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Evaluation of CBD stones using MRCP in patients with cholelithiasis -surgical correlation.

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Abstract

Background *Gall stone disease is most common in women and incidence of disease increase with age.Definitive treatment of gall stone disease is laproscopic cholecystectomy.Abnormal anatomy of bile tree predisposes the patient to high risk bilary duct injury and post operative complications.MRCP helps in indentifying abnormal ductal anatomy and variants which reduces the risk of ductal injuries during laproscopic cholecystectomy.*

Materials and Methods *The present study is a cross-sectional, observational study undertaken under taken to evaluate the role of preoperative MRCP in the patients of gall stone disease posted for laproscopic cholecystectomy being referred to department of Radiology at NRI MEDICAL COLLEGE & GH . All the study patients were investigated on 1.5 Tesla GE SIGNA EXPLORER MRI machine.*

Results *In our study, out of 50 patients, most of the patients that is 24% were aged 51-60 years, 54% of subjects were females in the current study, 14% of patients were having contracted gallbladder,58% had normal volume and 28% had distended below ampula. 82% of patients had multiple calculi. GB Sludge was absent in 92% of patients. Cystic dusct insertionof which Right lateral insertion was commonest(60%) presentation, followed by Anterior spiral and insertion. High insertion and low-medial insertion was seen in one patient each. CBD stones were seen in 8% of the patients. IHBR variants were seen in 8% of the patients in MRCP. Biliary atresia was not seen in any patient. Choledochal cyst was seen in 1 patient.*

Conclusions *MRCP is very helful in identifying biliary ductal anomalies and biliary ductal variants. This information helps in planning for cholecysectomy.*

Keywords *Magnentic resonance cholangiopancreaticography (MRCP),Intra Hepatic Biliary Radicals Pattern(IHBR pattern) , intrahepatic biliary radical dilatation(IHBRD), magnetic resonance imaging(MRI)*

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I. Introduction:

Gallstones(GST) or cholelithiasis is one of the common digestive disorders globally. Theycommonly form due todelayed and sluggish emptying of bile from gallbladder. When bile is not completely drained from the gallbladder, it can form sludge, which may laterform gallstones. Biliary obstruction like strictures in bile duct or tumors can alsocause gallstones. Commonest causeis precipitation of cholesterol.Not all gallstones are symptomatic. But in some patients, they may migrate near the opening of cystic duct and block the flow of bile, which can cause tension in the gallbladder, leading to biliary colicky pain. In case of continuous obstruction of cystic duct for few more hours, it can cause inflammation of the gallbladder wall called cholecystitis. Gallstone may move into the bile duct(BD) and cause obstruction, causing jaundice and abdominal pain. Patients with long-term gallstones can developincreasing fibrosis and loss of motor function of gallbladder. The main management forpatients with symptoms is laparoscopic cholecystectomy.

The prevalence of gallbladder disease (GBD) in the study of Unisa et al[1], done in North India is lower compared to the United States.In US, the incidence was5.3% to 8.9% for males and 13.9% to 26.7% for

females[2]. Hospital-based reports in north India showed an incidence of 13.44% asymptomatic GST in Varanasi and 11.14% symptomatic GST[3]. 3.3% of patients had asymptomatic GST and 64.9% had symptomatic GST in Chandigarh[4];and the incidence in New Delhi was 29.8%[5].Around 6.3 million females and 14.2 million males in the United States aged 20 to 74 years have gallstones.[6]

Most patients with gallstones are asymptomatic, but 10% will develop clinical features within five years, and 20%within 20 years of diagnosis. The prevalence increases with age. Around1/4th of females aged above 60 years will have gallstones. Gallstones have various compositions and aetiologies.[7]

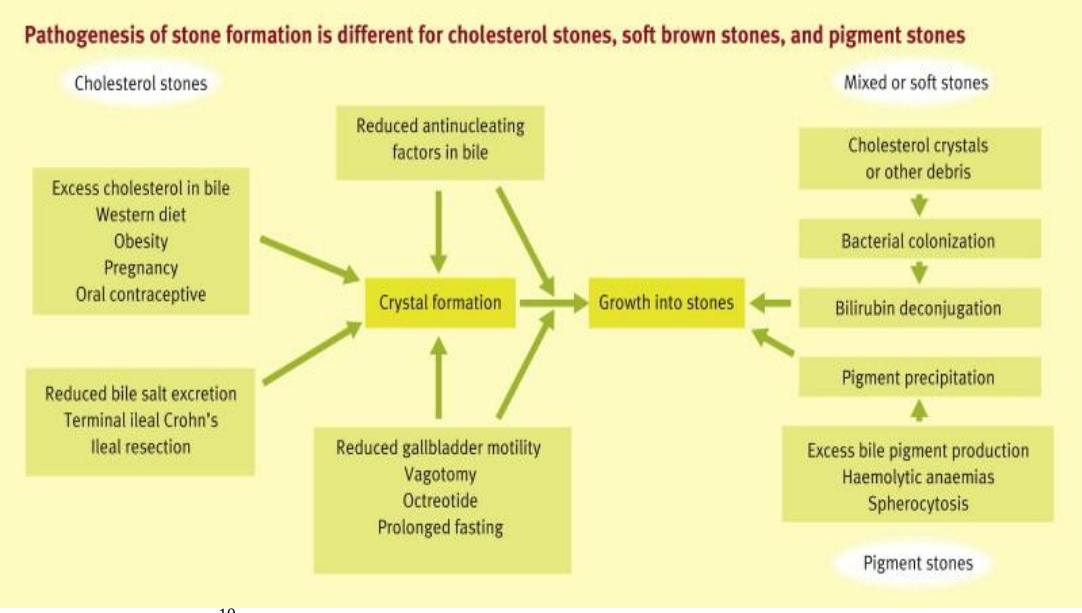
Magneticresonance cholangopancreatiography(MRCP) has now an established role in in the diagnosis of various biliary disorders, serving as a non-invasive diagnostic option to endoscopic retrograde cholangiopancreatography (ERCP). It makes use ofT2-weighted pulse sequences, exploiting the differences in the T2-weighted contrast between stationary fluidfilled structures of abdomen and adjacent soft tissue. Static moving fluids in the biliary tree and pancreatic duct appear of high signal intensity (SI) on MRCP, whilst surrounding tissue is of decreased SI. The current study was done to assess the role of MRCP in diagnosing bile duct anomalies before surgery among patients with GST.

Aetiology:

Gallstones (GST)form fromsluggish emptying of bile from the gallbladder. Commonest cause is the precipitation of cholesterol from cholesterol-rich bile. 2nd most common form is pigmented GST. This formdue to breakdown of red blood cells. Mixed stones are a combination of calcium substrates like calcium carbonate, cholesterol, and bile. Calcium stones occur due to precipitation of calcium in hypercalcemia patients. These patients usually have kidney stones also.[8]

Risk factors for GST: In pregnancy, progesterone reduces the contractility of gallbladder causing stasis, Genetic factors**,** Medications like estrogens, fibrates**,** Stasis, Being female**,** Rapid weight loss**,** Metabolic syndro**me,** Prolonged fasting**,** Bariatric surgery**,** Ileal resection**,** Crohn disease.

Complications occur byGST are direct effectsof occlusion of hepatic and biliary tree by sludge and stones.[9]



Pathogenesis of gallstones[10]

Biliary duct injuries:

As, laparoscopic cholecystectomy was now increasingly used to treat GST, the number of bile duct injuries (BDI) were also increased. The biliary tree and relationship of cystic duct along its insertion onto common hepatic duct(CHD) varies.Commonestcause of injuring the BD is misidentification of normal biliary anatomy.[11]
After injury, early recognition is crucial to facilitate appropriate treatment.
Iatrogenic injury occurs due to misidentification ofCBDfor cystic duct during laparoscopic cholecystectomy.[12]
The incidence is 0.3 to 0.7%, which is three times more compared to open cholecystectomy.[13]
Differing biliary anatomy can lead toinjury. Injury to biliary tree happens rarely in abdominal trauma and the incidence was 0.1% of hospital admissions for trauma. The management ranges from cholecystectomy, reconstruction, or hepatic resection or drainage.[14\]

Risk factors of bile duct injury:

- Anatomic variants
- Gallbladder pathology
- Surgeon related factors
- Hepatic duct junction variation
- Presence of ducts of Luschka
- Short cystic duct.
- Severe obesity, prior hepatobiliary surgery,
- Patients with liver disease

Acute cholecystitis raises the rate of duct injuries of bile(BDI) due to linked inflammation, gallbladder wall thickening, adhesions, and more bleeding.[15]

Routine intraoperative cholangiography does reduce the incidence of BDI. In cases of uncertain anatomy an intraoperative cholangiogram (IOC) or another alternative method is recommended.[16-17]

Evaluation

If there is a BDI, cholangiography must be done to delineate anatomy and plan treatment[18].If patients present after surgery, an abdominal ultrasound (US) can detect fluid collection or ductal dilation, along with abdominal pain, hyperbilirubinemia which indicates bile leak.

CT scan is sensitive to evaluate free fluid within the abdomen.

HIDA scan[19]can differentiate the normal postoperative fluid collections from bile spillage intraoperatively from an active bile leak, but it is tough to ascertain the leak level from HIDA scan.

ERCP helps to provide interventions through stenting. MRCP can help diagnose a biliary leak, and its level.

MRCP:

It was nearly two decades since MRCP was first described[20]. It has now a definite role in the investigation of various biliary disorders, acting as a non-invasive alternative option to ERCP. It uses heavily T2-weighted pulse sequences. Heavily T2-weighted images(T2WI) were achieved initiallythrough gradient-echo steady-state precession technique.[21]

Fast spin-echo sequence was introduced later[22], with an advantage of higher signal-to-noise ratio with less incidence of artefacts. Modified FSE sequences include rapid acquisition with RARE, HASTE, andFRFSE sequences. [23-25]

Parallel acquisition methodcaused even more spatial resolution and quick acquisition times. Functional assessment becomes possible through contrast mediaand secretin.[26-27]

Disadvantages of MRCP

Artefacts due to technique and reconstruction, Normal variants appearing similar to pathological conditions, intra-ductal and extra ductal factors.

Artefacts

Thick slab MRCP obscures various filling defects, as the spatial resolution is degraded due to volume averaging effects.

Clinical indications for MRCP

II. Materials and Methods

Method of data collection: The present study is a cross-sectional, observational study undertaken to evaluate the role of diffusion tensor imaging in the evaluation of space-occupying lesions being referred to the department of radiology, the NRI Medical College, and GH Chinnakakani.

Study design: Cross-sectional, observational study

Study location: Department of radiology, the NRI Medical College, and GH Chinakakani.

Study duration: October 2021 to October 2022

Sample size: 50

Sample size calculation:

The sample size is calculated as:

$N=Z^2PQ/E^2$

N- Sample size

P-Prevalence

P=4.15%

Q=1-P

E-Error: 5%,

90% confidence limits

N=44

44 is the minimum size

So, we included 50 patients in this study, considering few lost to follow up cases. All 50 patients provided consent for the study.

Subjects and selection method: All the study patients were investigated on a 1.5-Tesla GE Signa Excite MRI system with a phased array body coil using conventional MRCP sequences. Both normal and abnormal sides of the brain were evaluated using tractography. Age,Gender, presence of gallstones, presence of GB sludge, CBD dilatation were assessed in patients presented with cholelithiasis.

Inclusion criteria:

1. Any gender.
2. Patients aged above 18 years
3. Patients who provided informed consent to participate in the study

Exclusion criteria:

1. Pregnant and lactating women
2. Patients with cardiac pacemakers, prosthetic heart valves, cochlear implants, or any metallic implants
3. Patients with a history of claustrophobia

Imaging protocol The scanning protocol is 3Plane Loc SSFSE,COR 2D FIESTA fatsat,3D MRCP RTr, axial sections of 2D FIESTA fatsat,T2 FRFSE fatsat,SSFSE and T1.

Statistical analysis The data collected was entered in Excel 2019 and analysis was carried out using excel 2019 and software called Epi info version 7.2.5. The results were expressed in the form of descriptive statistics. Frequencies, percentages were mainly used. Continuous variables were expressed as mean and SD.

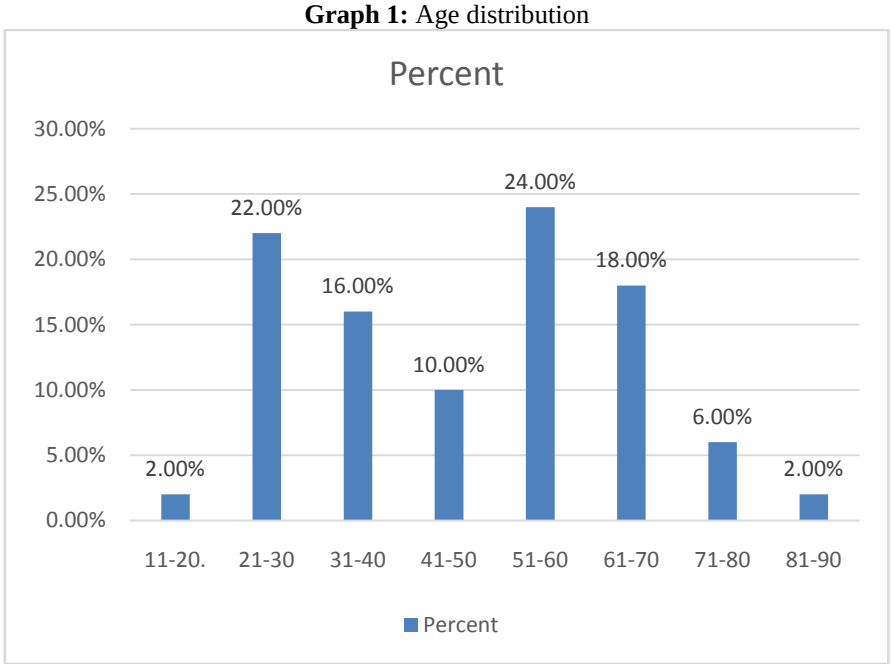
III. Results

Age distribution: Most of the patients were aged 51-60 years. 22% were aged 21 to 30 years. 10% were aged 41 to 50 years. 24% were aged 51 to 60 years. 18% were aged 61 to 70 years. 6% were aged 71 to 80 years.

Table 1: Age distribution

AGE GROUP	Frequency	Percent	Cum. Percent
11-20	1	2.00%	2.00%
21-30	11	22.00%	24.00%
31-40	8	16.00%	40.00%
41-50	5	10.00%	50.00%
51-60	12	24.00%	74.00%
61-70	9	18.00%	92.00%
71-80	3	6.00%	98.00%
81-90	1	2.00%	100.00%
Total	50	100.00%	100.00%

Graph 1: Age distribution



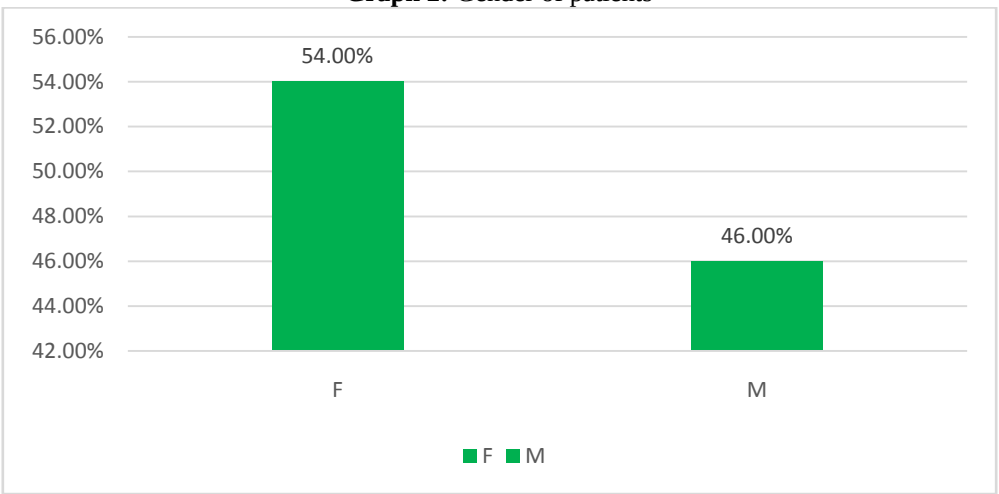
Mean age: The mean age was 48.4±17.8. Age of patients ranged from 18 to 86 years. The median age was 50 years

Gender:
54% of subjects were females in the current study. This implies that gallstones are common among females

Table 2: Gender of patients

GENDER	Frequency	Percent	Cum. Percent
Females	27	54.00%	54.00%
Males	23	46.00%	100.00%
Total	50	100.00%	100.00%

Graph 2: Gender of patients

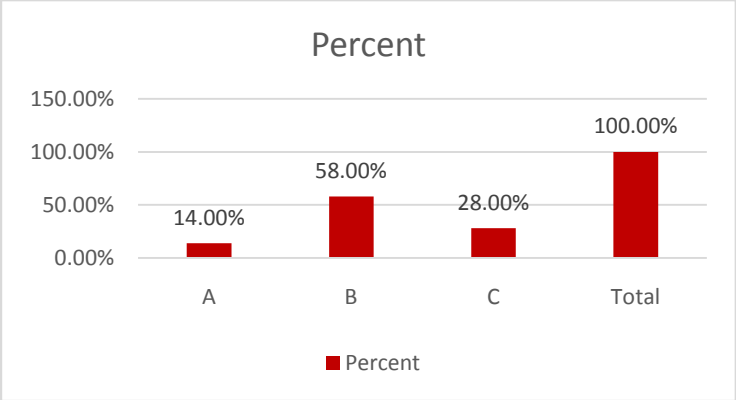


GB Volume:14% of patients were having contracted gallbladder. 58% had normal volume. And 28% had distended below ampulla.

Table 3: GB Volume

VOLUME	Frequency	Percent	Cum. Percent
A-contracted	7	14.00%	14.00%
B-Normal	29	58.00%	72.00%
C-Distended below ampulla	14	28.00%	100.00%
Total	50	100.00%	100.00%

Graph 3: GB Volume

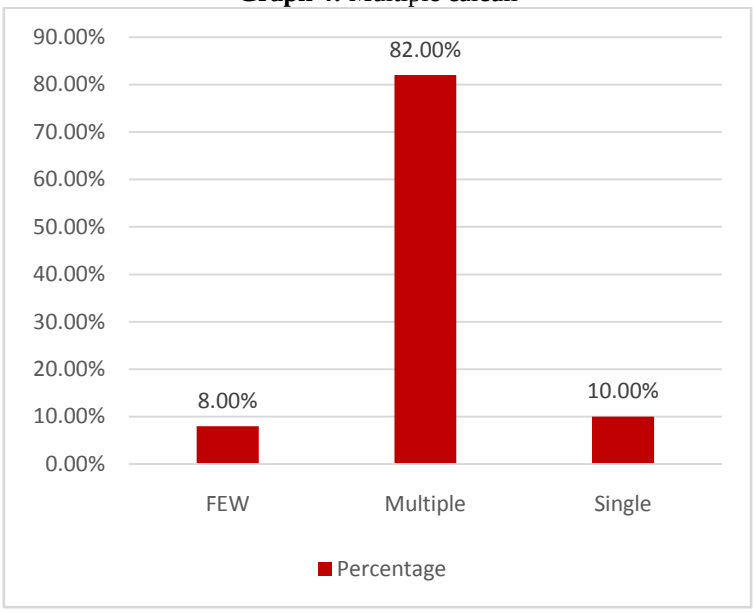


GALLSTONES:
Presence of calculi: 82% of patients had multiple calculi.

Table 4: Presence of gall stone calculi in MRCP

MULTIPLE CALCULI	Frequency	Percent
FEW	4	8.00%
Multiple	41	82.00%
Single	5	10.00%
Total	50	100.00%

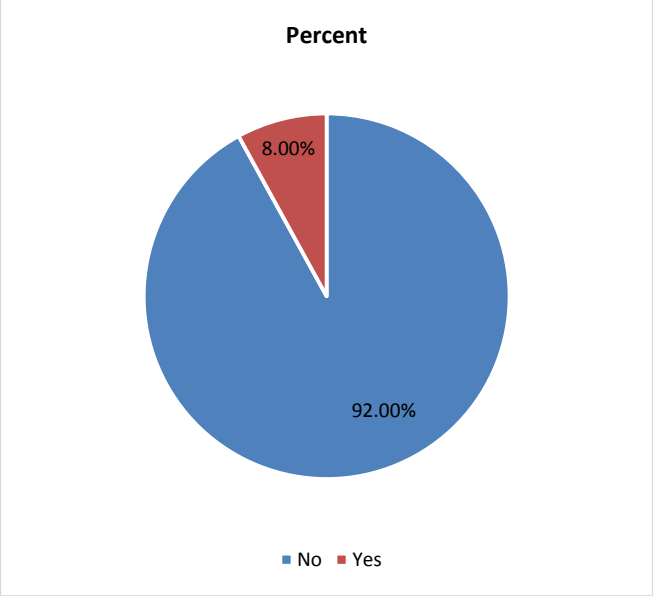
Graph 4: Multiple calculi



GB SLUDGE: GB Sludge was absent in 92% of patients.

SLUDGE	Frequency	Percent	Cum. Percent
No	46	92.00%	92.00%
Yes	4	8.00%	100.00%
Total	50	100.00%	100.00%

Table 5: Presence of gallbladder sludge



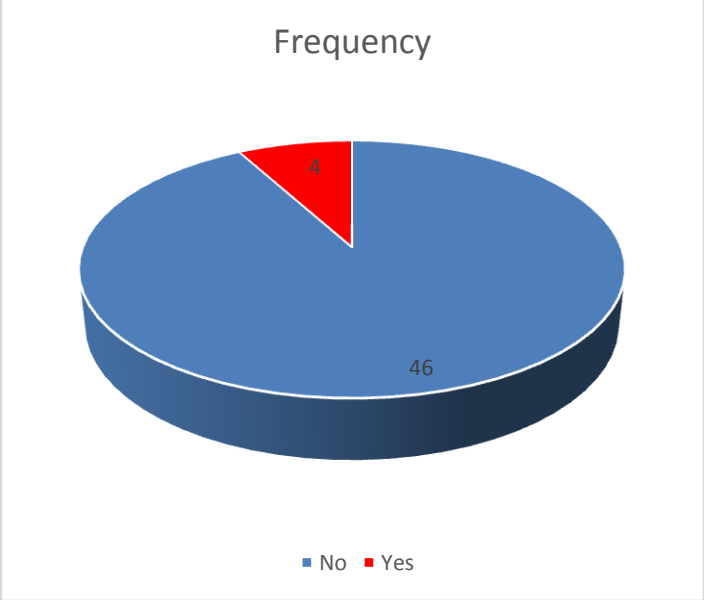
Graph 5: Presence of gallbladder sludge

CBD CALCULUS:

CBD stone was seen in 8% of the patients

CBD STONE	Frequency	Percent
No	46	92.00%
Yes	4	8.00%
Total	50	100.00%

Table 8: CBD stone in MRCP



Graph 7: CBD stone in MRCP

SCOPY TIME: The mean scopy time was 67.3 seconds**.**

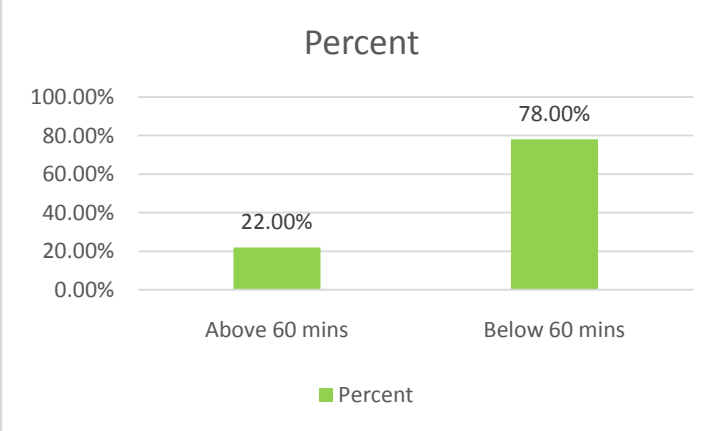
Obs	Total	Mean	Variance	Std Dev
50.0000	3366.0000	67.3200	1616.5894	40.2068

Table 11: Scopy time for patients

OPERATION TIME: Operation time was below 60 mins in 78% of patients.

OPERATION TIME	Frequency	Percent	Cum. Percent
Above 60 mins	11	22.00%	22.00%
Below 60 mins	39	78.00%	100.00%
Total	50	100.00%	100.00%

Table 12: Operation time for patients



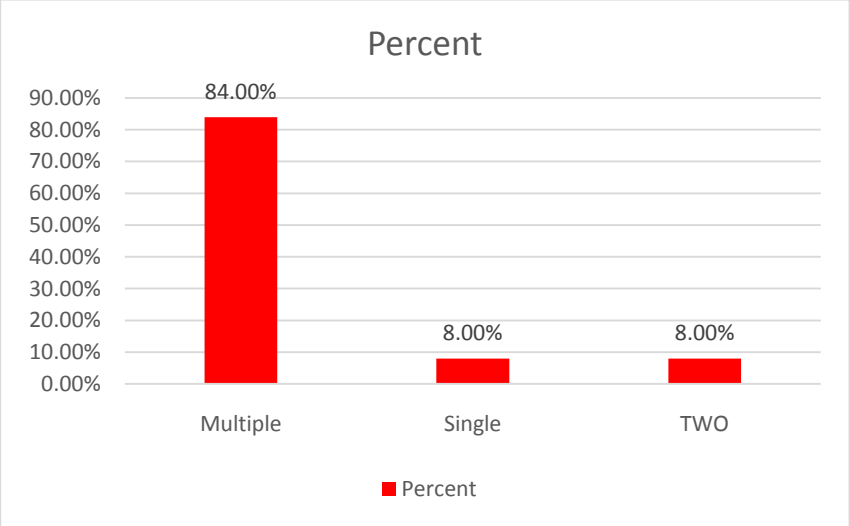
Graph 10: Operation time for patients

PEROPERATIVE FINDINGS:

84% of patients had multiple gallbladder calculi.

PEROPERATIVE	Frequency	Percent
Multiple	42	84.00%
Single	4	8.00%
Two	4	8.00%
Total	50	100.00%

Table 13: Per operative gallbladder calculi



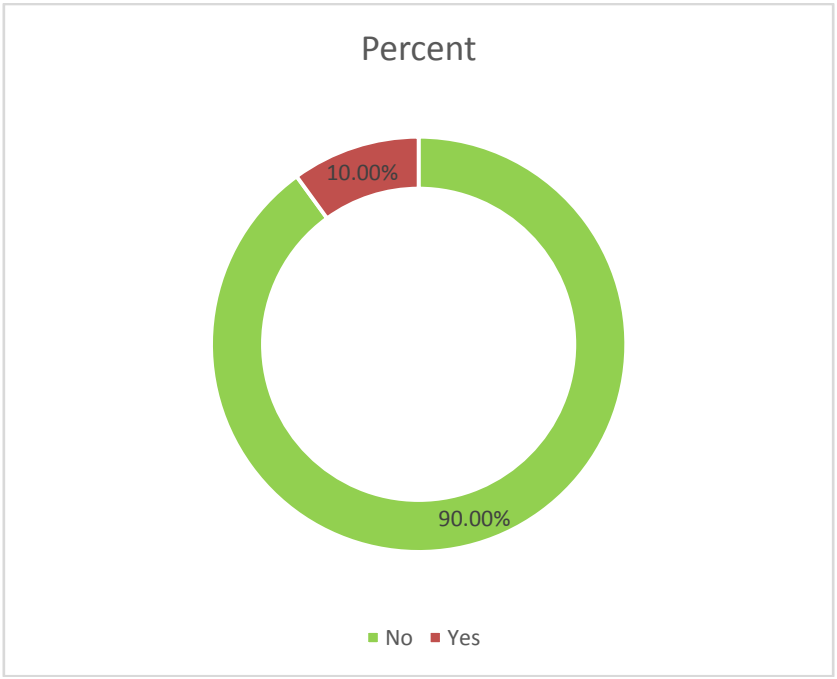
Graph 11: Per operative gallbladder calculi

GB SLUDGE PEROPERATIVE:

90% of patients had no sludge during surgery.

PER OP	Frequency	Percent	Cum. Percent
No	45	90.00%	90.00%
Yes	5	10.00%	100.00%
Total	50	100.00%	100.00%

Table 14- Gall bladder sludge among patients



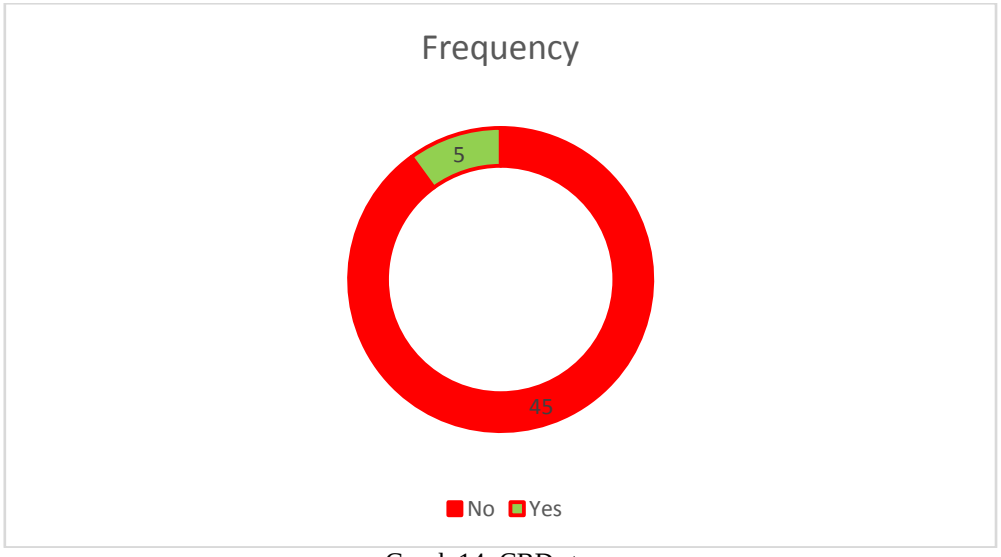
Graph 12- Gall bladder sludge among patients.

CBD STONE PER OPERATIVE:

90% of patients had no CBD stone per operatively. It was seen in 10% patients

STONE PER OP	Frequency	PERCENT
No	45	90%
Yes	5	10%

Table 16: CBD stone

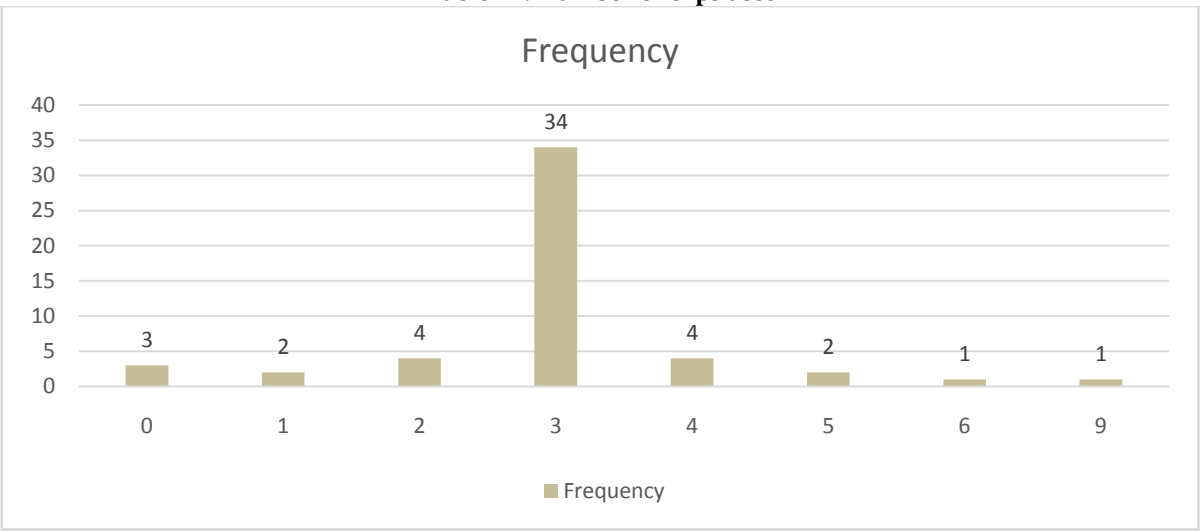


Graph 14: CBD stone

CLIPS: For most of the patients 3 clips were used. For 3 patients, clips were not used, for 2 patients, 5 clips were used.

CLIPS	Frequency
0	3
1	2
2	4
3	34
4	4
5	2
6	1
9	1
Total	50

Table 17: Number of clips used

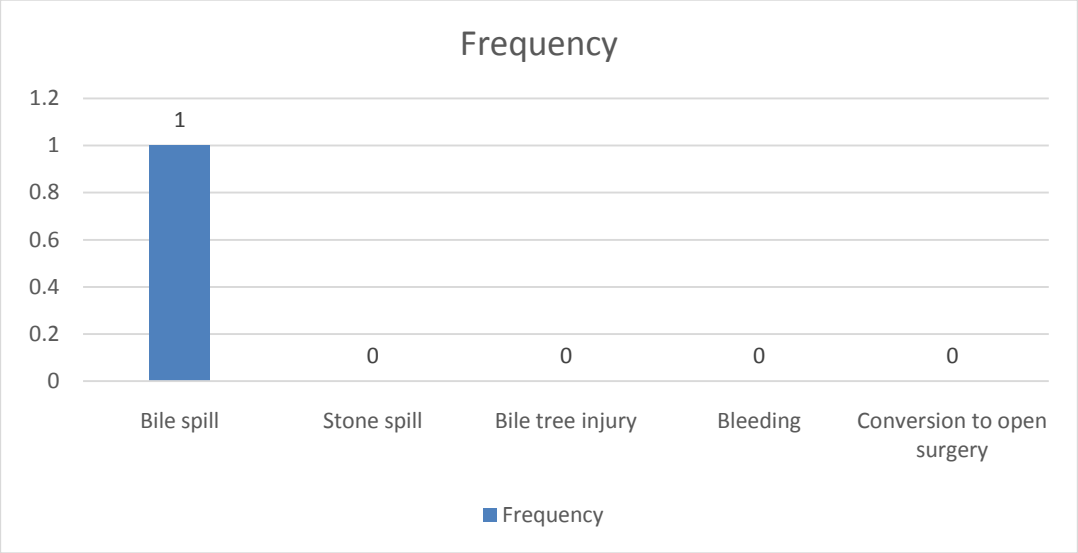


Graph 15:No of clips used

Side effects:
One patient had bile spill among 50 patients
No patient had bleeding, stone spill conversion to open surgery and bile tree injury in the current study.

Side effects	Frequency
Bile spill	1
Stone spill	Nil
Bile tree injury	Nil
Bleeding	Nil
Conversion to open surgery	Nil

Table 19: Side effects seen

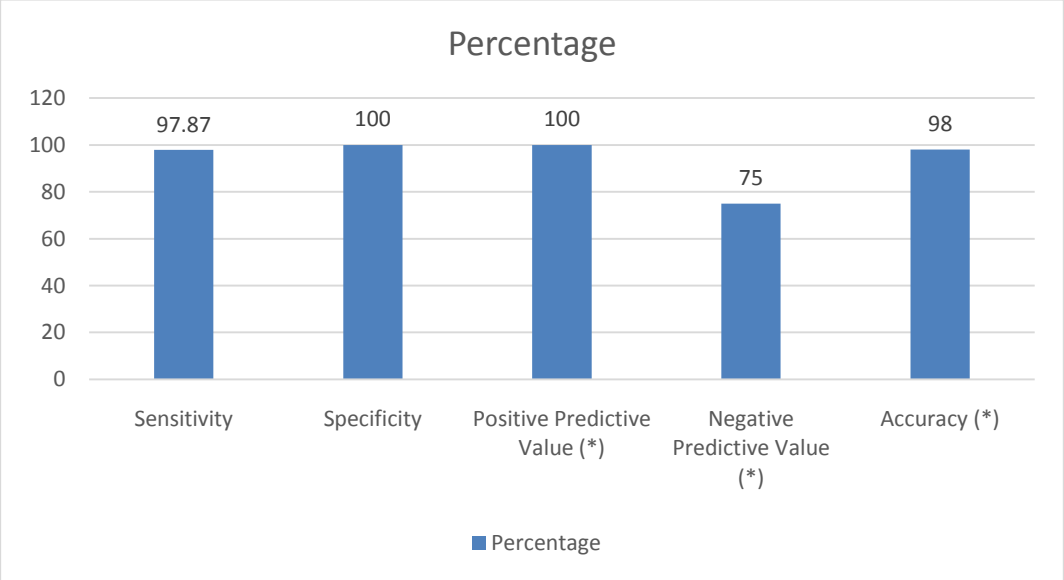


Graph 17: Side effects seen

MRCP comparison with per operative findings:
Gallbladder calculi: Sensitivity of MRCP in detecting gallbladder calculus was 97.87%, specificity was 100%, PPV was 100%, and NPV was 75%. Overall accuracy was 98%.

Sensitivity	97.87%	**CI** 88.71% to 99.95%
Specificity	100.00%	29.24% to 100.00%
Disease prevalence (*)	94.00%	83.45% to 98.75%
Positive Predictive Value (*)	100.00%	
Negative Predictive Value (*)	75.00%	30.14% to 95.42%
Accuracy (*)	98.00%	

Table 20: Accuracy of MRCP in detecting gall stones

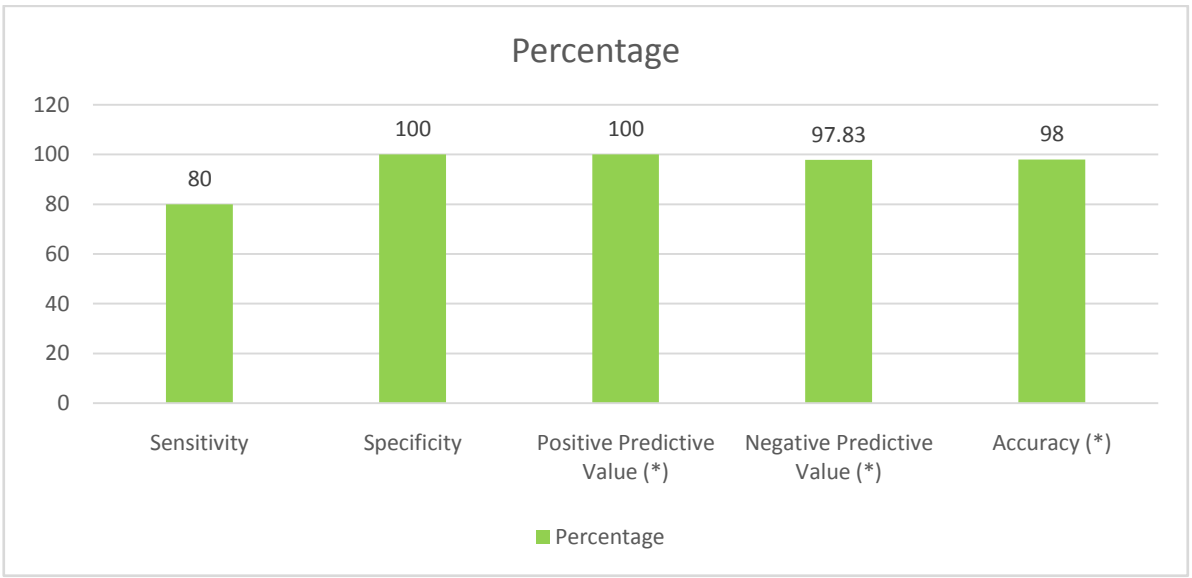


Graph 18: Accuracy of MRCP in detecting gall stones

GB SLUDGE: Accuracy of MRCP in detecting gall bladder sludge was 98%.

Statistic	Value	95% CI
Sensitivity	80.00%	28.36% to 99.49%
Specificity	100.00%	92.13% to 100.00%
Disease prevalence (*)	10.00%	3.33% to 21.81%
Positive Predictive Value (*)	100.00%	
Negative Predictive Value (*)	97.83%	88.63% to 99.62%
Accuracy (*)	98.00%	89.35% to 99.95%

Table 21: Accuracy of MRCP in detecting gall sludge

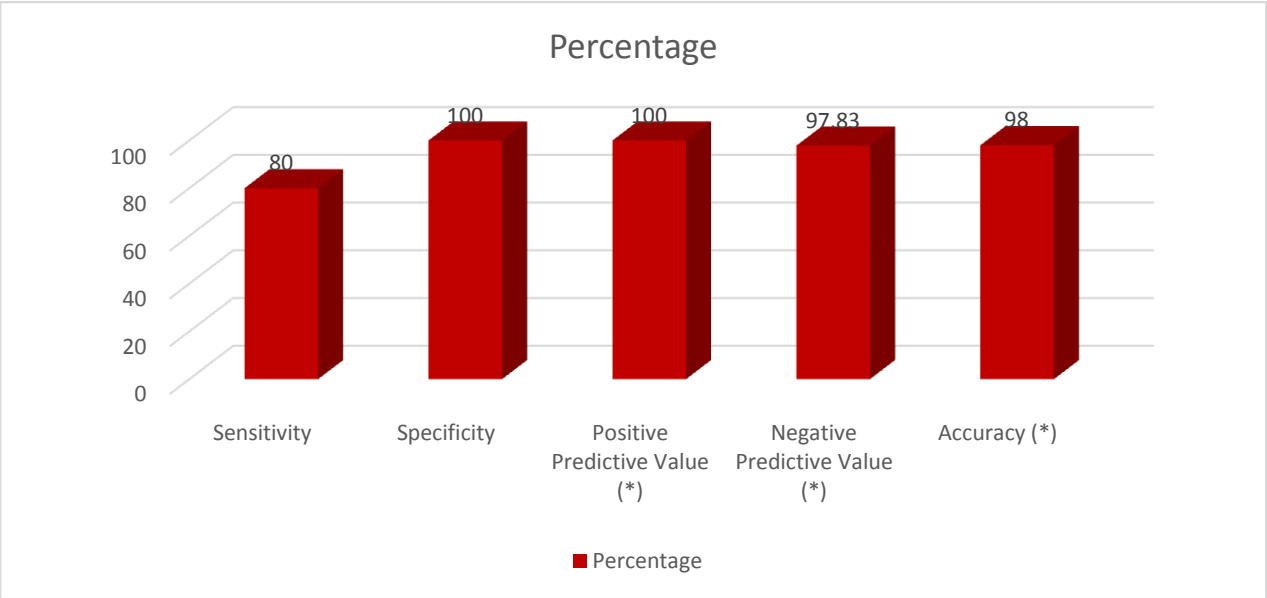


Graph 19: Accuracy of MRCP in detecting gall sludge

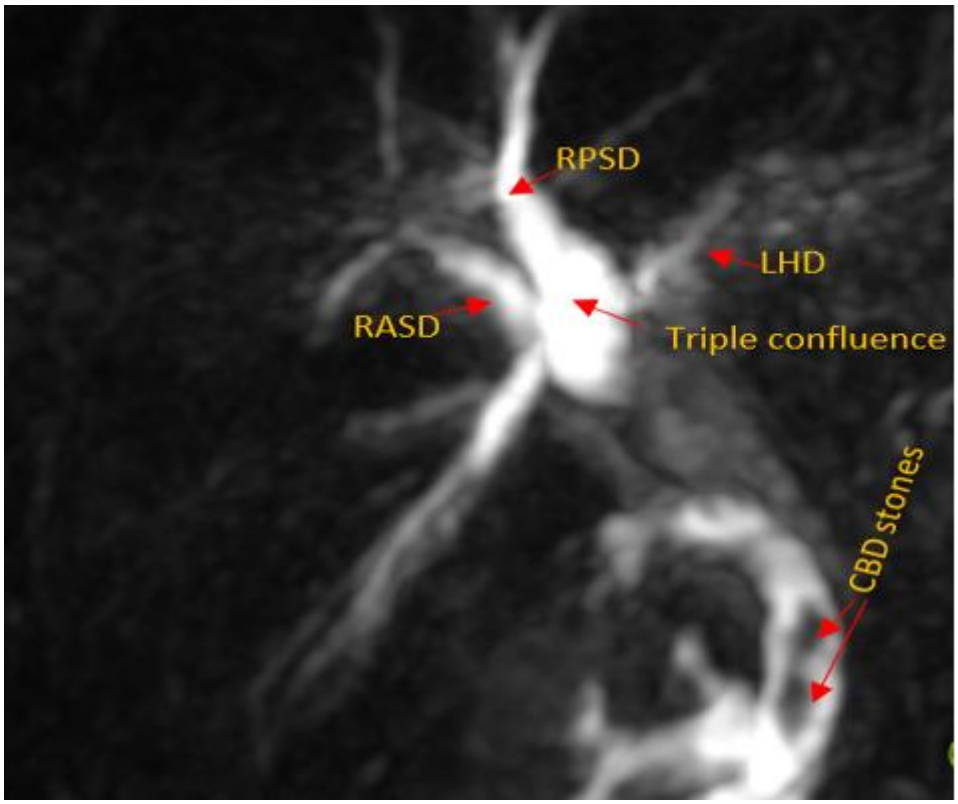
CBD Stone:
Accuracy of MRCP in detecting common bile duct stone was 98%.

Statistic	Value	95% CI
Sensitivity	80.00%	28.36% to 99.49%
Specificity	100.00%	92.13% to 100.00%
Disease prevalence (*)	10.00%	3.33% to 21.81%
Positive Predictive Value (*)	100.00%	
Negative Predictive Value (*)	97.83%	88.63% to 99.62%
Accuracy (*)	98.00%	89.35% to 99.95%

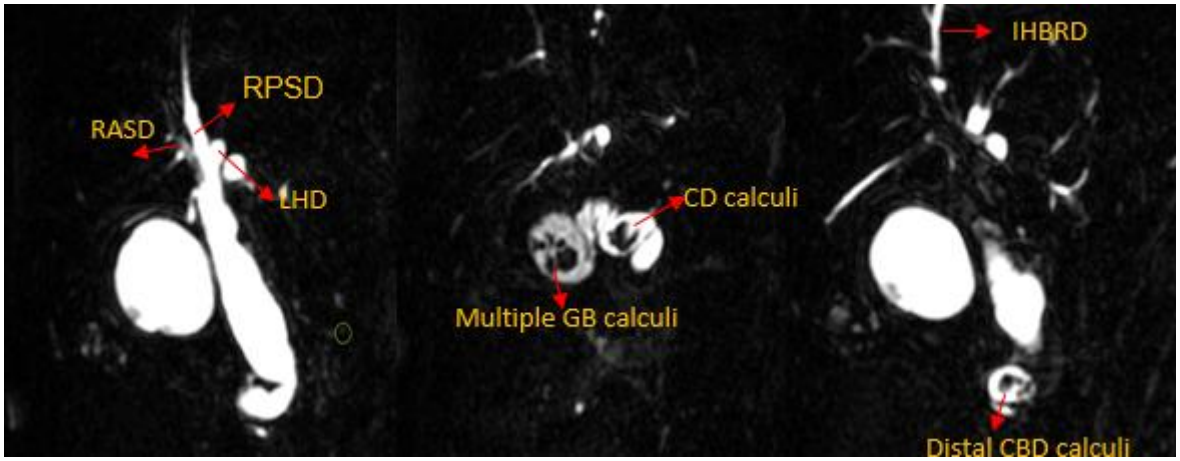
Table 23: Accuracy of MRCP in detecting CBD stone



Graph 21: Accuracy of MRCP in detecting CBD stone



Coronal MIP image showing GB calculi,mild IHBRD and triple confluence



Coronal MIP image showing GB calculi, CBD calculi, IHBRD and RPSD into LHD

IV. Discussion

Age of patients:

Most patients were aged 51-60 years. 22% of patients were aged 21 to 30 years. 10% of patients were aged 41 to 50 years. 24% of patients were aged 51 to 60 years. 18% of patients were aged 61 to 70 years. 6% of patients were aged 71 to 80 years. The mean age was 48.4±17.8. Age of patients ranged from 18 to 86 years. The median age was 50 years in the current study.

54% of patients were females in the current study. This implies that gallstones are common among females.

Age, gender, MRCP findings of gallstones, sludge, CBD dilatation, IHBRD and per operative findings were determined for all patients.CBD stones were seen in 8% of the patients in MRCP among 50 patients. It was seen in 10% of patients per operatively in the current study.Presence of calculi: 82% of patients had multiple calculi.GB Sludge was absent in 92% of patients.There's no IHBRD in 76% of patients, there's mild IHBRD in 14% of patients, moderate IHBRD in 6% of patients and severe IHBRD in 4% of patients.Sensitivity of MRCP

in detecting gall calculus was 97.87%, specificity was 100%.Accuracy of MRCP in detecting gall bladder sludge was 98%.Diagnostic accuracy of MRCP in detecting accurate IHBR and IHBRD pattern was 100%.Accuracy of MRCP in detecting common bile duct stone was 98%.

Subramanya[37] et did a study on 100 patients. MRCP findings were compared with per operative findings. CBD stones were seen in 7% patients in MRCP and per operatively. accuracy of detection of gall stone calculus as 98%, gall bladder sludge was 98% and common bile duct stones was 100%. These findings were almost similar to the current study.

Makmun[38] et al wanted to know the accuracy of MRCP in detecting choledocholithiasis. Their retrospective study was done on 62 patients with suspected choledocholithiasis patients. The study was done from 2013 to 2014. The accuracy of MRCP was compared with ERCP as a gold standard.The male to female ratio was 3:2. Males were more compared to females, in contrast to the current study. The mean age was 47.25 years, which is almost similar to the current study. for MRCP were 81%, 40%, 68%, 74%, and 50% respectively. These scores were more in our study comparatively. Also, the study found that Sensitivity, specificity, accuracy, PPV and NPV for MRCP were less compared to endoscopic ultrasound. In the present study, we didn't include EUS and ERCP but compared MRCP with per operative findings.

V. Conclusion

The current study looked at MRCP results from patients who had gall stones.

We discovered that MRCP is extremely useful in detecting structural anomalies, CBD stones,IHBR variants prior to surgery with good diagnostic accuracy,as evident. This information aids in the planning of surgery which helps to prevent most of the post operative and per operative complications, as evident from the results.

It also helps to decrease the misdiagnosis of retained choledocholithiasis with normal biochemical parameters and ultrasound examination.

Hence, we recommend performing this non-invasive, easily available, accurate mode of assessment (MRCP) for all patients, who were posted for laparoscopic cholecystectomy.

The study is self-sponsored.

There were no conflicts of interest.

References

[1]. Unisa S, Jagannath P, Dhir V, Khandelwal C, Sarangi L, Roy TK. Population-based study to estimate prevalence and determine risk factors of gallbladder diseases in the rural Gangetic basin of North India. HPB (Oxford). 2011 Feb;13(2):117-25. doi: 10.1111/j.1477-2574.2010.00255.x. Epub 2010 Dec 22. PMID: 21241429; PMCID: PMC3044346.

[2]. Everhart JE, Khare M, Hill M, Maurer KR. Prevalence and ethnic differences in gallbladder disease in the United States. Gastroenterology. 1999;117:632–639. [PubMed] [Google Scholar]

[3]. Pandey M, Khatri AK, Sood BP, Shukla RC, Shukla VK. Cholecystosonographic evaluation of the prevalence of gallbladder diseases. A university hospital experience. Clin Imaging. 1996;20:269–272. [PubMed] [Google Scholar]

[4]. Singh V, Trikha B, Nain C, Singh K, Bose S. Epidemiology of gallstone disease in Chandigarh: a community-based study. J Gastroenterol Hepatol. 2001;16:560–563. [PubMed] [Google Scholar]

[5]. Sharma MP, Duphare HV, Nijhawan S, Dasarathy S. Gallstone disease in north India: clinical and ultrasound profile in a referral hospital. J Clin Gastroenterol. 1990;12:547–549. [PubMed] [Google Scholar].

[6]. Jones MW, Weir CB, Ghassemzadeh S. Gallstones (Cholelithiasis). 2022 Apr 13. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2022 Jan–. PMID: 29083691.

[7]. Tsai TJ, Chan HH, Lai KH, Shih CA, Kao SS, Sun WC, Wang EM, Tsai WL, Lin KH, Yu HC, Chen WC, Wang HM, Tsay FW, Lin HS, Cheng JS, Hsu PI. Gallbladder function predicts subsequent biliary complications in patients with common bile duct stones after endoscopic treatment? BMC Gastroenterol. 2018 Feb 27;18(1):32. [PMC free article] [PubMed]

[8]. Rebholz C, Krawczyk M, Lammert F. Genetics of gallstone disease. Eur J Clin Invest. 2018 Jul;48(7):e12935. [PubMed]

[9]. Shabanzadeh DM. New determinants for gallstone disease? . Dan Med J. 2018 Feb;65(2) [PubMed]

[10]. Sethi H, Johnson CD. Gallstones. Medicine (Abingdon) [Internet]. 2011;39(10):624–9. Available from: http://dx.doi.org/10.1016/j.mpmed.2011.07.006

[11]. Pesce A, Palmucci S, La Greca G, Puleo S. Iatrogenic bile duct injury: impact and management challenges. Clin Exp Gastroenterol. 2019;12:121-128. [PMC free article] [PubMed]

[12]. Hassler KR, Collins JT, Philip K, Jones MW. StatPearls [Internet]. StatPearls Publishing; Treasure Island (FL): Apr 13, 2022. Laparoscopic Cholecystectomy. [PubMed]

[13]. Pesce A, Portale TR, Minutolo V, Scilletta R, Li Destri G, Puleo S. Bile duct injury during laparoscopic cholecystectomy without intraoperative cholangiography: a retrospective study on 1,100 selected patients. Dig Surg. 2012;29(4):310-4. [PubMed]

[14]. Thomson BN, Nardino B, Gumm K, Robertson AJ, Knowles BP, Collier NA, Judson R. Management of blunt and penetrating biliary tract trauma. J Trauma Acute Care Surg. 2012 Jun;72(6):1620-5. [PubMed]

[15]. Georgiades CP, Mavromatis TN, Kourlaba GC, Kapiris SA, Bairamides EG, Spyrou AM, Kokkinos CN, Spyratou CS, Ieronymou MI, Diamantopoulos GI. Is inflammation a significant predictor of bile duct injury during laparoscopic cholecystectomy? Surg Endosc. 2008 Sep;22(9):1959-64. [PubMed]

[16]. Brunt LM, Deziel DJ, Telem DA, Strasberg SM, Aggarwal R, Asbun H, Bonjer J et al. Prevention of Bile Duct Injury Consensus Work Group. Safe Cholecystectomy Multi-society Practice Guideline and State of the Art Consensus Conference on Prevention of Bile Duct Injury During Cholecystectomy. Ann Surg. 2020 Jul;272(1):3-23. [PubMed]

[17]. Nuzzo G, Giuliante F, Giovannini I, Ardito F, D'Acapito F, Vellone M, Murazio M, Capelli G. Bile duct injury during laparoscopic cholecystectomy: results of an Italian national survey on 56 591 cholecystectomies. Arch Surg. 2005 Oct;140(10):986-92. [PubMed]
[18]. Strasberg SM. Biliary injury in laparoscopic surgery: part 2. Changing the culture of cholecystectomy. J Am Coll Surg. 2005 Oct;201(4):604-11. [PubMed]
[19]. Snyder E, Kashyap S, Lopez PP. StatPearls [Internet]. StatPearls Publishing; Treasure Island (FL): Jun 5, 2022. Hepatobiliary Iminodiacetic Acid Scan. [PubMed]
[20]. Wallner BK, Schumacher KA, Weidenmaier W, Friedrich JM. Dilated biliary tract: evaluation with MR cholangiography with a T2-weighted contrast-enhanced fast sequence. Radiology. 1991;181:805–808. [PubMed] [Google Scholar]
[21]. Morimoto K, Shimoi M, Shirakawa T, et al. Biliary obstruction: evaluation with three-dimensional MR cholangiography. Radiology. 1992;183:578–580. [PubMed] [Google Scholar]
[22]. Outwater EK. MR cholangiography with a fast spin-echo sequence. J Magn Reson Imaging.1993: 3(P):131
[23]. Laubenberger J, Buchert M, Schneider B, Blum U, Hennig J, Langer M. Breath-hold projection magnetic resonance cholangiopancreaticography (MRCP): a new method for the examination of the bile and pancreatic ducts. Magn Reson Med.1995: 33:18–23 [PubMed]
[24]. Miyazaki T, Yamashita Y, Tsuchigame T, Yamamoto H, Urata J, Takahashi M.MR cholangiopancreatography using HASTE (half-Fourier acquisition single-shot turbo spin-echo) sequences. AJR Am J Roentgenol.1995; 166:1297–1303 [PubMed]
[25]. Sodickson A, Mortele KJ, Barish MA, Zou KH, Thibodeau S, Tempany CMC. Three-dimensional fast-recovery fast spin-echo MRCP: comparison with two-dimensional single shot fast spin echo techniques. Radiology. 2006;238:549–559. doi: 10.1148/radiol.2382032065. [PubMed] [CrossRef] [Google Scholar]
[26]. Fayad LM, Holland GA, Bergin D, et al. Functional magnetic resonance cholangiography (fMRC) of the gallbladder and biliary tree with contrast-enhanced magnetic resonance cholangiography. J Magn Reson Imaging. 2003;18:449–460. doi: 10.1002/jmri.10369. [PubMed] [CrossRef] [Google Scholar]
[27]. Baillie J, Kimberly J. Prospective comparison of secretin-stimulated MRCP with manometry in the diagnosis of sphincter of Oddi dysfunction types II and III. Gut. 2007;56:742–744. doi: 10.1136/gut.2006.111278. [PubMed] [CrossRef] [Google Scholar]

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