LAPAROSCOPIC BILE DUCT INJURIES-CONTROVERSIES AND CONSENSUS

S. Sankar [a], M. Subramanian [a]

ABSTRACT

Among the various advancements witnessed in the field of surgery towards the end of the last millennium, none has been so dramatic as Laparoscopy Cholecystectomy. Laparoscopic cholecystectomy is the prototype amongst the minimally invasive surgeries; however this unprecedented rapid advancement was plagued by the increased incidence of bile duct injuries. Frequency of bile duct injuries is almost double in Laparoscopy. The mechanism of injury is different. Laparoscopic anatomy is different. Though the recognition of injury is relatively early, the magnitude of injury can be devastating. The implications of post-laparoscopic cholecystectomy biliary injuries are serious in terms of the physical and fiscal inconvenience for the patients and the legal problems for the surgeon. For obvious reasons, accrual of data on this entity is extremely difficult. Despite the completion of learning curve, bile duct injuries continue to occur. This article reviews the controversies and consensus on the subject of post-laparoscopic cholecystectomy biliary injuries.

Key words:

Laparoscopic, Cholecystectomy, Bile duct diseases

INTRODUCTION

Born in secrecy and viewed with skeptism, Laparoscopic cholecystectomy (LC) stormed into the surgical arena, and in an unimaginable span of time has become the gold standard, for the treatment of Gall stone disease. The benefits of LC were so obvious that, till now there are no Randomized Controlled Trial comparing LC and Open Cholecystectomy (OC). In a lighter vein, the highest level of evidence (class A) is lacking, to support the advantages of LC. The incidence of bile duct injury in LC is 0.4% - 1.3 %(1,2,3,4,5,6) compared to 0.2%-0.3%(6,7) for OC. Despite the inherent difficulty in collecting data on laparoscopic bile duct injuries, these injuries occur twice more frequently in Laparoscopic cholecystectomy. This statistical data may look innocuous, but nevertheless there are major differences between the bile duct injuries associated with LC and OC.

Are Post laparoscopic Bile duct injuries anyway different

1. The so-called "classical Laparoscopic injury" (8) is characterized by significant segmental loss of bile duct, and often the proximal level of injury may reach the biliary confluence. This is because, the surgeon divides the CBD mistaking it for the Cystic duct, and further in the process of removing the GB, he divides the CHD proximally and finally ending up in a significant loss of length. Basically the cranial traction exerted on the GB fundus to lift the Liver makes the Cystic duct to align with the CBD and hence the mistake. This complex kind of injury is unique for Laparoscopy and unlikely to happen in OC.

2. Many a time bile duct injuries are associated with Right Hepatic Artery injury (RHAI) because of its close proximity to the CHD, which is invariably damaged in the classical LC bile duct injury. Normally it is thought that RHAI leads to increased incidence of complications like liver abscess, necrosis, bile leaks, unsuccessful repairs etc. In a retrospective study of 261 LC bile duct injuries, Stewart and Way analyzed the mechanism and consequences of RHAI (9). The incidence of RHAI was an amazing 32%, but ironically this was not associated with increased mortality, and did not alter the success of repair in the hands of experienced biliary surgeons (9). Belghiti's group has also reported the incidence of RHAI to be 36%(40). Most of the times the RHAI goes unrecognized. If the injury is recognized on the table, whether one should try to reconstruct is a matter of debate. But in the presence of pre-existing Liver dysfunction, Right Hepatic artery injury may have serious consequences.

3. Many LC biliary injuries are due to surgeons' misperception of the anatomy rather than an inadequacy of skill or judgment (10). Without realizing this optical illusion, the surgeon subconsciously feels that, what he was doing was correct. In cognitive psychology this is technically called the "Heuristic process". This means, biliary injuries will continue to occur, despite the completion of the often-repeated cliché, "learning curve". But this should not be misinterpreted as a justification for the errors, that carries tremendous physical, emotional, legal and financial implications. There have been suggestions to inculcate "methods of error reduction" in the laparoscopic training of a surgeon, something similar to that followed in sectors like aviation, nuclear technology, as errors in these fields can have serious consequences.

Laparoscopic Anatomy – is it different?

- The commonly described Calot's triangle is actually different from what it was originally described. In the original Calot's triangle, Cystic artery forms the boundary and not the content. The Hepato-Cystic triangle (also called as Mooseman's area or triangle of Buddie), is the one where Cystic artery forms the content and Liver forms a boundary.

CORRESPONDING AUTHOR :

Dr. S. SANKAR
Assistant Professor of Surgical Gastroenterology
Sri Ramachandra Medical College and Research Institute
Porur, Chennai - 600 116.
E-mail: drsshankar@gmail.com
[a] Department of Surgical Gastroenterology

- The cranial traction applied on the fundus of GB to retract the Liver, actually narrows the Calot's Triangle and hence an outward traction on the Harman's pouch is needed and causes the Cystic duct to align with the CBD
- The "reverse" or "posterior" dissection of the Calot's triangle gives a different view of the anatomy
- "Rouvier Sulcus" can be demonstrated in a majority of patients, this sulcus separates the right lobe and caudate process and corresponds to the porta hepatis harboring right hepatic pedicle. Hence the dissection should start anterior to the sulcus. Thus it provides an extra biliary reference point, which does not get altered due to the pathology of Gall bladder (41).
- In LC, the junction of cystic duct and Hartman's pouch is demonstrated. Whereas in OC the junction of Cystic duct and CBD is demonstrated.

Factors predisposing for biliary injuries include

A. Difficult anatomy

i. Anomalies of cystic duct (low insertion, high insertion, short duct, parallel duct)

ii. Right sectoral duct anomalies (in 20% of the cases one of the sectoral duct join the CHD)

iii. Intrahepatic GB

iv. Arterial anomalies (accessory Right hepatic artery, arterial humps)

B. Difficult pathology

i. Acute cholecystitis

ii. Scleroatrophic GB (contracted GB)

iii. Mirrizi syndrome

iv. Chronic cholecystitis

v. Frozen calots's triangle

C. Difficult in terms of technique

i. Casual attitude towards a "simple Gall bladder"

ii. Improper placement of trocars

iii. Bulky and hanging falciform ligament

iv. Bulky Quadrate lobe

v. Undue haste exercised in clamping or clipping in the event of bleeding

vi. Injudicious use of electro cautery in Calot's triangle

vii. Too much skeletonization of the Bile duct leading to ischemic strictures

viii. Surgeons' experience- the "learning curve effect", which implies that the bile duct injuries and experience of the surgeon are inversely proportional. There is considerable evidence to support this view (2, 5, 11, 12, 13). However there are also reports of major injuries, inflicted by surgeons of considerable experience (14)

Classification

Bismuth classification (15) is shown in figure 1.

This is used for strictures but the main drawback is, it does not include all possible biliary injuries during Laparoscopic Cholecystectomy.

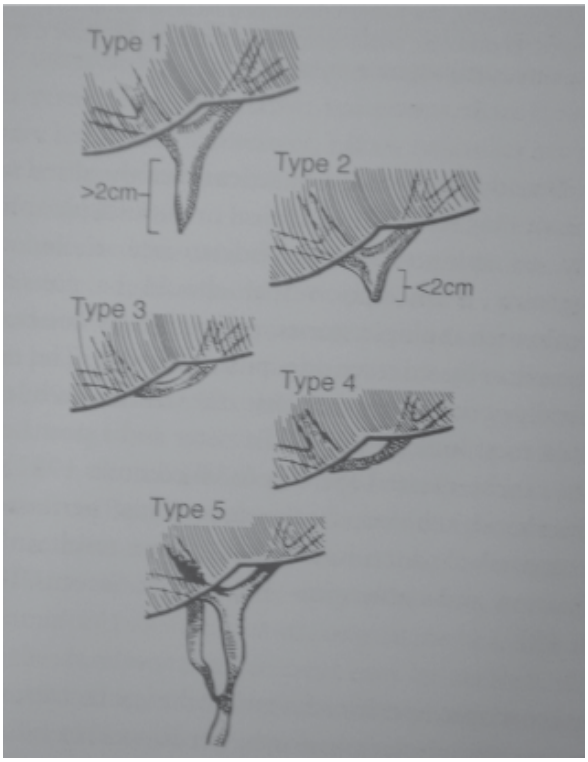

Fig. 1

Type I Stricture > 2cm from the confluence. More than 2 cm of CHD is available.

Type II Stricture < 2 cm from the confluence. Less than 2 cm of CHD is present.

Type III No CHD, but the confluence is patent and the right and left systems are communicating. Sikora et al have proposed a sub classification of type III strictures. III A, where both the floor and roof of the confluence are healthy. III B, where the roof of the confluence is healthy, but the floor is scarred (24). Their contention is, this sub classification has therapeutic and prognostic significance. Type III B strictures are difficult to treat and resembles that of type IV strictures.

Type IV Confluence is stricturous. The two systems are isolated.

Type V Stricture at the junction of the aberrant sectoral duct.

Strasburg classification (6) is represented in figure 2.

This classification includes all possible types of injuries, both leaks and strictures.

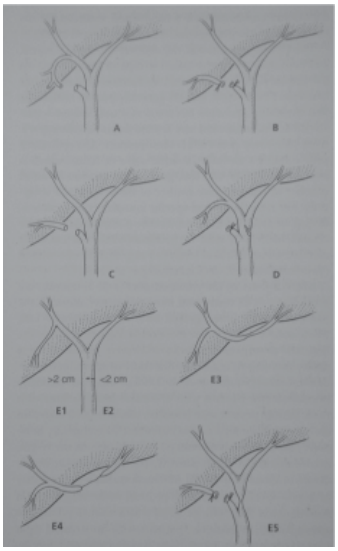

Fig. 2

Type A	leak from minor ducts like Cystic duct or duct of Lushka
Type B	Ligation of aberrant right sectoral duct
Type C	Division of aberrant right sectoral duct
Type D	Lateral injury the major extra hepatic duct
Type E	Classical LC bile duct injury E1, E2, E3, E4, E5 (as per Bismuth classification)

Stewart & Way classification (16) (figure 3)

This is more practical based on the different operative scenario, where injuries occur.

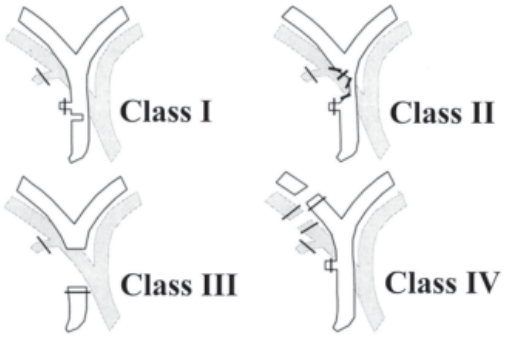

Fig. 3

Class I	CBD mistaken for Cystic duct, but recognized by the surgeon
Class II	Lateral damage to CHD due to clips or cautery
Class III	CBD mistaken for cystic duct. CBD, CHD resected
Class IV	RHD mistaken for CD, RHA mistaken for CA, RHD, RHA transected. Lateral damage to RHD due to clips or cautery

Clinical presentation

Depending on the temporal relation with the injury, three situations are possible, namely injuries recognized on the table, immediate postoperative period and delayed presentations.

1. At surgery:

The surgeon recognizes this by finding welling of bile in the operative field (excluding the bile spillage from the GB). Ideally at this point surgeon should convert and may request for expert help. In some cases bile duct injuries may become evident after an intra-operative cholangiography. Non-visualization of proximal Ductal system indicates major injury. Uncontrollable bleeding also mandates conversion instead of blindly clipping and cauterizing. If any one of the major ducts is clipped and if it is recognized immediately, the clip should be removed and usually nothing more is needed.

The role of intra-operative cholangiogram, whether routine or selective has been a matter of debate. Intra-operative cholangiography may only help to identify injuries and correct it, but it is unlikely to prevent occurrence of injuries (36). There are reports of low yield of intra-operative cholangiography and its routine use is discouraged (37, 38,39). Selective use of intra-operative cholangiography is preferred. When the anatomy is distorted, intra-operative cholangiography is indicated and it is recommended to convert to OC, since Laparotomy is less dangerous than undetected biliary injury.

2. Injuries detected in the immediate post operative period

Bile duct injuries sustained in Laparoscopic cholecystectomy are likely to be recognized relatively earlier than its counterpart, namely open cholecystectomy (8, 17), which probably reflects the differences in the pattern of injuries and the surgeon's awareness of the "potential of laparoscopy" in inflicting injuries (6)

On the first post-operative day, the patient should be "one hundred percent fine" in an otherwise smooth LC, and anything short of this recovery should alert the surgeon. The clinical features depend on various factors. Whether it is a bile leak or an occluded duct, occlusion may be partial or complete. Leaks may be "minor or major" and "contained or uncontained". Strasburg A, C, D and E are likely to present with leaks. Clinical features also depend on whether a drain is placed or not and whether the drain is draining or not. Most of the times drains help in detecting bile leaks. But, "a drain is useful only if it drains" and should not be an alternative to clinical monitoring. Drains can get blocked and can provide a false sense of security. Significant bile in the drain necessitates the surgeon to order for ultrasonogram. The use of drains in laparoscopic cholecystectomy should be selective. Sometimes patients are discharged early and get readmitted with features of sepsis.

Tachycardia, fever and general weakness may be the subtle signs of bile leak. In grossly obese individuals often

the signs of peritonitis are absent and one has to rely on indirect evidences (in these patients, a sense of "impending doom" may be an indicator of a serious problem). Bile leaks may range from being trivial to massive. Large subhepatic collections may compress the vena cava; reduce the preload to the heart and a fall in the systolic pressure (Waltman Walter syndrome). Undetected or neglected massive bile leaks may be fatal especially when they are uncontained and if the patient is allowed to slip into sepsis and its sequelae.

When the extra hepatic bile duct is occluded, patient present with varying degree of icterus and rising enzymes and vague abdominal pain. Usually it takes more than two weeks for the IHBR dilatation to occur. Isolated sectoral duct occlusion may not manifest with jaundice, but only enzymes are elevated.

Late presentation

Occurs typically in biliary stricture patients. Recurrent fever with mild icterus characterizes this group of patients. Recurrent cholangitis leads to general ill health and malaise. Often the bilirubin is elevated to moderate levels. Once again clinical features depend on the magnitude of occlusion and the location of stricture. Strictures of the right sectoral ducts may lead to recurrent infections, abscesses or atrophy of liver sector. Long standing biliary obstructions may predispose to secondary biliary cirrhosis and portal hypertension. Presence of portal hypertension may also be due to associated portal venous injury. Total occlusion of the duct may cause deep jaundice. Sometimes an elevated alkaline phosphatase may be the only abnormality. Even asymptomatic or minimally symptomatic patients may need therapeutic intervention, as secondary biliary cirrhosis is likely to occur.

Pathological consequences of biliary stricture

1. Fibrosis:

High local concentration of bile salt at the level of canalicular membrane sets a cascade of molecular and cellular changes, leading to fibrosis and scarring of bile ducts and ductules, which may sustain the cholestasis. However the fibrosis is not equivalent to cirrhosis as the liver architecture is maintained. Early drainage of the liver may produce reversal of changes and in this context a concept of "latent portal hypertension" has been proposed by some (18). In one study, duration of biliary obstruction and the trend of ALT levels were independent predictors of Hepatic fibrosis (32)

2. Atrophy

The liver mass is regulated by mechanisms that are poorly defined, but biliary drainage and portal venous flow has a bearing on it. Sectoral or segmental ductal obstruction may lead to atrophy of the corresponding segments. This is associated with contralateral lobe hypertrophy. Atrophy-hypertrophy complex is clinically significant as it has implications in diagnosis and surgical treatment. Atrophy-hypertrophy complex leads to rotation of the hepatoduodenal ligament leading to technical difficulties for the surgeon as the portal vein may be encountered more anteriorly.

3. Portal hypertension

The presence of portal hypertension in biliary stricture may be due to one of the following three reasons.

1. Secondary biliary cirrhosis
2. Portal vein injury
3. Pre-existing liver disease.

It takes nearly 2 years for the secondary biliary cirrhosis to contribute to portal hypertension. In alcoholics this period may be shortened. The concept of "Reversible" or "Latent portal hypertension" is interesting (18). Whatever may be the etiology of portal hypertension, it carries a poor prognosis, and for the surgeon, enough of technical difficulties. In the presence of portal hypertension some prefer a two-stage approach i.e.: a porto systemic shunt followed by hepaticojejunostomy or a single stage with venovenous bypass (19). Some prefer single stage procedure with acceptable morbidity, ie: Hepaticojejunostomy without a preliminary shunt surgery (20)

Management

Management depends on the scenario of injury. Three situations are possible.

1. On the table
2. Immediate postop period
3. Late (Biliary stricture)

Intra operatively detected injuries

Usually bile is found welling in the operative field or the anatomy is distorted and uncomfortable. An operative cholangiogram is indicated at this point to find out the cause of leak. Non-filling of proximal ducts on cholangiogram may also indicate CBD injury. Mostly this situation warrants conversion and the need for help. It is best to accept that any potential morbidity from a laparotomy is minor compared to a bile duct injury.

1. CBD transected, but no segmental loss.

If the CBD has been transected and there is no segmental loss, the best option is to do a Choledochojejunostomy. But fashioning a bilio enteric anastomosis in an undilated duct may be technically demanding. The other option is to do a primary repair with a T tube brought out separately. Though primary repair of CBD is associated with high rate of stricture formation (50% of cases), these strictures are the ones, which can best be managed with endoscopic methods. The high rate of stricture after primary repair is due to the axial blood supply, 60% coming from distal side.

2. CBD transected with segmental loss.

If CBD transected with segmental loss then it warrants a hepaticojejunostomy. If the surgeon is not confident or

no expertise is available, a good drainage is accomplished and patient is referred to a higher center where services of a Hepatobiliary surgeon is available.

3. Lateral injuries.

Lateral injuries of the CBD once again need biliary enteric anastomosis, as suturing over a "T-tube" may compromise the lumen and end up in a stricture. Inadvertent application of clips on the bile duct if recognized, immediate removal will suffice.

Immediate postoperative period

Reports of successful early repair of biliary injuries continue to appear (21). But the key issue is "a stable patient and absence of sepsis". The first priority in biliary injuries detected in the immediate postoperative period is to stabilize the patient hemodynamically. An USG abdomen is done to know whether the leak is contained or not. A CT is better than USG, because ultrasound is less sensitive in the evaluation of post operative fluid collections. If the leak is not contained, it has to be contained by proper drainage, either by a Radiological procedure or may be a Relaparoscopy. Once a leak is contained and the patient is hemodynamically stable, the next question to be answered is whether the biliary continuity is preserved or not. Non-invasive methods of knowing this is by MRCP or Isotope scan. MRCP and contrast (Mangafodipir) enhanced MRCP are increasingly being used in the evaluation of biliary injuries and are very reliable (22,23). Isotope scan suffers from the drawback of not being an anatomical investigation, but when the duodenum shows activity, it is indirectly inferred that biliary continuity is maintained. Having established the biliary continuity, the best option is to do an ERCP. If the leak is due to cystic duct blow out a stent or a nasobiliary drain with or without a sphincterotomy will settle the issue. With this modality the leak settles very quickly. Since majority of the cystic duct leaks tend to heal, some surgeons tend to treat conservatively without an ERCP, as long as the patient is stable without signs of sepsis. But the inherent problem with this approach is that the surgeon presumes that bile leak is from the cystic duct and not from major Ductal injury. Conservative treatment without an ERCP may also prolong the hospital stay.

When the biliary continuity is lost (classical LC bile duct injury), and the surgeon is experienced, early hepaticojejunostomy is accepted. "How early is early" may depend on the surgeon's philosophy and experience, apart from the logistics. In delaying, Hepaticojejunostomy may be postponed to a later date after containing the leak, as the first repair should be the best repair, and with every further attempt, surgery becomes less successful and more difficult.

Late presentation

This is essentially the typical biliary stricture. A good cholangiogram is an essential mandatory preop investigation. MRCP is an ideal modality and has almost replaced PTC (31) as it gives all the information that the surgeon wants, besides being non invasive. Of course the gold standard is PTC, which provides a good quality when compared to MRCP. If the patient is having cholangitis that is not responding, one may have to embark on a PTBD. Routine PTBD is not needed. When one decides to do a PTC, it is timed just before the surgery for fear of cholangitis.

The basic principle in the treatment of biliary stricture is to relieve the symptoms and prevent the development of secondary biliary cirrhosis. Surgery has been the standard treatment and the gold standard against which other treatments are compared. Any treatment modality should be durable and long lasting with less morbidity and no mortality. Surgery always carries morbidity and the remote possibility of mortality. The results of the surgery are variable. In the hands of experienced biliary surgeons results have been excellent. Long-term success rate of 80-90% has been reported from high volume centers (33, 34, 35). Biliary sepsis and portal hypertension are two factors hindering surgical success. The recurrence of stricture is reported in 10% of the patients. Treatment of choice for recurrent strictures after surgery is balloon dilatation. Some cases of recurrent stricture may warrant redo Hepaticohejunostomy.

A good Hepaticojejunostomy is the treatment of choice for biliary stricture. The classical Hepp Couinaud approach wherein a wide opening is made in the dilated CHD and extending onto the left duct and a side-to-side anastomosis is fashioned to a Roux Loop of Jejunum. In a nutshell the following are the principles of surgery.

- Careful meticulous dissection
- Duodenum, Colon and Stomach will be adherent to the GB fossa, which are taken down.
- Identification of dilated bile duct
- Lowering of hilar plate
- Bile duct opened and the incision is extended on to the left duct for a wide anastomosis
- Roux loop of jejunum is fashioned
- Single layer interrupted, mucosa to mucosa anastomosis with Vicryl or PDS
- Access loop in selected cases
- Appropriate Biliary stent and drains
- Long follow up

Surgery vs. Endoscopy

Traditionally management of biliary stricture has been a Surgeon's domain. An Endoscopist has a definite role to play in the rescue of the surgeon in the immediate postoperative period. With the advancements of endoscopic technique and accessories, endoscopic management is emerging as an alternative modality to surgery in the management of established biliary strictures. There are few studies directly comparing the results of surgery and endoscopic treatment. The available data is from retrospective

series. The studies showed endoscopy to be comparable with surgery, except for the fact that endoscopy could produce such an impressive results only by "repeated stenting" and "multiple stents"(25,26,27). Endoscopy has a high failure rate in hilar strictures. It is interesting to note that, reports of self-expanding covered metal stent have appeared in the scene (28). These stents can be removed after it has served the purpose. The concept seems to be appealing, but we have to wait for the long-term results. Bioabsorbable stents may have an important role to play in the future (29)

CONCLUSIONS:

Biliary injury is the Achilles' heel of Laparoscopic Cholecystectomy. William Halsted, the great Surgeon sustained biliary injury during Cholecystectomy and succumbed to it after resurgery. Anthony Eden one of the youngest prime minister of Great Britain had his political career curtailed, as he became a biliary cripple following cholecystectomy and subsequent repeated operations. However these were in the prelaparoscopic era. Despite all the precautions and learning curves, bile duct injuries will continue to occur, and be the nemesis for the Laparoscopic Surgeon. Errors happen at so many levels, but it is up to the Surgeon who is the last level in the Swiss cheese model, not to allow it to pass through him. Management of such complex problems should integrate the services of Hepato-biliary Surgeon, Interventional Endoscopist, Interventional radiologist and the Intensivist, to optimize the results.

REFERENCES:

1. Adamsen S, Hansen O H, Funch-Jensen P, Schulze S, Stage J G, Wara P Bile duct injury during laparoscopic cholecystectomy: a prospective nationwide series. Journal of American College of Surgeons 1997:184:571-578

2. Deziel D J, Millikan K W, Economou S G, Doolas A, Ko S T, Airan M C Complications of Laparoscopic Cholecystectomy: a national survey of 4292 hospitals and an analysis 0f 77604 cases. American journal of Surgery 1993:165:9-14

3. Fletcher D R, Hobbs M S T, Tan P, Valinsky L J, Hockey R L, Pickora T J, Knuiman M W, Sheiner H J, Edis A Complications of Cholecystectomy: risks of Laparoscopic approach and protective effects of operative cholangiography. Annals of Surgery 1999:229:449-457

4. MacFadyen J B, Vecchio R, Ricardo A E, Mathis C R Bile duct injury after laparoscopic cholecystectomy. The united states experience (Review) Surgical Endoscopy 1998:12:315-321

5. Richardson M C, Bell G, fullarton g, M, Incidence and nature of bile duct injuries following laparoscopic cholecystectomy: an audit of 5913 cases. British journal of Surgery 1996:83: 1356-1360

6. Strasburg S M, Hertl M, Soper N J An analysis of the problem of biliary injury during Laparoscopic cholecystectomy. Journal of American College of Surgeons 1995:180:101-125

7. Roslyn J J, Binns G S, Hughes E F, Saunders-Kirkwood K, Zinner M J, Cates J A Open cholecystectomy. A contemporary analysis of 42474 patients. Annals of Surgery 1993:218:129-137

8. Davidoff A M, Pappas T N, Murray E A, Hilleren d J, Johnson R D, baker M E, Newman G E, cotton P B, Meyers WC. Mechanisms of major biliary injury during laparoscopic cholecystectomy. Annals of Surgery.1992: 215:196-208

9. Stewart L, Robinson TN, Lee CM, Liu K, Whang K, Way LW. Right hepatic artery injury associated with laparoscopic bile duct injury: incidence, mechanism, and consequences. J Gastrointestinal Surg 2004 Jul-Aug;8(5): 523-30

10. Way LW, Stewart L, Gantert W, Liu K, Lee CM, Whang K, Hunter JG Causes and prevention of laparoscopic bile duct injuries: analysis of 252 cases from a human factors and cognitive psychology perspective. Ann Surg. 2003 Apr; 237(4): 460-

11. Gigot J, Etienne J, Aerts R, Wibin E, Dallemagna B, Deweer F, Fortunati D et al The dramatic reality of biliary tract injury during laparoscopic cholecystectomy. An anonymous multicenter Belgian survey of 65 patients. Surgical Endoscopy 1997:11:1171-1178

12. Woods M S, Traverso L W, Korzareck R A, Tso J I, Rossi R L, Gough D, Donahue J H Characteristics of biliary tract complications during laparoscopic cholecystectomy multi-institutional study. American Journal of Surgery 1994; 167; 27-34

13. Russel J C, Walsh S J, Mattie A S, Lynch j T bile duct injuries, 1989-1993: a statewide experience-Connecticut laparoscopic cholecystectomy registry. Archives of Surgery 1996:131; 382-388.

14. Carroll B J, Friedman R L, Liberman M a, Phillips E H Routine Cholangiography reduces sequelae of Common bile duct injuries. Surgical Endoscopy1996: 10:1194-1197

15. Bismuth H Postoperative strictures of the bile duct. In: Blumgart LH(ed) The Biliary tract. Clinical surgery international. Churchill Livingstone, Edinburgh. 1982:209-218

16. Lygia Stewart et al. Surgical management of Hepatobiliary and Pancreatic disorders; Poston & Blumgart(ed). Martin Dunitz, London and New York.2003: 316-319

17. Lillimoe K D, Martin S A, Cameron J L, Yeo C J, Talamini M A, Kaushal S, Coleman J, Pitt H A et al. Major bile duct injuries during laparoscopic cholecystectomy; follow up after combined surgical and radiological management. Annals of Surgery: 1997:225: 459-471

18. Ibrarullah M, Sikora S S, Agarwal D K, Kapoor V K, Kaushik S P. Latent portal hypertension in benign biliary obstruction. HPB Surgery; 1996:9:149-152

19. Christophi C, Dudley F, McInnes I E. Surgical treatment of biliary strictures with portal hypertension using venovenous bypass. Aust N Z J Surgery; 1991:61(4): 316-318

20. Perakath B, Sitaram V, Mathew G, Kandhuri P.Post cholecystectomy benign biliary strictures with portal hypertension: Is a Porto systemic shunt before hepaticojejunostomy necessary. Ann R Col Sur Eng.2003: 85(5): 317-20

21. Thomson B N J, Parks R W, Madhavan K K, Wigmore S J, Garden O J. Early specialist repair of biliary injury; BJS: 2006:93:216-220

22. Tahir R K, Javier C V, Berta M M, Raul C, Joe U L. Using MR Cholangiopancreatography to evaluate iatrogenic bile duct injury. AJR; 2001:177:1347-1352

23. Aduna M, Larena J A, Martin D et al. Abdominal Imaging; 2005:30:480-487

24. Sadiq S Sikora, Gadiyaram Srikanth, Anuj Sarkari, Ashok Kumar, Rajan saxena, Vinay K Kapoor. Hilar benign biliary stricture; need for sub classification. ANZ journal of surgery; 2003:73:484

25. Davids P, Tanka A, Rauws E A, Van Gulik T M, et al. Benign biliary strictures: Surgery or Endoscopy. Annals of surgery: 1993:217:237-43

26. Costamagna G, Pandolfi M, Mutignani M, Spada C, Perri V. Long-term results of Endoscopic management of postoperative bile duct strictures with increasing number of stents. Gastrointestinal Endoscopy; 2001; 54:162-8

27. Draganov P, Hoffman B, Marsh W, Cotton P, Cunningham J. Long-term outcome to patients with benign biliary strictures treated endoscopically with multiple stents. Gastrointestinal Endoscopy 2002; 55:680-6

28. Kahaleh M, Tokar J, Le T, yeaton P. Removal of self expandable metallic wall stents. Gastrintest Endosc 2004; 60:640-4

29. Freeman M L, Bioabsorbable stents for gastrointestinal endoscopy. Tech Gastrointestinal Endosc 2001; 3:120-5

30. Chaudhary A, Manisegran M, Chandra A, Agarwal A, Sachdev A K. Do bile duct injuries following Laparoscopic cholecystectomy differ from those following open cholecystectomy. J Laproendosc Adv Surg Tech.2001; 11:187-191

31. Chaudhary A, Negi S S, Puri S K, Narang P. Comparison of Ptc and MRCP in the evaluation of post cholecystectomy bile duct injuries. Br J Surg 2002; 89:433-6

32. Negi S S, Sakhuja P, Malhotra V, Chaudhary A. Factors responsible for hepatic fibrosis in patients with postcholecystectomy bile duct injuries Arch Surg 2004; 139:299-303

33. Bismuth H, franco D, Corlette M B, hepp J. Long-term result of Roux en Y hepaticojejunostomy. Surg gynaecology Obstet 1978; 146:161-7

34. Chapman W C, Havely A, Blumgart L H, Benjamin I S. Postcholecystectomy bile duct strictures: management and outcome in patients. Arch Surg 1995; 130:597-604

35. Murr M M, Gigot J F, Nagorney D M, harmsen W S, Ilstrup D M, farne M B. Long-term result of biliary reconstruction after laparoscopic bile duct injury. Arch Surg 1995; 134:604-10

36. Debru E, Dawson A, Leibman S, Richardson M, Glen L, Hollinshed J, Failk G L. Does routine intraoperative cholangiography prevent bile duct transection. Surgical Endoscopy. 2005; 19:589-593

37. Korman J, Cosgrove J, Furman M, Nathan I, Cohen J. The role of ERCP and cholangiography in Laparoscopic era. Ann Surg 1996; 223(2): 212-216

38. Madhavan K K, Macintyre I M C, Wilson R G , Saunders J H , Nixon S J , Hamer-hodges D W , The British journal of surgery;1995:82:249-252

39. J S Barkun, G M Fried, A N Barkun, H H Sigman, E J Hinchey, J Garzon, M J Wexler, and J L Meakins. Cholecystectomy without operative cholangiography. Implications for common bile duct injury and retained common bile duct stones. Ann Surg. 1993 September; 218(3): 371–379

40. Alves A; Farges O; Nicolet J; Watrin T; Sauvanet A; Belghiti J. Incidence and consequence of an hepatic artery injury in patients with postcholecystectomy bile duct strictures. Ann Surg. 2003; 238(1); 93-6

41. Hugh T B, Kelly M D, Mekisik A.Rouvier sulcus, a useful landmark in Laparoscopic cholecystectomy. BJS; 1997:84:1253-4