Implementing a modified intraoperative grading system for a difficult laparoscopic cholecystectomy

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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.
Implementing a modified intraoperative grading system in laparoscopic cholecystectomy

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INTRODUCTION

Laparoscopic cholecystectomy has become the gold standard surgery in the treatment of gallbladder pathology and is replacing open cholecystectomy. 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. 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.

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. 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. Cuschi 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. Nassar et al in 1995 published his grading system which graded operative findings from the simplest to the most complex used 22 parameters including 4 intra-operative parameters (distended/contracted or inflamed gallbladder, overhanging liver edge and cirrhosis).

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 Ethics Committee 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. Tables 5 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. 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. The pathogenesis of adhesion is combinations of trauma, inflammation and tissue hypoxia. The adhesion may be a thin film of connective tissue or a thick fibrous bridge containing blood vessels and nerve tissue.

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. 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, 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 15.

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 ducal anatomy. An accessory or double cystic artery being the most common minor anomaly occurred in 0.2%–2.3% of patients and failure to recognize it may result in the patient having a failed laparoscopic cholecystectomy or convert the procedure to open method by most surgeons, it may not meet the purpose assigned to it, meaning that it is not feasible to obtain its three components - cystic duct, cystic artery and inferior 1/3 of gallbladder bed 14,15. Despite increasing experiences and progress in laparoscopic skills of surgeons, the incidence 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 lower abdominal cavity the most effective approach to prevent bile duct injury. A silent killer anomaly is the cystic duct for the common bile duct can result in a bile leak. A long cystic duct which represents 7.02% cases 16.

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 cystic ductal anatomy. An accessory or double cystic artery being the most common minor anomaly occurred in 15%-20% of individual 16. The Caterpillar hump or Moynihan's hump which is a major vascular anomaly occurred in 3.78%. 17.

The most common ductal anomaly observed is a long cystic duct which represents 7.02% cases 17,18. In such a situation, the surgeon may try fundus first dissection, laparoscopic subtotal cholecystectomy, laparoscopic cholecystostomy or convert the procedure to open method 19,20. The frequency of gallbladder perforation during laparoscopic cholecystectomy may reach up to 33% 21. 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% 22. The reason for this includes large perforation, small stones, issues with instrumentation, friable gallbladders as well as the experience of surgeons 23. 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 24. 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 incidence 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 25. 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 thickened 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 has been associated with significant morbidity and mortality 26. Despite increasing experiences and progress in the laparoscopic skills of surgeons, the incidence is higher than open cholecystectomy which varies from 0 to 3% 27. Efforts to improve safety in laparoscopic cholecystectomy include the timing of the procedure and training as well as assessment of surgeons performing the procedure 28. Fortunately, no biliary injuries were recorded in this series.

Routine drain use after laparoscopic cholecystectomy is 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 29.

Although most studies indicate that it is not beneficial, 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...
Implementing a modified intraoperative grading system for laparoscopic cholecystectomy: A modified grading system depending on intraoperative findings in comparison with intraoperative events which may possibly 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.

**CONCLUSION**

Drain was not used to any patient in grade one, two or three but to all patients in grade four (P-value 0.0001).

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. 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).

**Table (1): Intraoperative findings**

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

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

<table>
<thead>
<tr>
<th>Grade</th>
<th>Points</th>
<th>Description</th>
<th>Number and percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0-2</td>
<td>Easy</td>
<td>168 (66)</td>
</tr>
<tr>
<td>2</td>
<td>3-5</td>
<td>Difficult</td>
<td>62 (24)</td>
</tr>
<tr>
<td>3</td>
<td>6-8</td>
<td>Very difficult</td>
<td>15 (6)</td>
</tr>
<tr>
<td>4</td>
<td>9-10</td>
<td>Extreme difficult</td>
<td>10 (4)</td>
</tr>
</tbody>
</table>

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

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

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

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

<table>
<thead>
<tr>
<th>Time range in minutes</th>
<th>Less than 20 minutes</th>
<th>Between 20 to 39 minutes</th>
<th>Between 40 to 59 minutes</th>
<th>More than 60 minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 1 168 (66%)</td>
<td>102(61)</td>
<td>58(35)</td>
<td>8(4)</td>
<td>0</td>
</tr>
<tr>
<td>Grade 2 62 (24%)</td>
<td>34(56)</td>
<td>12(19)</td>
<td>14(23)</td>
<td>2(2)</td>
</tr>
<tr>
<td>Grade 3 15 (6%)</td>
<td>0</td>
<td>4(27)</td>
<td>9(60)</td>
<td>2(13)</td>
</tr>
<tr>
<td>Grade 4 10 (4%)</td>
<td>0</td>
<td>0</td>
<td>7(70)</td>
<td>3(30)</td>
</tr>
</tbody>
</table>
Implementing a modified intraoperative..

Figure 5: Adhesion involve the neck and body

Figure 6: Adhesion covered the gall bladder

Figure 7: Simple grasp gall bladder

Figure 8: Difficult grasp gall bladder

Figure 9: Impossible to grasp without decompression

Figure 10: Double cystic duct

Figure 11: Abnormal right hepatic artery

Figure 12: 3 elements achieved
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