

## Implementing a modified intraoperative grading system for a difficult laparoscopic cholecystectomy

Yarub Momtaz Tawfeek Al-Hakeem\* , Professor Nashwan Qahtan Mahgoob\*\*

\*Aljamhori Teaching Hospital , \*\*Department of Surgery College of Medicine University of Mosul , Mosul , Iraq  
Correspondence yarob.momtaz@yahoo.com

(Ann Coll Med Mosul 2021; 43 (1):91-99).

Received: 10<sup>th</sup> Sept. 2020; Accepted: 15<sup>th</sup> March 2021.

### ABSTRACT

**Objective:** To analyze intraoperative grading findings during elective laparoscopic cholecystectomy by which we can assess the surgical performance regarding its safety, achievability and to determine a safe operative approach and/or time for conversion.

**Design:** An observational prospective case series study.

**Setting:** During the period from June 2018 to January 2020, operations were done by 4 qualified consultant surgeons and their teams at 4 hospitals in Mosul and Erbil.

**Participants:** Two hundred and fifty-five patients.

**Patients and Methods:** All patients underwent elective laparoscopic cholecystectomy for symptomatic gallbladder disease after full evaluation and taking their informed consents. An intraoperative difficulty calculation score has been implemented that divide the situation into 4 grades: easy, difficult, very difficult and extremely difficult, depending on the appearance of the gall bladder wall color, amount of adhesion, the presence of anatomical abnormalities, and the ability to achieve the critical view of safety. Perforation of the gallbladder, slipped stones, bleeding, using extra instruments, the need for extending the epigastric incision, the use of a drain and conversion to open procedure as well as the duration of surgical intervention had been recorded as predictors for the assessment of the difficulty level during surgery.

**Results:** The first grade included 168 (66%) patients, the second grade included 62 (24%) patients, while grades 3 and 4 represent 15 (6%) and 10 (4%) of patients respectively. Perforation showed no significance in the grading. Bleeding was more common in grades 3 and 4. Using accessory equipment was mandatory to complete the operation in grade 4 as well as an extension of epigastric port and the need for putting a drain. Conversion to open cholecystectomy was done in 2 operations (0.7%), both belonged to grade 3 and 4. The time needed to accomplish the operation was significantly high in grades 3 and 4.

**Conclusion:** This modified grading score can provide a tool for reporting operative findings and technical difficulties during laparoscopic cholecystectomy that allow the surgeon to know the seriousness of the situation and taking effective measures to overcome it.

**Keywords:** Laparoscopic cholecystectomy , conversion , intra-operative coplication .

### تنفيذ نظام تصنيف معدل أثناء الجراحة لاستئصال المرارة بالمنظار

يعرب ممتاز توفيق الحكيم\* ، الاستاذ نشوان قحطان محجوب\*\*  
\*مستشفى الجمهوري التعليمي ، \*\*فرع الجراحة ، كلية الطب ، جامعة الموصل ، الموصل ، العراق

#### الخلاصة

**المقدمة :** لتحليل نظام تصنيف المشاهدات الجراحية المطور خلال عملية استئصال المرارة بالمنظار الجراحي فيما يتعلق بأمان وسلامة المريض، للحصول على أداء جراحي آمن.

**التصميم :** دراسة المشاهدات خلال سلسلة من الحالات.

**الإعدادات :** خلال الفترة من حزيران ٢٠١٨ الى كانون الثاني ٢٠٢٠. العمليات اجريت من خلال اربعة جراحين استشاريين وفريقهم الجراحي في اربعة مستشفيات في الموصل واربيل.

**المشاركون في الدراسة :** مئتان وخمس وخمسون حالة.

**الأدوات والطرق :** جميع المرضى أجريت لهم عملية استئصال المرارة بالمنظار الباردة بعد تقييم الحالة من خلال الفحص السريري وإجراء كافة الفحوصات المطلوبة بالإضافة الى أخذ موافقة المرضى للعملية. نظام التصنيف للعملية قسم الحالات الى

أربعة اصناف: سهلة، صعبة، صعبة جدا وصعبة للغاية، اعتمادا على لون المرارة، وجود الالتصاقات، وجود التشوهات الخلقية في القنوات الصفراوية والشرايين المغذية لها بالإضافة الى إمكانية الحصول على منظر الأمان الحرج. ثقب المرارة غير المتعمد أثناء العملية، انزلاق الحصوات من ثقب المرارة، النزيف الدموي، استعمال أدوات إضافية، الحاجة الى وضع أنبوب تصريف جراحى، الحاجة الى تكبير المنفذ الجراحى إضافة الى وقت العملية، كل هذه المتغيرات سجلت كنقاط لأجل تصنيف صعوبة العملية.

**النتائج :** الصنف الأول شمل ١٦٨ مريض (٦٦%)، الصنف الثانى شمل ٦٢ مريض (٢٤%)، الصنف الثالث شمل ١٥ مريض (٦%) واخيرا الصنف الرابع شمل ١٠ مريض (٤%). ثقب المرارة غير المتعمد اثناء العملية وانزلاق الحصوات لوحظ بأنهم ليسوا ذو أهمية خلال التصنيف. النزيف الدموي كان أكثر خلال الصنف الثالث والرابع. استعمال أدوات إضافية كان ضروريا لإنهاء العملية فى الصنف الرابع إضافة الى تكبير المنفذ الجراحى والحاجة لوضع انبوب تصريف جراحى. تحويل مسار العملية من الناظور الى الفتح الجراحى أجرى لإثنين من المرضى (٠.٧%)، كليهما يعودان الى الصنف الثالث والرابع. الوقت المتطلب لإنهاء العملية كان ذو أهمية بالغة فى الصنف الثالث والرابع.

**الاستنتاج :** هذا النظام التصنيفى المطور يقدم لنا أداة لتسجيل المشاهدات والصعوبات التقنية اثناء عملية استئصال المرارة بالناظور، والتي تنبه الجراح لمعرفة خطورة الموقف واتخاذ التدابير اللازمة للتغلب عليه.

**الكلمات المفتاحية :** استئصال المرارة بالناظور ، تحويل مسار العملية من الناظور الى الفتح الجراحى ، المضاعفات اثناء العملية .

## INTRODUCTION

Laparoscopic cholecystectomy has become the gold standard surgery in the treatment of gallbladder pathology and is replacing open cholecystectomy<sup>1</sup>. This fact was confirmed by a lengthy work after the adoption of this method in 1985, which was performed for the first time by Erich Mühe in Böblingen, Germany<sup>2</sup>. Carrying out laparoscopic cholecystectomy may be very easy, or it may be very difficult to stay with the most experienced surgeons and it's regarded as one of the more unpredictable operations due to the variable operative findings and surprises<sup>3</sup>.

For this reason, many pre- and intra-operative grading scores and systems had been adopted to evaluate the procedure regarding its difficulty, assisting and planning the operative strategy as well as study the surgical outcomes and providing aid in training junior surgeons<sup>4-6</sup>. During not a long period, the laparoscopic surgery of the gallbladder demonstrated great importance in improving the level of performance through modern technologies. To maintain the success of this operation, there must be a classification through which the case is dealt with. Many pre- and intra-operative grading systems discussed and studied; the aim is to perform a safe procedure. Cuschieri et al published his 'scale of difficulty' for laparoscopic cholecystectomy in his textbook in 1992 and this was modified in later publication in The Lancet in 1998<sup>7,8</sup>. Nassar et al in 1995 published his grading system; which graded operative findings from the gallbladder, cystic pedicle, and associated adhesions<sup>6</sup>. Michael Sugrue et al used five key aspects to describe his grading system that includes: gallbladder appearance, percentage of adhesions, degree of distension/contracture of the gallbladder, ease of access, local septic

complications, and the time needed to identify the cystic artery and duct<sup>3</sup>. Vivek et al reported scoring assessment of difficulty in over 300 patients undergoing laparoscopic cholecystectomy, however, his system was complex used 22 parameters including 4 intra-operative parameters (distended/contracted or inflamed gallbladder, overhanging liver edge and cirrhosis)<sup>9</sup>.

The aim of this observational prospective case series study is to find a modified intraoperative grading system by giving points to special notifications and analyze them with intraoperative events to assess their safety, achievability as well as to determine a safe operative approach and/or time for conversion during laparoscopic cholecystectomy.

## PATIENTS AND METHODS

An observational prospective study was done from June 2018 and January 2020 at Aljamhori and Alsalam teaching hospital , Alzhrawi and Soran private hospitals. All official approvals were obtained by the Research Committee in the Health Department, the Research Ethics Committee. Samples were taken from the hospitals and private clinics of the surgeons included in the study, patients' approval were taken and the interventional procedure was signed. The operations were performed by four consultant surgeons; all of them were qualified and authorized by the ministry of health of Iraq as specialized general and laparoscopic surgeons. The study included 255 patients; all of them underwent elective laparoscopic cholecystectomy for symptomatic gallbladder disease after complete clinical and laboratory evaluation and signed the informed consent.

The operations were done by standard 4 ports and right up anti-Trendelenburg position. The following findings were recorded and given point scores according to the surgeon's view of the agreed scoring details (table -1-). The findings were as follows:

- 1- Color of the gall bladder wall. (Figure 1,2,3)
- 2- Amount of adhesion. (Figure 4,5,6)
- 3- Feasibility of grasping the gallbladder. (Figure 7,8,9)
- 4- Presence of anatomical variations. (Figure 10,11)
- 5- Ability to achieve a critical view of safety. (Figure 12,13,14)

The lowest degree that can be obtained from this score is zero, while the highest degree is 10. Patients have been classified into 4 grades, according to the score given in proportion to the effort made to complete the interventional procedure as shown in table 2 as follows:

- 1- Easy operation from 0 to 2.
- 2- Difficult operation from 3 to 5.
- 3- Very difficult operation from 6 to 8.
- 4- Extremely difficult operation from 9 to 10.

During the laparoscopic cholecystectomy, the following events were recorded (if any):

- 1- Perforation of the gall bladder.
- 2- Slipped stones.
- 3- Bleeding.
- 4- Biliary injury.
- 5- Using extra instruments and equipment.
- 6- Extending the epigastric incision.
- 7- The need for using a drain.
- 8- Conversion to open procedure.
- 9- Total surgical time (time from grasping the gallbladder till complete taken it off its bed).

The events that occurred during the surgical intervention concerning the grades were recorded, analyzed and statistically studied using open source epidemiologic statistics for public health version 3.01.

## RESULTS

There were 168 (65%) and 62 (25%) patients in the easy and difficult group respectively; their operations were completed by laparoscopic cholecystectomy. There were 15(6%) patients in very difficult and 10 (4%) patients in extreme difficult group in which 1 (0.3%) patient was converted to open cholecystectomy in each group as shown in Table 3.

Each grade was compared with the occurrence of events or problems that could arise during the process including gall bladder perforation, slipped stones, bleeding, biliary injury, using accessory equipment, an extension of epigastric port and the need of putting a drain. The surgical time was recorded for each operation. Table 4 summarizes the occurrence of problems for each grade. Tables5 demonstrate the time range in each grade.

Perforation of the gall bladder and slipped stones could happen in all grades with insignificant P-value while bleeding; uses of accessory instruments, an extension of the epigastric port, and the need for drain were of significant P values in grade 3 and 4 (statistically studied using open source epidemiologic statistics for public health version 3.01). Regarding the time of operation, grade 4 showed the longest range of time needed to complete the procedure. (P-value 0.0001) as shown in table 5.

## DISCUSSION

The first impression about the degree of difficulty can be gained from the gallbladder color, that's why it's given a degree in this scale. The normal gall bladder is grey-blue, its serosa appears shiny. Recurrent bouts of inflammation often will damage the wall of the gallbladder leads to thicken it, shrinks and lose its shines and become dusky color, it may turn red due to frequent infections and inflammations<sup>10</sup>. This change in color reflects the severity of the inflammation and gives the impression that the gallbladder has been subjected to repeated infections and inflammations that changed its physiological peculiarities.

The omentum plays an essential role in peritoneal defense by adhering to the site of inflammation, limiting the spread of infection, absorbing bacteria and providing leukocytes for immune response<sup>11</sup>. The pathogenesis of adhesion is combinations of trauma, inflammation and tissue hypoxia<sup>12</sup>. The adhesion may be a thin film of connective tissue or a thick fibrous bridge containing blood vessels and nerve tissue<sup>13</sup>.

The more the trauma, hypoxia and inflammation, the more and worse adhesion, this leads to the concealment of the anatomical picture of the Calot triangle makes retraction difficult and needs to be skinned from the gallbladder to facilitate retraction, which may lead to bleeding and gallbladder perforation.

A thick wall gall bladder is an indicator of more difficult surgery<sup>5</sup>. One of cornerstone in laparoscopic cholecystectomy is adequate retraction of gall bladder fundus towards the right shoulder and the infundibulum towards the right iliac crest<sup>14</sup>, this maneuver cannot be achieved

when the gallbladder wall is thick distended and unable to grasp, a trick to overcome the failure of adequate grasping is to work on a collapsed gallbladder by aspiration its contents<sup>15</sup>.

Extra-biliary anatomy relevant to laparoscopic cholecystectomy is unpredictable and varies from patient to patient; furthermore, the inflammatory process and fibrosis distort the existing anatomy that can lead to misidentification and misperception of biliary structures. Anatomical abnormalities can be related to vascular or biliary systems. Variations in the vascular supply are more common than ductal anatomy. An accessory or double cystic artery being the most common minor anomaly occurred in 15%-20% of individual<sup>16</sup>. The Caterpillar hump or Moynihan's hump which is a major vascular anomaly occurred in 3.78%.<sup>18</sup>

The most common ductal anomaly observed is a long cystic duct which represents 7.02% cases<sup>17</sup>.

A long cystic duct can be regarded as a minor anomaly and is of advantage to the surgeon as it allows easy manipulation, however; mistaking the cystic duct for the common bile duct can result in biliary injury. A silent killer anomaly is the cholecysto-hepatic ducts which observed in 0.2%–2.3% of patients and failure to recognize it may result in the post-operative fistula and bile leak<sup>19</sup>.

Strasberg et al, first suggested the technique of critical view of safety, to minimize the risk of injuries during laparoscopic cholecystectomy<sup>20</sup>.

The European Association of Endoscopic Surgery (EAES) recommends the critical view of safety as the most effective approach to prevent bile duct injury<sup>21</sup>. The aims are identifying the cystic duct, cystic artery and clear the lower third of gallbladder bed<sup>22</sup>. Although it is a preferred method by most surgeons, it may not meet the purpose assigned to it, meaning that it is not possible to obtain its three components (cystic duct, cystic artery and inferior 1/3 of gallbladder wall) in all cases, (92% cases in operative notes and 76% on video review)<sup>23</sup>. In such a situation the surgeon may try fundus first dissection, laparoscopic subtotal cholecystectomy, laparoscopic cholecystostomy or convert the procedure to open method<sup>24,25</sup>.

The frequency of gallbladder perforation during laparoscopic cholecystectomy may reach up to 33%<sup>26</sup>. In this research, perforation happened with insignificant P-value in all grades. Regarding slipped stone (s) the incidence in the literature ranges between 2 and 11 %<sup>28</sup>. The reason for this includes large perforation, small stones, issues with instrumentation, friable gallbladders as well as the experience of surgeons<sup>29</sup>. Slipped stones in this research have no significant P-value.

Bleeding can happen especially when the anatomy is distorted or unrecognized, and

persistence in using sharp dissection in a difficult Calot's<sup>30</sup>. In this research we divided the severity of bleeding according to the following criteria: Minor bleeding is bleeding that needed only one interventional step to stop it without further instrumentation or change of the equipment. Major bleeding is that bleeding which needs more than one step to control it or further instrumentation or change of the equipment. Extensive bleeding is that bleeding which needed conversion.

Minor bleeding was increased in its percentage with the severity of grades (P-value 0.0006), the source of bleeding was from gallbladder bed. Major bleeding occurred in 1 patient of grade 4 due to slip clips during dissection. No extensive bleeding was recorded.

The need for the use of more devices and tools than conventional one is an urgent necessity when the situation requires it. It reduces operation time and also reduces complications. This accessory equipment included bipolar electrocautery, harmonic knife, hydro-dissection, laser, and choledochoscope<sup>31</sup>. We urged to use one or two accessory equipment in grades 3 and 4 to accomplish the procedure appropriately.

In the four hospitals in which the study was conducted, the gallbladder was extracted through the 10-mm epigastric opening, the Surgeons need to enlarge the wound to extract the gallbladder in 25 cases due to the large size of the stone or very thicken gallbladder, this should not consider a harm but it increases the complications that may occur in the wound like bleeding, infection or hernia. The need for extension was significantly higher in grade 3 and 4 (P-value 0.0001).

Laparoscopic cholecystectomy bears a risk for iatrogenic bile duct injury. A complication that associated with significant morbidity and mortality<sup>33</sup>. Despite increasing experiences and progress in the laparoscopic skills of surgeons, the incidence is higher than open cholecystectomy which varies from 0 to 3%<sup>34</sup>. Efforts to improve safety in laparoscopic cholecystectomy include the timing of the procedure and training as well as assessment of surgeons performing the procedure<sup>35</sup>. Fortunately, no biliary injuries were recorded in this series.

Routine drain use after laparoscopic cholecystectomy is still not solved but the main indication for drain use in laparoscopic cholecystectomy is to manage a hematoma or biloma collection. This makes drain option in the presence of an aberrant biliary tract, or when dissection is difficult enough to cause bleeding<sup>36</sup>.

Although most studies indicate that it is not beneficial<sup>37</sup>, some surgeons insist on using it in a special situation as a warning tool relying on his experience and his perspective. In this series, a

drain was not used to any patient in grade one, two or three but to all patients in grade four (P-value 0.00001).

Lal et al, suggested that a difficult cholecystectomy is one taking longer than 90 minutes in total, spending more than 20 minutes dissecting the gallbladder adhesions, or more than 20 minutes dissecting Calot's triangle<sup>38</sup>.

Time will vary on surgical skills and experience but generally, it needs longer in case of severe inflammation and adhesions. Operations in the third and fourth grades were significantly needed more time than the first and second grades in our series (p-value 0.0001).

**CONCLUSION**

This is a modified grading system depending on intraoperative finding in comparison with intraoperative events which may possible to rely on to determine the difficulty of performing laparoscopic cholecystectomy. Its validity needs to be more evaluated in the future by larger series to be used as a template for future databases and research to improve patient outcomes.

Table (1): Intraoperative findings

Intraoperative findings	0 point	1 point	2 points
Color of gall bladder wall.	Grey-blue and shiny	Dull yellow	Red congested
Amount of adhesion	No adhesion	Involve the neck and body	Covered the gall bladder
Feasibility of grasping the fundus.	grasp with ease	Difficult grasp	Inability to grasp without decompression
Presence of anatomical variations	No	Minor	Major
Ability to achieve critical view of safety	3 elements achieved	2 elements achieved	One element achieved

Table (2): The grades of difficulty. No.(%)

Grade	Points	Description	Number and percentage
1	0-2	Easy	168 (66)
2	3-5	Difficult	62 (24)
3	6-8	Very difficult	15 (6)
4	9-10	Extreme difficult	10 (4)

Table (3): Results of intraoperative findings. No.(%)

Intraoperative findings	0 point	1 point	2 points
Color of gall bladder wall	Grey-blue and shiny 115(45)	Dull yellow 108(42)	Red congested 32(13)
Amount of adhesion	No adhesion 142(56)	Involve the neck and body 76(30)	Covered the gall bladder 37(14)
Feasibility of grasping the fundus	Grasp with ease 205(80)	Difficult grasp 42(17)	Inability to grasp without decompression 8(3)
Presence of anatomical variations	No variations 238(93)	Minor 12(5) 8 vascular / 3 ductal	Major 5(2) 4 vascular / 1 ductal
Ability to achieve critical view of safety	3 elements achieved 190(75)	2 elements achieved 58(22)	1 element achieved 7(3)

Table (4): Occurrence of problems for each grade. No.(%)

Problem occurred	Number of patients/ 255	Grade 1/168	Grade 2/62	Grade 3/15	Grade 4/10
Perforation of gall bladder	37(15)	24(14)	10 (16)	2(13)	1(10)
Slipped stones	7(3)	2(1.2)	3(5)	1(7)	1(10)
Minor Bleeding	5(2)	0	2(3)	2(13)	1(10)
Major bleeding	1(0.3)	0	0	0	1(10)
Biliary injury	0	0	0	0	0
using accessory equipment	27(11)	0	10(16)	9(60)	8(80)
extension of epigastric port	25(10)	2(1.2)	5(8)	10(67)	8(80)
putting a drain	24(9)	0	4(6)	10(67)	10(100)

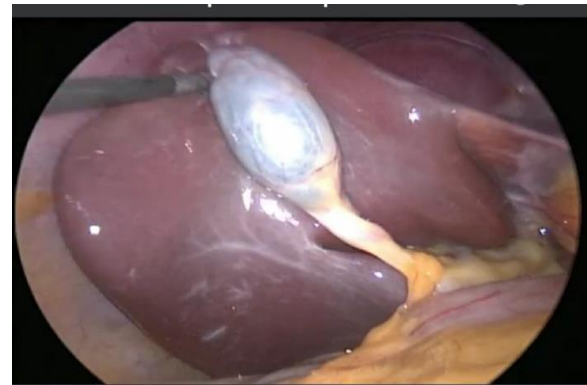


Figure 1 : Grey-blue and shiny gallbladder

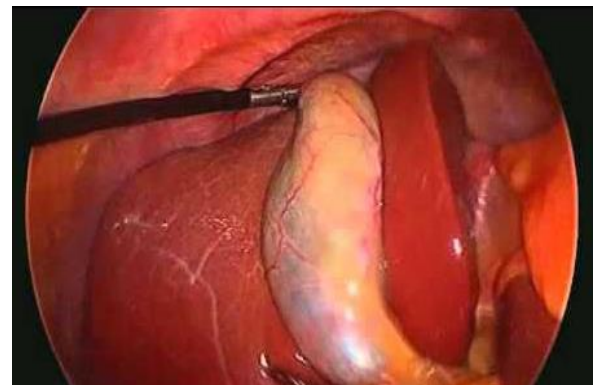


Figure 2 : Dull yellow gall bladder



Figure 3 : Red and congested gall bladder



Figure 4 : No adhesion

Table (5): The surgical time range. No.(%)

Time range in minutes	Less than 20 minutes	Between 20 to 39 minutes	Between 40 to 59 minutes	More than 60 minutes
Grade 1 168 (66%)	102(61)	58(35)	8(4)	0
Grade 2 62 (24%)	34(56)	12(19)	14(23)	2(2)
Grade 3 15 (6%)	0	4(27)	9(60)	2(13)
Grade 4 10 (4%)	0	0	7(70)	3(30)

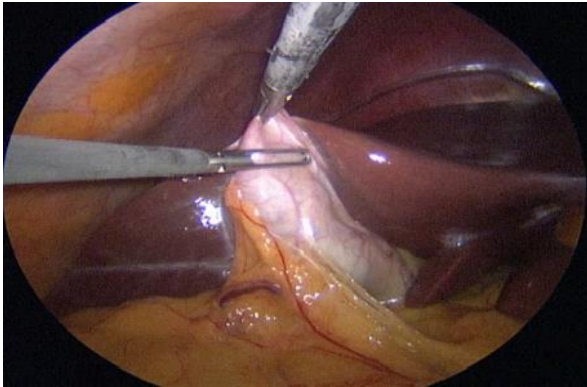


Figure 5 : Adhesion involve the neck and body



Figure 9 : Impossible to grasp without decompression

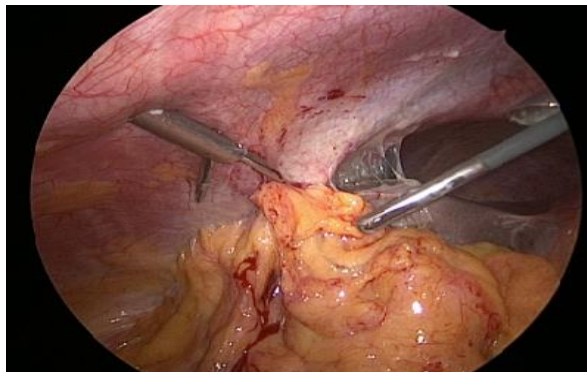


Figure 6 : Adhesion covered the gall bladder

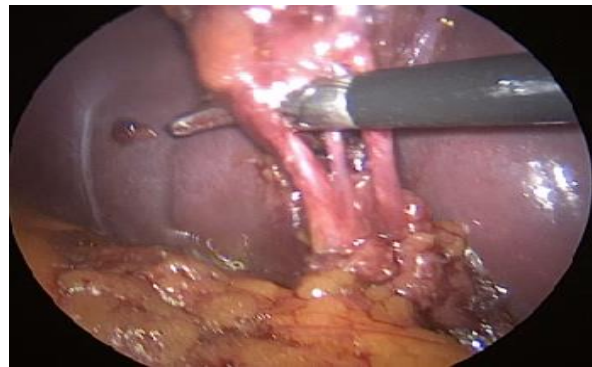


Figure 10 : Double cystic duct

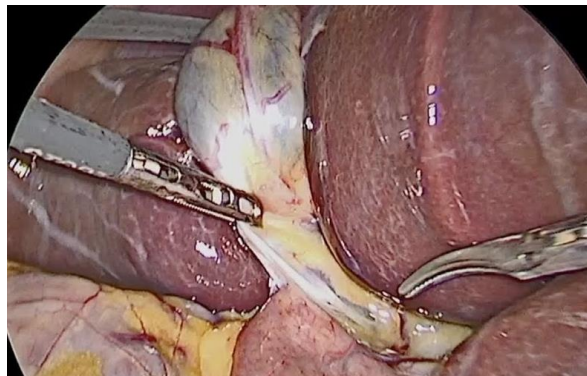


Figure 7 : Simple grasp gall bladder



Figure 11 : Abnormal right hepatic artery

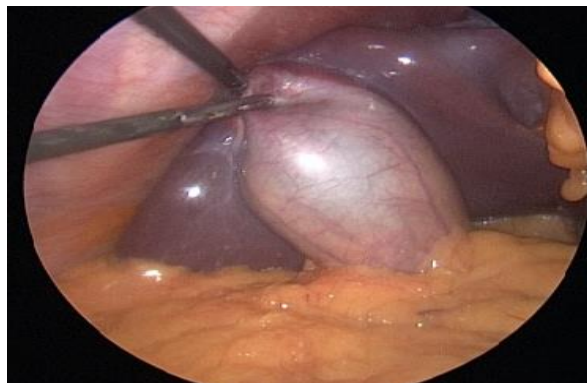


Figure 8 : Difficult grasp gall bladder

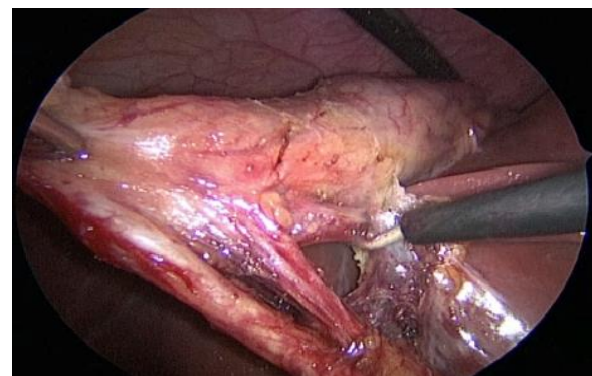


Figure 12 : 3 elements achieved

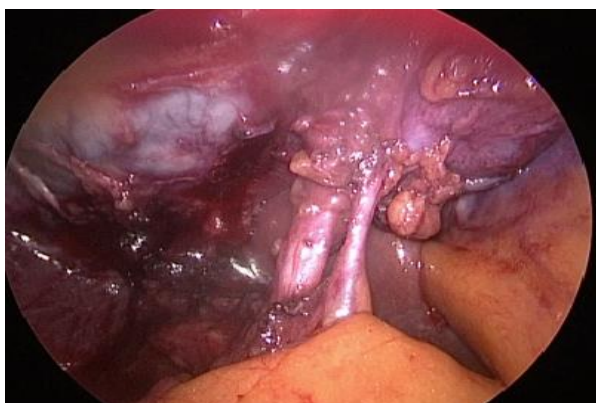


Figure 13 : 2 elements achieved

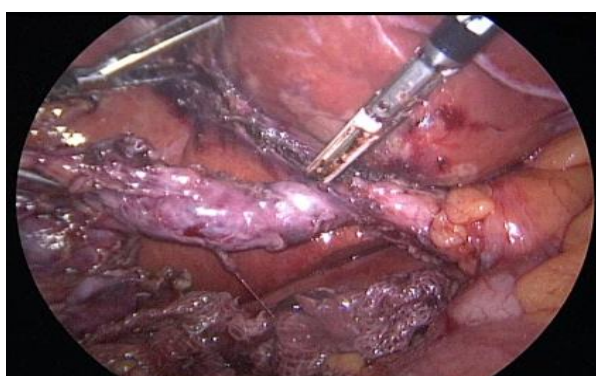


Figure 14 : 1 element achieved

## REFERENCES

1. A.M. Syed Ibrahim, M. S. Fais. "Grading Operative Findings At Laparoscopic Cholecystectomy A Scoring System in Grh, Madurai." *IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)*. 2017 ;16: (12): 34–43
2. Reynolds Jr, Walker. "The first laparoscopic cholecystectomy." *JSL: Journal of the Society of Laparoendoscopic Surgeons* 5.1 .2001; 89.
3. Michael M, Shaheelly SM, Ansaloni L, Zielinski MD . "Grading operative findings at laparoscopic cholecystectomy-a new scoring system." *World Journal of Emergency Surgery*. 2015; 10 (1): 14.
4. Vivek MAKM, Augustine AJ, Rao R. "A comprehensive predictive scoring method for difficult laparoscopic cholecystectomy." *Journal of minimal access surgery*. 2014; 10(2): 62.
5. Gupta N, Ranjan G, Arora MP, Goswami B; Chaudhary P, Kapur A et al. "Validation of a scoring system to predict difficult laparoscopic cholecystectomy." *International Journal of Surgery*. 2013; 11(9): 1002-1006.
6. Nassar AHM, Ashkar KA, Mohamed AY, Hafiz AA. "Is laparoscopic cholecystectomy possible without video technology?." *Minimally Invasive Therapy*. 1995; 4(2): 63-65.
7. Alfred C, Berci G. "Laparoscopic biliary surgery." 1991;78(6):641-765.
8. Hanna, George B., Sami M. Shimi, and Alfred Cuschieri. "Randomised study of influence of two-dimensional versus three-dimensional imaging on performance of laparoscopic cholecystectomy." *The Lancet* 351.9098 (1998): 248-251.
9. Vivek, Mittal, Godu Anantha Krishna Murthy, Alfred Joseph Augustine, and Ranjith Rao. "A comprehensive predictive scoring method for difficult laparoscopic cholecystectomy." *Journal of minimal access surgery*. 2014 10(2): 62.
10. Standring, Susan, et al. "Gray's anatomy: the anatomical basis of clinical practice." *American journal of neuroradiology*. 2005; 26(10): 2703.
11. Alagumuthu, M., et al. "The omentum: A unique organ of exceptional versatility." *Indian Journal of Surgery* 68.3 (2006): 136-141.
12. Atta, Hussein M. "Prevention of peritoneal adhesions: a promising role for gene therapy." *World Journal of Gastroenterology: WJG*. 2011; 17(46): 5049.
13. Diamond, M P , Freeman ML. "Clinical implications of postsurgical adhesions." *Human reproduction update*. 2001; 7(6): 567-576.
14. Suliman E, Palade R Ş, Suliman E. "Importance of cystic pedicle dissection in laparoscopic cholecystectomy in order to avoid the common bile duct injuries." *Journal of medicine and life*. 2016; 9(1): 44.
15. Shirah BH, Shirah HA, Albeladi KB. "The value of intraoperative percutaneous aspiration of the mucocele of the gallbladder for safe laparoscopic management." *Updates in surgery* 70.4 (2018): 495-502.
16. Benson EA , Page RE. "A practical reappraisal of the anatomy of the extrahepatic bile ducts and arteries." *British Journal of Surgery*. 1976; 63.11: 853-860.
17. Al Helli A, Al Tae M, Al Khafaji M. "Laparoscopic Surgical Anatomy of Calots Triangle" *Karbala Journal of Medicine*. 2011; 4(9): 957-963.
18. Singh K, Singh R, Kaur M. "Clinical reappraisal of vasculobiliary anatomy relevant to laparoscopic cholecystectomy." *Journal of Minimal Access Surgery*. 2017; 13(4): 273.
19. Singh K, Ohri A. "Anatomic landmarks: their usefulness in safe laparoscopic cholecystectomy." *Surgical Endoscopy and Other Interventional Techniques*. 2006; 20(11): 1754-1758.
20. Strasberg SM, Hertl M, Soper NJ. "An analysis of the problem of biliary injury during laparoscopic cholecystectomy." *Journal of the American College of Surgeons*. 1995; 180(1): 101-125.



21. Eikermann, M, Siegel R, Broeders I, Dziri C, Fingerhut A, Gutt C, et al. "Prevention and treatment of bile duct injuries during laparoscopic cholecystectomy: the clinical practice guidelines of the European Association for Endoscopic Surgery (EAES)." *Surgical endoscopy*. 2012; 26(11): 3003-3039.
22. Strasberg SM , Brunt LM. "Rationale and use of the critical view of safety in laparoscopic cholecystectomy." *Journal of the American College of Surgeons*. 2010; 211(1): 132-138.
23. Singh R, Brunt LM. Critical view of safety—its feasibility and efficacy in preventing bile duct injuries. *Annals of Laparoscopic and Endoscopic Surgery*. 2018; 3( 1 ) doi: 10.21037/ales.2017.12.04
24. Strasberg SM , Pucci MJ, Brunt LM, Deziel DJ. "Subtotal cholecystectomy—"fenestrating" vs "reconstituting" subtypes and the prevention of bile duct injury: definition of the optimal procedure in difficult operative conditions." *J AM Coll Surg*. 2016; 222 (1): 89-96.
25. Singh K, Matta H, Nain P, Basra B, Kumar R. "Modification of laparoscopic subtotal cholecystectomy." *Surgical endoscopy*. 2011; 25(8): 2760-2760.
26. Kalayci MU, Alis BVKH, Kapan S, Turhan AN, Aygun E. "Short-term effects of gallbladder perforations during laparoscopic cholecystectomy on respiratory mechanics and depth of pain." *Surgical endoscopy*. 2008; 22(5): 1317-1320.
27. Altuntas YE, Oncel M, Haksal M, Kement M, Gundogdu E, Aksakal N et al. Gallbladder perforation during elective laparoscopic cholecystectomy: Incidence, risk factors, and outcomes. *North Clin Istanbul*. 2018;5(1):47-53.
28. Memon, MA,Deeik RK,Maffi TR, Fitzgibbons Jr RJ. "The outcome of unretrieved gallstones in the peritoneal cavity during laparoscopic cholecystectomy." *Surgical endoscopy*. 1999; 13(9): 848-857.
29. Virupaksha S. "Consequences of spilt gallstones during laparoscopic cholecystectomy." *Indian Journal of Surgery*. 2014; 76(.2) : 95-99.
30. George T, Derveniz C. "Vascular injuries in laparoscopic cholecystectomy: an underestimated problem." *Digestive Surgery*. 2006; 23(5-6) : 370-374.
31. 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 Chirurgica*. 2013; 68(6): 537-542.
32. Li M, cao B, Gong R, Sun D, Zhang P, Jiang X et al. "Randomized trial of umbilical incisional hernia in high-risk patients: extraction of gallbladder through subxiphoid port vs. umbilical port after laparoscopic cholecystectomy." *Videosurgery and Other Miniinvasive Techniques*. 2018; 13(3) : 342.
33. Connor S, Garden O. J. "Bile duct injury in the era of laparoscopic cholecystectomy." *British journal of surgery*. 2006; 93(2) : 158-168.
34. Peters JH, Ellison EC, Innes JT, Nichols KE, Lomano JM, Roby SR et al. "Safety and efficacy of laparoscopic cholecystectomy. A prospective analysis of 100 initial patients." *Annals of surgery*. 1991; 213 (1):3–12.
35. Blohm My, Osterberg J, Sandblom G, Lundell L, Hedberg M, Enochsson L . "The sooner, the better? The importance of optimal timing of cholecystectomy in acute cholecystitis: data from the National Swedish Registry for Gallstone Surgery, GallRiks." *Journal of Gastrointestinal Surgery*. 2017; 21(1) : 33-40.
36. Gurer A,Dumlu EG, Dikili E, Kiyak G, Ozlem N. "Is a drain required after laparoscopic cholecystectomy?." *The Eurasian journal of medicine*. 2013; 45(3) : 181.
37. El-Labban G, Hokkam E, El-labban M, Saher A, Heissam K, El-kammash S. "Laparoscopic elective cholecystectomy with and without drain: A controlled randomised trial." *Journal of minimal access surgery*. 2012; 8 (3) : 90.
38. Lal P, Agarwal PN, Malik VK, Chakravarti AL. "A difficult laparoscopic cholecystectomy that requires conversion to open procedure can be predicted by preoperative ultrasonography." *JLS: Journal of the Society of Laparoendoscopic Surgeons*. 2002; 6(1) : 59.