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Original Research Article

Methylene Blue Coloration to Eliminate Bile Duct Injuries During Laparoscopic Cholecystectomy

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Abstract

Laparoscopic cholecystectomy has superiority over classical cholecystectomy in surgical management of gallbladder diseases. The main disadvantage of LC is an increased number of bile duct injuries. Many techniques have been used to eliminate this complication; however, most of these need specific equipment or expert specialists to interpret the results. The current study aimed to evaluate the efficiency of gallbladder coloration with methylene blue during laparoscopic cholecystectomy in reduction of bile duct injuries.A total of 98-symptomatic cholelithiasis patients were undergone laparoscopic cholecystectomy using methylene blue for delineation of the gallbladder. The gallbladder fundus was grasped and held tight towards the anterior abdominal wall. All the bile was aspirated and 50% or more methylene blue was injected slowly into the gallbladder which was then removed from the abdominal cavity. Operation time, hospital stay and complications, if any, were recorded. In addition, the coloration of different parts in different status of gallbladder was also evaluated. The results showed that mean operation time and hospital stay were 55min and 26hrs respectively. No bile duct injury was recorded, and coloration with MB was visible in four main anatomical parts of the gallbladder (gallbladder, cystic-Hartmann's pouch, junction, cystic duct and common bile duct). In uncomplicated gallstone, almost all parts of the gallbladder colored well; however, a noticeable reduction in coloration was observed especially in cystic duct and common bile duct in complicated cases.

Based on these results, it can be concluded that injection of MB could be considered as safe, effective and cheap technique to reduce or even eliminate BDIs during LC.

Key word: laparoscopic cholecystectomy, bile duct injuries, methylene blue, cholecystitis, cholelithiasis

التلوين بالثلين الازرق لتفادي أذى القناة الصفراوية أثناء استئصال المرارة بالجراحة التنظيرية

الخلاصة

تتفوق عملية استئصال المرارة بالجراحة التنظيرية على طريقة استئصال المرارة بالطريقة التقليدية في التعامل مع أمراض كالمرارة . العيب الرئيسي في استئصال المرارة بالجراحة التنظيرية هو زيادة عدد الاصابات في القناة الصفراوية . استخدمت العديد من التقنيات لتفادي هذه الاصابات الا ان معظم هذه التقنيات تحتاج الى معدات خاصة او متخصصين من الخبراء لتفسير النتائج . هدفت الدراسة الحالية الى تقييم كفاءة المثلين الازرق أثناء استئصال المرارة بالجراحة التنظيرية في الحد من أذى القناة الصفراوية . شملت الدراية 98 مريضا بحصى المرارة الذين خضعوا الى استئصال المرارة بالجراحة التنظيرية باستخدام المثلين الازرق لتلوين المرارة . تم مسك قاع المرارة وسحبه نحو الجدار الامامي للبطن ، وسحبت مادة الصفراء وحقن المثلين الازرق بتركيز 50% او أكثر ببطء في المرارة التي ازيلت من التجويف البطني . سجل الوقت اللازم لاتمام العملية والاقامة في المستشفى ووجود مضاعفات . فضلا عن ذلك فقد تم تقييم التلوين في الاجزاء المختلفة وللحالات المختلفة للمرارة . أظهرت النتائج ان متوسط مدة العملية والاقامة في المستشفى كان 55 دقيقة و 26 ساعة على التوالي . لم يتم تسجيل اي أذى للقناة الصفراوية ، وكان التلوين بالمثلين الازرق مرئيا في الاجزاء التشريحية الرئيسية الاربعة للمرارة (كيس الصفراء ، نقطة اتصال الكيس بجيب هارتمان ، القناة الكيسية ، والقناة الصفراوية المشتركة) . في حالة تحصي المرارة غير المعقد تلونت كل اجزاء المرارة تقريبا ، ولوحظ تلاشيا بالتلوين خاصة في القناة الكيسية والقناة الصفراوية المشتركة في الحالات المعقدة .

بناءا على هذه النتائج فانه يمكن اعتبار حقن المثلين الازرق تقنية آمنة وفعالة ورخيصة للحد من أو حتى تفادي أذى القناة الصفراوية اثناء استئصال المرارة بالجراحة التنظيرية .

الكلمات المفتاحية :استئصال المرارة بالجراحة التنظيرية ، اذى القناة الصفراوية ، المثلين الازرق ، التهاب المرارة ، تحصى المرارة .

Introduction

For more than a century, classical cholecystectomy has been the method of choice in surgical management of gallbladder disease [1]. Asan invasive procedure, cholecystectomy mostly involves abdominal operation. However, the most serious complication associated with this procedure is accidental injury to the common bile duct which occurs in 0.3-0.4% of cases [2].

Introduced in late eighties of the last century, laparoscopic cholecystectomy (LC) became the golden standard for surgical management of gallbladder injuries. It rapidly gained a popular reputation for its efficiency in reduction postoperative pain, recovery time and duration of hospitalization [3]. Furthermore, it results in more acceptable cosmetic outcome and less morbidity and mortality rate compared to open cholecystectomy [4].

Most surgeons started to incorporate this technique in their daily practice. However, a significant increase in bile duct injuries (BDIs) related to this procedure were encountered. Relatively high numbers of these injuries (three to four times higher than that in open cholecystectomy)were found to require bile duct repair [2].These injuries were primarily attributed to the misidentification of the GB anatomy and surgeons' experience [5]. Intrinsic factors like excessive fat and hemorrhage in hepatic area were also accused [6].

Although many published series have indicated the low incidence of BDIs (about0.2-0.4%) after LC, they are still somewhat higher than that of traditional open approach (0.1-0.2%) [7,8].Moreover, iatrogenic injuries of the biliary tract after LC have reached a considerable figure [9]. These complications were attributed partly to specific features of the minimally invasive approach [10,11]. A number of technical steps have been emphasized to avoid such injuries; however, the incidence of BDIs reached at least double that observed in open cholecystectomy. Even with the small incidence of BDIs following LC, serious complications may result in long term morbidity. These findings suggest a non-solved problem with LC after many years of the initial learning curve. Several techniques have been used to overcome this problem. Flum et al. [12] used intraoperative cholangiography (IOC) and reported a significant decrease in BDIs (RR=1.7, 95%CI=1.1-2.6). Huang et al. [13] adapted fundus-down LC and found it to be associated with lower complication rate and shorter postoperative hospital stay. Sari et al. [14] used intraoperative methylene blue in 46 Turkish patients and recorded a significant success; however almost all the patients were with uncomplicated cholelihtiasis which implies a normal thickness of gallbladder wall. To further evaluate the efficiency of this technique in preventing BDIs during LC, we used a larger number of patients with different gallbladder status (variable thickness of gallbladder wall).

Materials and Methods

A prospective cohort study was conducted for over 30 months from July 2012 to January 2015 to evaluate a new maneuver to reduce BDIs during LC. The study involved 98-symptomatic cholelithiasis patients recruited from Al-Imamain Al-Kadhumain Medical City/ Baghdad. The main complaints at presentation included one or more of these signs: right upper quadrant or epigastric pain, fat intolerance, dyspepsia or flatulence.

From each patient, informed consent form was obtained which included detailed demographic data, medical history and examination, the necessary investigations

and operative findings. Exclusive criteria were patients with multidrug allergies and patients with significant renal impairment.

Preparation of Methylene Blue

The standard solution (stock solution) was prepared by dissolving 1.127 g of MB in 1L of sterile distilled water [15]. From this stock, the required concentrations of 50% or 60% were then prepared.

Laparoscopic Cholecystectomy

Patients were undergone sustained LC by one consultant surgeon (the author and his team) in general surgical unit of Al-Imamein Al- kadhmein medical city, Baghdad. The patients were operated upon under general anesthesia (GA). The GB fundus was grasped and held tight towards the anterior abdominal wall with atraumatic graspers and then punctured by a special long needle aspirator/injector which was introduced via the abdominal wall in vicinity of GB fundus. Veress needle was also utilized sometimes. All the bile in the GB was aspirated as far as possible and 50 percent diluted sterile methylene blue equal to the amount of aspirated bile was injected slowly into the GB (figure1). Occasionally, higher concentrations of methylene blue (60% or more), were used to achieve coloration of thickened or fibrotic GB. After injection and withdrawal of needle, the hole(puncture site) in anterior fundus was either clipped or held closed by retracting grasper to prevent a leakage of dye (figure 2). The GB was removed from the abdominal cavity through the trocar inserted from lateral border of the rectus muscle.

Patients who had contracted small GB which was difficult to be punctured and filled with MB due to intra GB mucosal adhesions or stockiness with stones were also excluded. Postoperative follow up was carried out for over one month for any complications.

Figure 1: The injection of methylene blue into the gallbladder after After aspiration of bile

Efficiency evaluation for this technique based on the operation time, hospital residence, postoperative complications and visible coloration of different parts (gallbladder, cystic-Hartmann's pouch junction, cystic duct and common bile duct) and status (Uncomplicated, acute cholecystitis, chronic cholecystitis and mucocele) of GB.

Statistical Analysis

The Statistical Package for the Social sciences (SPSS, version 14) was used for statistical analysis. Chi square was used to compare between different parts in different status of GB regarding their effective coloration with MB. A p-value < 0.05was considered statistically significant.

Results

Over 30 months period, 110 patients with symptomatic cholelithiasis were involved among whom 12 patients were excluded due to failure of proper injection of MB. These patients either had contracted thickened GB where the bile was not inspirable, the GB was fully impacted with stones or an extravasation had occurred due to inadvertent submucosal injection with resultant coloration of subperitoneal areas around GB which forced us to stop injection and omit the procedure. In all these cases,

the operation proceeded without significant difficulty or complications.Table-1 shows characteristics of patients

Table 1: Characteristics of patients

Characteristic	Value
Age (range)	32.5 years (19-62 years)
Gender (male/ female)	26/ 72
Total patients eligible for the study	98 patients
Mean hospital stay following LC (range)	26 hrs (16-68hrs)
Mean operation time (range)	55 min (35-110 min)
Gallbladder Status	
Uncomplicated GB	48 patients
Acute cholecystitis	17 patients
Chronic cholecystitis	31 patients
Mucocele	2 patients

LC: laparoscopic cholecystectomy, GB: gallbladder

Bile duct injury was not recorded in any case included in this study. Twelve patients had intra-operative leakage of MB due to perforation of GB during stripping from its liver bed or retrieval out of the port. Nevertheless, we did not observe any operative or postoperative problem apart from change in urine color (bluish staining) for one to two days. Bile leakage in one case continued for 5 days and ceased spontaneously without untoward events.

Twenty-two patients were with single stone, while 76 patients were with multiple stones, however this variation did not have any influence on the coloration pattern of the GB and therefore was not included in statistics. Furthermore, the distribution of visible MB coloration was recorded in four main anatomical parts of the GB (gallbladder, cystic-Hartmann's pouch junction, cystic duct and common bile duct) as shown in table (2) and figure (3).

Table 2: Pattern of successful painting versus different gallbladder status

Anatomical parts / **Status**	GB (n) %	CHP junction (n) %	Whole CD (n) %	CBD (n) %	Total
Uncomplicated GS	(48)100%	(48) 100%	(46) 95.8%	(30) 62.5%	48
Acute cholecystitis	(17) 100%	(14) 82.3%	(1) 5.8%	0	17
Chronic cholecystitis	(30) 96.7%	(29) 93.5%	(14) 45%	(2) 6.4%	31
Mucocele	(2) 100%	0	0	0	2
Total	(97) 98.9%	(91) 92.8%	(61) 62.2%	(32) 32.6%	98

GB =gallbladder, CHP =cystic-hartmann's pouch junction, CD= cystic duct, CBD common bile duct

Figure 3: Coloration of different anatomical parts of gall bladder with methylene blue

From the table, it is obvious that GB topped while the CBD ranked last among these parts in taking MB staining. In uncomplicated gallstone, 100% of GB and CHP junction were stained and did not differed significantly from whole CD (95.8%). However, only 62.5% of CBD stained well with significant difference (P<0.001). With the presence of complications, the staining pattern reduced in many instances. Despite 100% of GB stained in acute cholecystitis, the percentage fell to 5.8% and 0% in whole Cd and CBD respectively with significant difference (P<0.001), and to 82.3% in CHP junction with non-significant difference (P=0.55).

Out of 31 chronic cholecystitis, 30 (96.7%) of GB stained well with MB and differed significantly from whole CD and CBD (45% and 6.4% respectively) and non-significantly from CHP junction (93.5%, P=0.07). In Mucocele, only GB stained well, however, the number was too small (only two cases) to be considered and statistical analysis.

Compared with GB which stained in almost all status, staining of CHP junction reduced significantly in acute cholecystitis (P=0.003) and non-significantly in chronic cholecystitis (P=0.075). Common bile duct took the stain in more than half (62.5%) of the uncomplicated GS but in only 2 cases of chronic cholecystitis.

Discussion

Methylene blue has a long history in the medical field. Therapeutic infusion of MB was frequently applied for the treatment of different illnesses [16]. Further, this dye was used in intraoperative localization of parathyroid gland and endoscopic marking during laparoscopic gastrointestinal surgery [17,18].The toxic dose of this dye exceeds 5 mg/kg [19]. Thus it is quite safe in LC because the total capacity of GB is 30-60 ml, and, in case of 60% MB, the total injected dose will be 10.14-20.28mg.

The study revealed the efficiency GB coloration with MB in reduction BDIs during LC. These results confirm that of Sari et al. [14]. However, Sari's study did not include the complications escorting cholelithiasis nor the coloration pattern of different parts of GB. Thus, the current study shaded more light and gave more details about this technique.

Mean operative time and hospital stay required for LC with MB were found to be 55 min and 26hrs respectively. These periods did not differ significantly, or even less than that in conventional LC. In a recent study by Damani et al. [20] involved 233 patients with chocystitis, they reported a mean operative time of 58hrs and 45hrs for acute and chronic cholecystitis respectively, and a period for hospital stay ranged from 2-6 days. Thus, using MB during LC does not need for extra time neither for operation nor for hospital stay.

The Hartmann- cystic duct junction is most important view to be obtained as it is considered the rate limiting step needed to identify cystic duct to be clipped in particular cases of short cystic duct and

acute or chronic cholecystitis[21,22]. In our setting, the visualization of this junction was 92.8% under different GB conditions and was 100% in normal wall (uncomplicated) GB which is very significant figure help greatly to reduce incidence BDI. The only limiting problem is the completely impacted stone as inmucocele where the painting diminished. The whole cystic duct is painted in 95.8% in uncomplicated GB which can clearly identify any anomalous or accessory duct aiding to avoid BDI and their morbidity. In the same group of patients, CBD was visualized in our technique by 62.5%, which is significant percent. However, in acute cholecystitis, the coloration rate was low. This can be simply attributed to edema accompanied by narrowing of cystic duct and to wall thickening and congestion which impair clear painting. Knowing that LC in acute cholecystitis has a three times likelihood of causing BDIs than an elective laparoscopic cases [6], it is recommended to increase MB concentration achieve successful coloration.

Collectively, the aforementioned data strongly indicate that using MB in 50% or more during LC is a very effective technique in reduction BDIs. Not only is this dye safe, cheap and easily prepared, but also its utilization has no tangible effect on operative time or hospital stay. However, further study involving a comparison with other BDIs preventive techniques are required to definitive recommendation for the using of MB in routine LCs.

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