ULTRASOUND & CT PICTURES OF CHOLANGIOCARCINOMA

Warinthorn PHUTTHARAK [1] Jiraporn SRINAKARIN[2]
Supinda PUNTACE[3] Vallop LAOPAIBOON[4]

Presented at 34th annual radiological scientific meeting on March, 1997 at the Royal Golden Jubilee Building, Soi Soonvijai, Bangkok, Thailand.

ABSTRACT

Our hospital, Srinagarind hospital, is located in the highest prevalence area of Cholangiocarcinoma (CHCA). The aim of this study is to present the findings of 110 ultrasound and 49 conventional CT images of 132 cases with histopathologically proven CHCA seen during 1991-1997. There were 2 major types; peripheral type 105 cases (US & CT = 22, US only = 65 and CT only = 18); extrahepatic type 27 cases (US & CT = 5, US only = 18 and CT only = 4). The peripheral type was divided into nodular and infiltrative forms. The nodular form was the most common US finding ; solitary mass (95.12%), large size > 5 cm. (71.5%), ill-defined border (53.65%), hyperechogenicity (68.29 %) and 23.17% of the cases had peripheral halo. The CT pictures were ill -defined hypodense mass with minimal peripheral enhancement. Most tumors located at posterior segment of the right lobe of liver. Peritumoral bile duct dilatation (41.46 % by US, 52.5 % by CT) was a useful finding in helping to distinguish CHCA from the other liver tumors. The infiltrative form was much less common (5 cases), can not be differentiated from hepatocellular carcinoma or liver metastases. The extrahepatic type CHCA (27 cases) was commonly located at hepatic duct confluence. The hilar mass could either be visualized or non – visualized.

(**Keywords;** Liver tumor, Bile duct carcinoma, cholangiocarcinoma, US – liver and bile duct, CT – liver and bile duct)

INTRODUCTION

Primary intrahepatic cholangiocarcinoma (CHCA) is known as an uncommon liver tumor in most parts of the world including several regions of Thailand (except the northeastern part) when it was compared to hepatocellular carcinoma in the past. The prevalence of CHCA is highest in the northeast Thailand. The people living in this region of Thailand have highest risk in developing CHCA in relation to liver fluke (Opistorchis viverrini, OV) infestation and nitrosamine (source of carcinogen) contamination.[4] Culturally - bound habits of eating ground raw fresh-water fish (Koi

[1, 2, 4] Department of Radiology, Faculty of Medicine, Srinagarind Hospital, Khon Kaen University, Khon Kaen, Thailand 40002
[3] Department of Pathology, Faculty of Medicine, Srinagarind Hospital, Khon Kaen University, Khon Kaen, Thailand 40002

Correspondence to

Warinthorn PHUTTHARAK Department of Radiology, Faculty of Medicine, Srinagarind Hospital, Khon Kaen University, Khon Kaen, Thailand 40002 Telephone : 043-348389 Fax : 043-348389

pla) and fish fermented in salt (Pla ra) as daily foods and even feeding them to infants,make the local people of the northeast predisposed to these risk factors in their early lives. This relationship is not different from association between Clonorchis sinensis infection and CHCA in the previous reports of other countries,[5] particularly Asia. CHCA may be classified as (a) peripheral type, which originates in an interlobular duct; and (b) extrahepatic type, which originates at major right or left hepatic duct, the main hepatic bifurcation, common hepatic duct and common bile duct.

The aim of this study is to analyze the US and CT findings of CHCA treated at our hospital which may be useful for future diagnosis and treatment planning.

MATERIAL AND METHOD

The ultrasound and CT images of 132 patients with histopathologically proven cholangiocarcinomas seen at Srinagarind Hospital, Khon Kaen University, during 1991-1997 (110 US, 49 conventional CT images) were retrospectively reviewed. The specimens were obtained either by surgery or biopsy. At microscopic examination, all tumors were diagnosed as CHCA; composed of acinar structures with atypia in a pattern characteristic of adenocarcinoma with the frequent presence of mucin, fibrosis, and calcification. Cholangiocarcinomas were classified as peripheral type in 105 patients (performed US - 65, CT - 18, US & CT - 22 cases); and extrahepatic type in 27 patients, (performed US - 18, CT - 4, US & CT - 5 cases). The study included 78 men and 54 women with an age range of 22 – 77 years (average age 53.5 years). One case had fascioliasis coinfection.

Ultrasonographic examinations were performed with a real time scanners (EUB – 40 Hitachi, or SSD 650 Aloka, Tokyo). The 3.5 MHz transducers (convex array) was used in all patients. The scanning was performed across the entire upper abdomen by the intercostal subcostal approaches, mainly transverse plane and additional sagittal oblique plane.

CT examinations were mostly performed with a CT 9800 (General Electric Medical System, Milwaukee, WI, USA). After obtaining a precontrast scan, a bolus hand injection of 100 ml., 60 % iodinated water soluble contrast agent was given and the scan was performed dynamically. The remaining small number of patients had CT from the outside hospitals.

All images of the peripheral type were analyzed for; a). number of tumor mass, size, margin, echo or density, degree of contrast enhancement, location; b). presence of peritumoral bile duct dilatation, calcification or cystic degeneration within the mass, retraction of the adjacent liver capsule, irregularity of adjacent diaphragm or nearby vascular involvement; c) presence of metastatic lesion.

All images of the extrahepatic type were analyzed for; a). site of obstruction, determined by pattern, distribution of dilated ducts; b). presence of a mass, echo or density of tumor mass, degree of contrast enhancement; c). associated findings; d). presence of extrahepatic metastases; e). comparing diagnostic accuracy for site of obstruction between CT and US (correlate with operative findings)

RESULTS

We found the peripheral type cholangiocarcinoma (105 cases, 79.54%) more than the central type (27 cases, 20.46%). US and CT findings were analyzed, regarding the anatomic location and tumor characteristic, respectively.

SONOGRAPHIC FINDINGS OF PERIPHERAL TYPE (87 cases)

Peripheral type was divided into two group; nodular form 82 cases (94.25%) and infiltrative form 5 cases (5.57%). The ultrasonographic (US) findings of nodular form were summarized in table 1.

Most of nodular form of the peripheral type CHCA presented as solid solitary mass (fig.1, 2). Four patients had multiple masses, the largest one with adjacent smaller satellite nodules were shown. The size of tumor ranged from 2 cm. to 15 cm. The tumor larger than 5 cm. were most frequently encountered. The tumor margin was either ill defined or well defined (fig.1, 2).

Echogenicity varied by tumor size. We found the highest frequency of the the big tumor size, larger than 5 cm. (59 of 82 cases, 71.5%). The big tumor size was likely to be hyperechogenic. (fig.1b)

Nineteen patients had peritumoral halo (23.17%) (fig.2). Peritumoral duct dilatation was shown in 34 cases, 41.46 % (Fig 1a). Most of the tumors were in the right lobe, particularly the posterior segment, and only 15 cases (18.29%) in the left lobe. The tumors rarely had calcification or cystic degeneration (2.44%,12.19%) (fig.1b)

Only one case (1.2%) was a cystic tumor by evidence of homogeneously hypoechoic mass with posterior enhancement with mural hyperechoic portion of the mass (fig. 3). Four cases (4.87%) of bright echoic spots without acoustic shadowing within the mass, possibly representing mucin products were depicted (fig.3, 4). In three cases (3.66%), atrophic change of the involved liver part was found. Irregularity of adjacent diaphragm was demonstrated in only 5 cases (6%) by US .

INFILTRATIVE FORM (5 cases)

Five patients (5.75%) had distorted parenchymal echo with inhomogeneous pattern involving the entire lobe of the liver. (fig.5) They were in RT. lobe (n = 2), LT. lobe (n = 2), and both lobes (n = 1). The extrahepatic extension were lymph nodes (n = 2), and diaphragm (n = 1).

SONOGRAPHIC FINDINGS OF THE EXTRAHEPATIC TYPE (23 cases)

In this type, the mass could be visualized in 12 patients (52.17%), and non-visualized in 11 patients (47.83%) (fig.6,7). The echogenicity of the mass were isoechoic in 3 cases (25%) and hyperechoic in 9 cases (75%). The site of obstruction were found mainly at the main hepatic duct bifurcation in 12 cases (52.17%), LT.main hepatic duct in 3 cases (13.04%), RT.main hepatic duct in 2 cases (8.59%), CBD in 6 cases (26%). The gallbladders were not able to be demonstrated in 2 cases (8.70%), contracted in 4 cases (17.39%), normal size in 10 cases (43.48%) and distended in 7 cases (30.43%). The extrahepatic extension was lymph nodes (n = 2, 8.69 %). The other findings were hepatic lobar atrophy (n = 3, 3.04%), increased periportal echo (n = 6, 26.08%).

CT FINDINGS OF PERIPHERAL TYPE (40 cases)

Almost all of these cases were nodular form with solitary mass , (n = 38, 95%) (fig.8). Two cases had multiple masses (5%), one dominant mass and adjacent satellite nodules in one patient (fig. 9). The tumor boundary was found to be ill defined (n = 28, 70%) more than well defined (n = 12, 30%). The tumor density varied; mainly hypodense (n = 37, 92.5%). Most enhancement pattern was mostly slightly enhanced (n = 30, 75%) (fig. 8b). The tumor size was commonly larger than 5 cm. (n=29, 72.5%). The tumor location was the RT. lobe (n = 2, 80%), particu-

larly posterior segment, more than the Lt. lobe. We found peritumoral duct dilatation in about half of the cases (n = 21 cases, 52.5%) (fig. 1a, 11b); calcification 8 cases (20%) (fig. 11); cystic degeneration (n = 2, 5 %); adjacent vascular involvement (n = 8, 20%); retraction of adjacent liver capsule (n = 7, 17.5%) (fig.5). The other findings were hepatic lobar atrophy (2 cases) ; gall stone (1 case) ; focal fatty liver (1 case). The extrahepatic extensions were involvement of adjacent diaphragm, 12 cases (30%) (fig. 10), lymphadenopathy 19 cases (47.5%) (fig. 12a), adjacent gastric wall involvement 1 case (fig. 12b), pulmonary metastases 1 case and pleural effusion 6 cases (15%).

CT FINDINGS OF EXTRAHEPATIC TYPE (9 cases)

The hilar mass was visualized in 7 of the 9 cases. They were mainly isodense (6 cases) (fig.13a). The remaining 1 case was a hyperdense mass. All lesions were slightly enhanced after the contrast injection. The common obstructive location was at main hepatic duct bifurcation (7 cases) (fig. 13, 14) and the remainings were at main duct 1 case and CBD 1 case.

The gallbladder size was normal in 4 cases, contracted 3 cases, enlarged 2 cases. The extrahepatic extensions were lymphadenopathy 2 cases, ascites 2 cases. Hepatic lobar atrophy was shown in 2 cases (fig. 14a).

Table 1 Us findings of nodular form of the peripheral type (82 cases)

	Number	%
NUMBER OF LESIONS		
- Solitary	78	95.12
- Multiple	4	4.87
TUMOR SIZE		
> 5 cm.	59	71.50
3-5 cm.	16	19.50
< 3 cm.	7	8.54
TUMOR BOUNDARY		
- Ill defined	44	53.65
- Well defined	38	46.35
- With peripheral halo	(19)	(23.17)
ECHOGENICITY		
- Hyperecho	59	68.29
- Hypoecho	13	15.85
- Isoecho	18	12.19
- Mixed echo	2	2.43
- Cystic Tumor	1	1.20
LOCATION		
- RT.lobe	67	81.7
Posterior segment	48	71.60
- LT.lobe	15	18.29
OTHER FINDINGS		
- Peritumoral duct dilatation	34	41.46
- Cystic degeneration	10	12.19
- Bright echo spots of mucin products	4	4.87
- Atrophy of involved liver segment	3	3.66
- Calcification	2	2.44
EXTRAHEPATIC EXTENSIONS		
- Regional node enlargement	10	12.19
- Irregularity, involved adjacent diaphragm	5	6

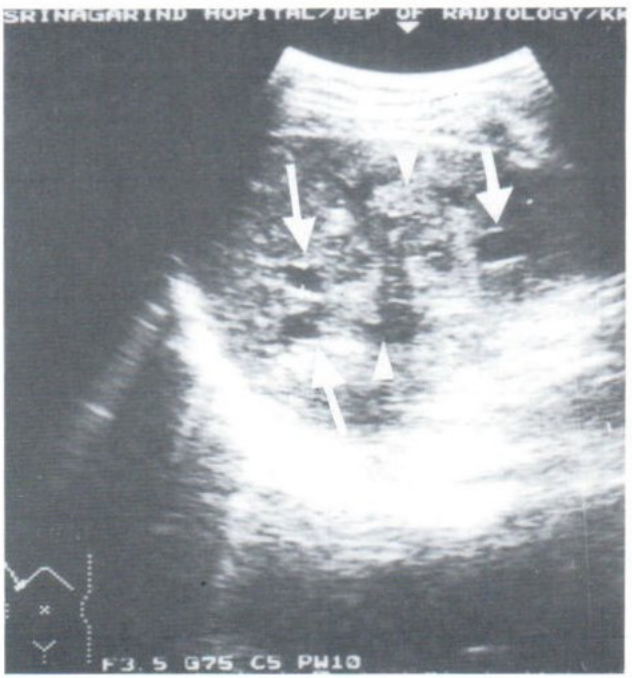
Table 2 CT findings of nodular form of the peripheral type 40 cases

	Number (n)	%
NUMBER OF LESIONS		
- Solitary	38	95
- Multiple	2	5
TUMOR SIZE		
> 5 cm.	29	72.5
3-5 cm.	7	17.5
< 3 cm.	4	10
TUMOR BOUNDARY		
- Ill defined	28	70
- Well defined	12	30
DENSITY		
- Hypodensity	37	92.5
- Isodensity	2	5
- Hyperdensity	1	2.5
ENHANCEMENT		
- Slightly	30	75
- Intermediate	10	25
- Markedly	-	-
LOCATION		
- Rt.lobe	32	80
- Posterior segment	(21)	(65.63%)
- Lt.lobe	15	20
OTHER FINDINGS		
- Peritumoral duct dilatation	21	52.5
- Cystic degeneration	2	5
- Bright echo s[ots of mucin products	7	17
- Atrophy of involved liver segment	2	5
- Calcification	8	20
EXTRAHEPATIC EXTENSION		
- Regional nodes Enlargement	19	47.5
- Irregularity of adjacent diaphragm	12	30
- Stomach	1	2.5

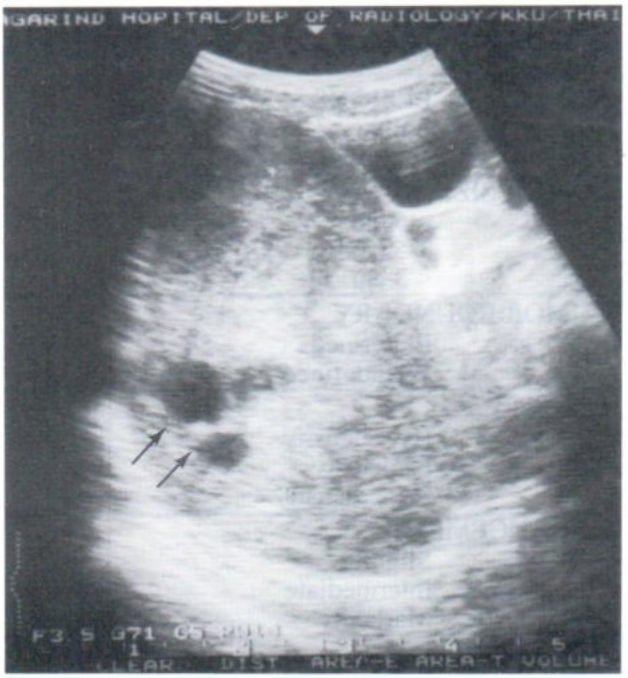
Table 3 Accuracy in the detection of extrahepatic type of CHCA by sites in the patients who had both US & CT

	CT		SONOGRAM	
Location	Surgical findings	CT detection	Surgical findings	US-detection
	(n)	total(%)	(n)	total(%)
-Main hep.Duct	2	2 (100%)	4	3 (75%)
-Bifurcation	3	3 (100%)	11	8 (72.73%)
-CHD	-	-	-	-
-CBD	2	1 (50%)	6	4 (66.67%)

** No surgical notes 2 cases



1A.



1B.

Fig. 1. US of nodular form of peripheral CHCA with ill defined margin a). Slightly hyperechoic mass at posterior segment, right lobe liver (white arrowheads), with peritumoral bile duct dilatation (arrows). Intercostal approach scanning. (b). The larger hyperechoic mass with small areas of cystic degeneration (arrows).

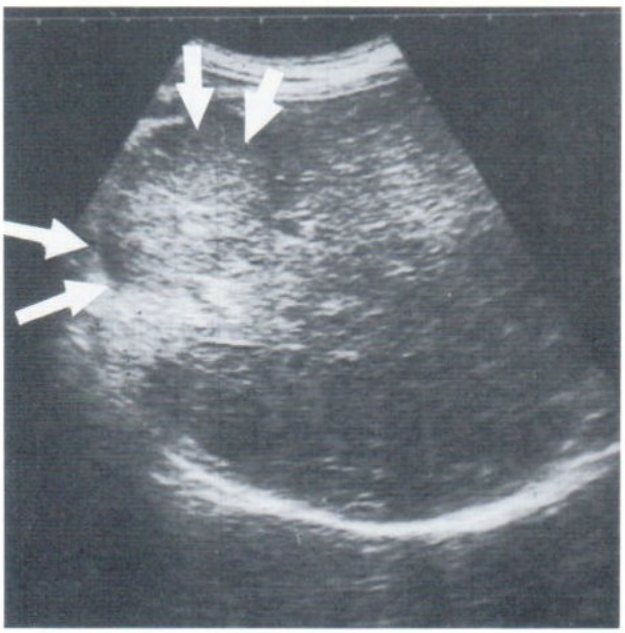


Fig. 2. Peripheral CHCA with well defined margin : Echoic right lobe mass with peripheral halo (arrows)

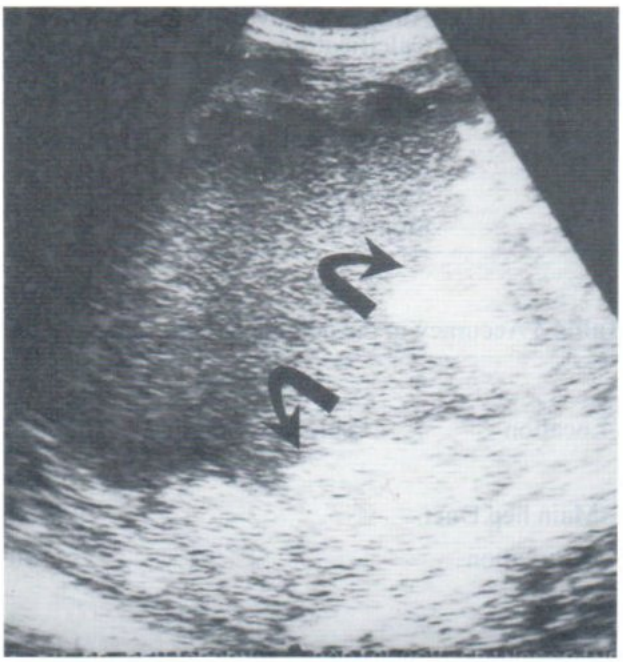


Fig. 3. Cystic CHCA : Large cystic tumor in the right lobe (by evidence of posterior enhancement) with visualized mural hyperechoic portion (curve arrows).

Fig. 4. Peripheral CHCA with mucin products : Large hyperechoic mass with bright echo areas (without acoustic shadowing) within the mass (arrows), probaby represent mucin products.

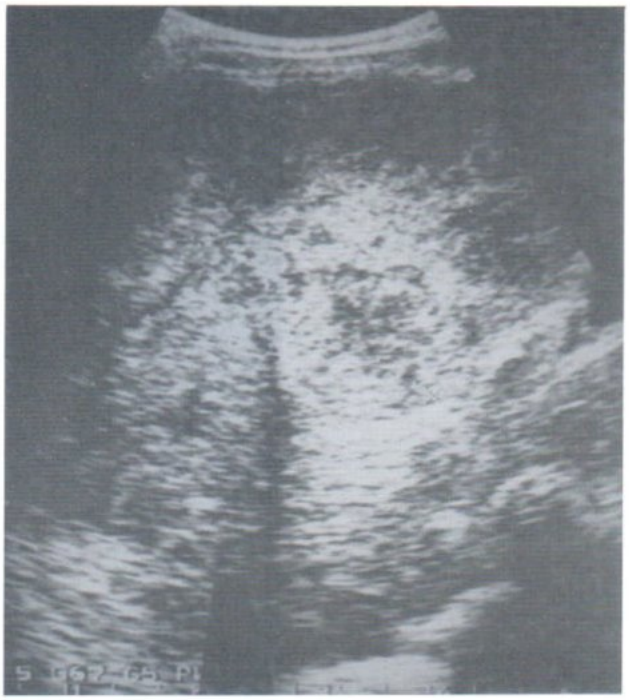
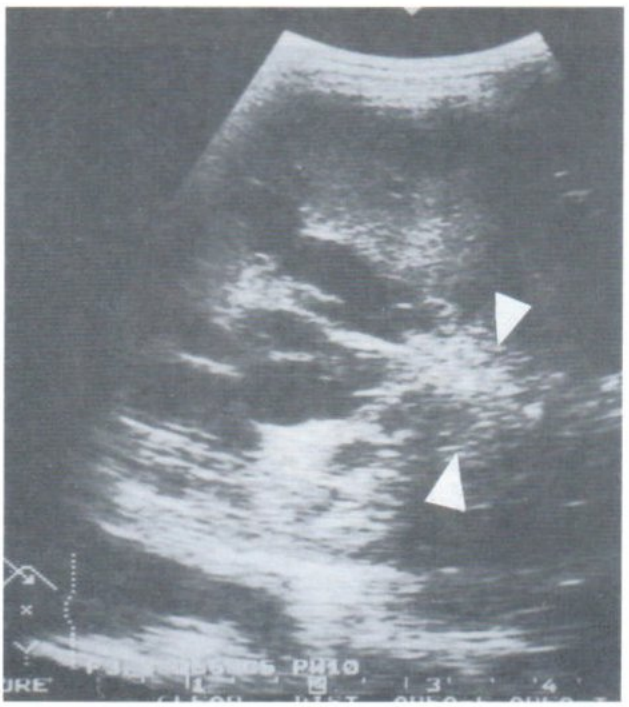


Fig 5. US of infiltrative form of peripheral CHCA : inhomogeneous echo pattern of the entire right lobe liver

6A



6B

Fig 6. Extrahepatic type CHCA (proximal duct) (a). CHCA at porta hepatis by visualized nonunion of dilated intrahepatic ducts both lobes of liver and non-visualized mass lesion (b). CHCA at porta hepatis with visualized hyperechoic mass (white arrow heads)

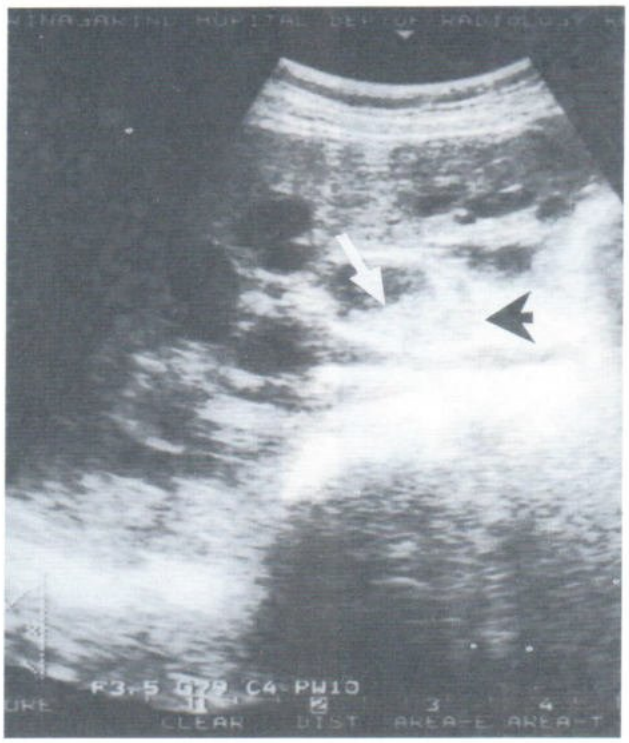
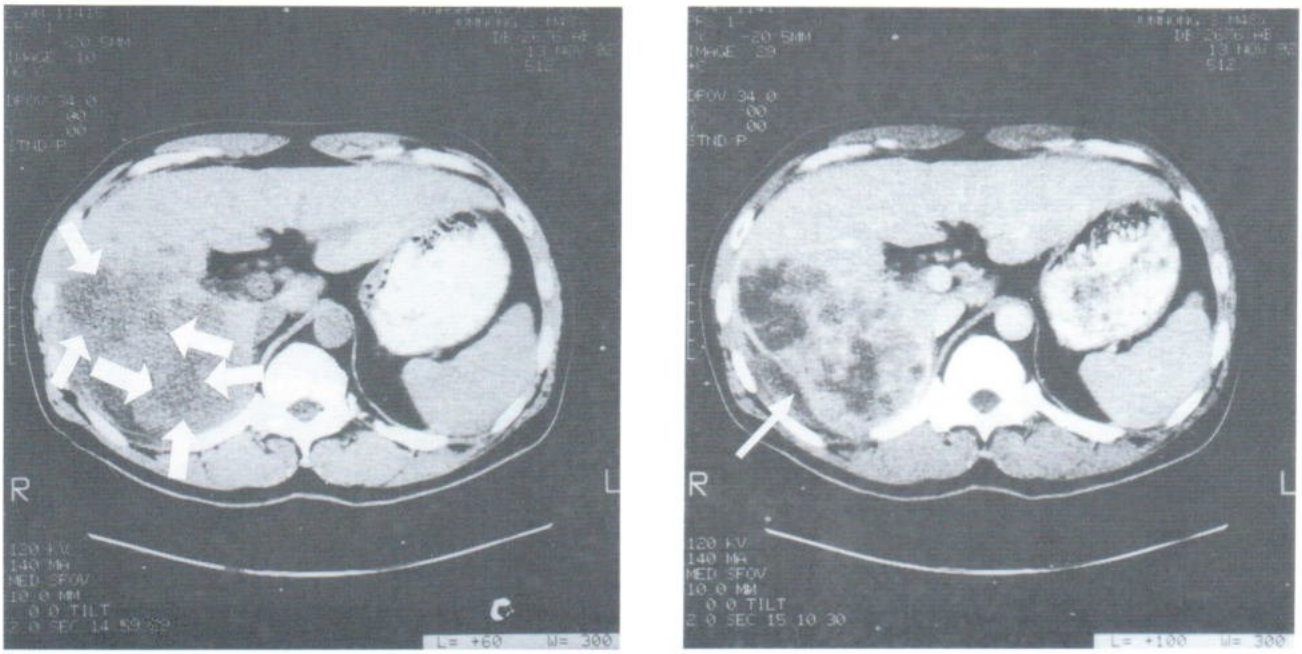


Fig. 7. Extrahepatic type CHCA (distal duct carcinoma) : Dilated CBD (black arrow) with obstruction by intraluminal mass (white arrow)



8A **8B**

Fig. 8. CT of solitary, peripheral CHCA
(a). Ill defined hypodensity-mass (arrows) at posterior segment, right lobe liver on pre-contrast CT scan. (b). Slightly contrast enhancement of the mass with retraction of adjacent liver capsule (long arrow).

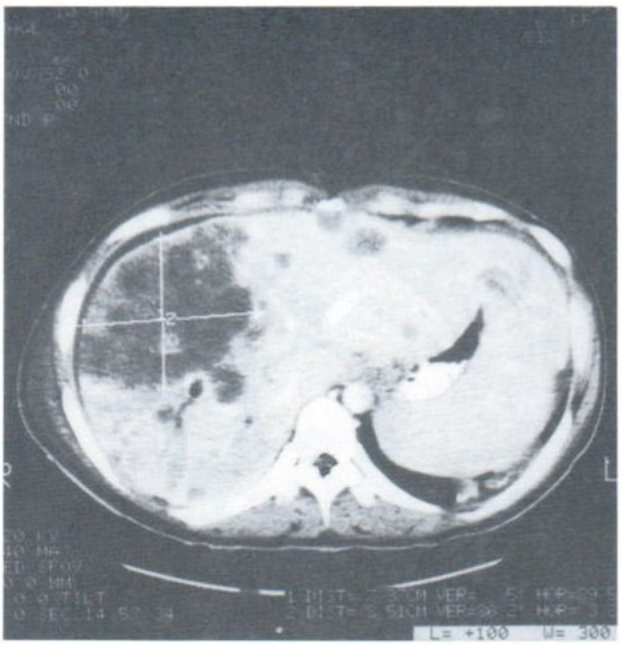


Fig. 9. Multiple masses of peripheral type CHCA The biggest mass at anterior segment of RT.lobe of liver with multiple small satellite nodules. Lesions at LT.lobe probably due to metastases.

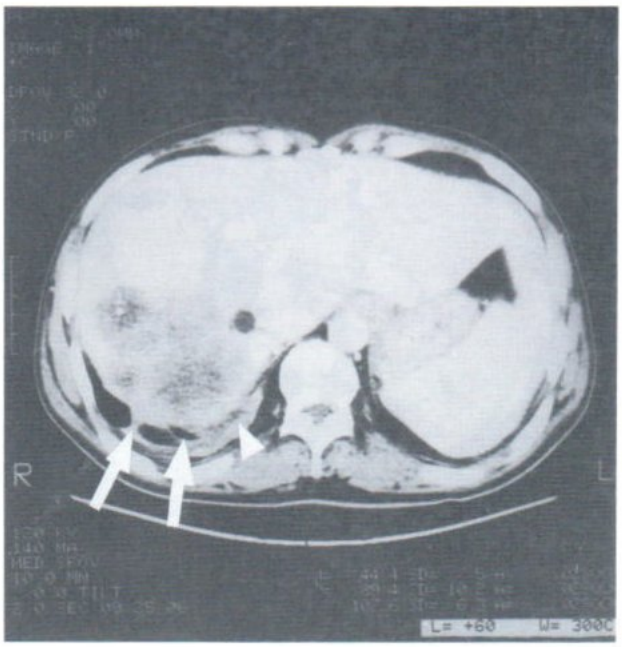
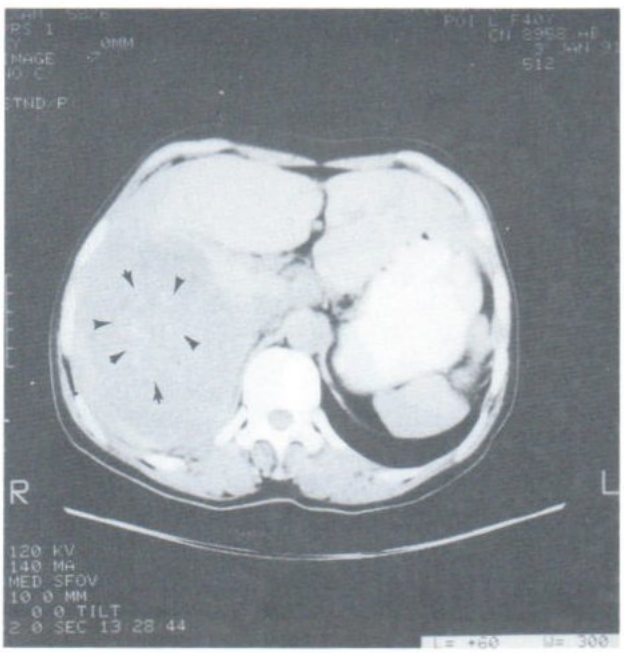
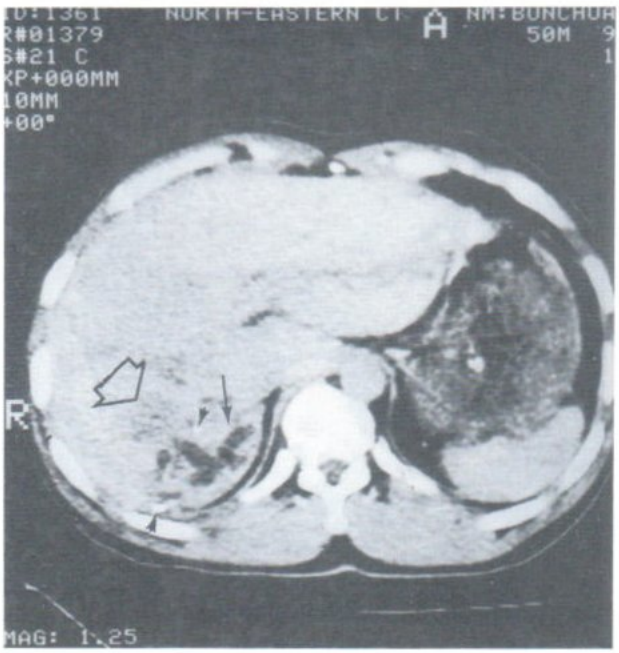


Fig. 10. Superoposterior segment, right lobe CHCA with involved adjacent diaphragm : By visualized evidence of irregular, thickening of diaphragmatic outline (arrows), minimal pleural effusion and /or pleural thickening (arrowheads).

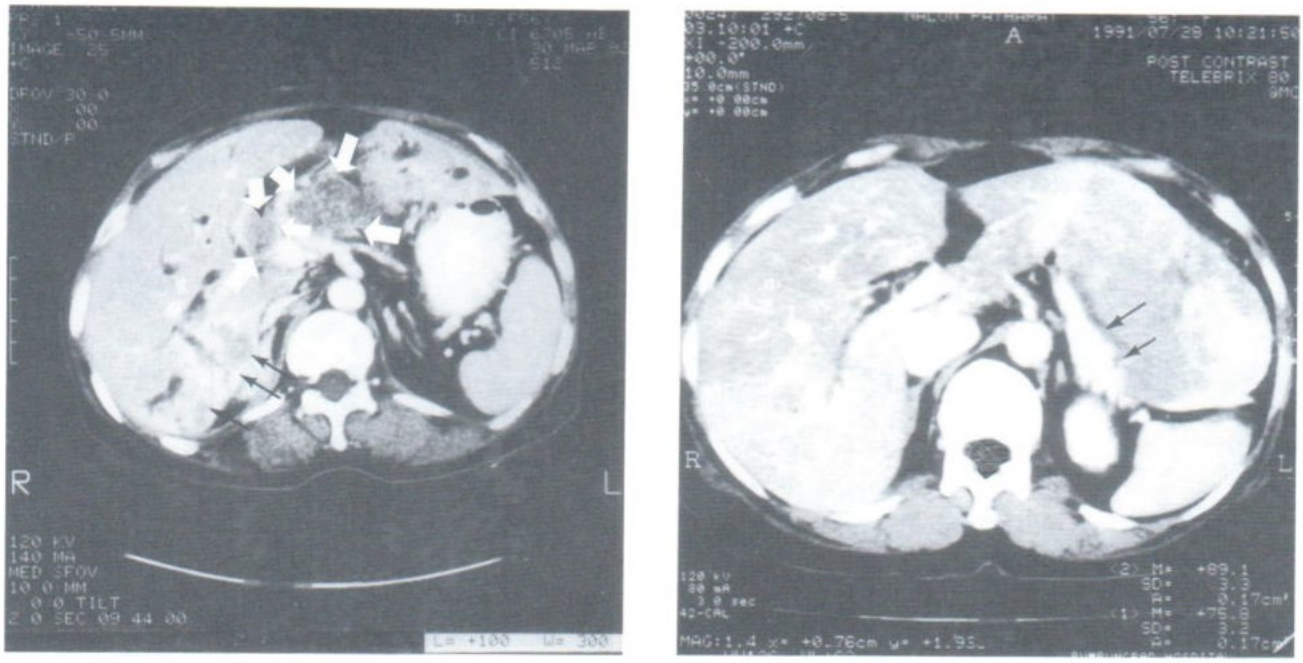


11A



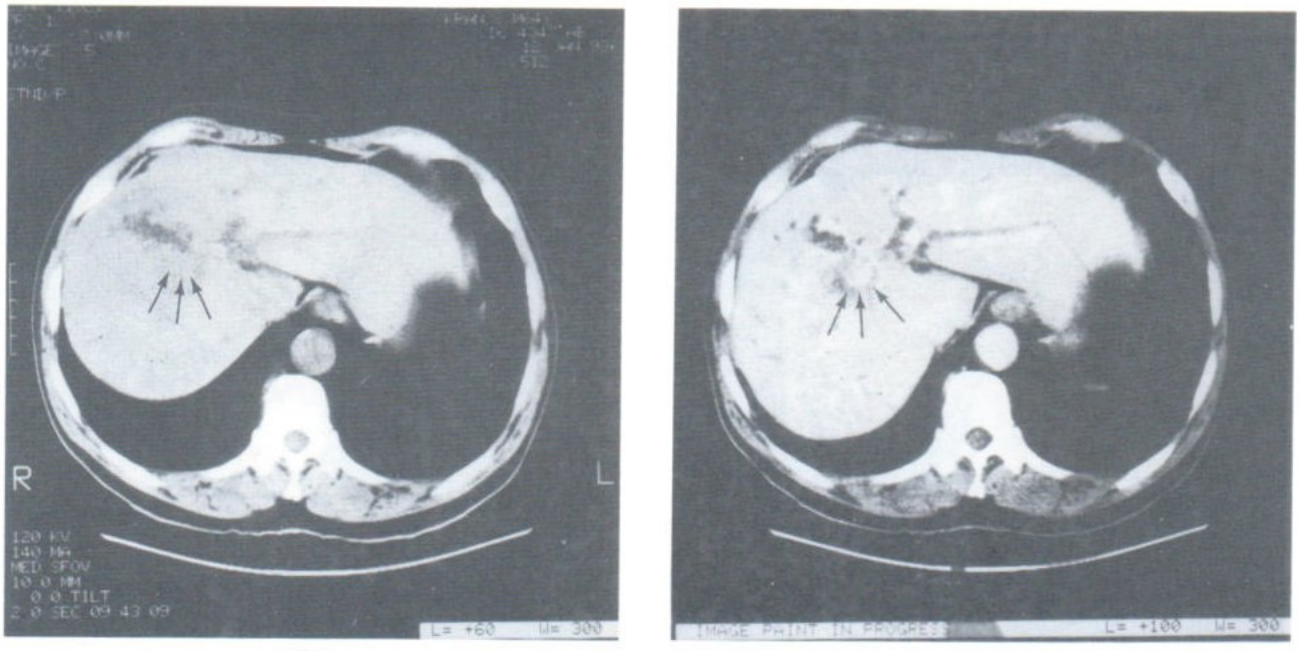
11B

Fig. 11. Peripheral CHCA with hyperdensity areas (a). powerlike high attenuation areas (arrowheads) within low attenuation mass in RT. lobe, mucin products or calcification (b). Right lobe mass (opened arrow) with peritumoral duct dilatation (black arrow) and a few tiny high density spots (arrowheads)



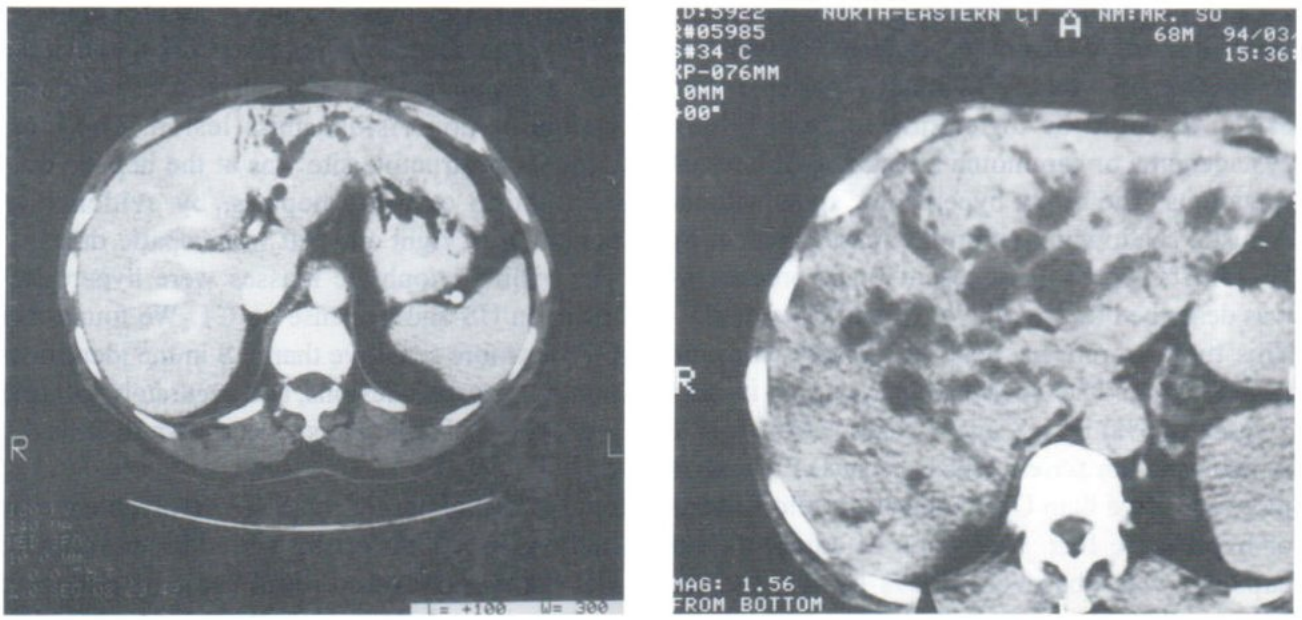
12A 12B

Fig. 12. Extrahepatic extension of CHCA
(a). Peripheral enhanced mass at posterior segment right lobe (arrow) with enlarged lymph nodes at celiac region (white arrows). (b). Large masses in both lobes of liver and involvement of adjacent gastric wall (black arrows) by left lobe mass lesion .



13A 13B

Fig. 13. CT findings of CHCA at porta hepatis with visualized mass lesion
(a). Non-union of dilated intrahepatic ducts in both lobes of liver with abrupt termination at the bifurcation by an isodense mass on pre-contrast study (black arrows) (b). slight enhancement on post-contrast study (black arrows)



14A 14B

Fig. 14. CT of extrahepatic type CHCA with non-visualized mass lesion
(a). Isolated dilatation of left main hepatic duct and branches indicates obstructive site at left main hepatic duct ,no mass is visible. Slightly atrophic change of involved liver at medial segment LT. lobe. (b). Marked dilatation of the intrahepatic ducts both lobes without extrahepatic duct dilatation by CHCA at porta hepatis, non-visualized mass .

DISCUSSION

In our series, we found a slightly male predominance, as was described in the previous literatures.[1, 2, 5, 9] The male : female ratio is about 1.44 : 1, with the average age of 53.5 years, which is lower than the studies at many institution, particularly Okuda et al. Series (62.2 yrs.),[1] but approximate with series of Choi et al. & Wibulpolprasert et al.[5, 9] The lowest age of our patient is 22 years old. We found more cases of peripheral type more than central type significantly because a large number of cases of operated central type underwent surgical bypass without biopsy. The US findings of peripheral type are two patterns of nodular and infiltrative forms (the former is more common). In the majority of cases, tumors were located in the right lobe, particularly posterior segment. Peritumoral duct dilatation was seen in nearly half of all cases. The CT findings of peripheral type are mainly the nodular form with solid hypodense mass. In more than half of cases, CT show peritumoral bile duct dilatation. Lymphadenopathy was detected by CT better than US. The US and CT findings of nodular form of the peripheral type in our study was not different from the previous reports, mainly solid, solitary, large size (>5 cm.) mass, ill or well defined margin with increased echogenicity and ill defined low density, slightly enhanced mass respectively. The common location is at the posterior segment of right lobe of liver. The tumor size was mostly large because they were rarely producing symptoms early in their course. We see dilated peritumoral intrahepatic ducts more often than the previous reports (41.46% by US, 52.5 % by CT). This is a helpful,although not definite finding for distinguishing CHCA from other liver tumors. We

have one case of cystic CHCA from US which is an uncommon type as previously reported by Lee et al.[13] It could be differentiated from biliary cystadenoma or carcinoma by lacking of internal septations. The bright hyperechoic spots without acoustic shadowing within the mass depicted by US (4.87%) probable represent mucin product, as was described by Kokubo et al. and Choi et al.[7, 8] This tumor rarely has calcific density or cystic degeneration. The calcification was seen in only 2 cases (2.3%) by US and 8 cases (20%) by CT imagings in our series. This is because CT scan is more sensitive than US in detecting calcification or hyperdense foci. Retraction of adjacent liver capsule was observed 17.5% by CT, as was reported by Soyer.[11] Multiple masses were found on US (4 cases) and CT (2 cases). The CT images revealed a dominant mass and adjacent satellite nodules, which could mimic with metastatic tumor. Liver atrophy was less uncommon in peripheral type than in central type CHCA.

In one case, fascioliasis was found, which may imply relationship between liver fluke and CHCA, or it may be an incidental findings. We could not definitely concluded.

When comparing CT with US findings in 22 patients who underwent both investigations, we found that CT was more sensitive than US for detecting a local extrahepatic extension, particularly diaphragmatic involvement and lymphadenopathy. Peripheral CHCA is commonly located at the posterosuperior part of right lobe of liver where it is difficult to detect by US unless a careful intercostal approach is performed, the same as previously mentioned by Wibulpolprasert et al.[9]

The infiltrative form of peripheral type CHCA (5 cases) could not be differentiated from infiltrative hepatoma or infiltrative metastases by US or CT.

Of 27 patients who had extrahepatic type CHCA, the images findings were dilatation of the bile ducts above the obstructive site, and either visible or non-visible mass lesion. The most frequent obstructive site was at the hepatic duct bifurcation or porta hepatis, by evidence of nonunion of right and left intrahepatic ducts.[7,16] The visible exophytic masses were hyperechogenic on US and isodense on CT. We found that CT was more sensitive than US in the identification of metastatic lesions, and accurately locating the level of obstructive site as shown in table 3.

Evaluation of vascular involvement was limited in our study because no additional doppler US were performed and lack of accurate portovenous phase in every case studied by CT. Doppler US and helical CT scan (two phases) are more effective in this regard.

CONCLUSION

We found : (1). high percentage of peritumoral duct dilatation in peripheral type of CHCA. (2). CT scan is more sensitive than US in the detection of local extrahepatic extension. (3). The images findings of infiltrative form of peripheral type can not be differentiated from infiltrative hepatoma or infiltrative metastases. (4). The extrahepatic type of CHCA, commonly affected at the main hepatic duct bifurcation with visible or non-visible mass lesion. (5). CT is more sensitive than US for the identification of the level of biliary obstruction and extrahepatic extension for extrahepatic type of CHCA.

We, therefore, use sonography as a screening examination and CT as a complementary study in the evaluation of CHCA and for tumor staging.

ACKNOWLEDGEMENT

We thank Professor Tula Dhiensiri, for editing the manuscript.

REFERENCES

1. Kunio Okuda, Yasuhiko Kubo, Nobuo Okazaki, Tsuneaki Arishima et al; Clinical aspects of intrahepatic bile duct carcinoma including hilar carcinoma: Cancer 1977; 39: 232-246
2. Edmondson HA, Peter RL; Tumor of the liver: pathologic features: Seminar Roentgenology 1983 ; 18: 75-83
3. P. Jongsuksuntigul and T. Insomboon; Epidemiology of Opisthorchiasis and national control programme in Thailand : Southeast-Asian-J-Trop-Med-Public-Health 1998, June; 29 (2): 327-32
4. Pairojkol C., Sithithaworn P., Sripa B., Thamawit W., Ito N., Itoh M. ; Risk groups for opisthorchiasis – associated cholangiocarcinoma: indicated by a study of worm burden related biliary pathology. Kan Tan Sui 1991; 22(3): 393-402
5. Byung Ihn Choi, Jae Hyung Park, Yong Il Kim: Peripheral Cholangiocarcinoma and Clonorchiasis: CT findings: Radiology 1988; 169: 149-153
6. Ana M. Viamonte Ros., William W. Onnsteu: Intrahepatic Cholangiocarcinoma: Radiology 1988; 167: 689-693
7. Byung Ihn Choi, Jeong Hun Lee, Man Chung Han; Hilar Cholangiocarcinoma; Comparative study with sonography and CT: Radiology 1989; 172: 689-692
8. Takashi Kokubo, Yuji Itai, Kuni Ohtomo; Mucin – hypersecreting Intrahepatic Biliary neoplasms : Radiology 1988; 168: 609-614
9. Busanee Wibulpolprasert, Tula Dhiensiri; Peripheral cholangiocarcinoma: Sonographic Evaluation: J Clin Ultrasound 1992; 20: 303-314
10. Yasuyuki Yamashita, Mutsumasa Takahashi, Susumu Kanazawa, Chusilp Charnsangavej and Sidney Wallace; Parenchymal Changes of the Liver in Cholangiocarcinoma: CT Evaluation: Gastrointest Radiology 1992; 17: 161-166
11. Phillippe Soyer, David A. Bluemke, Christiane Vissuzaine; CT of hepatic Tumors : Prevalence and specificity of Retraction of Adjacent Liver Capsule: AJR 1994; 162: 1119-1122
12. Steven J.Garber, Jennifer J. Donald, and William R. Lees; Cholangiocarcinoma: Ultrasound Features and Correlation of Tumor Position with Survival: Abdominal Imaging 1993; 18: 66-69
13. S.K. Lee, B.I. Choi , J.M. Cho ,J.K. Han ; Cystic peripheral cholangiocarcinoma : Sonography and CT: Abdominal Imaging 1995; 20: 131-132
14. Phillippe Soyer, David A. Bluemke, Ralph Reichle; Imaging of Intrahepatic Cholangiocarcinoma : AJR 1995; 165: 1427-1431
15. B.I. Choi, J.K. Han, Y.M. Shin; Peripheral Cholangiocarcinoma: Comparison of MRI with CT: Abdominal Imaging 1995; 20: 357-360
16. Carlo Emanuele Neumaier, Michele Bertolotto, Rosaria Perrone; Staging of Hilar Cholangiocarcinoma with Ultrasound: J Clin Ultrasound 1995; 23: 173-178.