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Review Article

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A comprehensive review of the factors predicting technical difficulty in laparoscopic cholecystectomy

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ABSTRACT

Laparoscopic cholecystectomy is the most common laparoscopic procedure performed all over the world. It has now become the gold standard management for symptomatic gallstones. Aim of the study was to identify and highlight the predictive factors determining intra operative technical difficulty in laparoscopic cholecystectomy. A database search was done in Medline, Google scholar and Journal seek using keywords 'Laparoscopic Cholecystectomy', 'difficult cholecystectomy' and 'predictive factors'. 54 abstracts were shortlisted out of which 15 were selected based on the time of publication (after 2005), size of study group, relevance to the title, level of evidence and the journal of publication. Results were compared and reviewed and the conclusion was reached. Fifteen papers were reviewed based on literature search and statistically significant variables predicting the technical difficulty in Laparoscopic cholecystectomy was found. These were age, sex, obesity, previous upper abdominal surgeries, comorbid diseases like Diabetes, acute cholecystitis, raised WBC counts, gall bladder wall thickness more than 3mm, presence of pericholecystitic collection, single impacted stone, multiple stones, contracted gall bladder, adhesions at Calot's triangle, intrahepatic gall bladder, complications like gangrenous GB and fistulisation. The predictive risk factors reviewed here need to be kept in mind by the laparoscopic surgeon during a laparoscopic cholecystectomy. Though none of them is an absolute contraindication, presence of these factors demand modifications in technique for a safe laparoscopic surgery.

Keywords: Difficult Cholecystectomy, Laparoscopic Cholecystectomy, Predictive factors

INTRODUCTION

Laparoscopic cholecystectomy is the most common laparoscopic procedure performed all over the world. It has now become the gold standard management for symptomatic gallstones.¹ As a corollary, it is one of the commonest procedures that is performed by minimal access surgeons in the early phase of their career at the beginning of their learning curves. Because of the complex anatomy of the biliary tree where anomaly is often the rule and also due to other contributing factors,

beginners often come across unanticipated complications in the peri operative period making the procedural technique difficult for them.2 However, with judicious preoperative evaluation and under-standing of these patient and disease factors, these complications can be anticipated and possibly averted.² This literature review analyses the factors that have been highlighted by various authors in their research studies that predict an intra operative technical difficulty in laparoscopic cholecystectomy often necessitating a conversion to open surgery.

METHODS

A literature search was done in Medline, Ebsco, Google Scholar. JournalSeek databases with kev-words 'Laparoscopic Cholecystectomy', 'difficult cholecystectomy' and 'predictive factors' between January 2005 to November 2016. 54 Articles relevant to the title were shortlisted out of which 15 abstracts were selected based on the size of study group, time of publication (after 2005), level of evidence and parent journal of publication. Individual case reports, non-English journal articles and articles with (n= less than 50 patients) were excluded. Various predictive factors highlighted by these authors were noted and reviewed. Based on these search results, conclusion was reached and compiled.

RESULTS

Fifteen research articles by various authors were shortlisted for review. Based on our understanding of these articles, the predictive factors were broadly described by authors under these categories:

- Clinical parameters Patient factors and Disease factors
- Radiological parameters
- Intra operative parameters

Clinical parameters- patient factors

Age

Constantini R et al listed age as one of the risk factors for intraoperative difficulty and conversion. In this study, patients with age more than 60 years had increased risk of conversion owing to adhesions and severe inflammatory features of acute cholecystitis.¹ Vivek et al found that patients more than 65 years have possibility of multiple attacks of cholecystitis and hence chances of adhesions at Calots' triangle, making the dissection difficult.² They concluded that age more than 60 years was a statistically significant variable in their study with increased risk for conversion. Lee et al and Simopoulos et al also identified advanced age (>60 years) as a significant risk prediction factor in their study.^{3,4} Other authors included age as a possible risk factor even though statistical significance was not found.

Gender

Ambe et al stressed the importance of gender as a major independent risk factor for severity of acute cholecystitis, thus increasing the technical difficulty and need for conversion.⁵ His study exclusively took gender into consideration and concluded that male gender was a statistically significant predictor of severe gall bladder inflammation, intraoperative blood loss and difficult cholecystectomy. Similar results were projected by Genc V et al where in their study, male gender was the only

statistically significant risk factor among the various variables studied.⁶ Studies by Nidoni et al, Vivek et al, Jethwani et al also found statistical significance in male sex as a risk factor for technical difficulty.^{2,7,8} Other authors, though they accept male sex as a risk factor for conversion, could not consolidate it statistically.

History of previous surgeries

Almost all authors found presence of abdominal scar as a statistically significant risk factor for technical difficulty and conversion. This was attributed to adhesions due to surgery, bleed and common bile duct injury during adhesiolysis leading to procedure conversion. Among them, Constantini et al observed that only the supra mesocolic surgeries contributed much to operative difficulty and that submesolic surgeries had no role in predicting operative difficulty. On the same lines, Jetwani et al investigated about role of lower abdominal surgeries in predicting difficulty which was not found to be significant. Vivek et al not also included presence of upper abdominal hernias in their study and found it to be a significant risk factor.

They also described that such a history would cause difficulty at the beginning of surgery even at the time of Umbilical port entry and creation of pneumoperitoneum. Gupta N et al found that it was not a significant factor in their study, but owed it to a sample bias. Genc V et al and Randhawa et al did not find any statistical significance for previous abdominal surgery in prediction of difficult lap cholecystectomy. This was attributed to experience of authors in adhesiolysis.

Body mass index

8 out of 15 authors studied BMI in their possible risk factors. Though Obesity is widely regarded as a technical difficulty in access of abdomen, only 4 authors found it to be a statistically significant variable. Authors attributed this contrasting observation to their expertise in laparoscopy and advanced techniques of tissue dissection. Ibrahim S et al.¹¹ found out that body weight more than 65 kg was a risk factor where's Vivek et al mentioned BMI>30kg/m² to be so.² Randhawa et al and Patil et al studied various subgroups of patients of BMI <25, 25.1-27.5, >27.5 and both studies found BMI>27.5 to be a statistically significant variable in predicting technical difficulty in Laparoscopic Cholecystectomy. 10,12

Comorbid diseases

As expected with any surgery, presence of co-existing diseases is expected to pose a challenge in the perioperative period and this was included as a possible risk factor by 6 authors. Diabetes was the most common disease studied. While Simopoulos et al and Constantini et al found the presence of diabetes as a statistically significant risk factor, Ibrahim S et al further elaborated by studying the safe levels of HbA1c in diabetic

patients.^{4,6,11} He found out that the risk of intraoperative difficulty and conversion was higher those diabetics with HbA1c levels more than 6%. Constantini et al also showed that a history of myocardial infarction has got a statistically significant risk of intraoperative procedure conversion in Laparoscopic cholecystectomy.¹ Though other diseases like Arterial Hypertension, COPD, Non-Ischemic Heart disease, Previous Pancreatitis, Cirrhosis Liver, history of cardiac surgeries was thought to have associations with conversion rates, they were not statistically significant in his study. An interesting association was investigated by Gholipour et al about the possible association of smoking and alcoholism with conversion rates in cholecystectomy, but found them to have no significance.¹³

Clinical parameters- disease factors

The commonest disease factor that was studied was the history or features of acute cholecystitis. This was either in the form of previous episodes of hospitalisation for acute cholecystitis, any attacks of biliary colic or signs of active inflammation like fever and elevated WBC count. Previous episodes of hospitalisation was found to be a statistically significant risk factor for conversion. 1,2,7,9,10,12 This was presumed due to more adhesions at the Calot's triangle due to adhesions. Signs of acute cholecystitis were investigated by authors either with clinical signs or laboratory parameters like WBC count. 1,3,4,7,11,13,14 Constantini et al found that a WBC count of greater than 9000 had a statistically significant correlation with conversion whereas Nidoni et al mentioned counts more than 11000 as significant in his study.^{1,7} Clinical signs of cholecystitis like pain and fever were found to be significant in prediction of difficulty by all authors, except in study by Constantini et al, where only the elevated WBC count was significant. 1,7

A derangement in the LFT, especially Bilirubin levels and enzymes were found to have a significant impact in prediction of difficulty.^{2,4,13} Vivek et al also found that raised amylase levels were a warning sign of a difficult gall bladder.² Role of preoperative ERCP in prediction of difficulty was investigated by Vivek et al and Constantini et al and was found to be significant. Gholipour et al and Genc V et al found that intraoperative difficulty and rates of conversion were higher in patients who were operated in emergency those operated in the elective setup. 1,2,6,13 An interesting observation by Randhawa et al in his study states a palpable gallbladder as a significant predictor of intraoperative difficulty.¹⁰ This was one of the unique predictive factor identified by the author. Patil et al too reiterated this in his study where a statistical significance was observed with this variable.¹²

Radiological parameters

All the authors subjected their patients to preoperative ultrasonogram. This was selected as the most sensitive investigation by all authors uniformly. The features of Gallbladder which predicted a risky procedure was the bladder thickness and the presence pericholecystitic collection. 1,3,8-10,12-15 Randhawa et al and Patil et al mentioned a wall thickness of more than 4mm as significant risk, whereas Lee et al, Jethwani et al and Gupta et al found it to be >3mm in their studies.^{3,8-10,12} The impacted stone was found to be a significant risk factor for conversion.^{9,10,12} The size of the stone was investigated by Jethwani et al and found to be a significant factor.8 Larger stones increased the risk of difficulty and conversion. Similarly, multiples stones was proved to be a risk factor by Jethwani et al and Atmaram et al.^{8,15} Some authors studied the shape and appearance of the gallbladder on Ultrasonogram and while some found that a contracted GB had more chances of conversion intraoperatively, Vivek et al showed that a grossly distended GB too was associated with statistically significant technical difficulty.^{2,8,14}

Intraoperative parameters

The most feared problem for all authors were adhesions at the Calot's triangle which forced a conversion. 1,2,6,8,14,15 Genc V et al and Atmaram et al had conversions due to intrahepatic location of gall bladders. 6,15 Signs of severe acute inflammation like gangrenous GB, pericholecystitic collection and friability were also reasons of difficulty and conversion.^{4,14,15} Genc et al and Singh et al faced the problems of complications like cholecystoenteric fistula which forced conversion.^{6,14} Anomalous anatomy were also a significant factor of intraoperative difficulty.^{2,8} As it can be seen, intraoperative factors of difficulty were not uniform among the surgeons, throwing light on the ex-perience of the surgeon. The influence of the surgeon's experience was put into study by Ibrahim et al and Gholipour et al and was found to significantly influence the outcome of surgery. 11,13

DISCUSSION

Cholelithiasis is one of the most prevalent diseases all over the world. Stinton et al studied the prevalence of gall bladder stones all over the world and it was found to be 10-22% in India.16 Due to advent of Laparoscopy and its advantages, the gold standard treatment for gallstones has shifted from Open to laparoscopic cholecystectomy and has been recommended by various surgical societies all over the world. 17,18 Hence, it is one of the commonly performed surgeries by beginner laparoscopic surgeons. Due to the natural history of the disease, various factors influence the outcome of this surgery. Also, due to the lack of standardized scoring systems for intraoperative findings, it becomes difficult to grade the procedure based on technical difficulty for future references. This gives rise to the necessity for identification of risk factors of difficulty and procedure conversion so that surgeons can be presumably aware of the dangers that they could face during procedure. However, these factors vary as per the surgeon's experience in laparoscopy and the learning curve. There is no accepted definition for a difficult laparoscopic cholecystectomy. Lal et al was of the view that a procedure which lasts for more than 90 minutes totally, or takes more than 20 minutes in dis-section of adhesions or Calot's triangle or perforates the gallbladder

must be termed a difficult cholecystectomy.¹⁷ Though a uniform consensus for predictors of intraoperative difficulty cannot be reached at, commonest risk factors can be identified from the randomized controlled trials carried out by various authors.

Table 1: Summary of risk factors predicting technical difficulty in laparoscopic cholecystectomy.

	Clinical patient factors	Clinical disease factor	Radiologi cal factor	Sur geon fact or	Intra operative parameters	Factors with statistical significance (p<0.01)	n	conversion rate & comments
Constantini et al ¹	age, sex, Obesity, Diabetes, Hypertension, Previous MI, COPD, Non- Ischemic heart disease, chronic hepatitis, cirrhosis, previous pancreatitis, previous abdominal surgery, previous cardiac surgery	previous attacks of cholecystitis, previous ERCP, presentation after onset of pain, fever, WBC count	signs of cholecysti tis	-	adhesions, associated hepatic biopsy	age >60, diabetes mellitus, h/o supramesocolic surgeries, WBC>9000, previous MI, previous ERCP, adhesions, ultrasound signs of cholecystitis	906	2.76%
Patil S et al ¹²	age, sex, BMI, abdominal scar	h/o hospitalisation, palpable gall bladder	wall thickness, perichole- cystitic collection, impacted stone			BMI>27.5, abdominal scar, previous hospitalisation, palpable gall bladder, thickened GB wall	50	14%
Randhawa et al ¹⁰	age, sex, BMI, abdominal scar	h/o hospitalisation, palpable gall bladder	wall thickne pericholec- ystitic collection, impacted sto			BMI>27.5, previous hospitalisation, palpable gall bladder, thickened GB wall	228	1.315%
Atmaram et al ¹⁵	age, sex	LFT	GB wall thickness, CBD diameter, pericholecy stitic collection, no of stones		adhesions, gallbladder embedded in liver, CBD adherent to liver, gangrenous gall bladder	adhesions, gallbladder embedded in liver, CBD adherent to liver, gangrenous gall bladder	526	2.6%
Vivek et al ²	age. sex, h/o upper abdominal surgeries, scars & hernias, BMI	LFT, elevated Amylase, previous ERCP, recurrent attacks of colic	Cirrhotic liver, contracted gall bladder, distended gall bladder		overhanging liver edge, adhesions, anomalous anatomy	age>65 years, male sex, BMI>30, h/o upper abdominal surgery, previous ERCP, abnormal enzymes, contracted or distended GB, adhesions, anomalous anatomy, cirrhotic liver	323	-
Jethwani et al ⁸	age, sex, BMI, h/o lower		size and no of stones, G		adhesions, anomalous	Male sex, single large stone, thick-	200	5% (H/o upper

	abdominal surgeries		wall thickness, contracted GB		anatomy	walled GB previous abdom- inal surgery, contracted gall- bladder		abdominal surgeries, deranged LFT, palpable GB were excluded from study)
Gholipour et al ¹³	age, sex, h/o pevious laparotomy, smoker, alcoholic, coexisting diseases	WBC count, temp., LFT, emergency	gall bladder thickening , CBD stone, pericholec ystitic edema	expe rienc e of surg eon		previous abdominal surgery, raised WBC co unt, fever, raised LFT, emergency, experience of surgeon	793	9%
Ambe et al ⁵	sex	-	-	-	-	male sex	138	13.8% (Study limited to acute cholecystitis-within 72 hours of onset and one variable)
Genc V et al ⁶	age, sex, comorbid diseases, h/o upper abdominal surgeries	elective/emer gency			Adhesions, thickened gall bladder, cholecystod uodenal fistula, buried gall bladder	Male sex	5164	3.16%
Nidoni et. Al ⁷	age, sex	previous attacks of cholecystitis, WBC count			GB wall thickness, pericholecys titic collection	Previous attacks, raised WBC, thickened GB wall, pericholecystitic collection	180	5.56%
Singh K et al ¹⁴	previous upper abdominal surgery	signs of cholecystitis	Acute cholecysti tis, contracted GB, empyema GB		adhesions, gangrenous GB, cholecystog astric/duode nal fistula	previous surgery, signs of cholecystitis, Acute cholecystitis, contracted GB, empyema, adhesion ns, fistulation, gangrenous GB	1518	1.66%
Gupta N et al ⁹	age, sex, BMI, abdominal scar	previous attacks of cholecystitis, palpable GB	Wall thickness, pericholecy stitic collectio, impacted stone			previous attacks of cholecystitis, palpable GB, thickened GB	210	4.28%
Simopoulos et al ⁴	age,sex,h/o previous surgery, diabetes	LFT, WBC count, fever			degree of inflammation	age> 60 years, male sex, h/o previous surgery, diabetes, raised LFT, raised WBC count, fever, severely inflamed gall bladder	1804	5.2%
Ibrahim S et al ¹¹	sex, BMI, h/o previous surgery, Hba1c levels in diabetics	acute cholecystitis, WBC count		experi ence of surge on		male sex, h/o previous surge ery, weight >65kg, Hba1c levels >6, acute	1000	10.3%

			cholecystitis, experience of surgeon
age, sex, BM diabetes mell previous upport abdominal surgery,	itus,	presence of pericholecy stic fluid, gallbladder wall thickness,	advanced age, male sex, h/o upper abdominal surgery, prep 346 11.9% diagnosis of acute cholecystitis, thickened GB

Increasing age is a predictive factor for difficulty owing to the risk of recurrent attacks of colic and resulting adhesions. Though there is no consensus regarding the upper limit of safe age, patients more than 60 years are generally considered at high risk by some surgeons. There is also an additional risk of comorbid diseases as age advances which adds to the perioperative morbidity. Diabetes has a significant influence in deciding the severity of inflammatory process. Long term diabetic control reflected by glycosylated haemoglobin levels influences increasing the intraoperative difficulty due to a severely inflamed gall bladder. Other co morbidities like Hypertension, COPD and systemic diseases may not affect the procedure as such but may disturb the normal physiology of ventilation during anaesthesia, coagulation during surgery and wound healing postoperatively. It has been shown by Palanivelu C et al that laparoscopic cholecystectomy is technically feasible and safe in cirrhotic patients with necessary modifications in technique.²⁰ Patients with recent history of Myocardial Infarction are at higher risk of perioperative morbidity.

Male patients are at higher risk of intraoperative technical difficulty during Gall Bladder surgery. This is since in male patients the threshold of pain is more, thus they tend to bear pain and take medications before consulting a surgeon. This increases the severity of inflammation at Calot's, causing severe inflammatory adhesions, empyema and gangrene of gallbladder. Ambe et al even recommended an early intervention in male patients than their female counterparts in Acute calculous cholecystitis.⁵

Obesity as well as adhesions due to previous upper abdominal surgery poses problems in trocar access. When thickness of abdominal wall is more, lengthier instrumentation is needed. These patients may have higher risk of fatty liver which causes difficulty in retraction of gall bladder and fat deposition in peritoneal layers would require more meticulous dissection at the Calot's triangle. Higher limit of safe BMI varies according to various authors. Generally BMI more than 30 is considered to be obese and pose a risk factor for safe Lap cholecystectomy. Previous upper abdominal surgeries cause adhesions at the Calot's triangle and port sites predisposing to veress and trocar injuries during access. It also increases the operating time, intra operative blood loss and CBD injuries due to the

requirement of adhesiolysis at Calot's triangle. Adhesions were identified as the single most factor intraoperatively that influences the operating time and technical difficulty. One of the most important factors predicting difficulty during Laparoscopic cholecystectomy is severity of the disease. This can be assessed either clinically, by laboratory tests or imaging studies. Clinically, the presence of recurrent biliary colics, pain or fever predicts an intra operative risk of difficult cholecystectomy. Raised WBC counts indicate a severe inflammation or superinfection and poses a risk. Mok et al studied the relation between quantitative levels of C Reactive Protein and severity of inflammation and conversion risk.²¹ It was found that CRP is a very good predictor of conversion and levels above 220 units had strong positive as well as negative predictive value. Ultrasonogram is the initial imaging investigation of choice for cholelithiasis and acute calculous cholecystitis.²²

Presence of wall thickness more than 3mm, a contracted gall bladder, an impacted stone, multiple stones and presence of pericholecystitic collection are indicators of a difficult cholecystectomy. A contracted gall bladder and an impacted stone causes difficulty in grasping gall bladder. These factors must be reported by the radiologist while imaging a gall bladder disease so that the surgeon can anticipate difficulty in case of any. But no author or study recommends any additional imaging to diagnose these risk factors other than the ultrasonogram. Anomalous anatomy at the Calots triangle, presence of an intrahepatic gall bladder, adhesions and complications like perforation, gangrene and fistulation of gall bladder are often encountered by a surgeon.

Tackling these problems depend on the experience and learning curve of the surgeon. It is a well-accepted fact that an experienced surgeon needs less operating time and is better equipped to face these risk factors. It must be understood that none of these risk factors are an absolute contraindication to proceed with the procedure. But while assessment of a patient these must be kept in mind so that intraoperative technical difficulty can be expected and averted.

CONCLUSION

Even though laparoscopic cholecystectomy is not a technically demanding surgery, there are certain risk

factors which predict intraoperative difficulty. This review concludes that age, sex, obesity, previous upper abdominal surgeries, comorbid diseases like Diabetes, acute cholecystitis, raised WBC counts, a Gall bladder wall thickness more than 3mm, presence of pericholecystitic collection, single impacted stone, multiple stones, contracted gall bladder, adhesions at Calot's triangle, intra-hepatic gall bladder, complications like gangrenous GB and fistulisation are significant predictors of technical difficulty and conversion in Laparoscopic cholecystectomy. A laparoscopic surgeon needs to approach these patients with caution keeping in mind the necessary technical modifications needed to perform a safe Laparoscopic Cholecystectomy.

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