



MR APPEARANCE OF SATURATED BILE: ASSOCIATION WITH PANCREATICOBILIARY PATHOLOGIES

Radiodiagnosis

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ABSTRACT

AIM: Identification of normal and abnormal bile in MR Imaging and determining its correlation with pancreaticobiliary conditions.

MATERIALS & METHODS: It is a retrospective study, conducted over a period of 2 years. 205 individuals who came for MRI Abdomen in the institution was taken for the study, irrespective of the indication excluding trauma for which the imaging was done in 1.5Tesla MRI

RESULTS: 122 individuals had T1 hyperintense bile and 83 individuals had normal T1 hypointense bile. Various causes including pancreatitis, chronic parenchymal liver disease, cholecystitis were correlated with T1 Hyperintense bile. Out of 122, supersaturated bile 37 individuals were found to have cholesterol stones, 17 individuals had fatty liver, 14 individuals had pancreatitis, 10 individuals had chronic liver disease, 16 individuals had Gall bladder sludge & 13 patients had cholecystitis. 95 individuals were found to have hepato-pancreatico-biliary disorders while 27 individuals had other non hepato-pancreatico-biliary causes including normal individuals.

CONCLUSION: T1 hyperintense supersaturated bile shows high association with hepato-pancreatico-biliary pathologies. Among the pancreaticobiliary pathologies gall stones especially cholesterol stones shows high association with saturated bile.

CLINICAL RELEVANCE: T1 Hyperintense bile should be considered as an important finding in MRI abdomen and look for hepato-pancreatico-biliary pathologies in such individuals.

ABBREVIATION: T1- T1 weighted MR sequence, MRCP- Magnetic Resonance Cholangio Pancreatography.

KEYWORDS

T1 hyperintense bile, Supersaturated bile, Cholesterol stones

INTRODUCTION:

In MRI, Normally Bile appears T1 Hypointense due to saturation with bile acids. Bile in which cholesterol concentration is supersaturated with bile acids appear diffuse T1 hyperintense. Supersaturated bile is a common finding in MRI. T1 hyperintense bile can be due to concentrated bile, sludge, stones, hemobilia (1). Sludge appears T1 hyperintense with layering in T1W, T2W. And also Hyperintense on IN-PHASE images, Hypointense on OUT-PHASE imaging. Hemobilia appears T1 Hyperintense without loss of signal in chemical shift imaging.(2)

T1 hyperintense bile due to Supersaturation of bile or the concentrated bile is a bile with precipitated cholesterol that is saturated with bile salts, and lecithin (2). And it is a prerequisite for cholesterol gall stone formation. The predisposing factors for Supersaturated bile are Increasing age, obesity, fat-rich diet. Pathological causes include biliary obstruction due to head of pancreas mass, periampullary carcinoma, hilar cholangiocarcinoma. Inflammatory conditions include cholecystitis, pancreatitis, acute hepatitis. Other systemic causes like pyelonephritis, pneumonia, sarcoidosis.

Supersaturated bile is the major prerequisite for the formation of cholesterol stones.

Cholesterol supersaturation of gallbladder bile, rapid progression of nucleation, and long-term gall bladder hypomotility are the three major steps in the cholesterol stone formation. Nucleation occurs when the balance between the nucleating and antinucleating factors is disrupted. (2) MR imaging will be useful in identifying Supersaturated bile and also even tiny gallstones, since CT may fail to depict them.

No study has been done in India, identifying T1 hyperintense bile and

its association with pancreaticobiliary conditions. In our study, we aimed to identify prevalence of T1 hyperintense bile in patients and its association with various pancreaticobiliary pathology, and also its association with cholesterol stones formation.

AIM:

Identification of normal and abnormal bile in MR Imaging and determining its correlation with pancreaticobiliary pathologies.

OBJECTIVE:

To find an association of T1 hyperintense supersaturated bile with hepato-pancreatico-biliary pathologies on imaging.

MATERIALS AND METHODS:

All the patients who came for MRI Abdomen in the institution was taken for the study for a period of 2 years, irrespective of the indication for which the imaging was done. Ethical committee consent for the study was obtained. Consent for the study was obtained from all the patients. And a total 205 patients were studied, using Magneto aera MRI SIEMENS GERMANY 48 Channel 1.5Tesla machine is used.

Fat-suppressed T1-weighted MR imaging sequences TR/TE-4.3/1.7, flip angle-10 degree, slice thickness—3.5mm, to study hyperintense bile by comparing with pancreas.

It also helps to improve the delineation of the gallbladder wall, bile ducts, and associated entities such as inflammation and neoplasms. T2-weighted sequences (spin-echo [SE] sequences with respiratory gating): Thin continuous sections of 3-4mm in the coronal and axial planes with intermediate TE of 200-300ms. 3D FSE Sequence, with high TE is acquired with respiratory triggering Axial and coronal balanced SSFP with respiratory triggering IN-PHASE images done at

TE value of 4.6ms and OUT-PHASE images at TE of 2.3ms was done, to identify fatty infiltration of liver. All the patients were done ultrasound examination of gall bladder.

We included all the patients whose imaging was obtained in fasting state. Patients in Non-fasting state, Contracted Gall bladder due to chronic cholecystitis, Partial cholecystectomy, Immediate post-operative patients on nil oral, post traumatic patients are excluded from the study.

Grading of T1 hyperintense bile is done by comparing with hyperintensity of pancreas. We have graded, Grade 1 – hypointense to pancreas, Grade 2- Isointense to pancreas, Grade 3- Hyperintense to pancreas. With T2-weighted sequences, both cholesterol and pigment stones appear as focal well-defined signal voids, whereas with T1-weighted sequences their signal intensity is variable. Cholesterol stones appear T1 hypointense and Pigment stone appear T1 hyperintense(3)

Statistical Analysis And Results:

To find the significance in categorical data **Chi square test** was used. The **P value of 0.05 is considered as significant**

Tab.1.Demographic and clinical profile:

Parameters	All Patients	T1 Hyperintense	Normal bile
AGE	Median-44.5 1-88 YRS	Median-44.5 1-88 YRS	Median 42 yrs 1-83 yrs
GENDER	M/F , 105/100	M/F, 68/54	37/46

Total of 205 patients studied, 122 had T1 hyperintense bile due to various causes including pancreatitis, cholangiocarcinoma, head of pancreas mass and systemic causes.

Tab.2 Shows Analysis Of Pancreaticobiliary Disease, Non Pancreaticobiliary Disease And Its Association With T1 Hyperintense Bile

CAUSE	T1 Hyperintense bile	Normal bile	Total
Pancreaticobiliary diseases	95	38	133
OTHER associations (Non-Hepatobiliary & pancreatic causes)	24	35	59
Normal abdomen (isolated finding)	3	10	13
TOTAL	122	83	205

Tab.3 Shows Analysis Of T1 Hyperintense Bile With Pancreaticobiliary Disease, Non Pancreaticobiliary Disease

Bile	Pancreaticobiliary diseases	OTHER associations (Non-Hepatobiliary & pancreatic causes)	Normal abdomen (isolated finding)	Other associations and normal abdomen	Total	P value
T1 hyperintense bile	95	24	3	27	122	<0.001
Normal bile	38	35	10	45	83	0.106

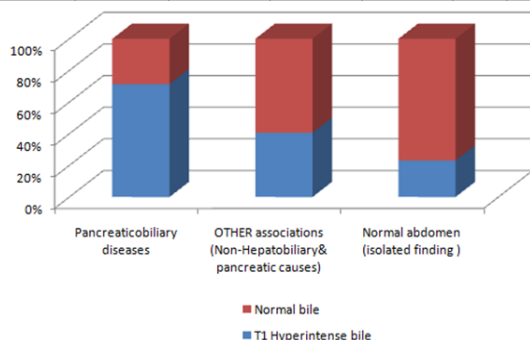


Fig.1 Shows Analysis Of Pancreaticobiliary Disease, non Pancreaticobiliary Disease And Its Association With T1 Hyperintense Bile

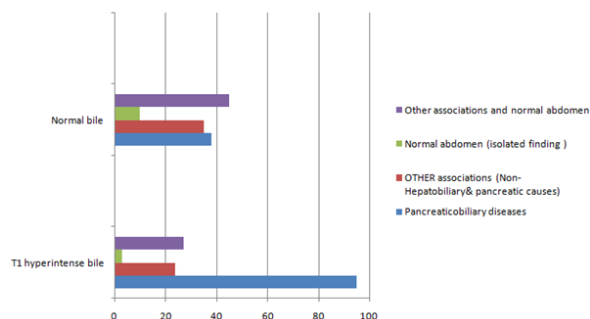


Fig.2 Shows Normal Bile And T1 Hyperintense Bile With Pancreaticobiliary And Non Pnacreaticobiliary Conditions

T1 Hyperintense Bile: Total of 122 patients had hyperintense bile and among them 22 cholesterol stones and 15 patients had both cholesterol stones and fatty liver .6 patients had pigment stones. Chronic parenchymal liver disease in 10 patients, cholecystitis in 13 patients. 14 patients had pancreatitis, 4 had cholangiocarcinoma, 1 had head of pancreas mass, 1 had periampullary carcinoma. Rare causes are Hepatocellular carcinoma-1, Post -TACE, for follow up- , acute hepatitis-1, fatty liver -1, fatty liver with indeterminate lesion-1. Systemic causes like pyelonephritis, PCOD, sarcoidosis.

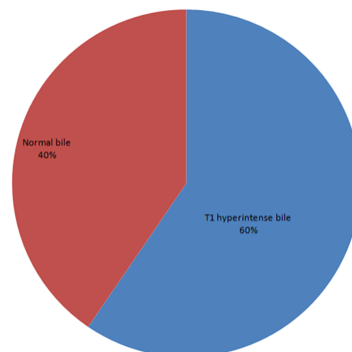


Fig.3 Pie Chart Shows Representation Of T1 Hyperintense Bile And Normal Bile

T1 Hyperintense Bile And Normal Bile: On comparing the association T1 hyperintense bile and normal bile with various conditions, 43 gall stones patients had hyperintense bile and only 4 had normal bile. Hyperintense bile with Fatty liver in 1 patient and normal bile with fatty liver in 2 patients. Cholecystitis and hyperintense bile in 13 patients, and only 2 cholecystitis patients' normal bile. There is mild increase in association of hyperintense bile in chronic parenchymal liver disease in 10 patients, normal bile in 6 patients and 14 patients of pancreatitis had hyperintense bile and 12 had normal bile. Among the 8 patients of cholangiocarcinoma 4 had hyperintense bile and 4 had normal bile. Only one case of Head of pancreas mass and is associated with hyperintense bile. Among the 4 cases of periampullary carcinoma 3 patients had normal bile and 1 patient had hyperintense bile.

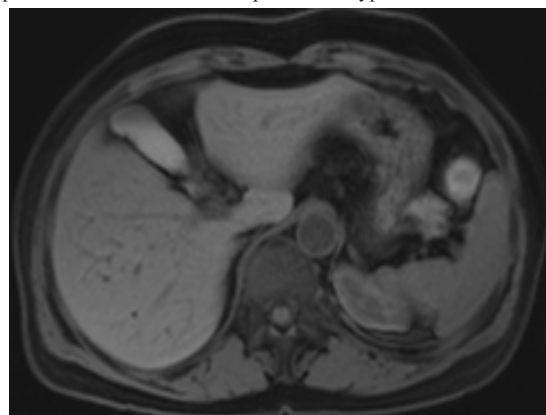


FIG.4.T1W FS Image Showing Grade II Hyperintense Bile In The Body, Neck Of Gallbladder..

Tab.4 Shows Analysis Of Grading Of T1 Hyperintense Bile With Pancreaticobiliary Disease,non Pancreaticobiliary Disease

CAUSES	Grade 1	Grade 2	Grade 3	T1 hyperintense bile	Normal bile	total
GALLSTONE				43	4	47
Cholesterol stone	13	7	2	37	1	38
Pigment stone	5	1	-	6	3	9
FATTY LIVER				17	3	20
Fatty liver (isolated)	-	1	-	1	2	3
Fatty liver with indeterminate lesion	-	-	1	1	-	1
Both fatty liver & cholesterol stone	10	2	3	15	1	16
GB SLUDGE				18	6	
Isolated sludge					1	
Choleodochol cyst with sludge				2	-	
Cholelithiasis with sludge				3		
CLD with sludge				1	1	
Cholecystitis with sludge				1		
Pancreatitis with sludge				6	3	
other causes				5	1	
GB:Cholecystitis	10	2	1	13	2	15
Gb polyp	-	2	-	2		2
Choledochol cyst	1	-	1	2		2
LIVER:Chronic parenchymal liver disease.	6	4	-	10	6	16
Acute hepatitis	-	1	-	1	1	2
HCC	-	-	1	1	3	4
HCC, Post-TACE	1	-	-	1	1	2
PANCREATITIS				14	12	26
Acute pancreatitis	4	4	2	10	6	16
Chronic pancreatitis	-	1	3	4	6	10
Acute Pancreatitis with sludge , cholelithiasis				1	1	2
Acute pancreatitis with sludge only				4	2	6
Acute pancreatitis with cholelithiasis				-	-	-
Acute Pancreatitis without sludge				3	3	6
Acute on CCP with sludge				2	-	2
Chronic Pancreatitis with cholelithiasis only				1	-	1
Chronic				1	-	1

pancreatitis with sludge only						
Chronic pancreatitis without sludge				2	6	8
Cholangiocarcinoma	2	-	2	4	4	8
Head of pancreas mass	-	-	1	1	-	1
Periampullary carcinoma	1	-	-	1	3	4
PANCREATICOBILIARY DISEASES	53	25	17	95	38	133

Grading Of Hyperintense Bile : T1 hyperintense bile is graded as Grade 1 –hypointense to pancreas, Grade2- Isointense to pancreas, Grade3- Hyperintense to pancreas. In pancreatitis we compared bile intensity to the liver. Among the 122 patients 61 had hypointense bile,33 had isointense bile,28 had hyperintense bile. Among the 37 patients who cholesterol stones 23 had hypointense bile to pancreas, 9 patients had isointense bile, 5 had bile hyperintense to pancreas. Among 6 patients of pigment stones, 5 had hypointense bile to pancreas, 1 had isointense bile to pancreas. Among 10 patients of chronic parenchymal liver disease 6 had hypointense bile to pancreas, 4 had isointense bile to pancreas

Tab.6 Shows Analysis Of Grading Of T1 Hyperintense Bile With Pancreaticobiliary Diseases

Causes	Grade 1	Grade 2	Grade 3	Total
Cholesterol stone	13	7	2	22
Both fatty liver & cholesterol stone	10	2	3	15
Pigment stone	5	1	-	6
Hcc	-	-	1	1
Hcc, post-tace	1	-		1
Acute hepatitis	-	1	-	1
Chronic parenchymal liver disease	6	4	-	10
Fatty liver	-	1	-	1
Fatty liver with indeterminate lesion	-	-	1	1
Acute pancreatitis	4	4	2	10
Chronic pancreatitis	-	1	3	4
Cholecystitis	10	2	1	13
Hilarcholangiocarcinoma	2		2	4
Head of pancreas mass	-	-	1	1
Periampullary carcinoma	1	-	-	1
Choledochol cyst	1		1	2
Gb polyp		2		2
With normal hepatobiliary system	2	1	-	3
Other causes (non-hepatobiliary&pancreatic causes)	6	7	11	24
Total	61	33	28	122

Out of 205 patients, only 3 patients had isolated supersaturated bile without any cholesterol stones.22 patients had associated cholesterol stones with no hepatobiliary, pancreatic pathology, and no systemic causes. Out of them 13 had hypointense bile compared to pancreas. 7 had isointense bile, and 2 had hyperintense bile .15 patients had both cholesterol stones and fatty liver, 10 patients had hypointense bile to pancreas, 2 had isointense bile, 3 had hyperintense bile. In acute pancreatitis patients out of 10 patients, 4 had grade 1hyperintense bile to pancreas, 4 had grade 2hyperintense bile, 2 had grade 3 hyperintense bile. While in chronic pancreatitis out of 4 patients, 3 had grade 3 hyperintense bile one had grade 2hyperintense bile. In cholecystitis out of 13 patients .10 patients grade 1hyperintense bile, 2 had grade 2hyperintense bile, 1 had grade 3 hyperintense bile. 2 patients of cholangiocarcinoma patients had grade 1 hyperintense bile and 2 had grade 3 hyperintense bile.

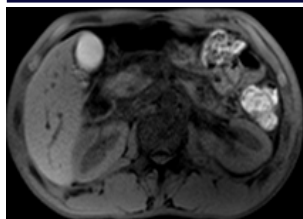


FIG .5.T1W FS image showing Grade III hyperintense bile in the body, neck of Gallbladder. bile appears hyperintense compared to the pancreas.



Fig.6. T1W FS image showing Mild hyperintense bile and hyperintense signal voids in the dependent position – Pigment stones.

Tab.7 Shows Association Of T1 Hyperintense Bile With Pancreaticobiliary Disease, non Pancreaticobiliary Disease

CAUSES	T1 hyperintense bile	Normal bile	total	P value.
GALLSTONE	43	4	47	<0.00007
Cholesterol stone	37	1	38	<0.00001
Pigment stone	6	3	9	0.371
FATTY LIVER	17	3	20	0.015
GB SLUDGE	18	6		>0.999
GB:Cholecystitis	13	2	15	0.026
Gb polyp	2	-	2	0.241
Choledochol cyst	2	-	2	0.241
LIVER:Chronic parenchymal liver disease.	10	6	16	0.800
PANCREATITIS	14	12	26	0.529
Acute pancreatitis	10	6	16	0.800
Chronic pancreatitis	4	6	10	0.197
Cholangiocarcinoma	4	4	8	0.576
PANCREATICOBIILIARY DISEASES	95	38	133	

Analysing the association of T1 hyperintense bile, sludge, cholelithiasis in pancreatitis: In Acute pancreatitis 4 patients T1 hyperintense bile and sludge, 2 had T1 hypointense normal bile with sludge. 3 patients had T1 hyperintense bile without sludge, 3 patients had T1 hypointense normal bile and without sludge. Only one patient of acute pancreatitis had T1 hyperintense with sludge, cholelithiasis. Only one patient of acute pancreatitis had T1 hypointense normal bile with sludge, cholelithiasis. In acute on chronic pancreatitis patients 2 patients had T1 hyperintense bile with sludge. In chronic pancreatitis 6 patients had normal bile without any sludge, 2 patients had T1 hyperintense bile without sludge, one patient had T1 hyperintense bile with sludge.

DISCUSSION:

Saturated bile is seen as T1 hyperintensity that fills the gallbladder lumen or hyperintense-hypointense bile level on fasting state (2). In our study population of locoregional patients, 122 patients had T1 hyperintense bile and 83 patients T1 hypointense normal bile. We analysed the various hepatobiliary conditions that causes T1 hyperintense bile and T1 normal bile. The common conditions such as pancreatitis which shows hyperintense bile in 14 patients, and hypointense bile in 12 patients. In chronic parenchymal liver disease 10 had hyperintense bile and hypointense bile in 6 patients. In Biliary tract carcinoma 6 had hyperintense bile, 7 had hypointense bile.

Tab.8.association Between Pancreato-biliary Conditions And Bile Appearance:

	T1 hyperintense bile	Normal bile	Total	X2	P- value
Pancreato-biliary cdns	95(71.6%)	38(28.4%)	133	20.93	0.000004
Non-pancreatobiliary cdns and normal abdomen	27(37.5%)	45((62.5%)	72		
Total	122	83	205		

Among those with pancreato-biliary conditions 71.6% had T1 hyperintense bile and the P value is 0.000004. There is a significant association between pancreato-biliary conditions and occurrence of T1 hyperintense bile. Among those with Non-pancreato-biliary conditions and normal abdominal study 62.5% had normal bile and 37.5% had T1 hyperintense bile and the P value is 0.000001. Hence there is high association of normal bile in non – pancreaticobiliary conditions and normal abdomen.

According to the study, Prevalence and type of biliary stones in India done on 2000 by Rakesh K Tandon,(6) In South India pigment and mixed gallstones are predominant, and cholesterol stones are more common in north Indian population due to the variation in dietary habits. In our study Total of 47 gall stones cases were present. And among them 38 cases were cholesterol stones contributing 86.3% of cases and 9 cases were pigment stones and 13.7% cases. In cholesterol stone cholelithiasis 37 had hyperintense bile and 1 had hypointense bile and the P value is 0.00001. In Pigment stones patients out of the total 9, 6 had hyperintense bile 3 had hypointense bile. 3 out of 205 had isolated supersaturated bile without gall stones.

Limitations:

One of the limitation was due to retrospective study design leading to uncontrolled data about confounding factors and absence of clinical characteristics (Diet, BMI etc..) of patients related to gall bladder stone formation. Other limitation was lack of USG findings in some patients.

CONCLUSION:

There is a significant association between pancreato-biliary conditions and the T1 hyperintense bile. Among the pancreaticobiliary pathologies gall stones especially cholesterol stones shows high association with saturated bile. Hence, this finding of T1 hyperintense bile should be considered while reporting cases of pancreaticobiliary pathologies.

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