Effect of Diabetes Mellitus on Patients Undergoing Laparoscopic Cholecystectomy: A Comparative Cross-Sectional Study

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Abstract: Diabetes was found to be a risk factor for gallstone formation, and complications. Diabetic patients are generally more prone to operative and post-operative morbidities than their normal counterparts. This study aimed to find whether diabetes is an independent risk factor for morbidities associated with laparoscopic cholecystectomy in our population. **Material and Methods:** This is a comparative cross-sectional study that was conducted at the Department of Surgery in King Abdulaziz University Hospital, Jeddah, Saudi Arabia, from June to December 2011. A total of 112 patients who have undergone laparoscopic cholecystectomy at our hospital were randomly selected and retrieved from the medical records department. Ethical Approval to conduct the study was obtained from the local ethical committee of king Abdulaziz University Hospital. A Performa designed by the study team was used to collect the data. **Results:** A total of 112 patients underwent laparoscopic cholecystectomy for cholelithiasis. 18 patients were male (16.1%) and 94 were female (83.9%) with a ratio of 1:5.2. The mean (±SD) age was 41.23 ± 13.82 years (range 15-75 years). Out of 112 patients, 18 were diabetics (16.1%) and 94 patients (83.9 %) were not diabetics. The operation was performed as an elective procedure in 104 patients (92.9%) and as an emergency in 8 patients (7.1%). Diabetics had a significantly higher rate of emergency admissions (22.2%) compared to non-diabetics (4.3%, p= 0.022). Laparoscopic cholecystectomy was converted to open procedure in 5 patients (4.5%) of which 3 were diabetics (16.7%) and 2 non-diabetics (2.1%). This shows a statistically significant higher (p=0.029) rate of conversion to open of diabetics compared to non-diabetics. Diabetics had a significantly higher (p= 0.029) mean length of post-operative hospital stay (2.06 ±1.60) compared to non-diabetics (1.43 ± 0.96). The level of HbA1c and fasting glucose level showed no significant effect on conversion to open procedure. The factors that were associated with higher risk of conversion to open were older age (p=0.004), male gender (p=0.029), diabetes (p=0.029), and acute calcular cholecystitis. **Conclusion:** Diabetes mellitus is associated with more emergency admission due to complicated cholelithiasis, more conversion rate from laparoscopic to open cholecystectomy and prolonged post-operative hospital stay. We found that neither fasting blood glucose level nor HbA1c level have any correlation with intraoperative or post-operative complication or conversion rate. We still however recommend a pre-operative control of blood glucose until we have a prospective randomized control trial comparing diabetic and non-diabetics patient going for laparoscopic cholecystectomy to know at which level of HbA1c or level of blood glucose should be achieved before surgery.

[Saleh M. Aldaqal, Alia T. Albaghdadi, Hanaa M. Tashkandi, Basem S. El-deek, Ghada A. Al-Malki; Ali M. Turki and Ahmed M. Makki. **Effect of Diabetes Mellitus on Patients Undergoing Laparoscopic Cholecystectomy: A Comparative Cross-Sectional Study.** Life Science Journal 2012; 9(1):431-439]. (ISSN: 1097-8135). http://www.lifesciencesite.com. 64

Key words: Diabetes mellitus, laparoscopic cholecystectomy, open cholecystectomy, gall bladder, gall stone.

1. Introduction:

Diabetes in Saudi Arabia is a tremendous health problem. The prevalence has reached to one of the highest in the world, affecting 23.7% of the Saudi population (1). It has significantly affected the morbidity and mortality of our population due to its numerous complications and associated co-morbidities.

From a surgical point of view, diabetes was found to be a risk factor for gallstone formation, and complications. Furthermore, diabetic patients are generally more prone to operative and post-operative morbidities than their normal counterparts.

This study aimed to find whether diabetes is an independent risk factor for morbidities associated with laparoscopic cholecystectomy (lap chole) in our population, to find out whether diabetics with a controlled disease have a better outcome than those with an uncontrolled disease, and to see whether the levels of blood glucose and HbA1c correlate with a higher risk of developing complications. It would also help us identify high-risk patients in lap chole and predict the complications that may be

encountered intra-operatively and post-operatively in that specific group of patients, and hence take precautions to achieve best possible outcome.

Identifying such a common disease as a risk factor for complications in a common procedure will improve preparation and communication with patients prior to operating.

2. Materials and Methods

Study Design

This is a comparative cross-sectional study that was conducted at the Department of Surgery in King Abdulaziz University Hospital, a tertiary care center and a teaching hospital in Jeddah, Saudi Arabia. The study was conducted over a period of 7 months (June - December 2011).

A total of 112 patients who has undergone laparoscopic cholecystectomy at the hospital were randomly selected. Ethical Approval to conduct the study was obtained from the local ethical committee of king Abdulaziz university hospital. A Preforma designed by the study team was used to collect the data.

Laparoscopic cholecystectomy at our hospital is usually performed by experienced consultant surgeons or senior residents under the supervision of a consultant. Pre-operative work up is done for all patients on the day of admission. Those include; Liver Function Tests, Coagulation profile, Pre-operative abdominal ultrasound to confirm diagnosis, to look at the site of stones, to measure wall thickness, and look for evidence of inflammation. All patients are also assessed pre-operatively by anesthetists to evaluate co-morbidities, and fitness for surgery.

Following the surgical procedure an operative note is recorded, that includes the duration of operation, and any complications that were encountered during the procedure. The gallbladder specimen is sent for histopathological evaluation. Patients are then transferred to the surgical ward or the surgical ICU at our hospital depending on their condition. Patients are closely monitored in the 1st 24 hours post operatively, and if well are discharged on the following day. The usual post-operative hospital stay is one day. Patients are then given follow up appointments at the surgery outpatient clinic of King Abdulaziz University Hospital, and are told to return to the ER in case of any significant related complaint, such as fever, persistent abdominal pain, vomiting, or jaundice. Patients are usually seen within 2 weeks post-operatively, to evaluate the port-site incision and to look for any late complications of Laparoscopic cholecystectomy.

On reviewing their files, Demographic data that is age, gender, and nationality was obtained for all patients to allow for comparison and to eliminate any confounding variables. The Patients were classified as diabetic - designated group 1 - or not diabetic - designated group 2 - This classification was based on the medical history found in their records and by checking their medication records for any anti-diabetic medications. Blood glucose measurements were done to confirm presence of diabetes.

Group 1 - Diabetics

Pre-operative glucose level and HbA1c were done for all patients. Those levels were recorded in order to see if there was any correlation between the outcome of lap chole with the level of HbA1c, and glucose levels among the diabetic group (Group1). We also recorded the type of diabetes (Type 1 or Type 2), the control of the disease based on the presence of complications found in their medical records, and also the duration of their disease calculated from the time of diagnosis of diabetes. Those parameters were recorded for comparison of complications within the diabetic group (Group 1).

The results of the routine pre-operative workup was also reviewed and recorded for all patients. We looked at their liver function tests to see if there was any association between the elevation of specific biomarker and the risk of complications. Also, the results of the pre-operative ultrasound was reviewed and recorded, this was done to allow for comparison between the two groups on the presence of gall bladder inflammation, which intern can complicate the operation and increase the operative duration and the risk of conversion to open. We also wanted to see if there was any association between diabetes and the stone size, and if there's any relation between the stone size and the rate of complications.

The Operative notes of all patients - groups 1 and 2 - were reviewed. We recorded the duration of the operation, and if there were any cases who required a conversion to open, and the reason behind it. We categorized the reasons for conversion to open into 3 categories: injury to the surrounding structures such as common bile duct (CBD) injury or bowel injury, the presence of uncontrolled bleeding, and difficult anatomy because of adhesions. We also recorded if there was any perforation of the gallbladder that has resulted in bile leak into the abdominal cavity, and the placement of drains. This was also done to compare between the two groups.

The progress notes were reviewed for immediate and early post-operative complications; that is within the 1st 24 hours post-operatively, and also for late post-operative complications by checking their files for any emergency room (ER) visits or re-admissions or from notes taken during the clinic follow up.

The immediate post-operative complications that we have collected were; post-operative fever, vomiting, cough, urine retention, chest pain, Deep Venous Thrombosis, and if there was any delay in resuming their diet postoperatively. Also we recorded the type of analgesics the patients were given and the frequency at which they were given analgesics postoperatively. This was done to see if there's any difference in pain control between diabetic and non-diabetic patients. The same parameters were also recorded in the 1st post-operative day. Those who have required the prolonged use of antibiotics were recorded.

Furthermore, we reviewed the files for any ER visits, readmissions, and clinic visits to detect any late complications as post cholecystectomy syndrome and incisional hernias. Histopathology results were also obtained.

The data we have collected was entered into the SPSS program for statistical analysis. The qualitative data were presented in the form of number and percentage. Chi-square test was done to compare between qualitative data. Yates correction was done when it is indicated. The quantitative data were presented in the form of mean, standard deviation and range. Student t-test was done to compare the quantitative data. Significance was considered when p value less than 0.05.

3. Results

A total of 112 patients underwent laparoscopic cholecystectomy for cholelithiasis. 18 patients were males (16.1%) and 94 were females (83.9%) with a ratio of 1:5.2. The mean (±SD) age was 41.23 ±13.82 years (range 15-75 years). Demographics and clinical data of all the patients that were included in our study are shown in table 1.

TABLE 1 - Demographics and clinical data of all the patients who have undergone laparoscopic cholecystectomy that were included in our study.

	Number of patients (N)	Percentage %
Age		
Mean ± SD	41.23 ± 13.82	
Range	(15 – 75)	
Gender		
Male	18	16.1
Female	94	83.1
Nationality		
Saudi	66	58.9
Non-Saudi	46	41.1
Diabetic	18	16.1
Type 1	1	5.9
Type 2	17	14.3
Non-Diabetic	94	83.9
Control of Diabetes		
Well controlled	8	7.1
Poorly controlled	10	8.9
Duration of Diabetes *(years)*		
Mean ± SD	9 ± 8.75	
Range	(3 – 30)	
Co-morbidities		
Hypertension	11	9.8
Hyperlipidemia	3	2.7
Hypothyroidism	3	1.8
Chronic Renal Failure	1	0.9
Asthma	2	1.8
Sickle Cell Anaemia	1	0.9
Multiple co-morbidities	9	8.0
History of previous abdominal operations	11	9.8

The operation was performed as an elective procedure in 104 patients (92.9%) and as an emergency in 8 patients (7.1%).

Diabetics had a significantly higher rate of emergency admissions (22.2%) compared to non-diabetics (4.3%) with a *p value* of 0.022. Also, our results shows that emergency admissions were associated with higher rates of conversion to open (80%) compared to elective admissions (20%) with a *p value* of 0.00.

Out of 112 patients, 18 cases of them were diabetics (16.1%), while 94 patients (83.9 %) were not diabetics. Among the diabetic patients, 8 had well controlled diabetes, and 10 were poorly controlled (7.1% and 8.9%, respectively). The mean (±SD) duration of the diabetes was 9± 8.75 years (range 3-30 years). Comorbidities found in our patients are shown in table 2.

TABLE 2 – Comparison of Diabetics with non-diabetics regarding demographics, comorbidities and pre-operative evaluation

	Diabetics		**Non- Diabetics**		**Significance – determined by *p value* <0.05**
	N	**%**	***N***	**%**	
DEMOGRAPHICS					
Gender					1.000
Males	3	16.7	15	16	
Females	15	83.3	79	84	
Nationality					0.071
Saudi	7	38.9	35	37.2	
Non-Saudi	11	61.1	94	94	
PRE-OPERATIVE EVALUATION OF DIABETICS VS. NON-DIABETICS					
Liver Function Tests					
Elevated AST	7	38.9	15	16.7	**0.040**
Elevated ALT	2	11.1	18	20.1	0.303
Elevated ALP	4	22.2	15	16.7	3.393
Elevated GGT	4	22.2	19	21.1	1.567
Pre-operative Ultrasound Diagnosis					1.000
Uncomplicated cholelithiasis	17	94.4	71	93.4	
Calcular cholecystitis	1	5.6	5	6.6	
Number of stones					0.123
Solitary stone	7	41.2	18	23.7	
Multiple stones	10	58.8	58	76.3	
Stone size - cm					
Mean ± SD	1.58 ± 0.74		1.29 ± 0.61		0.171
Increased Gallbladder Wall thickness > 4 mm	4	22.2	19	23.8	0.581
Type of admission					**0.022**
Elective admission	14	77.8	90	95.7	
Emergency admission	4	22.2	4	4.3	
Co-morbidities					**0.003**
Hypertension	6	33.3	74	80.4	
Hyperlipidemia	0	0	3	3.3	
Hypothyroidism	1	5.6	2	2.2	
Chronic Renal Failure	0	0	1	1.1	
Asthma	1	5.6	1	1.1	
Sickle Cell Anaemia	0	0	1	1.1	
Multiple co-morbidities	---	---	---	---	
History of previous abdominal operations	3	17.6	14	82.4	0.267

Pre-operative evaluation

Results of the pre-operative assessment revealed a mean HbA1c (±SD) of 8.45±1.73 (range 6.5-11.7) in our diabetic patients. The mean pre-operative fasting plasma glucose level (±SD) was 9.83±4.08 mmol/l (range 5.7-18.0) and the mean random plasma glucose level (±SD) was 9.10 ±5.41 mmol/l (range 5.9-17.2).

Liver enzymes were also measured in all patients prior to laparoscopic cholecystectomy. AST was elevated in 22 patients (19.6%), elevated ALT in 20 patients (17.9%), elevated ALP in 19 patients (17.0%) and elevated GGT in 23 patients (20.5%). Elevated liver enzymes when compared between group 1 and group 2 showed a significant difference in the elevation of AST in diabetics (Group 1) compared to non-diabetics (Group 2), with a p value of 0.040. However, elevation in liver enzymes showed no significance in relation to the conversion to open cholecystectomy.

Preoperative abdominal ultrasound showed uncomplicated cholelithiasis in 88 patients and calcular cholecystitis in 6 patients (78.6 % and 5.4%, respectively). There was a significant difference in the rate of conversion to open in those with calcular cholecystitis compared to uncomplicated gallstone disease with a p value of 0.031. On the other hand there was no difference in the pre-operative ultrasound findings between diabetics and non-diabetics.

Intraoperative course of laparoscopic cholecystectomy

The mean (±SD) duration of operation was 104.21±44.29 min (range 37 - 270 min). There was no statistically significant difference in the mean duration of operation in diabetics (114.06±60.01) compared to non-diabetics (102.30 ± 40.688). Table 3.

TABLE 3 - Comparison between diabetic and non-diabetic patients in intraoperative and immediate post-operative course (<24 hours)

	Diabetics		**Non- Diabetics**		**Significance – determined by *p value* <0.05**
	N	**%**	***N***	**%**	
INTRA-OPERATIVE COURSE OF DIABETICS VS. NON-DIABETICS					
Duration of operation*(min)* *Mean ± SD*	114.06 ± 60.01		102.30 ± 40.688		0.305
Intra-operative bleeding	2	11.1	1	1.1	0.068
Intra-operative injury to CBD and surrounding organs	---	---	---	---	
Gallbladder perforation with intra-peritoneal bile leak	5	27.8	11	12	0.135
Drain placement	3	16.7	3	3.2	0.053
Intra-operative adhesions	7	46.7	26	34.7	0.775
Conversion to open	3	16.7	2	2.1	**0.029**
IMMIDIATE POST-OPERATIVE COURSE <24h OF DIABETICS VS. NON-DIABETICS					
Fever	3	16.7	5	5.4	0.119
Vomiting	0	0	1	1.1	0.838
Cough	1	5.6	1	1.1	0.299
Chest pain	0	0	2	2.2	0.701
Shortness of breath - Need of oxygen mask	2	11.1	2	2.2	0.122
Post-operative pain					0.155
Mild – PRN analgesics	4	22.2	18	19.4	
Moderate – regular analgesics	14	77.8	65	69.9	
Severe - both	0	0	10	10.8	
Analgesia used					
Opiates for pain	15	83.3	68	73.1	0.277

There were a total of 3 (2.7%) patients who had intraoperative bleeding of which 2 were diabetics and 1 non-diabetic (11.1% and 1.1%, respectively with a *p value* of 0.068), thus we found no statistically significant difference between diabetics and non-diabetics with respect to intraoperative bleeding. However, intraoperative bleeding was associated with a higher rate of conversion to open cholecystectomy with a *p value* of 0.005.

Gall bladder perforation with intraperitoneal bile leak occurred in 16 cases (14.3%), of which 5 were diabetics, and 11 non-diabetics (27.8% and 12% respectively with a P- value of 0.135). Gallbladder perforation however was also associated with a higher rate of conversion to open (*p value* 0.021).

In our series, there was no intraoperative injury to CBD or surrounding organs.

A total of 33 patients had intra-abdominal adhesions (29.5%) of which 7 were diabetic (46.7%) and 26 non-diabetics (34.7%) with a *P value* of 0.775. Also, those with adhesions did not have a significantly higher rate of conversion to open compared to those who did not (p=0.058).

Laparoscopic cholecystectomy was converted to open procedure in 5 patients (4.5%) of which 3 were diabetics (16.7%) and 2 non-diabetics (2.1%). This shows a statistically significant higher rate of conversion to open of diabetics compared to non-diabetics with a *p value* of 0.029.

Immediate post-operative course (<24 hours) and early post-operative course (>24 hours)

There was no statistically significant difference between diabetics and non-diabetics regarding immediate post-operative complication such as fever and pain control or early post-operative course with respect to resumption of normal diet, persistent jaundice and need of post-operative antibiotics (Table 3 and4).

TABLE 4 - Comparison between diabetic and non-diabetic patients in early post-operative (>24 hours) and late post-operative course

	Diabetics		Non- Diabetics		Significance – determined by *p value* <0.05
	N	%	*N*	%	
EARLY POST-OPERATIVE COURSE >24h OF DIABETICS VS. NON-DIABETICS					
Diet not resumed > 24 hrs	2	11.1	1	1.1	0.068
Resumption of normal diet					0.118
POD1	15	83.3	89	95.7	
POD2	3	16.7	3	3.2	
POD3	0	0	1	1.1	
Delayed Mobilization >24hrs	1	5.6	1	1.1	0.299
Prolonged need of post-operative antibiotics > 24hrs	14	77.8	59	63.4	0.185
Jaundice persisting >24hrs	0	0	1	1.1	1.000
Length of hospital stay post-operatively (days)					
Mean ± SD	2.06 ± 1.60		1.43 ± 0.96		**0.029**
LATE POST-OPERATIVE COURSE OF DIABETICS VS. NON-DIABETICS					
Persistent pain	1	5.6	1	1.1	0.299
Persistent Jaundice	0	0	1	1.1	0.299
Port-site wound infection	1	5.6	1	1.1	0.162
Port-site incisional hernia	---	---	---	---	---
Post-cholecystectomy syndrome	---	---	---	---	---

Length of Hospital Stay

The mean length of post-operative hospital stay for the whole study population was 1.53 ±1.09 and ranged between 1-7 days. Diabetics had a significantly higher mean length of post-operative hospital stay (2.06 ±1.60) compared to non-diabetics (1.43 ±0.96) with a *p value* of 0.029.

Late post-operative course

Persistent post-operative pain was noted in 2 patients (1.8 %) of which 1 diabetic, and 1 non-diabetic (5.6 % and 1.1 %, respectively; *P- value* 0.299). Persistent jaundice occurred in only 1 patient from the non-diabetic group (1.1%) p=0.299. Port site wound infection occurred in 2 cases of which 1 was diabetic and 1 non-diabetic (5.6% and 1.1 %, respectively with a *P- value* 0.162). In our series,

there was neither port site incisional hernia nor post-cholecystectomy syndrome.

Histopathology diagnosis of excised gall bladder in diabetics versus non diabetics

Uncomplicated cholelithiasis was found in 16 cases (14.3%) of which 4 were diabetics and 12 non diabetics (22.2% and 12.9 % respectively). Acute calcular cholecystitis was diagnosed in 11 patients (9.8%) of which 2 were diabetics, and 9 non-diabetics (11.1% and 9.7% respectively), and chronic calcular cholecystitis in 83 cases (74.1%) of which 12 were diabetics and 71 non diabetic (66.7% and 76.3 %, respectively). Focal dysplasia was identified in one non-diabetic patient (1.1%). We had no patients who were found to have malignancy. There was no significant difference in histopathology results of diabetics compared to non-diabetics. However 60% of those who had a conversion to open had acute cholecystitis compared to 8% of those who did not have a conversion (p=0.029).

Factors associated with conversion to open cholecystectomy(Table 5).

Higher mean age was associated with increased rate of conversion to open cholecystectomy. The mean age (±SD) of those who had a conversion to open was 58.6 ±11.67 and the mean age of those who had no conversion was 40.42± 13.42. This shows a statistically significant difference with a ***p*** value of 0.004.

Males had a higher rate of conversion to open (60%) compared with females (40%), P=0.029.

Although Diabetics had a higher rate of conversion to open (60%) compared to non-diabetics (40%) with a p value of 0.029, the duration of diabetes mellitus, the level of HbA1c and fasting glucose level showed no significant effect on conversion to open procedure. The mean duration (±SD) of diabetes was equal in both who had a conversion and in those who did not (9.00± 9.45 years) giving a p value of 1.00. Patients who had a conversion to open had a mean HbA1c of 7.70 ±1.82, and a mean fasting glucose level of 11.13 ±6.24 mmol/l, while those who did not have a conversion had a mean HbA1c level of 8.55± 1.82 and a mean fasting glucose level of 11.13 ±6.24 mmol/l. (P- value 0.673 and 0.555 respectively) Table 5.

Pre-operative ultrasound diagnosis of calcular cholecystitis and post-operative histopathology diagnosis of acute calcular cholecystitis were associated with higher rates of conversion to open (*p value*= 0.031 and 0.029, respectively).

TABLE 5– Independent T-test done to assess factors associated with conversion to open cholecystectomy.

	Conversion to open	**No conversion**	**Significance – determined by *p value* <0.005**
Age *Mean ± SD*	58.60 ± 11.67	40.42 ± 13.42	**0.004**
Duration of DM (y) *Mean ± SD*	9.00 ± 9.45	9.00 ± 9.45	1.000
HbA1c *Mean ± SD*	7.70 ± 1.82	8.55 ± 1.82	0.673
Fasting glucose *Mean ± SD*	11.13 ± 6.24	9.5 ± 3.67	0.555

4. Discussion

Gallbladder disease is a worldwide concern. It affects more than 20 million people in the United States (2). In Saudi Arabia, the prevalence of gall stones and hence cholecystectomies have also been progressively rising over the years (3). This was linked to changes in dietary habits (3), and also was attributed to the introduction and availability of laparoscopic techniques (4). In 1997, a prospective study conducted in king Abdulaziz university hospital estimated the prevalence of asymptomatic gallstones among adult females. The results showed that 49% of the study population had gallstones. Also, it was significantly associated with old age, diabetes, and multiparity (5).

Several studies have shown the increased incidence of gall stone disease in diabetic patients (6,7). In 2004, **Pagliarulo *et al.*** found a significantly higher prevalence of gallstones in diabetics 24.8% compared with the general population 13.8 %(8). Some researchers suggest that this relationship is due to increased gallbladder volume (9), which in turn predisposes to bile stasis and hence stone formation. On the other hand, some researchers thought that diabetics are more prone to stone formation due to associated hyperlipidemia.

Due to its great outcome and low rates of complications compared to open cholecystectomy, Laparoscopic Cholecystectomy has become the gold standard treatment for gallstones for many years (10).

It has reduced the length of hospital stay and hence decreased costs.

Complications that may arise with laparoscopic cholecystectomy can be categorized into intra-operative and post-operative complications, which can be further subdivided into early and late complications.

Intra-operative complications such as bleeding, duct injury, bile leak, bowel perforation, if cannot be controlled, may necessitates the conversion to open cholecystectomy. Other reasons to convert to open procedure would be due to technical problems such as dense adhesions, inflammation, and difficult anatomy. Also, operative findings such as gangrenous cholecystitis or empyema may also require the conversion (11). Delayed post-operative complications of Laparoscopic Cholecystectomy are mainly Post-cholecystectomy syndrome, Intra-abdominal abscesses, and port-site incision hernias. Length of hospital stay usually used to assess the outcome and the complications of surgical procedures.

In 2000, **Lyass *et al.*** (12) studied several factors that may affect the outcome of lap chole. Their results showed that diabetes was one of the factors that significantly increased post-op morbidity, but did not increase the length of hospital stay after lap chole. Unlike our results that showed an increased length of hospitalization in diabetics post lap chole. Diabetics in our study had a significantly higher mean length of post-operative hospital stay (2.06 ±1.60) compared to non-diabetics (1.43 ±0.96) with a *p value* of 0.029.

In 2001, a study conducted in university of Erciyes, Turkey (13), found that operative and postoperative complications of lap chole in diabetics with symptomatic gallstones were significantly higher than non-diabetics. Their conversion to open rate was 7.1% in diabetics compared to 2.8% in non-diabetics. However, the comparison of operative time and length of hospital stay were not significant. Our results also showed a higher rate of conversion in diabetics compared to non-diabetics.

In 2006, a study conducted by Ibrahim ***et al.*** (14), in Singapore, found that the mere presence of diabetes does not appear to increase the risk of conversion to open, however they found an association between poorly controlled diabetes (elevated HbA1c >6) with an increased risk for converting to laparotomy. They thought that poorly controlled blood sugar levels leads to severe inflammation and hence severe adhesions distorting the anatomy as in patients with previous upper abdominal surgery. Also, patients who had a conversion were found to have significantly higher rates of complications postoperatively.

In our current study, we have had opposite results. The presence of diabetes in our patients increased the rate of conversion to open, however the levels of HbA1c and fasting glucose had no influence on the rate of conversion. On the other hand, we got similar results with respect to increased post-operative complications in those who have had a conversion.

In 2005, **Simopoulos *et al***. (15), found a significant correlation between male genders, age above 60, previous upper abdominal surgery, and diabetes with increased rate of conversion to laparotomy. Our results showed similar risks associated with conversion to open.

In 2007, **Cheng *et al.*,** researchers from Taiwan (16), linked prolonged hospital stay after lap chole with the occurrence of major complication, specifically those associated with pulmonary disease in the elderly. They also concluded that no other comorbidity has direct impact on the duration of hospitalization.

In 2010, a study done in king Faisal University, Alhofuf, Saudi Arabia (17), found that there was no difference in the outcome of lap chole in diabetics compared to non- diabetics with respect to conversion to open and operative time. However, the length of hospital stay was found to be significantly different. Our results were similar in the length of hospital stay and operative duration, however, diabetics did have a higher rate of conversion to open.

In 2010, **Paajanen *et al.*,** from Kipio University hospital in Finland (18) studied the post-operative outcome of lap chole compared to open in diabetic patients. In their study, their results demonstrated that 16% of their diabetic patients required conversion to open compared with only 7% of their non-diabetic controls. They have also suggested that comorbidities of diabetes, especially renal disease, were associated with a higher risk of complications. In our study, we had no co-morbidity associated with conversion to open.

Conclusion:

Up to our current state of knowledge, very few studies have evaluated the relationship of Diabetes and its pre-operative control (as measured by glucose levels and HbA1c) as a sole and independent risk factor for complications associated with lap chole. Furthermore, those studies have had conflicting results. And since both diabetes and gallstones are important health challenges in our country, we thought it was imperative to further assess this relationship, to provide our patients with better care and outcome.

In our study population, we found that diabetes is associated with higher rate of emergency admissions compared to non-diabetics (p=0.022). Emergency admissions in turn had higher rates of conversion to open compared to elective admissions (p=0.00). Diabetes was also associated with higher rates of conversion to open compared to non-diabetics (p=0.029), however, the duration of diabetes and the measured levels of HbA1c and fasting plasma glucose did not appear to correlate with the rate of conversion.

Diabetics had a significantly higher mean length of post-operative hospital stay compared to non-diabetics (p=0.029). The factors that were associated with higher risk of conversion to open were older age (p=0.004), male gender (p=0.029), diabetes (p=0.029), and acute calcular cholecystitis.

We still however recommend a pre-operative control of blood glucose until we have a prospective randomized control trial comparing diabetic and non-diabetics patient going for laparoscopic cholecystectomy to know at which level of HbA1c or level of blood glucose should be controlled before surgery.

Disclosure of benefit:
The authors have no conflict of interest, and are not supported/funded by any Drug Company.

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2/2/2012