RESULTS
&
CASE PRESENTATION

RESULTS

On the average , fifty one (51) focal nodules were detected in all series . (23 were benign , and 28 were malignant) . That were subjected to analysis were thirty (30) nodules . In all cases there were no combination between two pathologic entities apart from two (2) cases of degenerative nodules (benign lesions) found with H.C.C and both conditions were considered as malignant **(Case No. 1)** .

From the fifty one (51) focal nodules were detected , thirty (30) nodules were selected and subjected to analysis , one from each case . The nodules selected was the one that was pathologically studied , in order to avoid bias from calcifying benign as a malignant and the vice versa .The diagnosis of other nodules, whether benign or malignant , were partly based on biopsy data if available or on imaging features .

The data of each modalities and MR sequences were obtained separately and compared basically between the characteristic features relevant to benign and malignant. Statistical analysis was performed and tests of significance were obtained. Then, sensitivity, specificity, positive and negative predictive values were obtained for the three modalities on account of professional diagnosis of each (after calculation of the true positive and true negative in comparison of the pathologic nature of the lesions). Then, comparative analysis between the three modalities were obtained to assess the diagnostic capability for each. Lastly, the Receiver Operating Characteristic Curve (ROC) was done for each modality , to compare the results of the three modalities as regard its sensitivity and specificity (1- specificity) . The diagnostic capability was determined by calculating the area under the curve for each modality . The results were expressed as (the mean + or – 1 standard deviation) . **Kastsuyoshi Ito , et al 1997 .**

Thirty (30) patients having hepatic masses were studied . Eighteen (18) patients (60 %) proved to have malignant lesions , while twelve (12) patients (40 %) had benign lesions , based on histopathological diagnosis .Nineteen (19) patients (63.3 %) had solitary focal lesion , while eleven (11) patients (36.7 %) had more than one (1) lesion (multiple lesions) **(Case No. 2)** .

All the series had ultrasonography , Color Doppler US (CDUS) , CT scan , and Magnetic Resonance Imaging (MRI) . Twenty (20) patients had chest X ray .Together with complementary laboratory assay (Alpha pheto protein) in fifteen (15) patients (50 %).

Eventually , lesions were classified as benign in case of the following pathologic entities were proven : Hemangioma , Degenerative nodule , Abscess , Adenoma , Caroli syndrome , Focal nodular hyperplasia (F.N.H) and focal segmental hypertrophy (F.S.H) .They were diagnosed as malignant in case either Hepatocelluar carcinoma (H.C.C) , Cholangiocarcinoma, and Metastasis .**Table (1) , and Fig. (2)** show the incidence of different pathological types .

AGE OF THE PATIENTS

Age of the patients varied between (35- 70) years old . Patients with benign lesions had age varied between (35- 50) years with mean age of (43.4) years , while those with malignant lesions had age average between (37- 70) years with mean age of (55.7) years . The difference in age between benign and malignant lesions is statistically significant (P = .002) . **Table (2)** shows the mean age of benign and malignant patients .

SEX OF THE PATIENTS

Twenty six (26) patients (86.6 %) were male . Male patients with benign nodules were eight (8) patients (26.7 %) , while those with malignant nodules were eighteen (18) patients (60 %) . Only four (4) female patients (13.3 %) were included in this study and all were had benign lesions. The difference in sex is statistically not significant (Fisher's Exact Test of Chi – Square tests = .018) .**Table (3)** show the sex distribution between the benign and malignant lesions .

Table (1) Incidence of different pathological types

Types	Pathology	No	%
Benign (12 cases 40 %)	1- Hemangioma	3	10
	2-Adenoma	1	3
	3-Focal Nodular Hyperplasia	1	3
	4-Abscess	2	7
	5-Degenerative Nodules	3	10
	6-Caroli Syndrome	1	3
	7-focal segmental hypertrophy	1	3
Malignant (18 cases 60 %)	8-Hepato Cellular Carcinoma	14	47
	9-Metastasis	3	10
	10-Cholangiocarcinoma	1	3
Total		30	100

-No = Number of patients .

- % = Percent of the patients .

Bar chart showing the percentage of different types of pathology (Fig 2)

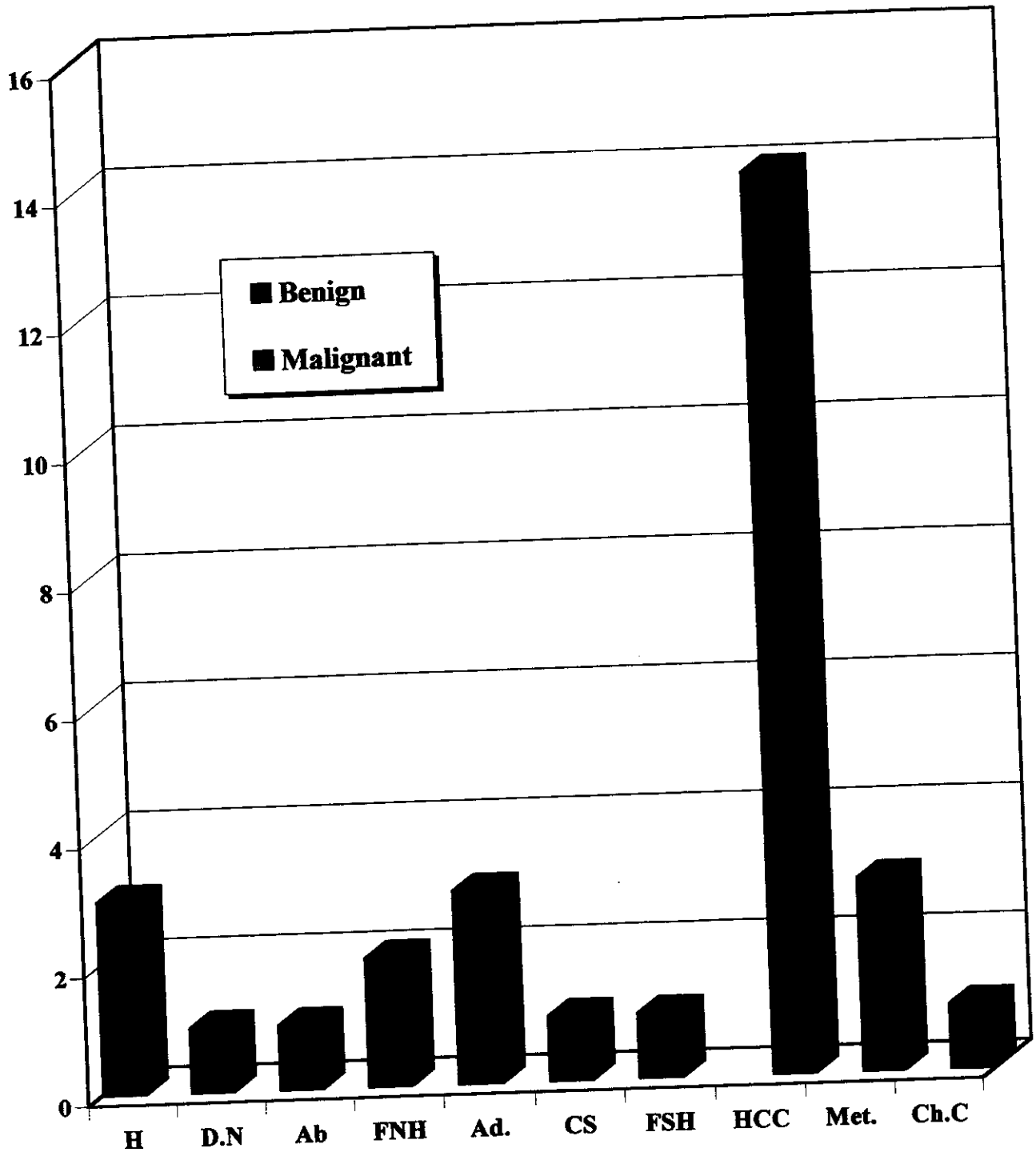


Table (2) The mean age of benign and malignant lesions.

Type	NO	Mean age	Standard Deviation	P value
Benign	12	43.4	9.4720	.0002
Malignant	18	55.7	9.4031	

Table (3) Sex incidence of benign and malignant lesions .

Types	Male		Female		Total	
	No	%	No	%	No	%
Benign	8	26.7	4	13.3	12	40
Malignant	18	60	-	-	18	60
Total	26	86.7	4	13.3	30	100

NB:
Fisher's Exact Test (of Chi Square) = .o18 (not significant) .

Ultrasonography Echocharacteristics

Echocharacteristics of different focal lesions in 30 patients examined were suggestive benign lesions in seven (7) patients (23.3 %) and were suggestive of malignant lesions in twenty three (23) patients (76.7 %) .

Five (5) benign cases were misdiagnosed as malignant .Two cases of degenerative nodules , one case of focal nodular hyperplasia (F.N.H) , one case of focal segmental hypertrophy , and one case of Hemangioma were misdiagnosed as H.C.C **(Case No. 3)** . As well as one case of large abscess was misdiagnosed as a large hemangioma..

- **Hypoechoic pattern :**

The Hypoechoic pattern were found in seven (7) patients (23.3 %) , two (2) patients (6.7 %) were benign and five (5) patients (16.7 %) were malignant . **Table 4** (A,B) shows the incidence of different echopattern in US .

- **Hyperechoic pattern :**

The Hyperechoic pattern were found in seven (7) patients (23.3 %) , four (4) patients (13.3 %) were benign and three (3) patients (10 %) were malignant .

- **Isoechoic pattern :**

The Isoechoic pattern was the least encountered pattern . It were found in four (4) patients (13.3 %) . Two (2) patients (6.7 %) were benign and the other were malignant .

- **Mixed pattern :**

The mixed pattern were found in twelve (12) patients (40 %) , four (4) patients (13.3 %) were benign and eight (8) patients (26.7 %) were malignant . **(Case No. 4)**

Table (4 A, B,C)

A- The incidence of different echopattern of the examined lesions by sonography (biopsy based) .

Echopattern	Benign		Malignant		Total	
	No	%	No	%	No	%
Hypoechoic	2	6.7	5	16.7	7	23.3
Hyperechoic	4	13.3	3	10	7	23.3
Isoechoic	2	6.7	2	6.7	4	13.3
Mixed	4	13.3	8	26.7	12	40
Total	12	40	18	60	30	100

B- The incidence of different echopattern of the examined lesions by sonography (Provisional US diagnosis) .

Echopattern	Benign		Malignant		Total	
	No	%	No	%	No	%
Hypoechoic	2	6.7	5	16.7	7	23.3
Hyperechoic	2	13.3	5	16.7	7	23.3
Isoechoic	1	3.3	3	10	4	13.4
Mixed	2	6.7	10	33.3	12	40
Total	7	23.3	23	76.7	30	100

C-Incidence of different ultrasonographic echo pattern of H.C.C

Echopattern	No .	%
Hypoechoic	2	14.3
Hyperechoic	1	7.1
Isoechoic	2	14.3
Mixed	9	63.3
Total	14	100

As a summary ,we noticed that the malignant lesions were mainly mixed or hypoechoic while the benign lesions were mainly hyperechoic , however , there is negative correlation between the US texture and the US diagnosis where (r = - .029) . **Table (7)** shows the correlation between the US texture , and biopsy diagnosis .

Texture and morphology of the lesion On US (Table 5)

- **Definition of the lesion** (well defined – ill defined) :

The majority of the discovered nodules were well defined , nineteen (19) cases (63.3. %) . Malignant lesions were more ill-defined , nighn (9) cases (30 %) ,while the benign ill-defined cases were only two (2) cases (6.7 %) , however the Fisher's Exact Test for Chi – Square is not statically significant (p = .121) .

- **Presence of the capsule in US :**

Two (2) cases (6.7 %) from all patients were had capsulated lesions . One (1) case was benign and other one was malignant . Fisher's Exact Test for Chi – Square is not statically significant (p = 1.000) .

- **Degeneration :**

Six (6) cases (20 %) showed degeneration .Most of these cases were malignant four (4) cases (13.3 %) . While two benign (2) cases (6.7 %) cases show degeneration . The difference was statically insignificant (P=.0358) .

- **Calcification :**

This was rare finding , one (1) case only (3.3 %) Shows calcification and it was a benign case .Table (5) shows the morphological aspects of he hepatic nodules on sonography and its statistical significance .

- **Hemorrhage :**

This was rare finding , one (1) benign case only (3.3 %) but this finding was not detected by US .

- **Fate :**

Fat was encountered in only one (1) case (3.3 %) and it was H.C.C .

Table (5) The morphological aspects of the lesion on the sonography .

Morphology	**Benign** (12 case)		**Malignant** (18 case)		**Total** (30 case)		**P value**
	No	**%**	**No**	**%**	**No**	**%**	
Capsule	1	3.3	1	3.3	2	6.7	1.000
Well-defined margin	10	33.3	9	30	19	63.3	.121
Ill- defined margin	2	6.7	9	30	11	36.7	
Calcification	1	3.3	-	-	1	3.3	-
Degeneration	2	6.7	4	13.3	6	20	.358
Fat	-	-	1	3.3	1	3.3	-
Presence of focal bulge	1	3.3	5	16.7	6	20	.358
Blood	-	-	-	-	-	-	-

* = Significance { by Chi square Test (Fisher's Exact Test) } .

- **Presence of focal bulge through the liver contour:**

Focal bulge is encountered in six (6) cases (20 %) . One (1) cases (3.3 %) was benign (focal segmental hypertrophy) and five (5) cases (16.7%) were malignant (all were H.C.C) . The difference was statistical not significant (P value = .358).

Other US data (table 6)

- **Cirrhosis :**

Cirrhosis was noted in fourteen (14) cases (36.7 %) . Eleven (11) cases were malignant and three (3) cases (10 %) were benign .

- **Ascites :**

Ascites was noted in fourteen (14) cases (36.7 %) . Eleven (11) cases were malignant and three (3) cases (10 %) were benign .

- **Biliary tree dilatation :**

Two (2) cases (6.7 %) were showed biliary radicals dilation . One (1) case (3.3 %) was benign and the other was malignant .

- **Hepatic veins thrombosis and Porta hepatis LN:**

Were not seen in any case .

- **Portal vein thrombosis :**

Portal vein thrombosis appeared echogenic mass within the lumen of the main portal vein or its right or left branches . (8) cases (26.7 %) were encountered and all were malignant . Fisher's Exact Test for Chi – Square is not statically significant (p = .290) . **(Case No. 5).**

- **Splenomegally :**

Splenomegally were found in fourteen (14) cases (46.7 %) . Eleven (11) cases were malignant .

- **Collateral :**

Collateral were found in nine (9) cases (30 %) . Seven (7) cases were malignant .Table (6) shows the hepatic and abdominal abnormalities in US .

Table (6) the incidence of hepatic and abdominal abnormalities in ultrasonography .

US Finding	Benign (12 cases)		Malignant (18 cases)		Total (30 cases)	
	NO	%	No	%	No	%
Cirrhosis	3	10	11	36.7	14	46.7
Ascites	3	10	11	36.7	14	46.7
Biliary Radicals Dilatation	1	3.3	1	3.3	2	6.7
Collateral	2	6.7	7	23.3	9	30
Hepatic vein Thrombosis	-	-	-	-	-	-
Porta Hepatis LN.	-	-	-	-	-	-
Splenomegally	3	10	11	36.7	14	46.7
Portal vein thrombosis	-	-	8	26.7	8	26.7

US provisional diagnosis (Table 7)

Ultrasound provisional diagnosis were suggestive of benign lesions in seven (7) cases (23.3 %) and were suggestive of malignant lesions in twenty three (23) cases (76.7 %) .

Five (5) benign cases were misdiagnosed as malignant ones . Two cases of degenerative nodules (hyperechoic) , One case of focal segmental hypertrophy (isoechoic) , one case of focal nodular hyperplasia (mixed echopattern) , one case of hemangioma (mixed echopattern) were misdiagnosed as H.C.C .

Statistically, there is negative correlation between the US texture and US provisional diagnosis , where (r = - .029) . On the other hand , there is correlation (mild) between the US provisional diagnosis and final diagnosis by biopsy , where the coefficient correlation (r = .676 *) and this correlation is statistically significant , where P < .0005 .

Table (7) correlation coefficient between US texture , US provisional diagnosis , and final diagnosis by biopsy .And its statistical significance by Chi – square test .

	Correlation & its significance	US Texture	US provisional diagnosis	Final diagnosis by biopsy
US Texture	Correlation coefficient	1.000	- .029	.008
	P value (significance)	.	.881	.966
Biopsy	Correlation coefficient	.008	.676 *	1.000
	P value (significance)	.966	.000	.
US provisional diagnosis	Correlation coefficient	- .029	1.000	.676 *
	P value (significance)	.881	.	.000

* Correlation is significant at the .o1 level .

Detection of thrombosis in the portal vein and its branches by color Doppler US.

We consider the color Doppler as the gold standard for estimation the patency of the portal vein and its main branches. Ten (10) cases (33.3 %) of thrombosis were detected by color Doppler US , five (5) (50 %) cases found in the main portal vein stem , while the remaining five (5) were found within its right or left branches .All detected cases were malignant (all were H.C.C , eight (8) cases were capsulated). Fisher's Exact Test for Chi – Square shows statistical significant difference between benign and malignant lesion among occurrence of PV thrombosis where (p = .002) **.Table (8)** . NB : only one case is found in the posterior branch of the right portal vein. **(Case No. 13) .**

Color map

The majority of cases twenty sex (26) cases (86.7 %) showed positive color follow related to the nodules **(Case No.6)** .About nine (9) cases (30 %) of benign lesions were positive for color follow ,while seventeen (17) cases (65.7 %) of the malignant cases showed this character . **Table (9)** .

Pattern of color map related to different hepatic nodules :

Table (10)

- **Basket pattern :**

This pattern were found in twelve (12) cases (40 %) , two (2) cases (6.7 %) were benign and ten (10) cases were malignant .

- **Vessels within the tumor :**

This pattern were found in ten (10) cases (33.3 %) . Five (5) cases (16.7 %) were benign , while five (5) cases (16.7 %) were malignant . **(plate 29)**

- **Spot pattern :**

This pattern were found in two (2) cases (6.7 %) , all were benign.

- **Detour pattern :**

This pattern were found in two (2) cases (6.7%) , all were malignant .

Table (8) Incidence of thrombosis in the main portal vein and its branches in conventional US and color Doppler US .

	Conventional US				Color Doppler US			
	Benign		Malignant		Benign		Malignant	
	No	%	No	%	No	%	No	%
Thrombosis in the main PV stem	-	-	**3**	**10**	-	-	**5**	**16.7**
Thrombosis in Branches of the PV.	-	-	**5**	**16.7**	-	-	**5**	**16.7**
Total	-	-	**8**	**26.7**	-	-	**10**	**33.3**

Table (9) Incidence of color flow map in relation to nodules .

	Benign		Malignant		Grand Total		St. Sig. (P value)
	NO	%	NO	%	NO	%	
Present	9	30	17	56.7	26	86.7	0.18
Absent	3	10	1	3.3	4	13.3	
Total	12	40	18	60	30	100	

Pattern of Doppler flow (Table 11)

- **Peri tumoral pulsating flow :**

This pattern of Doppler flow were found in eleven (11) cases (36.7 %) , all were malignant .

- **Intratumoral pulsating flow :**

This pattern not found .

- **Peritumoral continuos flow :**

Were found in five (5) cases (16.7 %) . Three (3) cases (10 %) were malignant and two (2) cases (6.7 %) were benign.

- **Intratumoral continuos flow :**

This pattern were found in ten (10) cases (33.3%) , six (6) cases were benign (20 %) and the remaining were malignant .

NB: The mean peak systolic velocities , end systolic velocities and resistance index mean value , were not calculated as these details are away from the interest of this thesis .

Table (10) Incidence of color Doppler pattern in different focal hepatic lesion .

	Benign		Malignant		Total	
	No	%	No	%	No	%
Basket pattern	2	6.7	10	33.3	12	40
Vessels within the tumor	5	16.7	5	16.7	10	33.3
Spot pattern	2	6.7	-	-	2	6.7
Detour pattern	-	-	2	6.7	2	6.7
Total	9	20	17	66.7	26	86.7

Table (11) Incidence of Doppler flow pattern in different focal hepatic lesions .

	Benign		**Malignant**		**Total**	
	No	%	No	%	No	%
Peri-tumoral pulsating flow	-	-	11	36.7	11	36.7
Intar – tumoarl pulsatinf flow	-	-	-	-	-	-
Peri-tumoral cotentious flow	3	10	2	6.7	5	16.7
Intra-tumoral contenious flow	6	20	4	13. 3	10	33.3
Total	9	30	17	56.7	26	86.7

Computed Tomography (CT) (Table 12)

CT density of different focal lesions in 30 patients examined were suggestive of benign lesions in nine (9) patients (30 %) and were suggestive of malignant lesions in twenty one (21) patients (70 %) .

Three (3) benign cases (10 %) were misdiagnosed as malignant. Two (2) cases of degenerative nodules(**Case No. 7)** and one (1) case of focal segmental hypertrophy were misdiagnosed as H.C.C

- **Hypodense pattern :**

This pattern was encountered in eighteen (18) patients (60 %) , Eight (8) cases (26.7 %) were benign and ten (10) cases (33.3 %) were malignant .

- **Hyperdense pattern :**

This pattern was encountered in two (2) cases only (6. 7 %) , one (1) case was benign (3.3 %) and the other was malignant .

- **Isodense pattern :**

This pattern was encountered only in one (1) case (3.3 %) and it was benign .

- **Mixed Density :**

This pattern was encountered in nine (9) cases (30 %) .Eight (8) cases (26.7 %) were malignant while only one (1) case was benign (3.3 %) .

Table (**12** A, B) shows the variable density character of the examined nodules on CT .

Table (15) shows the correlation between the CT texture , CT diagnosis and Biopsy diagnosis .

Table (12 A, B, C)

A- The variable density character of the examined lesions by CT (biopsy based) .

Density Character	Benign		Malignant		Total	
	No	%	No	%	No	%
Hypodense	8	26.7	10	33.3	18	60
Isodense	1	3.3	-	-	1	3.3
Hyperdense	2	6.7	-	-	2	6.7
Mixed	1	3.3	8	26.7	9	30
Total	12	40	18	60	30	100

B- The variable density character of the examined lesions by CT (Provisional CT diagnosis) .

Density Character	Benign		Malignant		Total	
	No	%	No	%	No	%
Hypodense	7	23.7	11	36.3	18	60
Isodense	-	-	1	3.3	1	3.3
Hyper dense	1	3.3	1	3.3	2	6.7
Mixed	1	3.3	8	26.7	9	30
Total	9	30	21	70	30	100

C-Incidence of different CT density in H.C.C

Density	No .	%
Hypodense	7	5o
Hyperdense	-	-
Isodense	1	7.1
Mixed	6	42.9
Total	14	100

Texture and morphology of the lesion on CT

(Table 13)

- **Capsule :**

Three (3) patients showed capsule on CT .Two (2) cases (6.7 %) were malignant , while one (1) case (3.3 %) was benign. Fisher's Exact Test for Chi – Square is statically not significant (p = 1.000) .

- **Degeneration :**

Eleven (11) cases (36.7 %) show degeneration .Nine (9) cases (30 %) were malignant and two (2) cases (6.7 %) were benign . The difference is statically not significant by Fisher's Exact Test for Chi – Square is (p = .058) .**(Case No. 8).**

- **Calcification :**

Calcification was found in one (1) cases (3.3 %) and it was benign .

- **Definition of the lesion** (well defined –ill-defined) :

Twenty (20) patients (66.7 %) showed well defined margin , nine (9) cases (30 %) were malignant and eleven (11) cases (36 .7 %) were benign . The difference is statically not significant (p = .049) .

- **Enhancement :**

Nineteen (19) patients (63.3 %) showed enhancement after intravenous contrast administration , eleven (11) cases (36.6 %) were malignant and eight (8) cases (26.7 %) were benign .

- **Hemorrhage :**

Hemorrhage were not encountered in any case by CT .

- **Fate :**

Fat was encountered in only one (1) case (3.3 %) and it was H.C.C . **(Case No. 9) .**

- **Presence of focal bulge through the liver contour:**

Focal bulge is encountered in six (6) cases (20 %) . One (1) cases (3.3 %) was benign (focal segmental hypertrophy) and five (5) cases (16.7 were malignant (all were H.C.C) . The difference was statistical not significant (P value = .358).

Table (13) The morphological aspects of the lesions on the CT .

Morphology		**Benign** (12 case)		**Malignant** (18 case)		**Total** (30 case)		**P value**
		No	**%**	**No**	**%**	**No**	**%**	
Capsule		1	3.3	2	6.7	3	10	1.000
Margin	Well-defined margin	11	36.7	9	30	20	66.7	.049
	Ill-defined margin	1	3.3	9	30	10	33.3	
Calcification		1	3.3	-	-	1	3.3	
Degeneration		2	6.7	9	30	11	36.7	.058
Enhancement		8	26.7	11	36.7	19	63.3	-
Presence of focal bulge		1	3.3	5	16.7	6	20	.358
Fat			-	1	3.3	1	3.3	-
Blood		-	-	-	-	-	-	-

* = Significance { by Chi square Test (Fisher's Exact Test) } .

Other CT data (Table 14)

- **Cirrhosis :**

Cirrhosis was noted in fourteen (14) cases (36.7 %) . Eleven (11) cases were malignant and three (3) cases (10 %) were benign .

- **Ascites :**

Ascites was noted in fourteen (14) patients (46.7 %) . Eleven (11) cases (36.7 %) were malignant and three (3) cases were benign .

- **Biliary tree dilatation :**

Two (2) cases (6.7 %) were detected . One (1) benign **(Case No. 10)** and the other was malignant **.(Case No. 15)**

- **Hepatic veins thrombosis :**

Hepatic vein thrombosis was not seen in any case .

- **Porta hepatis lymph node :**

Porta hepatis lymph node was not seen in any case .

- **Portal vein thrombosis :**

Portal vein thrombosis appeared as a faintly dense thrombus within the lumen of the portal vein . Six (6) cases (20 %) were shown to have portal vein thrombosis and all were malignant . However the difference is statically not significant by Fisher's Exact Test for Chi – Square is (p = .141) .

- **Splenomegally :**

Fourteen (14) cases (46.7 %) were detected . Eleven (11) cases (36.7 %) were malignant .

Collateral :

Were found in nine (9) cases (30 %) . Seven cases (7) were malignant and two (2) cases were benign .

Table (14) the incidence of hepatic and abdominal abnormalities in CT.

CT Finding	Benign (12 cases)		Malignant (18 cases)		Total (30 cases)	
	NO	%	No	%	No	%
Cirrhosis	3	10	11	36.7	14	46.7
Ascites	3	10	11	36.7	14	46.7
Biliary Radicals Dilatation	1	3.3	1	3.3	2	6.7
Collateral	2	6.7	7	23.3	9	30
Hepatic vein Thrombosis	-	-	-	-	-	-
Porta Hepatis LN.	-	-	-	-	-	-
Splenomegally	3	10	11	36.7	14	46.7
Portal vein thrombosis	-	-	6	20	6	20

CT provisional diagnosis

(Table 15)

CT density of thirty (30) patients examined were suggestive of benign lesion in nine (9) cases (30 %) and were suggestive of malignant lesions in twenty one (21) patients (70 %) .

Three (3) benign cases (10 %) were misdiagnosed as malignant . Two (2) cases of degenerative nodules (one hypodense and one hyperdense) and one (1) case (3.3 %) of focal segmental hypertrophy (isodense) were misdiagnosed as H.C.C.

Statistically , there is no correlation between the CT texture and CT provisional diagnosis , where ($r = 0.256$) . On the other hand ,there is moderate correlation between the CT provisional diagnosis and final diagnosis by biopsy , where the correlation coefficient ($r = 0.802^*$) and this correlation is statistically significant , where $P < .0005$.

Table (15) correlation coefficient between CT texture , CT provisional diagnosis , and final diagnosis by biopsy .And its statistical significance by Chi – square test .

	Correlation & its significance	**CT Texture**	**CT provisional diagnosis**	**Final diagnosis by biopsy**
CT Texture	Correlation coefficient	1.000	.256	.217
	P value (significance)	.	.172	.250
Biopsy	Correlation coefficient	.217	.802 *	1.000
	P value (significance)	.250	.000	.
CT provisional diagnosis	Correlation coefficient	.256	1.000	.802 *
	P value (significance)	.172	.	.000

* Correlation is significant at the .o1 level .

Magnetic Resonance Imaging

MRI was preformed for thirty (30) patients , the all series . Three (3) sequences were done for each patient , (T_1 weighted , Fast T_2 weighted ,Fast heavy T_2 with multiple echo pulse sequences). Contrast was used only in one case with T_1 parameters. **(Case No. 11).**

Signal Intensity Characteristics in MRI

(Tables 16-A,B,C,D,E,F,)

T_1 Weighted Image :

On this sequence , forty five (45) focal lesions were detected , where nineteen (19) nodules were benign and twenty six (26) nodules were malignant . Fifteen (15) lesions (50 %) in this sequence were hypointese , four (4) lesions (13.3 %) were benign and eleven (11) lesions were malignant . The hyperintense pattern was shown in three (3) cases (10 %) , all were benign . The isointense pattern was shown in five (5) cases (16.7 %) , three (3) cases (10 %) were malignant while two (2) cases (6.7 %) were benign .The mixed pattern was shown in seven (7) cases (23.3 %) , two (2) cases (6.7 %) were benign while five (5) cases (16.7 %) were malignant .**(Table 16-A, D)** show the incidence of different intensity in T_1 benign (16-A) and malignant lesions (16- D) .

The hyperintense pattern were strictly confined to the benign lesions while the hypointese and mixed pattern are more in the malignant lesion , however no statistical correlation between the MRI texture and MRI diagnosis **(Table 20)** .

Fast T_2 Weighted Image :

Fifty one (51) focal lesions were detected by this sequence , twenty three (23) were benign while twenty eight (28) were malignant .(NB: only thirty (30) lesions were subjected to analysis) .

The hyperintense pattern was the most common pattern accounted , fifteen (15) cases (50 %) . Eight (8) cases (26.7 %) were malignant , while seven (7) cases (23.3 %) were benign . The isointense pattern was encountered in eight (8) cases (26.7 %) , six

(6) cases (20 %) were benign and the remaining two (2) were malignant (**Case No. 12**) .

The mixed pattern was found in six (6) cases (20 %) , four (4) cases (13.3 %) were malignant while two (2) case (6.7 %) were benign . The hypointense pattern was found in one (1) case only (3.3 %) and was a benign one . .(**Table 16-B,E)** show the incidence of different intensity in Fast T_2 among benign (16-B) and malignant lesions (16- E) .

The mixed pattern was found more in the malignant lesions while the hyperintense pattern found nearly equal in both benign and malignant lesions . Statistical correlation of MRI texture and diagnosis seen at **(table 20) .**

Fast Heavy $T_2$with multiple echo pulse sequences :

The hypointense pattern was the least encountered intensity . It was encountered only in one (1) case (3.3 %) and it was benign . The isointense pattern was the most common encountered pattern . Thirteen (13) cases (43.3 %) were recorded , eight (8) cases (26.7 %) were malignant and five (5) cases (16. 7 %) were benign .Ten (10) cases (33.3 %) were encountered as a hyperintense pattern , six (6) cases (20 %) were malignant ,while four (4) case (13.3 %) were benign . Mixed pattern were represented in six (6) cases (20 %) , four cases (13.3 %) were malignant and two (2) cases (6.7 %) were benign. **(Table 16-C, F)** show the incidence of different intensity in Fast heavy T_2 benign (16-C) and malignant lesions (16- F) .

Table (16) The different signal intensity pattern of the hepatic lesions in different MRI sequences .

Intensity	Sequence	Benign		Malignant		Total	
		No	**%**	**No**	**%**	**No**	**%**
Hypo	**T_1**	4	13.3	11	36.7	15	50
	Fast T_2	1	3.3	-	-	1	3.3
	Fast H. T_2	1	3.3	-	-	1	3.3
Hyper	**T_1**	3	10	-	-	3	10
	Fast T_2	7	23.3	8	26.7	15	50
	Fast H. T_2	4	13.3	6	20	10	33.3
Iso	**T_1**	3	10	2	6.7	5	16.7
	Fast T_2	2	6.7	6	20	8	26.7
	Fast H. T_2	5	16.7	8	26.7	13	13.3
Mixed	**T_1**	2	6.7	5	16.7	7	23.3
	Fast T_2	2	6.7	4	13.3	6	20
	Fast H. T_2	2	6.7	4	13.3	6	20

Table (16-A) Incidence of signal intensity of the different benign lesions in T_1 .

The lesions	Hypointense	Hyperintense	Isointense	Mixed	Total
Hemangioma	2		1		3
Degenerative nodules		2	1		3
Abscesses	1			1	2
Adenoma		1			1
F.N.H				1	1
F.S.H			1		1
Caroli	1				1
Total	4	3	3	2	12

Table (16-B) Incidence of signal intensity of the different benign lesions in Fast T_2.

The lesions	Hypointense	Hyperintense	Isointense	Mixed	Total
Hemangioma		3			3
Degenerative nodules	1	1	1		3
Abscesses		1		1	2
Adenoma		1			1
F.N.H				1	1
F.S.H			1		1
Caroli		1			1
Total	1	7	2	2	12

Table (16-C) Incidence of signal intensity of the different benign lesions in Fast Heavy T_2.

The lesions	Hypointense	Hyperintense	Isointense	Mixed	Total
Hemangioma		3			3
Degenerative nodules	1		2		3
Abscesses			1	1	2
Adenoma			1		1
F.N.H				1	1
F.S.H			1		1
Caroli		1			1
Total	1	4	5	2	12

Table (16-D) Incidence of signal intensity of the different malignant lesions in T_1.

Intensity pattern	H.C.C		Metastasis		Cholangiocarcinoma		Total
	No	%	No	%	No	%	
Hypointense	7	50	3	100	1	100	11
Hyperintense	-	-	-	-	-	-	-
Isointense	2	14.3	-	-	-	-	2
Mixed	5	35.7	-	-	-	-	5
Total	**14**	**100**	**3**	**100**	**1**	**100**	**18**

Table (16-E) Incidence of signal intensity of the different malignant lesions in Fast T_2.

Intensity pattern	H.C.C		Metastasis		Cholangiocarcinoma		Total
	No	%	No	%	No	%	
Hypointense	-	-	-	-	-	-	-
Hyperintense	4	28.6	3	100	1	-	8
Iso or faint hyperntense	6	42.8	-	-	-	-	6
pMixed	4	28.6	-	-	-	-	4
Total	**14**	**100**	**3**	**100**	**1**	**100**	**18**

Table (16-F) Incidence of signal intensity of the different malignant lesions in Fast Heavy T_2.

Intensity pattern	H.C.C		Metastasis		Cholangiocarcinoma		Total
	No	%	No	%	No	%	
Hypointense	-	-	-	-	-	-	-
Hyperintense	2	14.2	3	100	1	-	6
Isointense	8	57.2	-	-	-	-	8
Mixed	4	28.6	-	-	-	-	4
Total	**14**	**100**	**3**	**100**	**1**	**100**	**18**

- **Calcification**

Was not encountered in any case by MRI

- **Hemorrhage :**

Hemorrhage was encountered (only by MRI) in one (1) case (3.3 %) and it was a benign one . **(Case No. 14)**

- **Fat :**

Fat was encountered in only one (1) case (3.3 %) and it was H.C.C . **(Case No. 9)**

- **Presence of focal bulge through the liver contour:**

Focal bulge is encountered in six (6) cases (20 %) . One (1) cases (3.3%) was benign (focal segmental hypertrophy) and five (5) cases (16.7 %) were malignant (all were H.C.C) . The difference was statistical not significant (P value = .358). **(Case No. 16)** .

Morphology of the lesions by MRI

(Table 17 , 18)

- **Capsule :**

Fourteen (14) capsule (46.7 %) were detected , eleven (11) capsules (36.7 %) were malignant and only three (3) capsules (10 %) were benign .The difference was statically significance (p = .oo5) . All the malignant lesions having capsule in T_1 were H.C.C. **(Case 13) .**

T_1 weighted image was more sensitive in detecting capsule .It detected capsules in fourteen (14) cases (46.7 %) , while Fast T_2 and Fast heavy T_2 detected capsules in ten (10) cases (33.3 %) .

- **Definition of the lesion :**

Definition of the lesion is the ability to define the lesion among the adjacent parenchyma .The definition is hampered by cirrhosis ,which distort the liver signal pattern . **(Masayuki Kanematsu , et al , 1999)**

Fast T_2 and Fast heavy T_2 were more better than T_1 as regard the definition of the lesions , where twenty four (24) cases (80 %) were well defined on these sequences . Fourteen (14) cases were malignant and ten (10) cases (33.3 %) were benign .On the other hand , in the T_1 weighted image fourteen (14) cases (46.7 %) were well defined , eight (8) cases (26.7 %) were malignant and sex (6) cases (20 %) were benign .

The ill defined margin more encountered in malignant lesions along all pulse sequences .However , no statistical significance (P = 1.000) .

- **Degeneration :**

Degeneration was depicted in eleven (11) cases (36.7 %) nine (9) cases (30 %) were malignant and two (2) cases (6.7 %) were benign . MRI was very helpful and clear in characterization of these degenerative changes . The difference was statically insignificant (P = 0.121) . **(Case No. 8 & 16)**

Table (17) The presence of capsule and margin in different hepatic lesions by MRI different sequences .

Morphology by MRI		Sequence	Benign		Malignant		Total		P Value
			No	%	No	%	No	%	
Capsule		T_1	3	10	11	36.7	14	46.7	* .005
		Fast T_2	3	10	7	23.3	10	33.3	
		Fast H.T2	3	10	7	23.3	10	33.3	
Margin	Well - Defined	T_1	6	20	8	26.7	14	46.7	1.00
		Fast T_2	10	33.3	14	46.7	24	80	
		Fast H. T_2	10	33.3	14	46.7	24	80	
	Ill - Defined	T_1	6	20	10	33.3	16	53.3	
		Fast T_2	2	6.7	4	13.3	6	20	
		Fast H. T_2	2	6.7	4	13.3	6	20	

Table (18) The presence of degeneration , fat , calcification and blood in hepatic lesions by different MRI sequences .

Morphology by MRI	Sequence	Benign		Malignant		Total		P value
		No	%	No	%	No	%	
Degeneration (central necrosis)	T_1	2	6.7	8	26.7	10	33.3	.121
	Fast T_2	2	6.7	9	30	11	36.7	
	Fast H. T_2	2	6.7	9	30	11	36.7	
Calcification	T_1	-	-	-	-	-	-	
	Fast T_2	-	-	-	-	-	-	
	Fast H. T_2	-	-	-	-	-	-	
Fat	T_1	-	-	1	3.3	1	3.3	
	Fast T_2	-	-	1	3.3	1	3.3	
	Fast H. T_2	-	-	1	3.3	1	3.3	
Presence of focal bulge	T_1	1	3.3	5	16.7	6	20	.358
	Fast T_2	1	3.3	5	16.7	6	20	
	Fast H. T2	1	3.3	5	16.7	6	20	
Blood	T_1	1	3.3	-	1	3.3	-	
	Fast T_2	1	3.3	-	1	3.3	-	
	Fast H. T_2	1	3.3	-	1	3.3	-	

Other MRI Features

(Table 19)

- **Cirrhosis :**

Cirrhosis was noted in fourteen (14) cases (36.7 %) . Eleven (11) cases were malignant and three (3) cases (10 %) were benign .

- **Ascites :**

Ascites was noted in fourteen (14) cases (36.7 %) . Eleven (11) cases were malignant and three (3) cases (10 %) were benign **.(Case No. 16).**

- **Biliary tree dilatation :**

The biliary radical dilatation was detected as dilated branches of the ducts (signal void at T_1 WI and hyper intense in T_2WI) .
Two (2) cases (6.7 %) were showed biliary radicals dilation . One (1) case (3.3 %) was benign **(Case No. 10)** and it was Caroli syndrome and the other was malignant and it was cholangiocarcinoma **.(Case No.15) .**

- **Hepatic veins thrombosis & Porta hepatis lymph node:**

Were not seen in any case .

- **Portal vein thrombosis :**

Portal vein thrombosis appeared as a loss of the signal void of the vein in T_1 & T_2, or changes in the signal intensity of the related segment (S) of the liver .Ten (10) Cases (33.3 %) were detected by MRI , five (5) cases were detected in the main portal vein stem , while the other five (5) cases were detected within its right or left branches. All the detected cases were malignant and were H.C.C .This is statically significant by Fisher's Exact Test for Chi – Square ($p = .002$) . **(Case No. 16)**

- **Splenomegally :**

Splenomegally were found in fourteen (14) cases (46.7 %) . Eleven (11) cases (36.6 %) were malignant and three (3) cases (10 %) were benign . All the malignant cases were H.C.C except one case was cholangiocarcinoma .

- **Collateral :**

Collateral were found in nine (9) cases (30 %) , either in splenic hilum or gastric bed . Seven (7) cases (23.3%) were malignant and two (2) case were(6.7 %) benign .

Table (19) the incidence of hepatic and abdominal abnormalities in MRI.

MRI Finding	Benign (12 cases)		Malignant (18 cases)		Total (30 cases)	
	NO	%	No	%	No	%
Cirrhosis	3	10	11	36.7	14	46.7
Ascites	3	10	11	36.7	14	46.7
Biliary Radicals Dilatation	1	3.3	1	3.3	2	6.7
Collateral	2	6.7	7	23.3	9	30
Hepatic vein Thrombosis	-	-	-	-	-	-
Porta Hepatis LN.	-	-	-	-	-	-
Splenomegally	3	10	11	36.7	14	46.7
Portal vein thrombosis	-	-	10	33.3	10	33.3

MRI provisional diagnosis

(Table 20)

MRI were suggestive of benign lesion in twelve (12) cases (40 %) and were suggestive in malignant lesions in eighteen (18) cases (60 %) and these finding are identical with the biopsy diagnosis (no false positive nor false negative) .The correlation coefficient between MRI provisional diagnosis and final diagnosis by biopsy is very strong where (r = *1.000) .

However there is no correlation between the MR texture and MR provisional diagnosis , where (r = .188) and this is statically not significant , where (P > .005) . **Table (20) .**

Table (20) correlation coefficient between MR texture , MR provisional diagnosis , and final diagnosis by biopsy .And its statistical significance by Chi – square test .

	Correlation & its significance	**MR Texture**	**MR provisional diagnosis**	**Final diagnosis by biopsy**
MR Texture	Correlation coefficient	1.000	0.188	0.188
	P value (significance)	.	0.321	0.321
Biopsy	Correlation coefficient	0.188	1.000 *	1.000
	P value (significance)	0.321	.	.
MR provisional diagnosis	Correlation coefficient	0.188	1.000	1.000
	P value (significance)	0.321	.	.

* Correlation is significant at .01 .

Comparison Between The Modalities

(Table 21, 22)

After analysis of imaging modalities data , diagnosis was attempted based on imaging signs of each modality . The pathological diagnosis (biopsy based) , was correlated to this imaging diagnosis of each modality whether benign or malignant . The true and false positive and negative results were calculated and then the sensitivity , specificity , positive and negative predictive values were calculated **(table 21, 22)** .

As regard the sensitivity of the different modalities , all the modalities had (100 %) sensitivity . Fast MRI sequences (Fast T_2 and Fast heavy T_2) had the highest specificity (100 %) , followed by CT (75 %) and ultrasonography (58 %) . **Figure 3(ROC curve)** shows the relation between the sensitivity and specificity of US and CT.

Positive Predictive value

Fast MRI sequences had the highest positive predictive value (100 %) , followed by CT (86 %) and US (78 %) .

Negative Predictive value

All the modalities had (100 %) .

Comparison Between The different Modalities in detection of P.V thrombosis

Color Doppler is the gold standard in detection of portal vein thrombosis . MRI , notably the Fast sequences , in addition to T_1 weighted image were had the highest sensitivity and negative predictive value (100 %) , followed by conventional US (80 % sensitivity and 90.9 % negative predictive value) , then CT (50 % sensitivity and 80 % negative predictive value) . **Table (23)**

Table (21) A, B & C

- **(A)** US Evaluation Parameters :

Parameter	%
- Sensitivity	100
- Specificity	58
- Positive predictive value	78
- Negative predictive value	100

- **(B)** CT Evaluation Parameters :

Parameter	%
- Sensitivity	100
- Specificity	75
- Positive predictive value	86
- Negative predictive value	100

- **(C)** MRI Evaluation Parameters :

Parameter	%
- Sensitivity	100
- Specificity	100
- Positive predictive value	100
- Negative predictive value	100

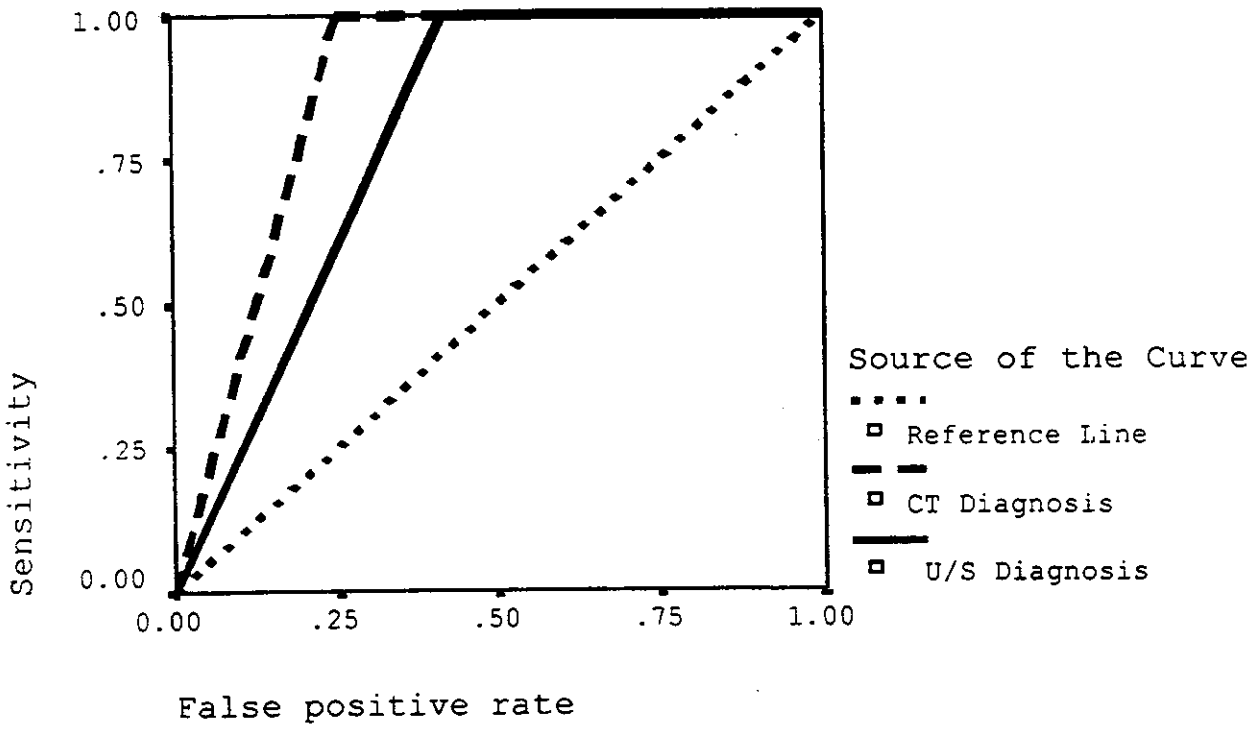
Table (22) Comparison between the parameters modalities :

Parameter	US	CT	MRI
Sensitivity	100	100	100
Specificity	58	75	100
Positive predictive value	78	86	100
Negative predictive value	100	100	100

(Table 23) Detection of PV thrombosis by different modalities:

	CT	US	MRI	CDUS
Sensitivity	50	80	100	100
Specificity	100	100	100	100
Positive predictive value	100	100	100	100
Negative predictive value	80	90.9	100	100

ROC curve for US and CT
(Fig.3)



- **Fig.(3)** : Shows the relation between sensitivity and specificity (1- specificity) or false positive .
- Used to compare between the diagnostic tests. This by calculation the area under the curve which range between zero and one .
- If the area under the curve close to one (1) ...this mean that , the curve is right for diagnosis .If the area under the curve close to zero (0) ...this mean that , the test is wrong for diagnosis .
- **NB:** MR is not represented as it identical to biopsy (no false positive nor false negative) ,so it will be represented at the Y and X axis .