

Original Article

Anatomical variations of hepatobiliary triangle in patients operated laparoscopically for gallbladder diseases from Lahore and Sahiwal

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Abstract

This study was conducted in different hospitals of Lahore and Sahiwal on patients who presented with symptomatic gallstones during the period 2011 to 2015. All the patients irrespective of their age, sex, past history of acute cholecystitis and obesity were subjected to Laparoscopic cholecystectomy. Patients' age was between 18-70 years, gender ratio was 1:3.5 with female dominance, mean operative time 99.6 minutes and patients remained admitted for 1-3 days. The procedure was performed successfully in 91% of the cases. In 09% cases, a conversion to standard open cholecystectomy was necessary; the most common cause was unclear anatomy. Laparoscopic cholecystectomy pivots around hepatobiliary triangle. Current study was aimed to assess anatomy of hepatobiliary triangle and its variations in the patients using a laparoscope. It was a descriptive prospective cross-sectional study. Random sampling technique was employed to record the relevant information data. During the course of this study evaluation of 2500 patients, including 2350 women and 150 men, who underwent exploration of hepatobiliary triangle during laparoscopic cholecystectomy for different gallbladder diseases was performed. Total of 63.6% of patients expressed cystic duct, cystic lymph nodes and cystic artery variations. Among them 12% depicted cystic duct variations, 32.2% of patients demonstrated cystic lymph nodes variations and 19.4% of the patients showed cystic artery variations. In addition to variations mentioned above, fat deposition, fibrosis and adhesions were more prevalent in hepatobiliary areas of female patients. Gallbladder disease with stone is much common in female population. It was observed that these variations were found more common in urban as compared to rural population with respective percentages of 66.67% and 60%. Gallbladder disease with stone was found to be much common in the age group between 31-60 years. Laparoscopic surgeons must know variant anatomy of hepatobiliary triangle to avoid intraoperative damage to blood vessels and extrahepatic biliary apparatus during laparoscopic cholecystectomy to prevent postoperative complications.

Key words: Anatomical variations, Cystic artery, Cystic duct, Cystic node, Extrahepatic biliary apparatus, Laparoscopic removal of gallbladder stones.

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INTRODUCTION

Laparoscopic cholecystectomy is a modern and preferred treatment modality for removal of stones from gallbladder in or within one hour time (Fathy *et al.*, 2003). Short skin openings, less bleeding, one to two days hospital stay, quick return to health, small incisions ensuring less execution of interior of abdomen and less chances of invasion by microorganisms, less scarring, less pain, less incidence of abnormal protrusion of abdominal contents through the wound, same day

discharge, faster return to daily living, enhanced visual field for surgeons and better cosmesis are benefits of this procedure (Al-Kubati *et al.*, 2013). Calot in 1891 described a "triangular area formed by the cystic artery, common hepatic duct and the cystic duct. Calot space was later renamed as hepatobiliary, hepatocystic or cystohepatic triangle; bounded above by the liver, common hepatic duct and below by the duct draining gallbladder (Hugh *et al.*, 1992). Arteries of right lobe of liver, the artery of gallbladder, lymph node of gallbladder, lymphatics and connective tissue are the

contents of cystohepatic triangle. If patient does not possess any structural variations, laparoscopic removal of gallbladder stones is a routine practice for a surgeon. Vascular and ductal variations can disorientate the surgeon on learning curve (Andall *et al.*, 2015). Laparoscopic surgery is a technique of choice for gallbladder stones (Bergman *et al.*, 2001). Because of huge popularity of this procedure worldwide, the term 'laparoscopic anatomy' is now used (Arslan *et al.*, 2013). Magnifications of structural elements under laparoscope give difficult time to operator especially when there are arterial and biliary anomalies (Strasberg *et al.*, 1995; El-Bakary and Abd Ellal., 2013). Chronic cholecystitis brings changes in anatomical structures which result in difficulty in operative procedures. (Z'graggen *et al.*, 1998; Saidi *et al.*, 2007). Anatomists-Laproscoptists collaboration lead to mutual intimation of variations of anatomy of this vital area (Mau and Ng, 2012). Results of current study will describe normal and variant surgical anatomy of hepatobiliary area of local population which will be helpful in performing safe laparoscopic cholecystectomy.

MATERIALS AND METHODS

Sample size and study population

This research work was conducted on 2500 patients with age range between 18-70 years including 2350 females. The mean operative time was 99.6 minutes. Large sample size is considered better representative of a population. Patients were selected randomly. They were admitted throughout patient departments of recommended hospitals and put on regular planned operation list. Demographical variables included age, name and sex of each patient and complaints presented by the patients.

Area of study

AS and RB of PU was the competent authority to allow this study to be conducted in five teaching hospitals of Pakistan i.e., LG Hospital, SZ Hospital, DHQ Hospital Sahiwal, Mayo Hospital and JH

Methodology

Inclusion criteria included all patients with stones in gallbladder, mucocele gallbladder, empyema gallbladder, chronic cases of enteric fever, pottery gallbladder,

recent infection of gallbladder due to stones or without stone, benign tumor of gallbladder and polyps. Exclusion criteria include patients with complicated cholecystitis, patients with severe cardiac diseases and COPD, patients with history of operative work on right hypochondrium, bleeding disorders and cases not approved for GA. Cystic arteries were subclassified in two groups, group-1 cystic artery passing through Calot triangle and group 11 cystic artery passing outside triangle. Study involved specific focus to look for variations of cystic artery, cystic duct, cystic lymph nodes which were demonstrated and recorded on USB inserted in camera port, of the laparoscope (Stryker).

Experimental procedure/ technical considerations.

Laparoscope instruments included a 30 laparoscope (Stryker), crafted in computer-controlled machine technology with rotating and non-rotating slide lock graspers. Total of four ports are used, optical (10mm) is at or near the umbilicus, 5mm, next 10mm and further 5mm assisting port. Our surgical team followed these steps to perform laparoscopic cholecystectomy, Patients were put, supine position steep head-up and left tilt. Surgeon on the left side of the patient with the camera holder- team member, one surgeon stood on other side of the subject holding the instrument to catch hold of gallbladder. Patient was made ready for surgery, Peritoneal cavity of the patient was filled with gas, Ports were made and laparoscopic survey was made for abdominal organs. Peritoneum which intimately covers the organs was surgically excised, Calot area was surgically opened, the vessel and duct of gallbladder were cut and clips applied, gallbladder was surgically removed from its adjoining area of liver. Gallbladder with stones was taken out and the exposed anatomical elements were washed and sucker was then used, Finally CO2 was completely removed and incised wound was repaired. Cystic duct, cystic artery and cystic lymph nodes were taken as dependable variables.

RESULTS AND DISCUSSION

In majority of cases the laparoscopic surgery was successful in removing the gallstones. Overall as well as hospital wise variations of cystic duct, cystic lymph node and cystic artery

in the patients included in this study are shown in Table I. Mean age of the patients was 40.85 ± 17.82 . When the hepatobilliary variations were categorized into urban and rural populations of

the total 2500 cases 66.67% were from urban localities. Similarly when gender of the patients include in this study was considered, 94% of them were females.

Table 1: Overview of total number of patients from respective hospitals, categorized into subgroups expressing different variations of hepatobilliary triangle with percentile scores shown within parentheses

Parameter	Hospitals including in the study					Total
	Sheikh Zayed	Jinnah	Lahore General	DHQ Sahiwal and Allied	Mayo	
Total Patients	100	400	500	1400	100	2500
Total patients showing variations	86 (86)	251 (62.75)	291 (58.20)	875 (62.5)	87 (87)	1590 (63.6)
Patients with cystic duct variations	24 (24)	68 (17)	72 (14.4)	112 (8.07)	24 (24)	300 (12)
Patients with cystic lymph nodes variations	34 (34)	98 (24.5)	140 (28)	498 (35.5)	35 (35)	805 (32.2)
Patients with cystic artery variations	28 (28)	85 (21.2)	79 (15.8)	265 (18.9)	28 (28)	485 (24)



Figure 1: 1) gallbladder, 2) cystic duct, 3) double cystic artery and 4) common bile duct.

The present study showed that 63.6% of a total 2500 patients manifested different categories of variations of hepatobiliary triangle.

Of the percentage mentioned above, 12% patients showed cystic duct variations which is comparable with documented data (Shaw *et al.*,

1993; Champagne *et al.*, 2012). Normal cystic duct was documented in 83.85% of the patients. Percentages of cystic duct variations in our study included broad cystic duct in 4%, long tortuous cystic duct in 3.67%, short cystic duct in 4.33%, absence cystic duct in 0.33%, spiral cystic duct in 2.70%, double cystic duct in 0.33%, accessory cystic duct in 0.1%, adherent cystic duct in 0.33%, and parallel insertion of cystic duct to form common bile duct in its retroduodenal part in 0.15% cases. Cystic duct variations appeared higher amongst female population with a value of 66.67% compared to the males being 33.34%. The gender wise distribution of the patients is very nearer to one reported in an earlier study (Turner and Fulcher, 2001; Polgaj *et al.*, 2014). These variations were found more common in urban as compared to rural population with respective percentages of 60% and 66.67% which are not consistent with work done by previous workers (Bincy and Somayaji, 2010). One conversion more is better than one bile duct injury more". Insult to extrahepatic biliary passages cause the serious morbidity linked with laparoscopic cholecystectomy and is considered to be major torrential complication (Hasan *et al.*, 2013). Bleeding and biliary injury force surgeon to do open abdominal operation especially when structural variations are encountered. It is not easy to radiologically pick up these anomalies prior to operation (Talpur *et al.*, 2010). Literature review provides wide variety of data.

Analysis of the results of present work reveals that 32.2% of the patients had cystic lymph node variations which compares favourably with world literature (XIE *et al.*, 2014). Further percentages of cystic lymph node variations in current study included cystic lymph node posterior to cystic duct in 8.1%, cystic lymph node antrolateral to cystic duct 8.1%, and cystic lymph node outside hepatobiliary triangle in 8% of the patients. These findings were demonstrated more frequently in female patients as compared to males with respective of percentages of 75% and 25%, which are very nearer to the data reported in an earlier work (Sebben, *et al.*, 2013). These variations were found more common in urban as compared with rural populations with respective percentages of 58.34% and 41.66% which is in contrast to work done by previous workers (Strasberg *et al.*, 1995; Suzuki *et al.*, 2000). Results of current study revealed that 19.4% of patients showed cystic artery variations which is comparable with past data (Polgaj *et al.*, 2010). In current work

single cystic artery was in hepatobiliary triangle in 76.02%. We found double artery in hepatobiliary triangle in 09.88% of the cases. Literature review shows that double cystic artery can be injured and its relation with bile ducts and portal vein in the hepatobiliary triangle is crucial. Cystic artery coursed through the hepatobiliary triangle, superficial to the cystic duct, with the accessory artery near gallbladder outside the triangle in 13 (5.3 %) of 244 Japanese patients and double cystic artery in 11.1 % of 27 cases (Suzuki *et al.*, 2000). Cystic artery coursed through the hepatobiliary triangle, superficial to the cystic duct, with the accessory artery near gallbladder outside the triangle in 5.46 % of 220 Pakistani patients (Zubair *et al.*, 2012). Double cystic artery was present in only 3 of 300 cases (1 %) in another study in Pakistan (Talpur *et al.*, 2010). Congenital absence of the deep branch of the cystic artery has also been documented (Sugita, *et al.*, 2008) but we did not find this anomaly in our series. Percentages of other cystic artery variations which we found included; cystic artery having prominent anterior branch in 4.06% patients, compound type of artery one outside and other within the Calot's triangle in 4.04%, cystic artery having prominent posterior branch in 2% cases, cystic artery outside Calot triangle in 2.05%, cystic artery arising from common hepatic artery in 1.05%.

Cystic artery variations occurred more frequent in female population as compared to males with respective score of 75%. This distribution pattern is very nearer to one reported in an earlier study (Hugh *et al.*, 1997). These variations were more common in urban as compared with rural populations with respective percentages of 62.5% to 37.5% which are not consistent with previously reported ones (Hugh *et al.*, 1992). Gallbladder disease with stone was found to be much common in the age group between 31-60 years.

Conclusion

For safe execution of laparoscopic cholecystectomy and to avoid postoperative bleeding and biliary leakage, hepatobiliary surgeons must have full knowledge of variant vascular and biliary ducts anomalies. Result of current work from Pakistan will be helpful for radiologists, endoscopists, anatomists, surgeons regarding better patients' management and educating medical graduates. These findings are highly valuable for preparing surgeons mentally

to deal with a given case of suspected variation(s).

REFERENCES

- AL-KUBATI, W.R., 2013. Bile duct injuries following laparoscopic cholecystectomy: a clinical study. *Saudi J. Gastroenterol.*, **16**(2): 100-104.
- ANDALL, R.G., MATUSZ, P., DUPLESSIS, M., WARD, R., TUBBS, R.S. AND LOUKAS, M. 2015. The clinical anatomy of cystic artery variations: a review of over 9800 cases.
- ANTONIOU, S.A., POINTNER, R. AND GRANDERATH, F.A., 2011. Single-incision laparoscopic cholecystectomy: a systematic review. *Surg. Endosc.*, **25**(2): 367-77.
- ARSLAN, K., DOGRU, O., KOKSAL, H. AND BAKDIK, S., 2013. The unusual localization of right hepatic artery multiple anatomic variants in celiac axis. *Eur. J. Gen. Med.*, **10**(Suppl 1): 62-65.
- BAKHEIT, M.A. 2009. Prevalence of variations of the cystic artery in the Sudanese. *East Mediterr Health J* **15**:1308-1312.
- Bincy M.G. and Somayaji S.N. 2010. Multiple variations of the subhepatic hepatobiliary vasculature porta. *Int. J. Anat. Var.* **3**: 39-40.
- CHAMPAGNE, B.J., PAPACONSTANTINO, H.T., PARMAR, S.S., ET AL., 2012. Single-incision versus standard multiport laparoscopic colectomy: a multicenter, case-controlled comparison. *Ann Surg.* **255**: 66-9.
- CHEN, T.H., SHYU, J.F., CHEN, C.H., MA, K.H., WU, C.W., LUI, W.Y. AND LIU, J.C. 2000. Variations of the cystic artery in Chinese adults. *Surg Laparosc Endosc Percutaneous Tech* **10**:154-157.
- CONNER, C.E.H., DAWSON, D.L. 2009. *The abdominal region. Operative anatomy*, 3rd edn. Lippincott Williams & Wilkins, Philadelphia, pp 428-429.
- COVEY, A.M., BRODY, L.A., MALUCCIO, M.A., GETRAJDMAN, G.I. AND BROWN, K.T. 2002. Variant hepatic arterial anatomy revisited: digital subtraction angiography performed in 600 patients. *Radiology*, **224**:542-547.
- DING, Y.M., WANG, B., WANG, W.X., WANG, P. AND YAN, J.S. 2007. New classification of the anatomic variations of cystic artery during laparoscopic cholecystectomy. *World J Gastroenterol* **13**:5629-5634.
- DOUARD, R., CHEVALLIER, J.M., DELMAS, V. AND CUGNENC, P.H. 2006. Clinical interest of digestive arterial trunk anastomoses. *Surg Radiol Anat* **28**:219-227.
- EL-BAKARY, T.A. AND ABDELLAL, A., 2013. Laparoscopic cholecystectomy with multiple anatomic variances: a case report. Available at: <http://www.verhagenhost.com>
- FATHY, O., ZEID, M.A., ABDALLAH, T., FOUAD, A., ELEINIEN, A.A., EL-HAK, N.G., ELEIBIEDY, G., EL-WAHAB, M.A., SULTAN, A., ANWAR, N. AND EZZAT, F. 2003. Laparoscopic cholecystectomy: a report on 2000 cases. *Hepatogastroenterology*, **50**:967-971.
- FLISIN'SKI, P., SZPINDA, M. AND FLISIN'SKI, M. 2004 The cystic artery in human foetuses. *Folia Morphol (Warsz)*, **63**:47-50.
- FUTARA, G., ALI, A. AND KINFU, Y. 2001. Variations of the hepatic and cystic arteries among Ethiopians. *Ethiop Med J*, **39**:133-142.
- HASAN, M.M., REZA, E., KHAN, M.R., LAILA, S.Z., RAHMAN, F. AND MAMUN, M.H. 2013. Anatomical and congenital anomalies of extra hepatic biliary system encountered during cholecystectomy. *Mymensingh Med. J.* **22**: 20-26.
- HUGH, T.B., KELLY, M.D. AND LI, B. 1992. Laparoscopic anatomy of the cystic artery. *Am. J. Surg.* **163**: 593-595.
- IMRAN, M., HASAN, A., MASOOD, R., ULLAH, S. AND TAIMUR, M. 2011. Control of cystic artery in Laparoscopic Cholecystectomy: to clip or to use monopolar electrocautery. *Pak J Med Sci*, **27**:981-998.
- LAROBINA, M. AND NOTTLE, P.D. 2005. Extrahepatic biliary anatomy at laparoscopic cholecystectomy: is aberrant anatomy important? *ANZ J Surg*, **75**:392-395.
- LOUKAS, M., FERGURSON, A., LOUIS, R.G. JR. AND COLBORN, G.L. 2006. Multiple variations of the hepatobiliary vasculature including double cystic arteries, accessory left hepatic artery

- and hepatosplenic trunk: a case report. *Surg Radiol Anat*, **28**:525–528.
- MAU LO, C. AND NG, K.K. 2012. The gastrointestinal Tract. In: *Fischer JE (ed) Fischer's mastery of surgery*, 6th edn, Vol. 1. Wolters Kluwer Health / Lipincott Williams and Wilkins, Philadelphia. 1158-1159.
- MLAKAR, B., GADZIJEV, E.M., RAVNIK, D. AND HRIBERNIK, M. 2003. Anatomical variations of the cystic artery. *Eur J Morphol*, **41**:31–34.
- NARA, E., FUJIMURA, A. AND NAZAKA, Y. 2004. Rare case of the inferior mesenteric artery and the common hepatic artery arising from the superior mesenteric artery. *Clin Anat*, **17**:518–521.
- PAUL, S., JACINTH, S. AND MUNIAPPAN V. 2013. Variations of the Extrahepatic Biliary Tract: *Cadaveric Study- IOSR-10*(1).
- POLGUJ, M., PODGORSKI, M., HOGENDORF, P. AND TOPOL, M. 2014. Variations of the hepatobiliary vasculature including coexistence of accessory right hepatic artery with unusually arising double cystic arteries: case report and literature review. *Anat Sci. Int.* **89**: 195-198.
- POLGUJ, M., GABRYNIAK, T. AND TOPOL, M. 2010. The right accessory hepatic artery; a case report and review of the literature. *Surg Radiol Anat*, **32**:175–179.
- SAHANI, D.V., KRISHNAMURTHY, S.K., KALVA, S., CUSACK, J., HAHN, P.F., SANTILLI, J., SAINI, S., MUELLER, P.R. 2004. Multidetector-row computed tomography angiography for planning intra-arterial chemotherapy pump placement in patients with colorectal metastases to the liver. *J Comput Assist Tomogr*, **28**:478–484.
- SAIDI, H., KARANJA, T.M. AND OGENGO, J.A. 2007. Variant anatomy of the cystic artery in adult Kenyans. *Clin Anat*, **20**:943–945.
- SEBBEN, G.A., ROCHA, S.L., SEBBEN, M.A., PARUSSOLO, FILHO, P.R. AND GONCALVES, B.H. 2013. Variations of hepatic artery: anatomical study on cadavers. *Rev. Col. Bars. Cir.* **40**: 221-226.
- SHAW, M.J., DORSHER, P.J. AND VENNES, J.A., 1993. Cystic duct anatomy: an endoscopic perspective. *Am J Gastroenterol*, **88**: 2102-6.
- STRASBERG, S.M., HERTL, M. AND SOPER, N.J., 1995. An analysis of the problem of biliary injury during laparoscopic cholecystectomy. *J. Am. Coll. Surg.*, **180**: 101-125.
- SUGITA, R., YAMAZAKI, T., FUJITA, N., NAITOCH, T., KOBARI, M. AND TAKASHASHI, S. 2008. Cystic artery and cystic duct assessment with 64-de0tectir row CT before laparoscopic cholecystectomy. *Radiology*. **248**: 124-131.
- SUZUKI, M., AKAISHI, S., RIKIYAMA, T., NAITOH, T., RAHMAN, M.M. AND MATSUNO, S. 2000. Laparoscopic cholecystectomy, Calot's triangle, and variations in cystic arterial supply. *Surg Endosc*, **14**:141–144.
- TALPUR, K.A., LAGHARI, A.A., YOUSFANI, S.A., MALIK, A.M., MEMON, A.I. AND KHAN, S.A. 2010. Anatomical variations and congenital anomalies of extra hepatic biliary system encountered during laparoscopic cholecystectomy. *J Pak Med Assoc*, **60**:89–93.
- TORRES, K., CHROS' CICKI, A., GOLONKA, A., TORRES, A., STAS'KIEWICZ, G., PALCZAK, R., CEJA-SANCHEZ, J.M., CECCARONI, M. AND DROP, A. 2009. The course of the cystic artery during laparoscopic cholecystectomy.
- TURNER, M. A. AND FULCHER, A. S. 2001. The cystic duct: normal anatomy and disease processes. *Radiographics*, **21**:3-22.
- XIE, K.G., TENGA, X.P., ZHU, S.Y., QIUB, X.B. AND YE, X.M., 2014. E Peptides. 60:8-12. doi: 10.1016/j.peptides.2014.07.017.
- Z'GRAGGEN, K., WEHRLI, H., METZGER, A., BUEHLER, M., FREI, E. AND KLAIBER, C. 1998. Complications of laparoscopic cholecystectomy in Switzerland. *Surg. Endosc*, **12**: 1303-10.
- ZUBAIR, M., HABIB, L., MIRZA, M.R., CHANNA, M.A., YOUSUF, M., QURASHY, M.S. 2012. Anatomical variations of cystic artery: telescopic facts. *Med J Malays*, **67**:494–496.