Comparison Study between Clipping, Ligasure and Diathermy of Cystic Artery in Laparoscopic Cholecystectomy

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Abstract: Background: Laparoscopic cholecystectomy (LC) is the gold standard for the surgical treatment of symptomatic gallstones. The advantages of this surgical approach have included a positive impact on the postoperative quality of the patient's life as well as optimal short and long term results. **Objectives:** The aim of this study was to assess safety, and outcome of the division cystic artery by clipping compared with Ligasure and Diathermy for treatment of calcular cholecystitis. **Patients and Methods:** The study was conducted on ninety nine (99) consecutive patients with calcular cholecystits admitted at the general surgery department, Gamal Abd Elnasr health insurance hospital that were managed by laparoscopic cholecystectomy randomly divided into three groups: All patients whom will be operated upon Laparoscopic Cholecystectomy with clipping cystic artery (Group 1), All patients whom will be operated upon Laparoscopic Cholecystectomy with Ligasure (Group 2), All patients whom will be operated upon Laparoscopic Cholecystectomy with cauterization diathermy (Group 3). **Results:** The Data evaluation were based mainly on the comparison between clipping versus Ligasure versus diathermy by laparoscopic cholecystectomy as regard: operative time, blood loss, drain flow, post operative complication. All the parameters were statistically significant. **Conclusion:** In group A (clipping technique), only one patient had post op. hematoma diagnosed by U/S 1 day post op. which was dealt by follow up U/S 1 week post op. In group B (Ligasure technique), no complication had been recorded, while; In group C (diathermy technique), three patients had post op. hematoma, two of them resolved on follow up by U/S 1 week while last one referred to intervention radiology. The group B (Ligasure technique) is the fastest in op. time followed by group C (diathermy technique) then group A (clipping technique).

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1. Introduction

The first laparoscopic cholecystectomy was done on September 12, 1985 by Prof Dr Med Erich Mühe of Böblingen, Germany. In 1990, at the Society of American Gastrointestinal Surgeons Convention (SAGES) perform early laparoscopic cholecystectomy, but Mühe was not. However, in 1999 he was recognized by SAGES for having performed the first laparoscopic cholecystectomy **(Phillips et al., 2012).**

Laparoscopic cholecystectomy has become the gold standard in the treatment of symptomatic gall stones, the major advantages of laparoscopic cholecystectomy include less postoperative pain, less time required for hospitalization and recovery, and better cosmetic results **(Terho et al., 2016).**

Laparoscopic cholecystectomy was compared with the open procedure in a prospective comparative study focusing on complications. The only postoperative death occurred after open cholecystectomy. The need for postoperative analgesics and Hospital stay was significantly reduced by laparoscopic cholecystectomy so it carries a lower risk of serious complications than the open procedure **(Bhar et al., 2013).**

However, in comparison between two different school new and old one, open and laparoscopic cholecystectomy we shouldn't forget important of open cholecystectomy in laparoscopic contraindication including empyema of the gallbladder, gangrenous cholecystitis, coagulopathy, portal hypertension and peritonitis. Take in consideration different preoperative predictor factor of conversion of Laparoscopic cholecystectomy to open cholecystectomy **(Widmer et al., 2015; Ghazanfar et al., 2017).**

Gall stone disease is one of most common disease all over the world, as in USA >700,000 Cholecystectomies, 10:15% of white adults in developed countries harbor gallstones **(Knab et al., 2014).**

A good knowledge of the incidence and types of anomaly or variation is key to a safe cholecystectomy, as 50% of patients presenting with significant

variation from the expected normal pattern **(Al-Sayigh et al., 2010).**

The best way to avoid laparoscopic cholecystectomy complication is using the Critical View of Safety (CVS) to identify cystic duct and cystic artery during laparoscopic cholecystectomy **(Strasberg et al., 2010).**

The technique of performing LC has undergone many changes and variations. Several surgeons have tried to reduce the size and number of ports to improve cosmetic and postoperative outcomes and developed their own different versions. The standard technique of performing LC is to use 4 ports. However, the most recent development in technique of LC is single incision laparoscopic surgery (SILS), single site laparoscopic cholecystectomy (SSLC), 3 ports, Natural orifices transluminal endoscopic surgery (NOTES) **(Haribhakti et al., 2015).**

There are many ways to achieve homeostasis: monopolar electro coagulation (ME), bipolar electro coagulation (BE), Ligasure (LS), a modern bipolar vessel sealing system, and Ultracision (UC) **(Hirunwiwatkul et al., 2010).**

The Ligasure Vessel Sealing System (LVSS) is a bipolar electrosurgical device with integrated active feedback control, sealing vessels up to 7 mm in diameter. It facilitates surgery by achieving the efficient haemostasis of blood vessels encountered during dissection, and allowing the rapid and secure division of vascularised tissues, while minimizing thermal injury to adjacent tissues **(Hirunwiwatkul et al., 2010).**

Aim of the work

To review the procedure's safety and effectiveness. Through a comparison review between clipping or clippless either Diathermy cauterization or Ligasure during laparoscopic cholecystectomy, the authors examine the operative and post operative complication to this techniques.

2. Patients and methods

Patients:

This study included **(99)** patients with chronic calcular cholecystitis whom will be operated upon for Laparoscopic cholecystectomy in the period from October 2018 to April 2019 admitted at the general surgery department, Gamal abdel naser hospital and Theodor Bilharz Research Institute (TBRI) with:

- **Inclusion Criteria:**

All patients with chronic calcular cholecystitis whom will be operated upon for Laparoscopic cholecystectomy.

- **Exclusion Criteria:**
  - Patients with umbilical and par umbilical hernia.
  - Pregnancy.
  - Associated Cardiac or Pulmonary co-morbidity that contraindicate General Anesthesia.
  - Non-English articles

All Patients were randomly divided into (3) main groups:-

1. All patients whom will be operated upon Laparoscopic Cholecystectomy with clipping cystic artery (Group 1).
2. All patients whom will be operated upon Laparoscopic Cholecystectomy with ligature (Group 2).
3. All patients whom will be operated upon Laparoscopic Cholecystectomy with cauterization diathermy (Group 3).

Methods:

Preoperative preparation

1. Laboratorial (CBC, liver functions, ALT, AST, Total bilirubin, direct bilirubin, ALP, GGT, Albumin, renal functions, coagulation profile)
2. Radiological (abdominal ultrasonography)
3. Anesthetic consultation
4. Consent (the procedures were explained, written and informed consent obtained)
5. Preparation (Fasting 8-10 hrs, Shaving, I.V antibiotic)

Operative procedures

Clipping cystic artery technique in laparoscopic cholecystectomy **(Group 1):**

Patient positioning:

The patient was lying supine and the surgeon was positioned on the patient's left side (North American positioning). The camera operator stands on the patient's left and to the left of the surgeon, while the assistant stands on the patient's right. The video monitor was positioned on the patient's right above the level of the costal margin. Exposure can be improved by tilting the patient in the reverse Trendelenburg position and rotating the table with the patient's right side up. Gravity pulls the duodenum, the colon, and the omentum away from the gallbladder, thereby increasing the working space available in the upper abdomen.

Post-operative

A comparison was made between the three groups as regard:

1. Time of operation
2. Postoperative hemorrhage:

I. Drain flow
II. Postoperative ultra sound by 1 day
III. Postoperative ultra sound by 1 week

3. Results

Patients were 24 females (72.7%) and 9 males (27.3%) with mean age of 39.58 ± 9.87 years old (range 22.0 – 58.0years old) in clipping cystic artery (Group A1), patients were 26 female (78.8%) and 7

male (21.2%) with mean age of 43.33 ± 9.75years old (range 23.0 – 59.0 years old) in ligaturing cystic artery (group B), Patient were 20 females (60.6%) and 13 males (39.4%) with mean age of 47.24 ± 8.66 years old (range 31.0 – 59.0years old) in cauterization cystic artery by diathermy (group C). **(Table 4).**

Table (4): Distribution of age and sex in all groups

	Group A (n = 33)		Group B (n = 33)		Group C (n = 33)		Test of Sig.	p
	No.	%	No.	%	No.	%		
Sex								
Male	9	27.3	7	21.2	13	39.4	χ^2=2.731	0.255
Female	24	72.7	26	78.8	20	60.6		
Age (years)								
Min. – Max.	22.0 – 58.0		23.0 – 59.0		31.0 – 59.0			
Mean ± SD.	39.58 ± 9.87		43.33 ± 9.75		47.24 ± 8.66		F=5.437*	0.006*
Median	41.0		43.0		48.0			
Sig. bet. Grps	p_1=0.244, p_2=0.004*, p_3=0.218							
BMI (kg/m^2)								
Min. – Max.	22.0 – 38.0		21.0 – 38.0		21.0 – 37.0			
Mean ± SD.	29.58 ± 4.40		29.61 ± 4.17		29.27 ± 4.39		F=0.060	0.942
Median	30.0		30.0		31.0			

χ^2: **Chi square test**
F: **F for ANOVA test**, Pairwise comparison bet. each 2 groups was done using **Post Hoc Test (Tukey)**
p: p value for comparing between the studied groups p_1: p value for comparing between **group A** and **group B**
p_2: p value for comparing between **group A** and **group C**p_3: p value for comparing between **group B** and **group C**
*: Statistically significant at $p \leq 0.05$

Table (5): Comparison between the three studied groups according to timing for operation (min)

Timing for operation (min)	Group A (n = 33)	Group B (n = 33)	Group C (n = 33)	H	p
Min. – Max.	17.0 – 28.0	8.0 – 20.0	13.0 – 23.0		
Mean ± SD.	22.70 ± 2.86	11.82 ± 3.03	17.42 ± 2.51	71.585*	<0.001*
Median	23.0	11.0	17.0		
Sig. bet. Gps	p_1<0.001*, p_2<0.001*, p_3<0.001*				

H: H for **Kruskal Wallis test,** Pairwise comparison bet. each 2 groups was done using **Post Hoc Test (Dunn's for multiple comparisons test)**
p: p value for comparing between the studied groups p_1: p value for comparing between **group A** and **group B**
p_2: p value for comparing between **group A** and **group C** p_3: p value for comparing between **group B** and **group C**
*: Statistically significant at $p \leq 0.05$
In comparing between three studied groups p_1<0.001*, p_2<0.001*, p_3<0.001*

Table (6): Comparison between the three studied groups according to visceral injury and Major vascular injury

	Group A (n = 33)		Group B (n = 33)		Group C (n = 33)	
	No.	%	No.	%	No.	%
Visceral injury						
No	33	100.0	33	100.0	33	100.0
Yes	0	0.0	0	0.0	0	0.0
Major vascular injury						
No	33	100.0	33	100.0	33	100.0
Yes	0	0.0	0	0.0	0	0.0

Percentage of intra operative complication between three Groups is shown in **table (6).**
Percentage of intra operative complication in clipping cystic artery (Group A) was **0.0%**

- Percentage of intra operative complication in ligaturing cystic artery (group B) was **0.0%**
- Percentage of intra operative complication in cauterization cystic artery by diathermy (group C) was **0.0%.**

Table (7): Comparison between the three studied groups according to Tube drain collection/24h postop.

	Group A (n = 33)		Group B (n = 33)		Group C (n = 33)		Test of Sig.	p
	No.	%	No.	%	No.	%		
Tube drain								
>500 cc	32	97.0	33	100.0	30	90.9	χ^2= 3.781	MCp= 0.327
100 cc	1	3.0	0	0	2	6.1		
200 cc	0	0.0	0	0	1	3.0		

χ^2: Chi square test MC: Monte Carlo H: H for Kruskal Wallis test
p: p value for comparing between the studied groups

1) Tube drain collection/24h postop. comparison between three Groups is shown in **table (7).**

- Percentage of intra operative complication in clipping cystic artery (Group A) was **0.0%**
- Percentage of intra operative complication in ligaturing cystic artery (group B) was **0.0%**
- Percentage of intra operative complication in cauterization cystic artery by diathermy (group C) was **0.0%**

Table (8): Comparison between the three studied groups according to U/S 1d pot op. for hematoma

	Group A (n = 33)		Group B (n = 33)		Group C (n = 33)		Test of Sig.	p
	No.	%	No.	%	No.	%		
Follow up U/S 1day								
No	32	97.0	33	100.0	30	90.9	χ^2= 3.010	MCp= 0.320
Yes	1	3.0	0	0	3	9.1		

χ^2: **Chi square test** MC: **Monte Carlo**
H: H for **Kruskal Wallis test**
p: p value for comparing between the studied groups

2) U/S follow up Comparison between three Groups for 1 day post op. hematoma is shown in **table (8).**

- 32 patients out of 33 passed free with percentage **97%** (Group A)
- 33 patients out of 33 passed free with percentage **100%** (group B)
- 30 patients out of 33 passed free with percentage **90.9%** (group C)

Table (9): Comparison between the three studied groups according to U/S 1w pot op. for hematoma

	Group A (n = 33)		Group B (n = 33)		Group C (n = 33)		Test of Sig.	p
	No.	%	No.	%	No.	%		
Follow up U/S 1day								
No	33	100.0	33	100.0	32	97.0	χ^2= 1.838	MCp= 1.000
Yes	0	0.0	0	0	1	3.0		

χ^2: **Chi square test** MC: **Monte Carlo**
H: H for **Kruskal Wallis test**
p: p value for comparing between the studied groups

3) U/S follow up Comparison between three Groups for 1 week post op. hematoma is shown in **table (9).**

- 33 patients out of 33 passed free with percentage **100.0%** (Group A)
- 33 patients out of 33 passed free with percentage **100.0%** (group B)
- 32 patients out of 33 passed free with percentage **97.0%** (group C)

4. Discussion

Laparoscopic cholecystectomy has become the gold standard in the treatment of symptomatic gall stones, the major advantages of laparoscopic cholecystectomy include less postoperative pain, less time required for hospitalization and recovery, and better cosmetic results **(Lombardo et al., 2018).**

Cholecystectomy is the most common abdominal procedure performed for removal of gall bladder in cholelithiasis. Various advances have been made in the laparoscopic cholecystectomy procedures **(Knab et al., 2014).**

Cholecystectomy is the most common operative procedure performed on the biliary tract and the second most common major operation performed

today. This technique was developed almost a century ago by a German who has received little recognition. The familiar names of Billroth, Kocher, Czerny, Courvoisier, and Mikulicz reflect the contributions of German surgery. The name Langenbuch seems foreign among them, yet the genesis of surgery of the biliary tract may be traced to the conception and execution of the first gallbladder extirpation by Carl Langenbuch **(Polychronidis et al., 2008).**

The first laparoscopic cholecystectomy was done on September 12, 1985 by Prof Dr Med Erich Mühe of Böblingen, Germany. In 1990, at the Society of American Gastrointestinal Surgeons Convention (SAGES) perform early laparoscopic cholecystectomy, but Mühe was not. However, in 1999 he was recognized by SAGES for having performed the first laparoscopic cholecystectomy **(Phillips et al., 2012).**

Laparoscopic cholecystectomy was compared with the open procedure in a prospective comparative study focusing on complications. The only postoperative death occurred after open cholecystectomy. The need for postoperative analgesics and Hospital stay was significantly reduced by laparoscopic cholecystectomy so it carries a lower risk of serious complications than the open procedure **(Talpur et al., 2011).**

Surgical treatment of gallstone disease has changed dramatically because of the introduction of laparoscopic cholecystectomy. In some populations as many as 80 percent of cholecystectomies are now performed laparoscopically **(Steiner et al., 1994).**

The rapid and widespread adoption of laparoscopic cholecystectomy has aroused concern about the safety of the new procedure. In addition, one wonders whether the availability of a less invasive approach to cholecystectomy has led to a change in the spectrum of patients undergoing the procedure and in the threshold for performing it **(Al-Rubaiee et al., 2009).**

The technique of performing LC has undergone many changes and variations. Several surgeons have tried to reduce the size and number of ports to improve cosmetic and postoperative outcomes and developed their own different versions **(Haribhakti et al., 2015).**

The standard technique of performing LC is to use 4 ports. However The most recent development in technique of LC is single incision laparoscopic surgery (SILS), single site laparoscopic cholecystectomy (SSLC), 3 ports, Natural orifices transluminal endoscopic surgery (NOTES) **(Haribhakti et al., 2015).**

A “normal” cystic artery was found in only 72% of patients. The most important laparoscopically noted variations were doubling of the cystic artery (22%) and an artery that ran inferior to the cystic duct (6%). Small branches of the cystic artery, which we suggest be named Calot's arteries, supply the cystic duct and may cause troublesome bleeding during laparoscopic dissection in the hepatobiliary triangle **(Prasoon et al., 2018).**

Careful identification of arterial anomalies should help to reduce the incidence of bile duct injuries during laparoscopic cholecystectomy **(Prasoon et al., 2018).**

Uncontrolled arterial bleeding during laparoscopic cholecystectomy is a serious problem and may increase the risk of bile duct damage. Therefore, accurate identification of the anatomy of the cystic artery is important **(Rashid et al., 2015).**

There are many ways to achieve homeostasis: monopolar electro coagulation (ME), bipolar electro coagulation (BE), Ligature (LS), a modern bipolar vessel sealing system, and Ultracision (UC) **(Haribhakti et al., 2015).**

Gall bladder perforation during dissection from the liver bed with spillage of bile and loss of stones in the peritoneal cavity is a common operative problem during laparoscopic cholecystectomy **(Sathesh-Kumar et al., 2004).**

The incidence of gallbladder perforation during laparoscopic cholecystectomy has been reported to be 20–40%. During surgery, gall bladder perforation with spillage of bile and loss of stones disrupts the level of surgery and prolongs its duration **(Mahabaleshwar et al., 2012).**

At present, mono-polar-electro-cautery is the main cutting method used for gallbladder dissection from the liver bed. It is associated with local thermal and distant tissue damage, which might cause inadvertent perforation of the gallbladder during gallbladder bed dissection **(Ramzanali et al., 2012).**

The LigaSure™ device [LigaSure vessel sealing system (LVSS), Valleylab, Boulder, CO, USA] was designed for sealing vessels up to 7 mm in diameter as an alternative to the use of clips or ligature **(Hirunwiwatkul et al., 2010).**

The LVSS, a bipolar electrosurgical device, is a method of bipolar hemostasis that denatures the collagen and elastin of the vascular wall and the connective tissue around the vessels. The LVSS creates tissue fusion that forms a true seal rather than a proximal thrombus that is created by bipolar electrocautery **(Turial et al., 2011).**

The LVSS was originally designed mostly for vessel sealing in abdominal operations. This technology can seal vessels with a diameter less than or equal to 7 mm according to the manufacturer’s instructions **(Hirunwiwatkul et al., 2010).**

When the seal cycle is complete, energy delivery is automatically interrupted by a feedback-controlled

response. The LVSS has been used to secure hemostasis in various open and laparoscopic procedures **(Turial et al., 2011).**

Also, the use of the LVSS for resection or transection of various parenchymal organs and soft tissues, biliary duct closures, intestinal resection, and anastomosis, and even for the closure of the appendicular stump during appendectomy has been described in recent literature **(Turial et al., 2011).**

Comparative studies have been proven that it is as safe, feasible, and even beneficial as other vessel closure techniques such as the plasma trisector, Ultracision, surgical clip application, harmonic scalpel, and conventional hemostasis **(Turial et al., 2011).**

This study was carried out in the department of General surgery, Gamal abd El-naser hospital in the period from October 2018 to March 2019.

The aim of this study was to compare between clipping, Ligasure and diathermy of cystic artery in laparoscopic cholecystectomy as regards Timing, Complications and to find out which technique is preferred.

The total number of the patients in our study was 99 (33 Group A, 33 Group B, 33 Group C) and were 24 females and 9 males with mean±SD age of 39.58 ± 9.87 years old (range 22_58 years old) in Group A (clipping group) with Mean±SD BMI 29.58 ± 4.40(range 22.0_38.0), patients were 26 female and 7 male with mean±SD age of 43.33 ± 9.75 years old (range 23.0_59.0 years old) in Group B (Ligasure group) with Mean±SD BMI 26.1 ± 4.17 (range 21.0_38.0), patients were 20 female and 13 male with mean±SD age of 47.24 ± 8.66 years old (range 31.0_59.0 years old) in Group C (Diathermy group) with Mean±SD BMI 29.27 ± 4.39 (range 21.0_37.0).

These patients were admitted to hospital as they had met the inclusion criteria in which all patients with chronic calcular cholecystitis whom will be operated upon for laparoscopic cholecystectomy which was quoted with some modifications from classical clinical, laboratory and imaging criteria of cholecystolithiasis were used.

The sex distribution in our study revealed that cholecystolithiasis was more common in females with a female to male ratio of 24 _ 9 (72.7%: 27.3%) in Group A & 26 _ 7(78.8%: 21.2%) in Group B & 20 _ 13(60.6%: 39.4%) in Group C. This was in agreement with many studies which found that the gallstones were more common in females **(Stanley et al., 2010).**

The most common decades of life for development of cholecystolithiasis in our study were the fourth and fifth decades. Median of Group A (41.0) & (43.0) in group B & (48) in group C. This was in some agreement with several studies which found that the gall stones were more common in the fourth to Fifth decade of life **(Topal et al., 2007).**

The most common complaint in our patients was right upper quadrant pain (RUQP). These findings were in some agreement with several studies which reported that, the most common complaints were (RUQP), epigastric pain, nausea and jaundice came as the sixth most common complaint **(Topal et al., 2007).**

Abdominal ultrasonography (US) revealed gallstones in all patients. This denotes that (US) is highly accurate for detection of gallstones (100%). These finding were also reported by several studies, which found that the sensitivity of (US) for detection of gallstones was (80-100%) **(Freitas et al., 2006).**

In this study the operative time For dissect and separate cystic artery in minutes in clipping technique (Group A) Mean±SD was 22.70 ± 2.86 compared with ligasure technique (Group B) 11.82±3.03. compared with Diathermy technique (Group C) 17.42±2.51 with significant difference **($p < 0.001$).**

This similar to several studies reported that ligasure technique is least consuming time rather than Diathermy and clipping **(Samer et al., 2011).**

In this study there was no visceral and vascular injury in all Groups (A, B, C). These findings were in some agreement with no significant visceral or vascular injury recorded **(Shamiyeh, 2004),** situations, including previous abdominal operations **(Roger Pozzo et al., 2016).**

In this study Post Operative tube drain 24 hours score 32 patient in clipping technique (Group A) were less than 50cc (97%) compared with 33patinet in ligasure technique (Group B) less than 50 cc (100 %) and 30patients (90.9 %) in diathermy technique (group C) with significant difference **(P-value 0.0327).**

At 1993 American journal of roentgenology enumerate Complications after laparoscopic cholecystectomy: imaging finding intra peritoneal hemorrhage may be caused either by laceration of liver during dissection of gall bladder from liver bed or from incomplete ligation of cystic artery with may lead to abscess formation due to infected hematoma or biloma.

So it's an important reason to make post operative imaging after laparoscopic cholecystectomy **Ray (1993).**

In this study I make follow up imaging U/S by one day and one week to all cases to exclude any complication and early management if happened.

In 1 day follow up one case recorded hematoma (3.0%) by clipping technique (group A) compared with ligasure technique (group B) no recorded case (0.00%) while 3 cases (9.0%) recorded in diathermy

technique (group C) with no significant difference **(P-value 0.320).**

After 1 week follow up was done again no cases recorded in both group A & B compared by one case recorded in group C (diathermy technique) which referred to radiological intervention after sureness of Biliary stasis and hemodynamically stable with no significant difference **(P-value 1.000).**

Conclusion

1. In group A (clipping technique), only one patient had post op. hematoma diagnosed by U/S 1 day post op. which was dealt by follow up U/S 1 week post op. In group B (Ligasure technique), no complication had been recorded, while; In group C (diathermy technique), three patients had post op. hematoma, two of them resolved on follow up by U/S 1 week while last one referred to intervention radiology.

2. The group B (Ligasure technique) is the fastest in op. time followed by group C (diathermy technique) then group A (clipping technique)

3. The comparison between three groups in post op. complication:

a. In both groups A & B, no post op bleeding was encountered with less than 100cc serosangous in tube drain/24h, while one patient in group C encountered with 200 cc blood in tube drain / 24h.

b. In group A only one case complicated with seroma, while no case in group B, and four patients complicated with seroma in group C.

During laparoscopic cholecystectomy, clip usage and Ligasure energy application are equally competent in achieving haemostasis of cystic artery and more patent than diathermy.

Ligasure technique is more safest and fast method with no complication.

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