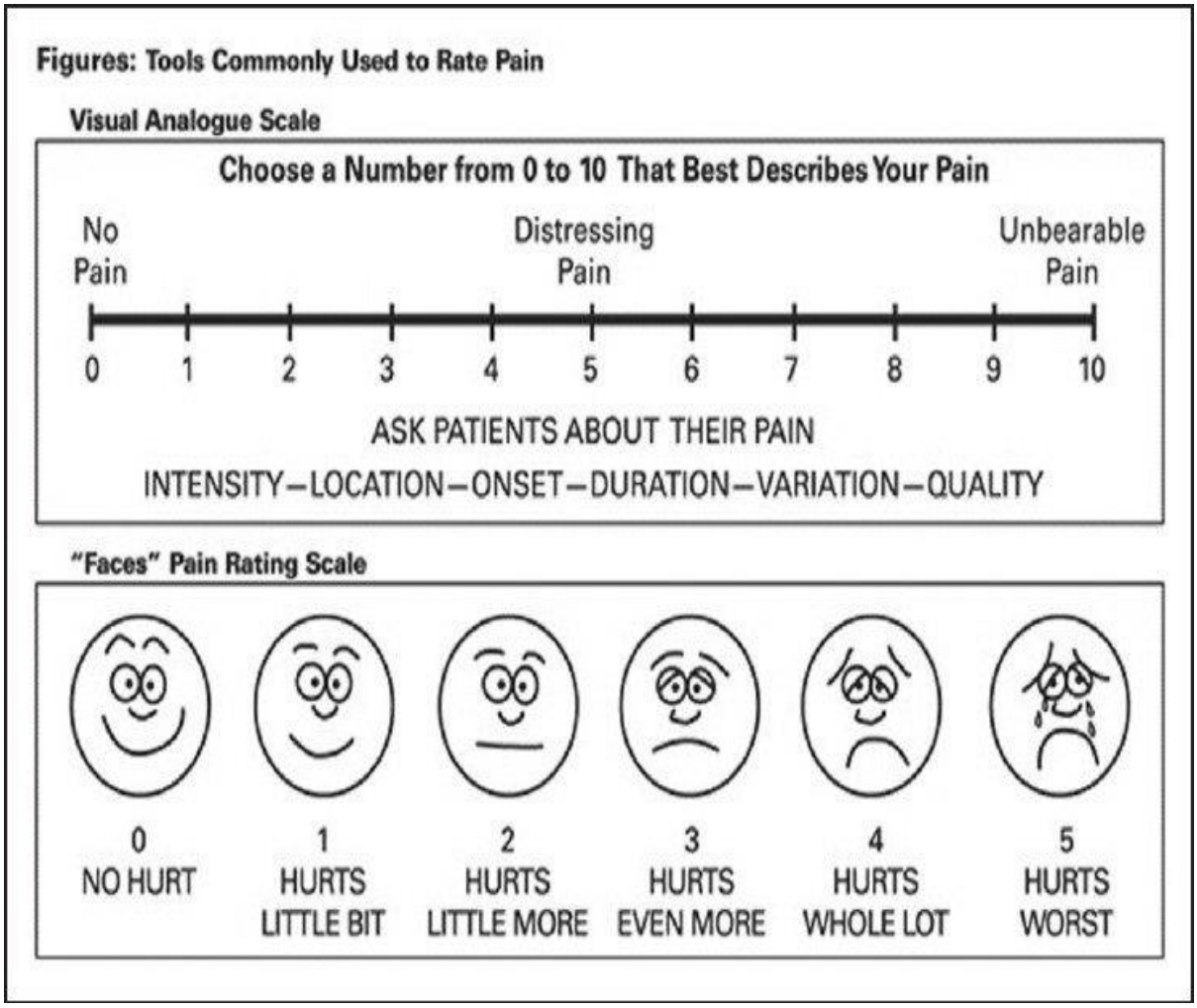
Parameters

1) Operative time
2) Intra operative Bleeding:- suction bottle measurement
3) Post operativepain:-visual analogue scale
4) Duration of hospital stay.

Outcome of the patient

Patients are followed up for any post operative complication for a period of 30 days from the day of surgery.

Figures: Tools Commonly Used to Rate Pain



PATIENT INFORMATION SHEET

Study Title:-**‘ Is Ultrasonic Shears A Safe Alternative to Monopolar Electrocautery In Laparoscopic Cholecystectomy – A Comparative Study ’**

GUIDE :- DR. P N SREERAMULU

STUDY CONDUCTED BY DR. BANGARU VENKATA NAVEEN KUMAR YADAV

STUDY LOCATION :- R. L. JALAPPA hospital and Research center attached to SRI DEVARAJ URS MEDICAL COLLEGE, TAMAKA, KOLAR

This is to inform you that you have been diagnosed with infection of gall bladder. Surgery can be either by conventional open approach or laparoscopic approach. For laparoscopic Cholecystectomy approach, two energy sources can be used either ultrasonic shears or mono polar electrocautery. This study is being conducted to compare the efficacy of ultrasonic shears and mono polar electrocautery. Following complications can be associated with it such as port site infection, bile duct injury, Hepatic artery injury& sinus formation. If you are willing, you will be enrolled in this study. You will receive the standard care after laparoscopic cholecystectomy.

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

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

For further information contact :-

Dr. Bangaru Venkata Naveen Kumar Yadav (Post graduate)

Phone no. 8971214957

Department of general surgery

SDUMC, Kolar

SIGNATURE/ thumb impression OF PATIENT

INFORMED CONSENT FORM

I Mr./Mrs. have been explained in my own understandable language, that I will be included in a study " Is Ultrasonic Shears ASafe Alternative to Monopolar Electrocautery In Laparoscopic Cholecystectomy– AComparative Study'', which is being conducted in R L JALAPPA HOSPITAL .

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

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

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

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

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

Signature/ thumb impression of the patient:

Name:

Signature/ thumb impression of the witness:

Name:

Relation to patient:

Date: Place:

ತಿಳಿವಳಿಕೆಯ ಸಮ್ಮತಿ ಪಾತ್ರ

ನಾನು ಶ್ರೀ /ಶ್ರೀಮತಿ ನನ್ನ ಅರ್ಥವಾಗುವಂತಹ ಭಾಷೆಯಲ್ಲಿ ವಿವರಿಸಲಾಗಿದ್ದು, ನಾನು ಆರ್ ಎಲ್ ಜಲಪ್ಪಾ ಆಸ್ಪತ್ರೆಯಲ್ಲಿ ನಡೆಸಿದ "ಲ್ಯಾಪರೊಸ್ಕೋಪಿಕ್ ಕೊಲೆಸಿಸ್ಟೆಕ್ಟೊಮಿಯಲ್ಲಿ ಮೊನೊಪೊಲಾರ್ ಎಲೆಕ್ಟ್ರೋಕಾಟರಿಗೆ ಅಲ್ಟ್ರಾಸಾನಿಕ್ ಶಿಯರ್ಸ್ ಸುರಕ್ಷಿತ ಪರ್ಯಾಯವಾಗಿದೆ-ತುಲನಾತ್ಮಕ ಅಧ್ಯಯನ" ದಲ್ಲಿ ಸೇರಿಸಲಾಗುವುದು.

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

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

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

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

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

ರೋಗಿಯ ಸಹಿ / ಹೆಬ್ಬೆರಳು ಗುರುತು:

ಹೆಸರು:

ಸಾಕ್ಷಿಯ ಸಹಿ / ಹೆಬ್ಬೆರಳು ಗುರುತು:

ಹೆಸರು:

ರೋಗಿಗೆ ಸಂಬಂಧ:

ದಿನಾಂಕ:

ಸ್ಥಳ:

MASTERCHART

S.no.	Age (years)	Gender	Indication	Energy Used	Intra operative blood loss (ML)	Operating time in mins	VAS ON POD1	Length of hospital stay (days)
1	72	Male	Acute Calculous Cholecystitis	Ultrasonic Energy	10	40	6	6
2	29	Female	Calculous Cholecystitis	Monopolar Electrocautery	15	70	7	7
3	28	Female	Cholelithiasis	Ultrasonic Energy	10	45	4	5
4	50	Female	Calculous Cholecystitis	Monopolar Electrocautery	25	60	3	9
5	38	Female	Cholelithiasis	Ultrasonic Energy	15	40	5	7
6	35	Female	Cholelithiasis Post(Ercp)	Monopolar Electrocautery	35	55	4	10
7	26	Female	Cholelithiasis	Ultrasonic Energy	10	45	5	4
8	65	Female	Calculous Cholecystitis	Monopolar Electrocautery	25	60	6	9
9	50	Female	Calculous Cholecystitis	Ultrasonic Energy	10	30	4	3
10	75	Female	Cholelithiasis	Monopolar Electrocautery	30	60	5	7
11	46	Female	Cholelithiasis	Ultrasonic Energy	10	45	3	5
12	52	Female	Cholelithiasis	Monopolar Electrocautery	25	75	7	10
13	57	Male	Cholelithiasis	Ultrasonic Energy	10	35	4	7
14	42	Female	Cholelithiasis	Monopolar Electrocautery	30	50	6	7
15	53	Female	Cholelithiasis	Ultrasonic Energy	5	45	4	5
16	30	Female	Cholelithiasis	Monopolar Electrocautery	15	75	6	7
17	24	Female	Calculous Cholelithiasis	Ultrasonic Energy	10	45	5	5
18	36	Female	Calculous Cholelithiasis	Monopolar Electrocautery	20	75	7	8
19	38	Female	Cholelithiasis	Ultrasonic Energy	5	40	4	7
20	37	Female	Cholelithiasis	Monopolar Electrocautery	15	60	7	10
21	54	Female	Cholelithiasis	Ultrasonic Energy	10	30	3	5
22	70	Female	Calculous Cholelithiasis	Monopolar Electrocautery	20	55	5	7
23	45	Female	Cholelithiasis	Ultrasonic Energy	5	45	4	5
24	39	Male	Calculous Cholelithiasis	Monopolar Electrocautery	15	70	7	9
25	37	Female	Cholelithiasis	Ultrasonic Energy	10	40	5	6
26	30	Female	Cholelithiasis	Monopolar Electrocautery	10	45	4	7
27	44	Female	Cholelithiasis	Ultrasonic Energy	5	35	3	5
28	43	Male	Calculous Cholelithiasis	Monopolar Electrocautery	25	75	6	8
29	56	Female	Cholelithiasis	Ultrasonic Energy	10	30	4	7
30	29	Female	Cholelithiasis	Monopolar Electrocautery	20	60	7	9
31	36	Female	Calculous Cholelithiasis	Ultrasonic Energy	15	45	3	6
32	60	Female	Cholelithiasis	Monopolar Electrocautery	25	60	7	8
33	68	Female	Cholelithiasis	Ultrasonic Energy	10	40	5	7
34	42	Female	Cholelithiasis	Monopolar Electrocautery	30	50	6	10
35	80	Male	Calculous Cholelithiasis	Ultrasonic Energy	5	35	4	6
36	31	Male	Cholelithiasis	Monopolar Electrocautery	20	50	7	8
37	47	Male	Cholelithiasis	Ultrasonic Energy	10	45	3	5
38	40	Female	Gallbladder Polyp	Monopolar Electrocautery	25	75	5	8
39	34	Female	Gallbladder Polyp	Ultrasonic Energy	15	35	4	7
40	42	Female	Symptomatic Cholelithiasis	Monopolar Electrocautery	28	55	3	6
41	52	Male	Gallbladder Polyp	Ultrasonic Energy	20	40	4	7
42	40	Female	Porcelain Gallbladder	Monopolar Electrocautery	30	70	6	10
43	35	Female	Cholelithiasis	Ultrasonic Energy	10	40	4	5
44	75	Female	Cholelithiasis	Monopolar Electrocautery	25	70	4	7
45	20	Female	Cholelithiasis	Ultrasonic Energy	5	45	3	5
46	32	Female	Cholelithiasis	Monopolar Electrocautery	30	55	5	8
47	44	Male	Calculous Cholecystitis	Ultrasonic Energy	10	60	4	6
48	50	Female	Cholelithiasis	Monopolar Electrocautery	15	75	5	10
49	36	Female	Cholelithiasis	Ultrasonic Energy	5	35	3	6
50	55	Female	Cholelithiasis	Monopolar Electrocautery	20	55	5	8
51	70	Female	Cholelithiasis	Ultrasonic Energy	10	40	4	6
52	25	Female	Cholelithiasis	Monopolar Electrocautery	15	55	6	7
53	80	Male	Cholelithiasis	Ultrasonic Energy	20	60	5	6
54	41	Female	Calculous Cholecystitis	Monopolar Electrocautery	30	50	4	8
55	36	Female	Cholelithiasis	Ultrasonic Energy	5	30	2	5
56	42	Female	Cholelithiasis	Monopolar Electrocautery	25	50	4	7
57	43	Female	Cholelithiasis	Ultrasonic Energy	10	40	3	6

58	26	Female	Cholelithiasis	Monopolar Electrocautery	15	70	6	10
59	45	Male	Cholelithiasis	Ultrasonic Energy	20	60	5	7
60	34	Female	Cholelithiasis	Monopolar Electrocautery	35	75	4	7
61	27	Female	Cholelithiasis	Ultrasonic Energy	10	45	3	5
62	38	Female	Cholelithiasis	Monopolar Electrocautery	25	55	6	8
63	65	Female	Cholelithiasis	Ultrasonic Energy	15	40	3	7
64	25	Female	Cholelithiasis	Monopolar Electrocautery	30	60	5	8
65	39	Female	Cholelithiasis	Ultrasonic Energy	10	35	4	6
66	60	Female	Cholelithiasis	Monopolar Electrocautery	30	55	6	7
67	50	Male	Cholelithiasis	Ultrasonic Energy	20	50	7	7
68	32	Female	Cholelithiasis	Monopolar Electrocautery	35	70	5	10
69	30	Female	Calculous Cholelithiasis	Ultrasonic Energy	15	50	3	7
70	67	Male	Cholelithiasis	Monopolar Electrocautery	30	70	5	10
71	45	Female	Cholelithiasis	Ultrasonic Energy	15	40	3	5
72	28	Female	Cholelithiasis	Monopolar Electrocautery	25	55	5	9
73	41	Female	Cholelithiasis	Ultrasonic Energy	10	35	2	5
74	35	Male	Cholelithiasis	Monopolar Electrocautery	30	70	4	8

PHOTO GALLERY

Figure 20: HARMONIC INSTRUMENT

Figure 21: TEAM OF SURGEONS

Figure 22: ULTRASONIC GENERATOR WITH MONOPOLAR GENERATOR

Figure 23: HARMONIC SHEARS

Figure 24: LAPAROSCOPIC INSTRUMENT SET

Figure 25: LAPAROSCOPIC MONITOR TROLLEY

Figure 26: GALL BLADDER SPECIMEN

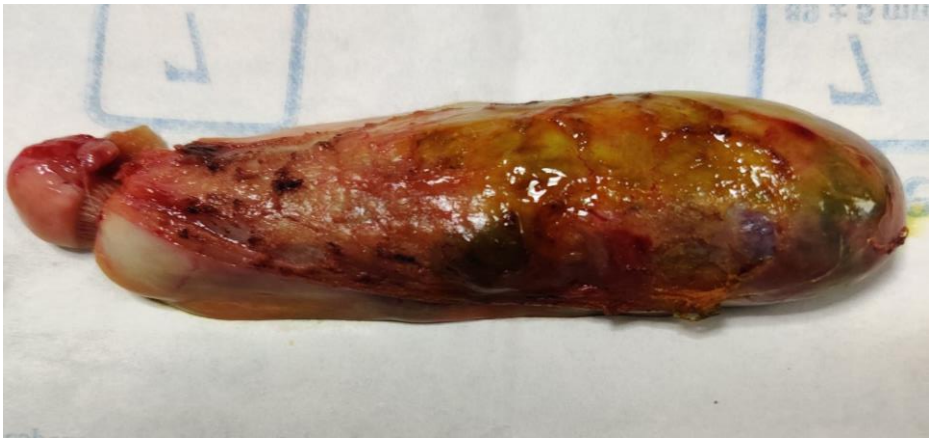
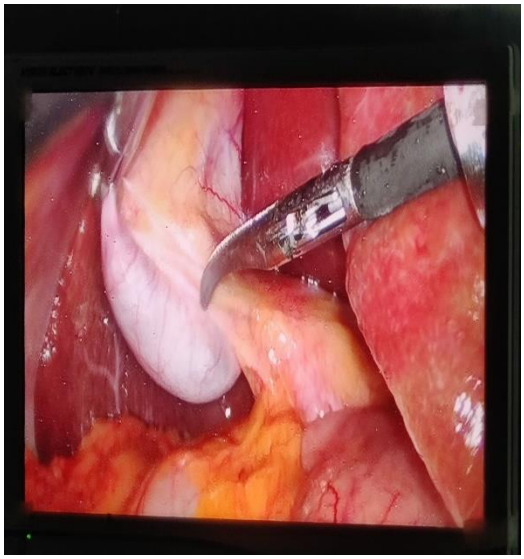
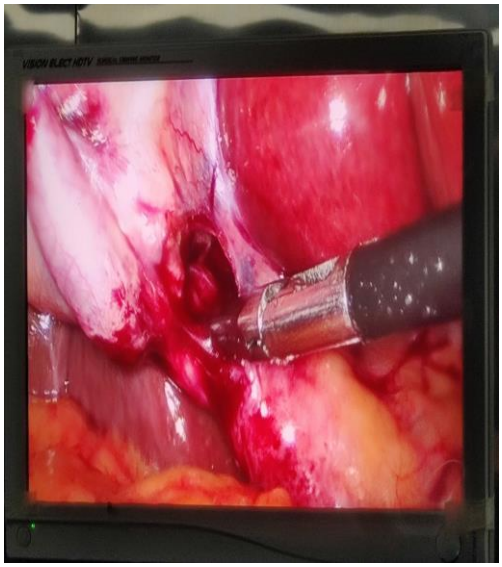


Figure 27: LAPAROSCOPIC CHOLECYSTECTOMY USING ULTRASONIC SHEARS





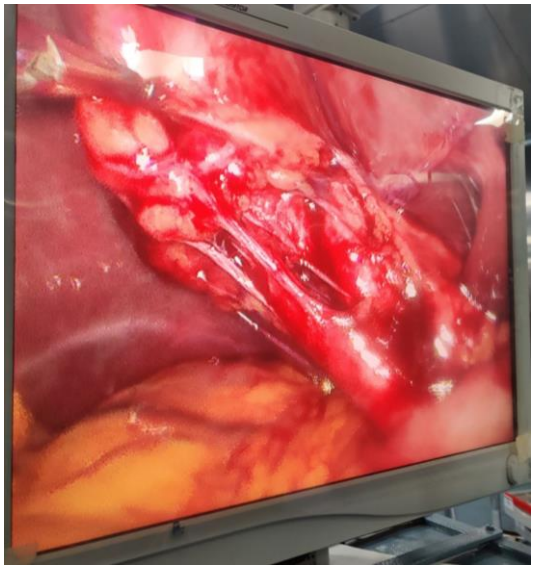


Figure 28: CALOTS TRIANGLE AND APLLICATION OF LIGACLIPS

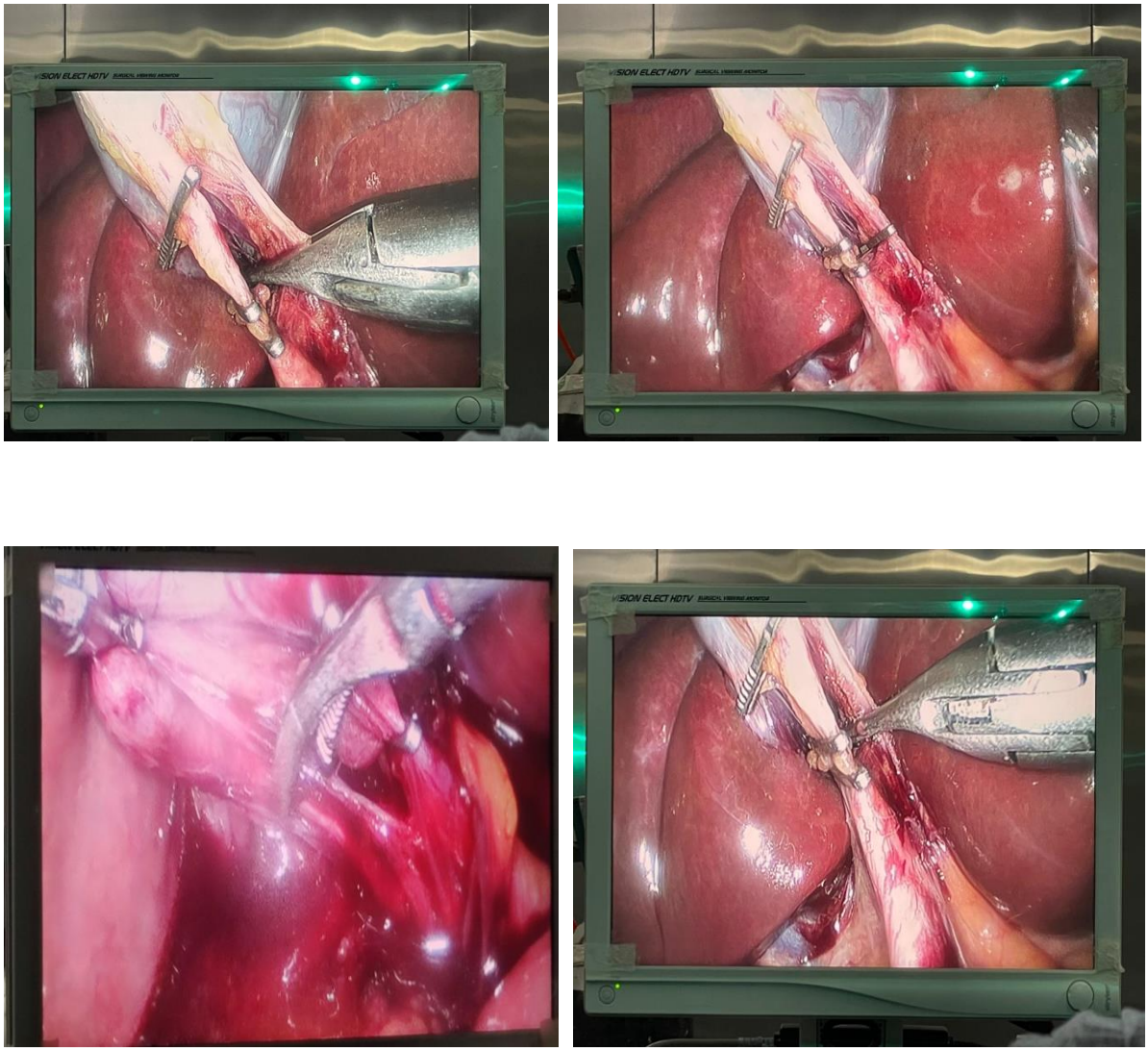
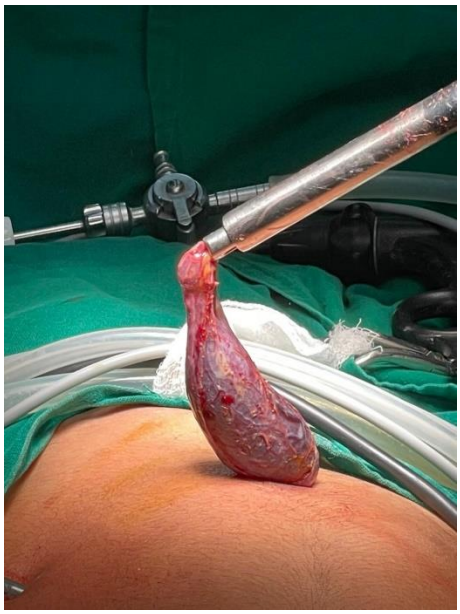


Figure 29: EXTRACTION OF GALLBLADDER



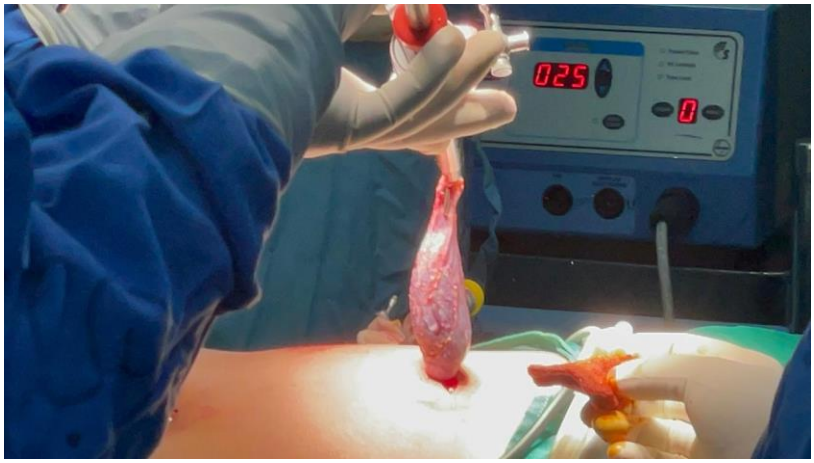


Figure 30: GALLBLADDER SPECIMEN WITH GALLSTONES