Original Research Paper

Volume - 14 | Issue - 01 | January - 2024 | PRINT ISSN No. 2249 - 555X | DOI : 10.36106/ijar

General Surgery

A COMPARATIVE STUDY OF GALLBLADDER DISSECTION DURING LAPAROSCOPIC CHOLECYSTECTOMY BY ULTRASONIC BIPOLAR DISSECTION VERSUS MONOPOLAR ELECTROCAUTERY

Ranendra Hajong

ABSTRACT **Background:** Laparoscopic cholecystectomy (LC) is the 'gold' standard treatment for benign gallbladder diseases. Dissection of gallbladder from its bed is an important step during LC which is often complicated by gallbladder perforation leading to the spillage of bile or gallstones into the peritoneal cavity. This may lead to unwanted complications with the resultant delay in the duration of the procedure. The aim of this study was to compare the usage of ultrasonic bipolar dissection and electrocautery for dissection of gallbladder from its bed and to assess the various intra-operative parameters and the resultant consequences thereof. **Methods:** This was a prospective analytical type of cross-sectional study conducted in the department of General Surgery in a tertiary care hospital in North East India from January 2021 till June 2023. A total of 192 patients undergoing elective laparoscopic cholecystectomy were divided into two equal groups of 96 patients each with the even numbered patients allocated to electrocautery group and odd numbered patients were allocated to ultrasonic bipolar dissection for gallbladder dissection. The main outcome measures were gallbladder perforation, number of patients requiring lens cleaning and the total operating time. Data were collected in the Microsoft Xcel, 2010 and analysed by using SPSS, Version 23. A p value of ≤ 0.05 was considered statistically significant. **Results:** The overall rate of gallbladder perforation was 20.83% (12.5% in the ultrasonic bipolar group and 29.17% in the monopolar group). The number of patients requiring lens cleaning and also the number of times of lens cleaning required per patient was significantly lower in the ultrasonic bipolar dissection group (p value 0.003). The overall duration of surgery was significantly shorter in the ultrasonic bipolar dissection group (23.25 ± 5.82 minutes versus 37.63 ± 9.46 minutes). **Conclusion:** The use of ultrasonic bipolar dissection for gallbladder dissection from its bed during laparoscopic cholecystectomy when compared with monopolar electrocautery have the following advantages- decreased incidence of gallbladder perforation, lesser number of lens cleaning due to less smoke generation and shorter duration of operation.

KEYWORDS : Laparoscopic cholecystectomy, gallbladder dissection, ultrasonic bipolar, monopolar electrocautery, morbidity profile.

INTRODUCTION:

Laparoscopic cholecystectomy (LC) is a safe procedure and is the "Gold Standard" treatment for symptomatic gallstone disease. It offers shorter hospital stay, early return to work, better cosmetic results, and lesser post-operative pain. [1] However, thermal injuries caused by monopolar electrocautery are troublesome problems especially during gallbladder dissection around Calot's triangle and during dissection of gallbladder from its bed resulting in gallbladder perforation which leads to spillage of bile and stones in peritoneal cavity. [2-5] The incidence of gallbladder perforation during its dissection from its bed ranges from 20%–40%. [6,7] In contrast to monopolar electrocautery, ultrasonic dissection generally produces a smaller zone of tissue damage allowing for more accurate dissection around Calot's triangle and has been suggested as an alternative to monopolar electrocautery in laparoscopic cholecystectomy. [8-10] Thunderbeat (Olympus, USA) integrates ultrasonic and bipolar energy and allows for more accurate dissection. This study was undertaken to compare the feasibility and morbidity profile of gallbladder dissection by ultrasonic bipolar device (Thunderbeat) as against the conventional monopolar electrocautery as no similar study has been reported earlier.

MATERIAL & METHODS:

This was a prospective analytical type of cross-sectional study conducted in the department of General Surgery in a tertiary care hospital in North East India from January 2021 till June 2023. A total of 192 consenting patients scheduled to undergo laparoscopic cholecystectomy for benign gallbladder diseases were included in the study. Patients with suspicion of malignancy, acute cholecystitis, common bile duct calculi and patients who had undergone ERCP with biliary stenting were not included in the study. In 96 patients, gallbladder dissection was done from its bed by ultrasonic bipolar device (Thunderbeat, Olympus, USA) and in the remainder 96 patients; monopolar electrocautery was used to dissect the gallbladder from its bed. Written informed consents were obtained from the patients. Odd number of patients was assigned in the ultrasonic bipolar group and even number of patients was placed in the monopolar group. The operations were performed by the same surgeon with more than 15 years of experience in laparoscopic surgeries. The standard four ports laparoscopic cholecystectomy was performed. Calot's triangle was dissected along with coagulation of cystic artery with Thunderbeat in those patients in whom the gallbladder was dissected from its bed by Thunderbeat. Whereas in the monopolar electrocautery group, Calot's triangle was dissected with the standard laparoscopic instruments and the cystic artery was managed by clipping. Cystic duct was clipped in both the groups. The various outcome measures that were analysed between the groups- gallbladder perforation, bile spillage, stone spillage, mean number of lens cleaning during surgery, mean duration (In minutes) required to dissect the gallbladder from its bed, intraoperative blood loss, use of haemostatic agents (Ab Gel), use of drains and postoperative complications if any. Blood loss was calculated by measuring the amount from the suction devices. Dissection time was calculated after the ligation of cystic duct and artery till the time the gallbladder was disconnected from its bed. Post-operatively drains were removed mostly on day 1 or 2 after measuring the output and looking at the colour. No patients developed any post-operative collection in those patients without any drains. None of the patients had any bile duct injury.

Data were collected in the Microsoft Xcel, 2010 and analysed by using SPSS, Version 23. Quantitative variables were estimated using measures of central location (mean, median) and measures of dispersion (standard deviation and standard error). Normality of data was checked using measures of skewness and Kolmogorov–Smirnov tests of normality. For normally distributed data, we compared means using the Student *t* test for both groups. For skewed data, we used the Mann–Whitney *U* test. Qualitative or categorical variables were described as frequencies and proportions. Proportions were compared using the $\chi 2$ or Fisher exact test as applicable. The risk of gallbladder perforation in the presence of complicating factors was also estimated by calculating odds ratios. All statistical tests were 2-sided and performed at a significance level of $\alpha = 0.05$.

RESULTS:

Out of 192 patients, 141 were females and the remainder 54 were male patients. The clinical and radiological profile of patients in both the groups was evenly matched in terms of gender, BMI, co-morbidities, pre-operative ultrasonic findings, etc. (Table 1 & 2). Lesser incidence of gallbladder perforation resulting in bile and stone spillage intraperitoneally was observed in the ultrasonic bipolar group which was statistically significant (Table 3). 59 patients required cleaning of lens during gallbladder dissection from its bed in the ultrasonic bipolar group in comparison to 93 patients in the monopolar group. The mean number of lens cleaning required per patient in the ultrasonic bipolar group was 2.7 ± 1.22 (SD= Standard deviation), as against 5.8 ± 2.32 (SD) in the monopolar group which was statistically significant (p value 0.003). The mean duration of gallbladder dissection from its bed was also significantly shorter in the ultrasonic group 3.54 ± 1.23 (SD) as against 6.78 ± 2.98(SD). The average blood loss requiring usage of haemostatic agents (AbGel) and abdominal drains were significantly lower in the ultrasonic bipolar group (Table 3). The Postoperative

wound infection rate was very minimal in both the groups.

Table 1. Profile of patients in both the groups.

Characteristic	Ultrasonic bipolar, n = 96	Monopolar electrocautery, n = 96	p value
Mean age in years	43.46	45.56	0.62
Gender			
Male	27.08 %	29.17%	0.53
Female	77.08 %	75 %	0.53
Mean BMI	21.64	22.42%	0.42
Symptomatology			
Pain abdomen	67.71%	70.83%	0.32
Dyspepsia	29.17%	27.08%	0.24
History of gallstone pancreatitis	3.13%	2.08%	0.81
Diabetes mellitus	16.67%	18.75%	0.46
Hypertension	23.96%	27.08%	0.41
Hypothyroidism	2.08%	3.13%	0.73
Previous abdominal surgeries	7.29%	9.38%	0.64
Intraoperative complications	12.5%	9.38%	0.42

Table 2. Pre-operative ultrasonographic findings in both the groups

USG Finding	Ultrasonic bipolar, n = 96	Monopolar electrocautery, n = 96	p value
Distended gallbladder	44.79%	42.71%	0.62
Stone size ≥ 1 cm	34.38%	37.5%	0.67
Impacted stone at gallbladder neck	27.08%	29.17%	0.73
Gallbladder wall thickness ≥ 3 mm	23.96%	20.83%	0.71
Single calculus	18.75%	16.67%	0.64
Multiple calculi	63.54%	61.46%	0.52
Gallbladder polyp	3.13%	4.17%	0.88
Sludge	14.58%	17.71%	0.37
Common bile duct diameter ≥ 6 mm	11.46%	9.38%	0.79
Pericholecystic fluid	5.2%	7.29%	0.69

Table 3. Intraoperative and postoperative findings in both the groups

Intra/post-operative	Ultrasonic bipolar, n = 96	Monopolar electrocautery, n = 96	p value
Thickened gallbladder wall	23.96%	20.83%	0.71
Difficult Calot's	13.54%	12.5%	0.88
Mucocele of gallbladder	15.63%	17.71%	0.76
Empyema of gallbladder	11.46%	13.54%	0.78
Intrahepatic gallbladder	9.38%	8.33%	0.87
Gallbladder perforation	12.5%	29.17%	0.043
Bile spillage	12.5%	29.17%	0.043
Pus spillage	11.46%	13.54%	0.78
Stone spillage	9.38%	25%	0.038
Number of patients requiring lens cleaning	53.13%	93.75%	0.026
Mean number of lens cleaning per patient	2.7 ± 1.22 (SD)	5.8 ± 2.32 (SD)	0.003
Mean duration of gallbladder dissection from bed (In minutes)	3.54 ± 1.23 (SD)	6.78 ± 2.98 (SD)	0.002
Mean duration of surgery (in minutes)	23.25 ± 5.82 (SD)	37.63 ± 9.46 (SD)	0.002
Average blood loss in milliliter	27.67 ± 7.58 (SD)	45.64 ± 11.35 (SD)	0.004
Use of hemostatic agents in patients	19	31	0.005
Use of drains in patients	11.46%	21.88%	0.046
Wound infection	1.04%	2.08%	0.89

SD= standard deviation

DISCUSSION:

Monopolar electrocautery is most frequently used for cutting and coagulation during laparoscopic cholecystectomy even though various other modalities are available during laparoscopic surgeries. [11] However, Minhas A, et al [12] and Mahabaleshwar V, et al [13] have compared the usage of ultrasonic dissector (Harmonic Ace curved shears, Ethicon Endo-Surgery, Johnson & Johnson Co.) against the conventionally used monopolar electrocautery for gallbladder dissection from its bed during laparoscopic cholecystectomy.

Monopolar electrocautery generates intense collateral heat causing tissue necrosis or ischemia and even injury to the adjacent tissues which may go unrecognized during surgery but may present late adding to the morbidity and even mortality to the patients. [11] Ultrasonic dissectors on the other hand denature protein by vibrating at a frequency of 50- 55000 Hz per second, and the generated mechanical energy when transferred to the tissues results in simultaneous cutting and coagulation. The vibrating ultrasonic dissector does not generate much heat unlike monopolar or laser cautery, and produces only microaromized water droplets in place of smoke in monopolar electrocautery thereby keeping the surgical field of vision clear. [14] Besides, as no electric current is generated in the surgical field; ultrasonic dissection is safe even in patients with pacemaker implantations. [15]

The Thunderbeat™ device (Olympus, USA) delivers integrated bipolar and ultrasonic energies simultaneously to the tissues allowing reliable vessel sealing and rapid tissue cutting. [16] Thunderbeat™ when compared in animal models to other electrosurgical devices (Harmonic ACE, Ligasure V, and EnSeal) available commercially has shown superior cutting speed and versatility. [17,18]

The most frequent complication occurring intraoperatively during laparoscopic cholecystectomy is gallbladder perforation, the incidence of which ranges from 13 to 50% with the resultant spillage of bile and stones in 10 - 40% of these patients. [19, 20] Spillage of bile and gallstones into the peritoneal cavity may prolong the surgical procedure and also have serious consequences. [21] The incidence of gallbladder perforation in the ultrasonic bipolar group in the present series was 12.5% which was significantly lower than in the monopolar group (29.17%). Similar lower rates of gallbladder perforation in the ultrasonic dissection group than the monopolar group have been reported by Minhas A, et al (24% versus 38%), Mahabaleshwar V, et al (16.7% vs 40%) and Janssen IM, et al (16% vs 50%) respectively. [12, 13, 4] Ultrasonic dissection is preferred for gallbladder dissection in patients with complications such as thickened and fibrotic gallbladder, acute cholecystitis, and difficult Calot's dissection due to dense adhesions. [4]

In the present series, 53.13% of patients in the ultrasonic bipolar group required lens cleaning during surgery as against 93.75% of patients in the monopolar group which was statistically significant (p value 0.026). Similar lower rates of lens cleaning in the ultrasonic group have been reported by Mahabaleshwar V, et al (63.3% vs 90%). [13]

The average blood loss during surgery was significantly lower in the ultrasonic bipolar group as against the monopolar group (27.67 ± 7.58 ml vs 45.64 ± 11.35 ml). The resultant usage of haemostatic agents and abdominal drains were also lesser in the ultrasonic bipolar group. Minhas A, et al also reported a lower loss of blood in the ultrasonic group when compared with the monopolar group (38.92 35.53 cc versus 52.90 46.35 cc). [12]

Thunderbeat™ device (Olympus, USA) delivers integrated bipolar and ultrasonic energies simultaneously to the tissues and replaces the need for dissector, clip applier, scissors and electrosurgical hook or

spatula, etc. It also less smokes thus allowing the surgeon a clearer operative field throughout the operation.

Due to lesser incidences of smoking requiring lens cleaning and decreased incidence of gallbladder resulting in bile and stone spillage; the mean duration of gallbladder dissection from its bed by ultrasonic bipolar method was significantly lower (3.54 ± 1.23 minutes) than in the monopolar group (6.78 ± 2.98). This ultimately resulted in shorter overall duration required to complete the laparoscopic cholecystectomy in the ultrasonic bipolar group (23.25 ± 5.82 minutes versus 37.63 ± 9.46 minutes). Similar shorter duration of surgery in the ultrasonic group have been reported by Minhas A, et al (40 ± 8.63 minutes versus 50.8 ± 9.33 minutes), by Mahabaleshwar V, et al (27.20 min v. 34.37 min) and by several other authors. [11,12,13,22,23] Increased cost of the surgical procedure due to the usage of Thunderbeat™ device is not a concern in the present series as our hospital is Government of India financed hospital providing the machine as well the hand pieces required from time to time.

CONCLUSION:

Laparoscopic Cholecystectomy is considered the gold standard for the management of symptomatic gall stone diseases. Dissection of gallbladder from its bed is one of the important steps of the procedure. There have been constant evolutions of technology to carry out the various steps of the surgery in terms of monopolar electrocautery to ultrasonic harmonic scalpel to Thunderbeat™ device. With use of Thunderbeat™ device, lesser incidence of gallbladder perforation and resultant bile and stone spillage, lower incidence of bleeding, lower incidence of smoking thereby allowing clearer operative field to surgeons have been reported in the present series which significantly reduced the mean duration of the surgery (LC). It has been found to be safe to do dissection around Calot's triangle and also effective for gallbladder dissection from its bed during laparoscopic cholecystectomy.

Limitations of the study:

Thunderbeat is not readily available in low resource hospitals in rural areas and cost may also be a limiting factor in the use of Thunderbeat as the probes needs to be changed frequently adding to the cost of the whole procedure.

Conflict of Interest: Nothing to disclose.

REFERNCES:

1. Polychronidis A, Karayiannakis A, Simopoulos C. 'Laparoscopic Cholecystectomy' or Simply Cholecystectomy'. Medical Principles and Practice.2003;12(4):276. https://doi.org/10.1159/000072299
2. Strasberg SM, Eagon CJ, Drebin JA. The 'hidden cystic duct' syndrome and the infundibular technique of laparoscopic cholecystectomy — the danger of the false infundibulum. J Am Coll Surg 2000;191:661-7. doi: 10.1016/s1072-7515(00)00717-1.
3. Rosenberg J, Leinskold T. Dome down laparoscopic cholecystectomy. Scand J Surg 2004;93:48-51. doi: 10.1177/145749690409300110.
4. Janssen IM, Swank DJ, Boonstra O, et al. Randomized clinical trial of ultrasonic versus electrocautery dissection of the gallbladder in laparoscopic cholecystectomy. Br J Surg 2003;90:799-803. doi: 10.1002/bjs.4128.
5. Diez J, Arozamena C, Gutierrez L, et al. Lost stones during laparoscopic surgery. HPB Surg 1998;11:105-8. doi: 10.1155/1998/95874
6. Peters JH, Gibbons GD, Innes JT, et al. Complications of laparoscopic cholecystectomy. Surgery 1991;110:769-7877; discussion 77-8. PMID: 1833848.
7. Soper NJ, Dunnegan DL. Does intraoperative gallbladder perforation influence the early outcome of laparoscopic cholecystectomy? Surg Laparosc Endosc 1991;1:156-61. PMID: 1669395.
8. Amaral JF. Laparoscopic cholecystectomy in 200 consecutive patients using an ultrasonically activated scalpel. Surg Laparosc Endosc 1995;5:255-62. PMID: 7551275.
9. Power C, Maguire D, McAnena OJ, et al. Use of the ultrasonic dissecting scalpel in laparoscopic cholecystectomy. Surg Endosc 2000;14:1070-3. doi: 10.1007/s004640000034. PMID: 11116422.
10. Wetter LA, Payne JH, Kirshenbaum G, et al. The ultrasonic dissector facilitates laparoscopic cholecystectomy. Arch Surg 1992;127:1195-98; discussion 1998-9. doi: 10.1001/archsurg.1992.01420100053009. PMID: 1417485.
11. 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 2010;14:323-8. doi: 10.1007/s11605-009-1039-8. Epub 2009 Oct 31. PMID: 19882194.
12. Minhas A, Rajdev V, Chauhan A, Devkaran B, Gupta AK. Comparative study of monopolar electrocautery versus ultrasonic dissection of gall bladder in laparoscopic cholecystectomy: A prospective observational study. Int J Surg Sci 2022;6(2):125-127. DOI: https://doi.org/10.33545/surgery.2022.v6.i2b.905
13. Mahabaleshwar V, Kaman 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 Oct;55(5):307-11. doi: 10.1503/cjs.000411. PMID: 22854110; PMCID: PMC3468642.
14. Lee SJ, Park KH. Ultrasonic energy in endoscopic surgery. Yonsei Med J 1999;40:545-9. doi: 10.3349/ymj.1999.40.6.545. PMID: 10661030.
15. Strate T, Bloechle C, Broering D, et al. Hemostasis with the ultrasonically activated scalpel. Effective substitute for electrocautery in surgical patients with pacemakers. Surg Endosc 1999;13:727. doi: 10.1007/s004649901084. PMID: 10384086.
16. James CA, Williams GA, Jin LX, Liu J, Sanford DE, Fields RC, Doyle MMB, Strasberg SM, Hawkins WG, Hammill CW. Thunderbeat™ Integrated Bipolar and Ultrasonic Forceps in the Whipple Procedure: A Prospective Randomized Trial. Mo Med. 2020 Nov-Dec;117(6):559-562. PMID: 33311789; PMCID: PMC7721432.
17. Milsom J, Trencheva K, Monette S, et al. Evaluation of the safety, efficacy, and versatility of a new surgical energy device (Thunderbeat) in comparison with Harmonic ACE, LigaSure V, and EnSeal devices in a porcine model. Jour Laparoendosc Adv Surg Tech. 2012;22(4):378–385. doi: 10.1089/lap.2011.0420. Epub 2012 Feb 24. PMID: 22364404.
18. Seehofer D, Mogl M, Boas-Knoop S, et al. Safety and efficacy of new integrated bipolar and ultrasonic scissors compared to conventional laparoscopic 5-mm sealing and cutting instruments. Surg Endosc. 2012;26:2541–2549. doi: 10.1007/s00464-012-2229-0. Epub 2012 Mar 24. PMID: 22447285; PMCID: PMC3427482.
19. De Simone P, Donadio R, Urbano D. The risk of gallbladder perforation at laparoscopic cholecystectomy. Surg Endosc 1999;13:1099-102. doi: 10.1007/s004649901181. PMID: 10556446.
20. Memon MA, Deeik RK, Maffi TR, et al. The outcome of unretreived gallstones in the peritoneal cavity during laparoscopic cholecystectomy. A prospective study. Surg Endosc 1999;13:848-57. doi: 10.1007/s004649901118. PMID: 10449837.
21. Tucker RD. Laparoscopic electrosurgical injuries: survey results and their implications. Surg Laparosc Endosc 1995;5:311-7. PMID: 7551285.
22. Bessa SS, Al-Fayoumi TA, Katri KM, et al. Clipless laparoscopic cholecystectomy by ultrasonic dissection. J Laparoendosc Adv Surg Tech A 2008;18:593-8. doi: 10.1089/lap.2007.0227. PMID: 18721011.
23. Cengiz Y, Janes A, Grehn A, et al. Randomized clinical trial of traditional dissection with electrocautery versus ultrasonic fundus-first dissection in laparoscopic cholecystectomy. Br J Surg 2005;92:810-3. doi: 10.1038/s41598-019-55401-6. PMID: 31822771; PMCID: PMC6904718.