《Original Article》

Tc-99m-Sn Colloid Dynamic and Static Scintigraphic Evaluation of Patients with Portal Hypertension

Shahid KAMAL*, Tariq LODHI**, Huma QURESHI**, Sarwar ZUBERI** and Rafiq KHAN*

Abstract Dynamic scintigraphy of the liver and spleen was performed by injecting Tc-99m-Sn colloid as a bolus in 15 normal controls and 17 patients presenting with portal hypertension. Using a computer, the hepatic and splenic time-activity curves were analyzed. In addition to the Ratio of Area, the Ratio of Integral and Slope of Integral for liver to spleen were also calculated.

The Ratio of the Area (L/S) was significantly different in the normal and portal hypertensives ($p<0.001$). The Ratios of the Integral and the slope of the Integral were not only significantly different in the normals and portal hypertensives ($p<0.001$) but were also significantly different in the cirrhotic and the non-cirrhotic group of portal hypertensives ($p<0.001$).

In the routine study of liver scintigraphy in cases of portal hypertension, by adding the above mentioned method, the increased information of uptake dynamics seems to be useful for differentiating the cirrhotic and non-cirrhotic groups of portal hypertension.

Introduction

Radioactive colloids are useful for the evaluation of reticuloendothelial cell-function status of the liver and spleen in various hepatobiliary diseases. In conjunction with the long established static imaging, dynamic studies have been used extensively in the estimation of liver perfusion and function[1]. Quantitative assessment of hepatic and splenic blood flow by scintigraphy and the computation of various hepatic and splenic indices from the time-activity curves has now been well established and authenticated in normals and in various liver diseases viz., hepatitis, cirrhosis, hepatoma and metastatic liver diseases[2-7]. In this paper we present a method of applying the colloid technique for the differentiation between the cirrhotic portal hypertensive and the non-cirrhotic portal hypertensive groups of patients.

* Atomic Energy Medical Centre, Jinnah Postgraduate Medical Centre, Karachi, Pakistan
** Pakistan Medical Research Council, Jinnah Postgraduate Medical Centre, Karachi, Pakistan
First Copy Received: October 30, 1985
Final Revised: January 20, 1986
Reprint requests to Dr. Shahid Kamal, Atomic Energy Medical Centre, Jinnah Postgraduate Medical Centre, Karachi-35, PAKISTAN.

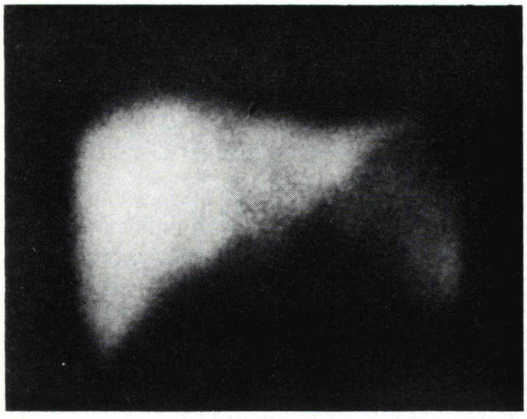
Methods

IMAGING: Patients were placed supine beneath a LFOV gamma camera† so that the liver, spleen and the heart were included in an anterior image. An injection of about 4 mCi (150 MBq) Tc-99m tin colloid was administered intravenously as a bolus. Using an on-line computer system††, digital images were recorded in a 64×64 matrix at 0.5 sec intervals for 240 sec following injection. Anterior and posterior images of 1,500 K counts each were also acquired at 15 min to obtain the static part of the study.

ANALYSIS: 15 normal healthy volunteers and 17 patients presenting with portal hypertension were studied. Static anterior and posterior images were evaluated and reported as in routine scans. ROIs were then drawn around the liver and spleen on the static pictures and the total number of pixels in each ROI noted. Ratio of liver to spleen area

Key words: Tc-99m-Sn colloid, Dynamic hepatosplenic scintigraphy, Portal hypertension.

† SCINTRONIX Gamma Camera Model 480
†† Data General Nova 4X computer system



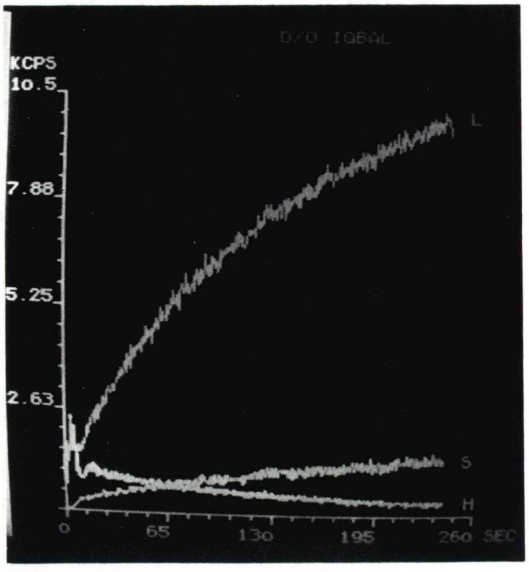


Fig. 1 Static scan and time-activity curves in a normal control.
L: Liver, S: Spleen, H: Heart

Table 2 Patients with

	Age	Sex	Length of history	History of jaundice	Liver enlargement	Spleen enlargement	Ascites	Oesophageal varices	Haem. melaena
1	45	F	5 yrs.	−	—	5 cms	+	+	+
2	48	F	2 yrs.	+	—	11 cms	−	+	+
3	14	M	6 mths	+	4 cms	8 cms	+	+	+
4	40	M	acute bleed	−	—	3 cms	+	+	+
5	25	M	4 yrs.	−	—	20 cms	−	+	−
6	20	M	3 yrs.	−	—	8 cms	−	+	+
7	24	M	3 mths	+	—	9 cms	−	+	+
8	35	M	1 yr.	+	—	6 cms	−	+	−
9	35	F	14 yrs.	+	—	11 cms	−	+	+
10	40	F	8 yrs.	−	5 cms	8 cms	−	+	+
11	30	F	2 yrs.	+	—	5 cms	−	+	+
12	40	M	acute bleed	−	—	5 cms	−	+	+
13	65	F	7 yrs.	+	3 cms	5 cms	−	+	+
14	26	M	3 yrs.	−	—	9 cms	+	+	+
15	65	F	2 yrs.	−	5 cms	8 cms	+	+	−
16	50	F	10 yrs.	−	—	6 cms	+	+	−
17	45	F	4 mths	−	2 cms	4 cms	+	+	+

* Child's criteria of assessment of the degree of liver function impairement[8]

Table 1 Normal controls

	Age	Sex	Static images	A L/S*	I L/S**	SI L/S***		Age	Sex	Static images	A L/S*	I L/S**	SI L/S***
1	23	M	normal	6.05	7.56	8.75	9	34	M	normal	5.34	9.14	9.81
2	32	M	normal	4.84	4.82	5.32	10	30	M	normal	3.92	5.97	6.62
3	40	M	normal	2.92	10.93	14.18	11	41	F	normal	5.56	8.10	8.61
4	30	M	normal	3.36	7.61	8.24	12	28	M	normal	5.95	6.38	6.25
5	35	F	normal	4.79	10.59	11.61	13	24	F	normal	3.55	5.26	7.04
6	33	M	normal	4.24	10.00	10.01	14	18	F	normal	5.78	5.27	4.87
7	26	M	normal	5.11	8.64	9.97	15	17	F	normal	4.66	6.91	5.74
8	30	M	normal	5.84	6.17	8.87							

* Ratio of the liver to spleen Area
** Ratio of the liver to spleen Integral
*** Ratio of the liver to spleen Slope of the Integral

portal hypertension

Impairement of LFTs*	Biopsy	Static images**	A L/S	I L/S	SI L/S	Conclusion
minimal	—	L-↓, patchy, NCA S-e, good conc.	0.80	0.77	0.31	cirrhotic p. hypertension
minimal	cirrhosis	L-↓, patchy, NCA S-e, good conc.	0.82	0.99	0.97	cirrhotic p. hypertension
moderate	—	L-e↓, patchy, NCA S-e, good conc.	1.16	0.42	0.26	cirrhotic p. hypertension
minimal	no cirrhosis	L-NCA S-e, good conc.	1.22	1.73	1.97	non-cirrhotic p. hypertension
moderate	cirrhosis	L-↓, patchy, NCA S-e, ↑conc.	0.47	0.28	0.24	cirrhotic p. hypertension
minimal	no cirr. seen	L-↓, NCA S-e, good conc.	1.86	3.27	3.69	non-cirrhotic p. hypertension
minimal	cirrhosis	L-↓, patchy, NCA S-e, good conc.	0.80	0.94	0.75	cirrhotic p. hypertension
minimal	—	L-multiple cold areas. S-e	1.87	1.47	1.51	non-cirrhotic p. hypertension
minimal	cirrhosis	L-↓, patchy, NCA S-e, ↑conc.	0.39	1.05	0.76	cirrhotic p. hypertension
minimal	no sig. change	L-disp. down, NCA. S-e.	1.89	1.89	1.95	non-cirrhotic p. hypertension
minimal	no cirrhosis	L-↓, NCA S-e, good conc.	1.13	1.74	1.74	non-cirrhotic p. hypertension
minimal	no cirr. seen	L-↓, NCA S-e, good conc.	1.81	1.97	1.91	non-cirrhotic p. hypertension
moderate	cirrhosis	L-↓, patchy, NCA S-e, good conc.	1.18	0.70	0.69	cirrhotic p. hypertension
moderate	cirrhosis	L-↓, patchy, NCA S-e, good conc.	1.06	1.05	0.75	cirrhotic p. hypertension
minimal	cirrhosis	L-↓, NCA S-e, good conc.	1.51	0.73	0.69	cirrhotic p. hypertension
moderate	cirrhosis	L-↓, patchy, NCA S-e, good conc.	1.75	0.92	0.79	cirrhotic p. hypertension
minimal	cirrhosis	L-↓, patchy, NCA S-e, good conc.	1.69	1.10	0.92	cirrhotic p. hypertension

** e: enlarged, ↓: reduced, ↑: increased, NCA: no cold area (Heam.=Haematemesis)

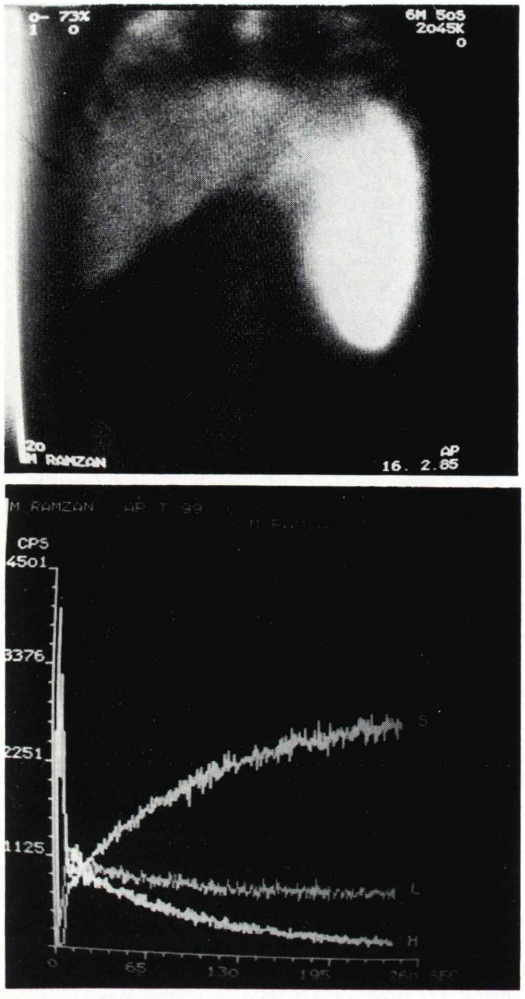


Fig. 2 Static scan and time-activity curves in a cirrhotic portal hypertensive.
L: Liver, S: Spleen, H: Heart

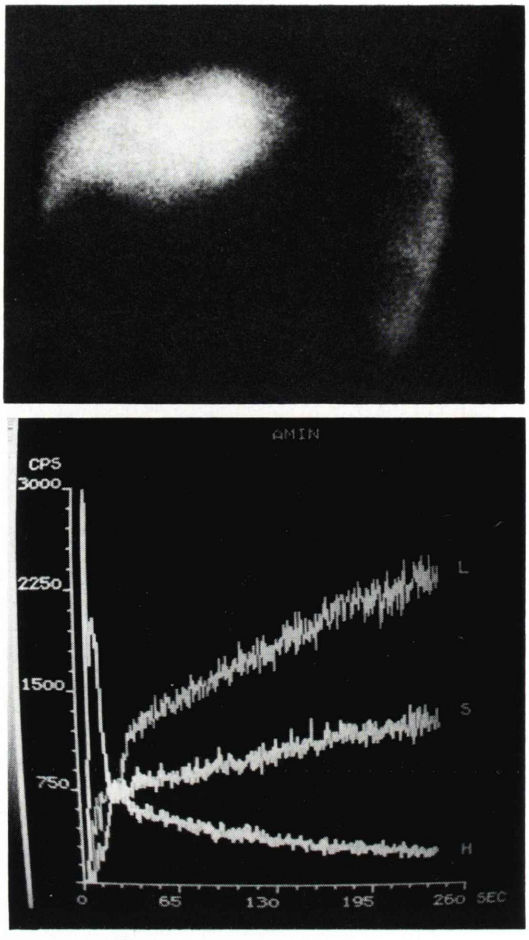


Fig. 3 Static scan and time-activity curves in a non-cirrhotic portal hypertensive.
L: Liver, S: Spleen, H: Heart

(A L/S) was thus calculated by dividing the number of pixels in the liver with that of the spleen.

The 480 digital frames of the dynamic study were added together to obtain a good quality summation picture for drawing the ROIs around the liver, spleen and a representative portion of the heart. In choosing all these regions of interest (ROIs), overlap with other organs was avoided. Time-activity curves were constructed for each region. Typical normal static images and curves are shown in Fig. 1.

The total integrated counts of the liver and spleen time-activity curves and the slope of the integral were computed to derive the following ratios:-

$$\text{Ratio of the Integral (I L/S)} = \frac{\text{Total integrated counts of the hepatic timeactivity curve}}{\text{Total integrated counts of the splenic timeactivity curve}}$$

$$\text{Ratio of the Slope of the Integral (SI L/S)} = \frac{\text{Slope of the liver integral}}{\text{Slope of the spleen integral}}$$

The Slope (cps/s) of the Integral was arrived at by obtaining the difference in the count rate (cps)

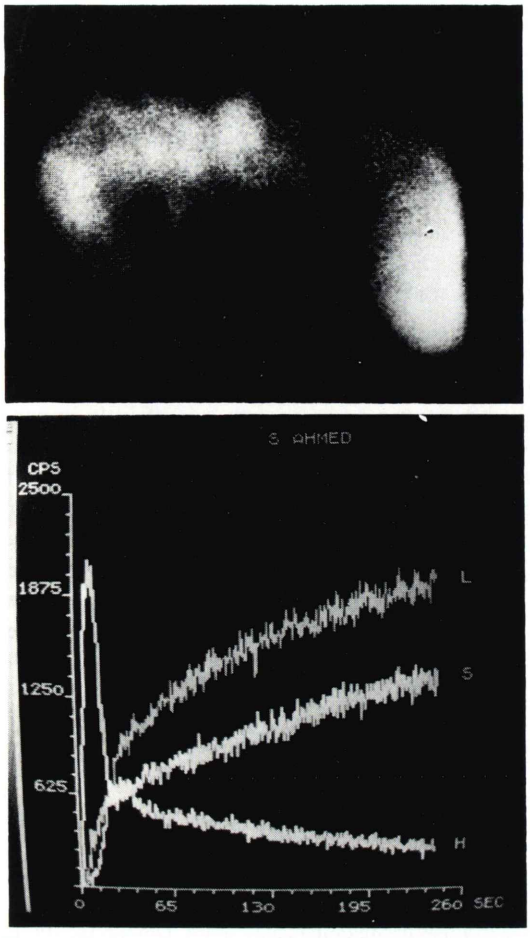


Fig. 4 Static scan and time-activity curves in non-cirrhotic portal hypertensive with metastatic liver disease.
L: Liver, S: Spleen, H: Heart

between the first frame (the intercept of the curve on the X axis) and the last frame and dividing it by the total time in seconds incorporated by the two frames.

Table 1 and Table 2 give the data of the normals and patients with portal hypertension respectively.

Results

Figures 2, 3 and 4 show the static images and the time-activity curves obtained respectively in a cirrhotic, a non-cirrhotic portal hypertensive and a non-cirrhotic portal hypertensive with metastatic liver disease. Out of the 17 patients studied, 11

Table 3 Evaluation of results

	Ratio of area (L/S) (1)				Ratio of integral (L/S) (2)				Ratio of slope of integral (L/S) (3)				Significance level of difference*	
	No.	Range	Mean	S.D.	No.	Range	Mean	S.D.	No.	Range	Mean	S.D.		
Healthy controls (A)	15	2.92 to 6.05	4.79	1.00	15	4.82 to 10.59	7.56	1.98	15	4.87 to 14.18	8.42	2.52	A1 vs. B1+C1	$p<0.001$
													A2 vs. B2	$p<0.001$
													A2 vs. C2	$p<0.001$
Cirrhotic portal hypertension (B)	17	0.39 to 1.89	1.26	0.50	11	0.28 to 1.10	0.27	0.08	11	0.24 to 0.97	0.65	0.26	B2 vs. C2	$p<0.001$
													A3 vs. B3	$p<0.001$
Non-cirrhotic portal hypertension (C)					6	1.47 to 3.27	2.01	0.64	6	1.51 to 3.69	2.13	0.78	A3 vs. C3	$p<0.001$
													B3 vs. C3	$p<0.001$

* Significance levels were determined using paired t-test.

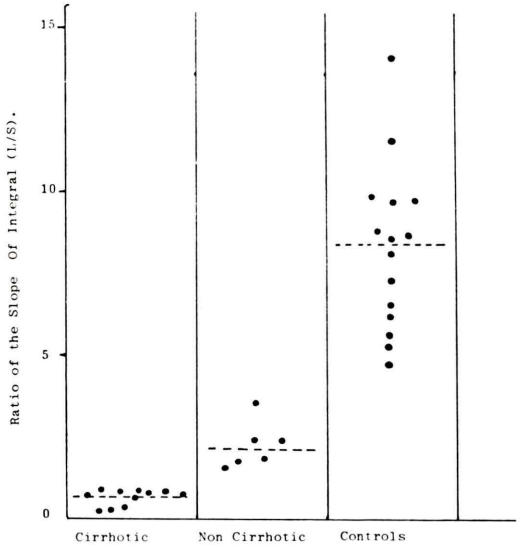


Fig. 5 Scattergram of ratio of slope of integral (L/S) (----) mean of the group.

(64.8%) were concluded to be cirrhotic portal hypertensives and 6 (35.2%) non-cirrhotic portal hypertensives. In the cirrhotic portal hypertension cases, histometric reports were available in 9 (81.8%) cases and they all collaborated with the scintigraphic results. In the non-cirrhotic portal hypertension cases definitive collaborative evidence was present in all cases in the shape of exclusion of cirrhosis by histopathology in 5 cases and the evidence of multiple metastatic disease in 1 case.

Table 3 gives the evaluation of scintigraphic results. Ratio of Area (L/S) was significantly different in the normals and in cases of portal hypertension ($p<0.001$) but showed little difference between the cirrhotic and non-cirrhotic groups. However, the Ratio of the Integral (L/S) and the slope of the Integral (L/S) in the cirrhotic and the non-cirrhotic portal hypertensives were not only significantly different from the normals ($p<0.001$) but also from each other ($p<0.001$).

Figure 5 shows the scattergram of the Ratio of the Slope of the Integral (L/S) in the three groups. The three ratios can thus be utilised not only to differentiate between the normals and portal hypertensives but also between the cirrhotic and the non-cirrhotic groups.

Discussion

We have presented a simple, non-invasive and rapid method for differentiating the cirrhotic from the non-cirrhotic portal hypertensive. Its usefulness would be enhanced in regions like ours where detailed and accurate histometry, pressure studies and specialised radiological investigations are not freely available. Scintigraphic evaluations may be used as screening tests to isolate the non-cirrhotic portal hypertensives who may then be investigated more vigorously. The incidence of Idiopathic Portal Hypertension (IPH) in our country is not exactly known, and although it is of little importance to the western countries[9], its significance in Japan[10,11] and countries like India[12] is well established. We suspect that there may be a higher proportion of IPH cases as alcoholic cirrhosis is a minor entity in our country. This accentuates the need to properly identify these cases and the scintigraphic method may be used as a valuable adjutant for doing so.

Acknowledgement

The authors thank Mr. Khalid Khumar for typing the manuscript.

References

1) Taplin GV: Dynamic studies of liver function with radioisotopes. In 'Dynamic Studies with Radioisotopes in Medicine'. New York, Unipub Inc, 1971, pp. 373–392
2) Kashiwagi T, Koizumi T, Kimura K: Computer Analysis of the Time-Activity Curves Associated with the Liver Using Nonlinear Regression Analysis. Jpn J Nucl Med **20**: 321–327, 1983
3) Nabeshima K, Sugimura K, Itoh K, et al: Analysis of Hepatic Flow Curve by Tc-99m-Sn Colloid. (abstr) Jpn J Nucl Med **20**: 561, 1983
4) Matsuo H, Suzuki S, Koga T, et al: Radionuclide Examination of the Hepatoma. (abstr) Jpn J Nucl Med **20**: 558, 1983
5) Seto H, Futatsuya R, Kamei T, et al: Quantitative Assessment of Portal Venous Flow Ratio by 1st Pass Hepatic Angiography with Tc-99m-Sn Colloid, Using Height Ratio Technique. (abstr) Jpn J Nucl Med **20**: 561, 1983
6) Narabayashi I, Nishiyama S, Sugimura K, et al: Quantitative Assessment of Hepatic and Splenic Blood Flow Detected by Tc-99m-Sn Colloid Liver Scintigraphy. Jpn J Nucl Med **20**: 625–631, 1983

7) Ogawa T, Suruga K, Nagase K, et al: Evaluation of Infantile Liver Cirrhosis by RI Hepatogram Using $^{99m}TcO_4^-$. Jpn J Nucl Med **22**: 895–899, 1985
8) Child CG: The Portal Circulation. New Eng J Med **262**: 837, 1955
9) Sherlock S: The Portal Venous System and Portal Hypertension. In 'Diseases of the Liver and Biliary System'. Blackwell Scientific Publication, 1981, pp. 135–176
10) Okuda K: IPH Research Committee Report. Japan Ministry of Health and Welfare Publication, pp. 1–310, 1980
11) Okuda K: IPH Research Committee Report. Japan Ministry of Health and Welfare Publication, pp. 1–421, 1981
12) Nundy S, Tandon BN: Portal Hypertension in India. All-India Institute of Medical Sciences compilation, pp. 1–135, 1980