

# Arteriovenous Shunts in Cirrhotic Patients Studied with Human Serum Albumin Macroaggregates Tagged with I <sup>131</sup> (MAA<sup>131</sup>I)\*

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**Abstract :** DAL PALÙ, C., DONAGGIO, G., DAL ZOTTO, I. & PESSINA, A. C. (1968) Arteriovenous Shunts in Cirrhotic Patients Studied with Human Serum Albumin Macroaggregates Tagged with I<sup>131</sup> (MAA<sup>131</sup>I). *Scand. J. Gastroent.* 3, 425-431, 1968.

Experiences with injection of human serum albumin macroaggregates (MAA<sup>131</sup>I) in some afferent vessels of pulmonary, peripheral, and visceral circulations of cirrhotic patients have demonstrated the presence of arteriovenous shunts greater than 25 microns. Particularly demonstrative are the observations concerning the pulmonary circulation of 22 cirrhotic patients. Comparison of the radioactivity curves obtained in cirrhotic patients with those of controls shows the validity of the method used. More extensive studies are requested to achieve a more complete understanding of intrasplenic, mesenteric, and intrahepatic anastomoses in controls and in cirrhotic patients.

**Key-words:** Arterio-venous shunts; isotopes; liver; liver cirrhosis

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Hyperkinetic hemodynamics is a characteristic feature of cirrhosis of the liver. Increased cardiac output, diminished systemic vascular resistance, palmar erythema, capillary pulsations, cutaneous spider angiomas, and arterial oxygen unsaturation are the principal cardiovascular abnormalities which have been demonstrated in this disease (Bashour et al. 1961, Georg et al. 1960, Heinemann et al. 1960, Mazzei et al. 1966, Rydell et al. 1956).

In order to explain this hemodynamic behaviour, many hypotheses have been proposed. One of them emphasizes the opening of multiple arteriovenous fistules at various points of the vascular bed (Hales, Mellemaard et al. 1963). The purpose of the present study has been to determine the extent of arteriovenous anastomoses in the visceral and peripheral circulations of cirrhotic patients. For this aim we have used an original method (Dal Palù et al. 1966, Donaggio et al. 1965), namely the selective injection of human serum albu-

min macroaggregates tagged with I<sup>131</sup> (MAA<sup>131</sup>I)\*\* Usually this tracer is employed for pulmonary scanning, as the macroaggregates do not pass beyond the capillary network of the lungs, their diameter being larger than that of the capillaries (Taplin et al. 1964).

However, it may also be used to detect arteriovenous communications in other vascular areas provided that it is injected into an afferent vessel and that the scintillation counter is collimated over an area corresponding to the afferent vessels.

The validity of this method is confirmed by the marked difference between the curves obtained in normal subjects and in patients with shunts.

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\*\*Prepared for us by Sorin, Saluggia, with a diameter of 25-40μ

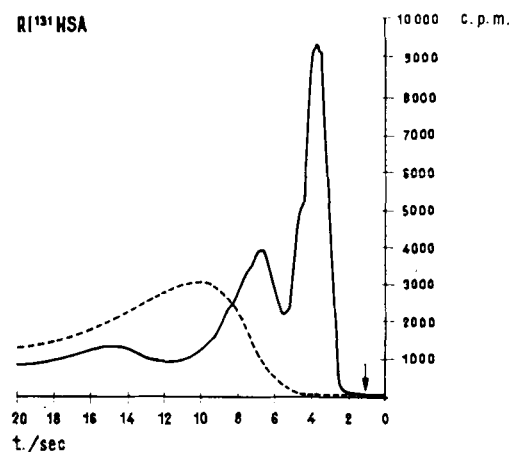


Fig. 1. C.S. ♂ (34 y.o.) normal subject, injection in subclav. vein

——Heart      - - - - -Head

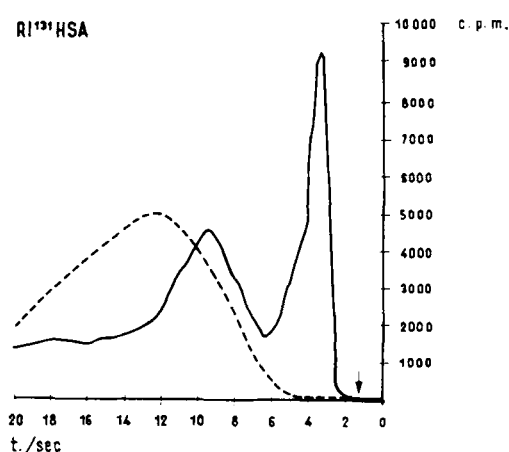


Fig. 2. C.O. ♀ (54 y.o.) liver cirrhosis, injection in subclav. vein

——Heart      - - - - -Head

### MATERIAL AND METHOD

Forty-one cirrhotic patients and 20 controls, convalescent from diseases which do not affect the cardiovascular system, have been studied.

Twenty-two cirrhotics and 15 controls were examined for pulmonary arteriovenous shunts. 15  $\mu$ C of MAA<sup>131</sup>I (0.02-0.03 ml) were injected into a subclavian vein through a polythene catheter (1.5 mm diameter); the catheter was rinsed by an immediate injection of 4-5 ml of saline from another syringe attached by a Y piece to the catheter. In each case a pre-

vious radiocardiogram with RIHSA was carried out.

Two scintillation counters with crystal of NaI (Tl) 2"  $\times$  2" were collimated respectively over the 3rd-4th intercostal space at the left sternal border and over the left temporal area. The counters were connected to a ratemeter with a time constant of 0.005 sec and a single-canalyzer,\* and these in turn to a double pen recorder at paper speed of 5 mm/sec.\*\*

\*Nuclear Tracerlab ratemeter

\*\*Texas recti-righter

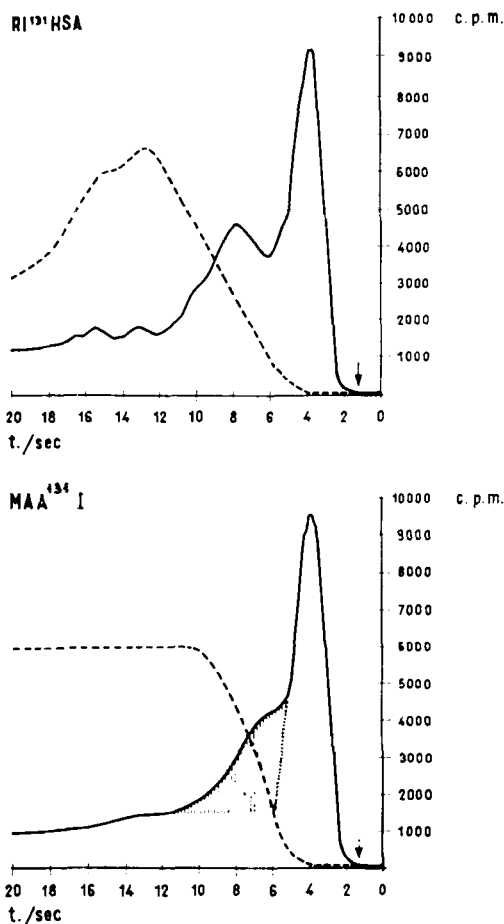


Fig. 3. H.A. ♀ (11 y.o.) juvenile cirrhosis, cyanosis, injection in subclav. vein.

—— Heart      ----- Head

In 12 patients (7 cirrhotics with portocaval shunts, 2 cirrhotics and 1 patient with chronic hepatitis and no shunts, 1 patient with portal thrombosis and 1 with splenic vein thrombosis), the macroaggregates were injected into the spleen and counts were taken from the hepatic area (8th right intercostal space between the anterior and mid-axillary lines) and from the praecordial area. Splenoportography was carried out immediately afterwards using the same needle.

In one patient with portal cirrhosis  $\text{MAA}^{131}\text{I}$  was injected directly into the left branch of the

portal vein, via the umbilical vein cannulated for an omphaloportography; a single detector was collimated over the praecordium.

In 4 cases,  $\text{MAA}^{131}\text{I}$  ( $20 \mu\text{C}$ ) was injected into the splenic and/or superior mesenteric artery through a Seldinger catheter immediately before an arteriography. Scintillation counters were collimated over the spleen, the liver and the praecordium when injection was made into the splenic artery; over the right lower abdomen (3 cm below the transverse umbilical line) over the liver, and over the praecordium after injection into the superior mesenteric artery.

Arteriovenous anastomoses of the limbs were studied by injection of  $20 \mu\text{C}$  of  $\text{MAA}^{131}\text{I}$  into a brachial artery and by injection of  $30 \mu\text{C}$  of

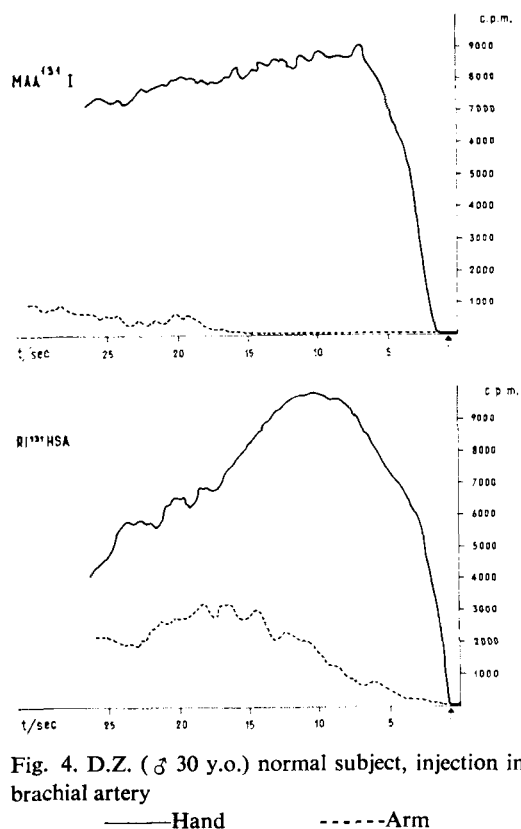


Fig. 4. D.Z. (♂ 30 y.o.) normal subject, injection in brachial artery

—— Hand      ----- Arm

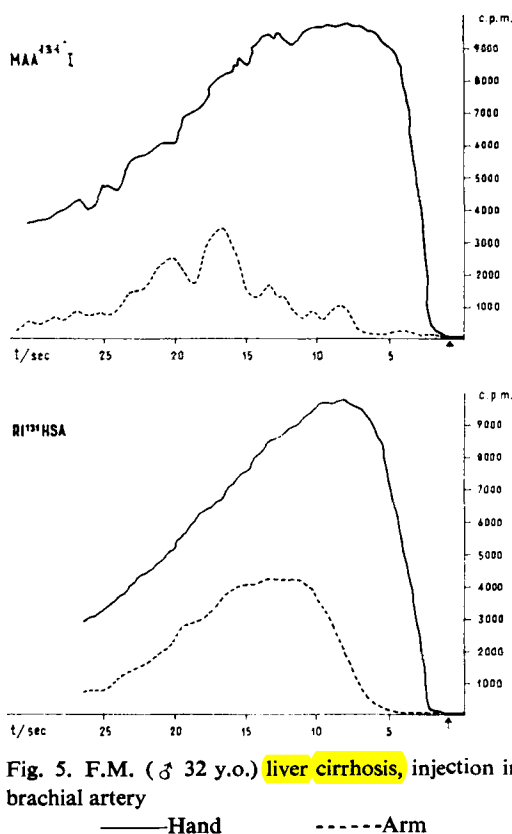


Fig. 5. F.M. (♂ 32 y.o.) liver cirrhosis, injection in brachial artery

— Hand      - - - - - Arm

MAA<sup>131</sup>I into a femoral artery. The counters were placed over the palm of the hand and over the upper arm in the first case, over the sole of the foot and over the inguinal area in the second case. The brachial artery was injected in 2 controls and in 3 cirrhotics; the femoral artery in 2 controls and in 2 cirrhotics.

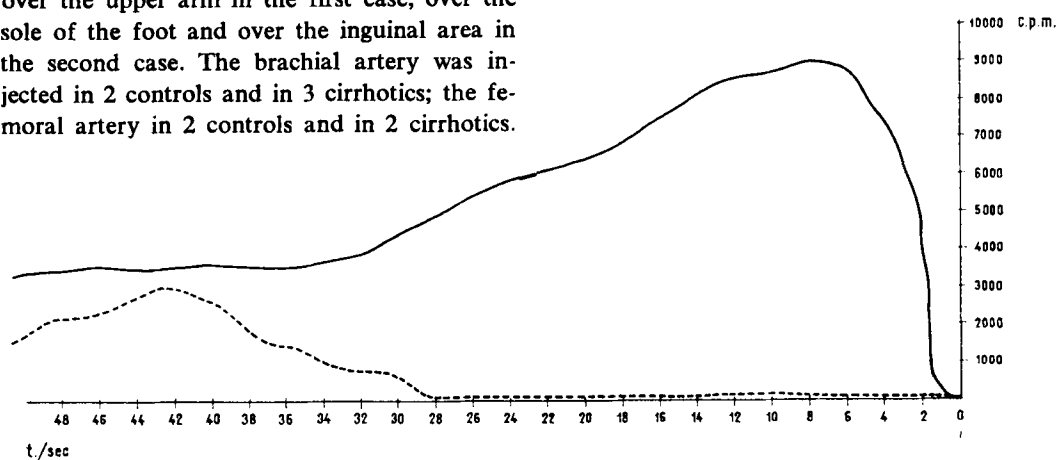


Fig. 6. C.E. (♂ 47 y.o.) liver cirrhosis, injection of MAA<sup>131</sup>I in femoral artery

— Foot      - - - - - Right abdomen

## RESULTS

### *Injection of MAA<sup>131</sup>I into a subclavian vein.*

In 15 normal subjects the curves registered over the praecordium had the shape of a pure right ventricular curve. No radioactivity was revealed by the counter placed over the temporal area, nor was any tracer found in the arterial blood taken from a brachial artery (Fig. 1).

In 7 out of 22 patients with liver cirrhosis, curves were similar to those of the controls. In 15 cirrhotics, praecordial and temporal curves and arterial blood assay revealed that variable quantities of the tracer had bypassed the capillary network of the lungs (Fig. 2). No significant correlation could be found between the quantity of shunted tracer, as indicated by the shape of the curves, and some clinical features of the disease, namely the number of spider angiomas, the presence or absence of icterus, ascites, neurological disturbances and the general deterioration of the patient. However the most striking abnormalities of the curves were observed in the only patient who had cyanosis and clubbing of the fingers (juvenile cirrhosis, Fig. 3).

*Injection into the brachial and femoral arteries.* A small radioactivity curve could be

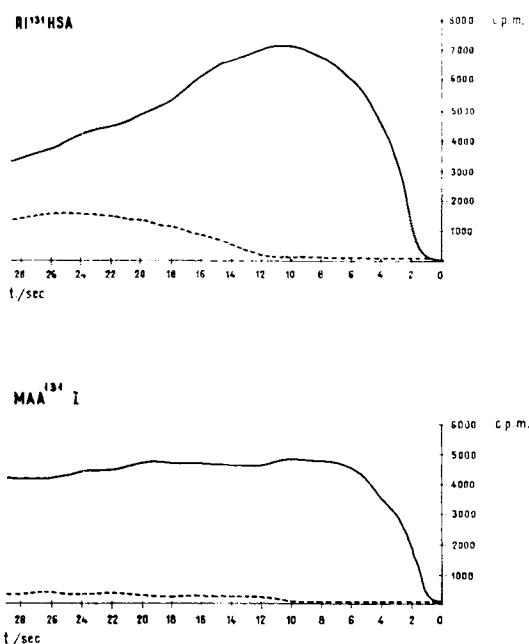


Fig. 7. Z.A. (♂ 32 y.o.) chronic hepatitis, no portosystemic shunts, intrasplenic injection

— Liver      ----- Heart

registered over the upper arm in 2 normal subjects after injection of  $\text{MAA}^{131}\text{I}$  in the brachial artery (Fig. 4). The same curves were much higher in 3 cirrhotics (Fig. 5).

After injection of  $\text{MAA}^{131}\text{I}$  into the femoral artery no radioactivity could be found over the ipsilateral lower abdominal area in 2 normal subjects. In 2 cirrhotics, curves of moderate size were registered (Fig. 6).

**Intrasplenic and intraportal injection.** After intrasplenic injection of  $\text{MAA}^{131}\text{I}$  high radioactivity curves were recorded over the praecordium in 7 cirrhotics and in 2 patients with splenic vein thrombosis and conspicuous portosystemic shunts.

No tracer appeared beyond the liver in one patient with chronic hepatitis and no portosystemic shunts (Fig. 7). On the contrary, in 2 cirrhotics in whom splenoportography did not reveal any collateral circulation, curves of moderate radioactivity were recorded over the praecordium after intrasplenic injection of

$\text{MAA}^{131}\text{I}$  (Fig. 8). Similar curves were obtained in one cirrhotic patient after injection of  $\text{MAA}^{131}\text{I}$  into the left branch of the portal vein, via the umbilical vein (Fig. 9). It is our opinion that in these cases the tracer must have bypassed the liver sinusoids through some portohepatic anastomoses inside the liver.

**Injection into the splenic and mesenteric arteries.** No radioactivity was detected by counters collimated over the liver and praecordium after injection of  $\text{MAA}^{131}\text{I}$  into the splenic and mesenteric arteries of a patient with an islet cells tumor of the pancreas.

Curves of moderate amplitude were registered over the liver and praecordium in 2 cirrhotic patients after injection into the mesenteric artery (Fig. 10). Portosystemic shunts being present, it is not possible to state whether the tracer had reached the right atrium by-

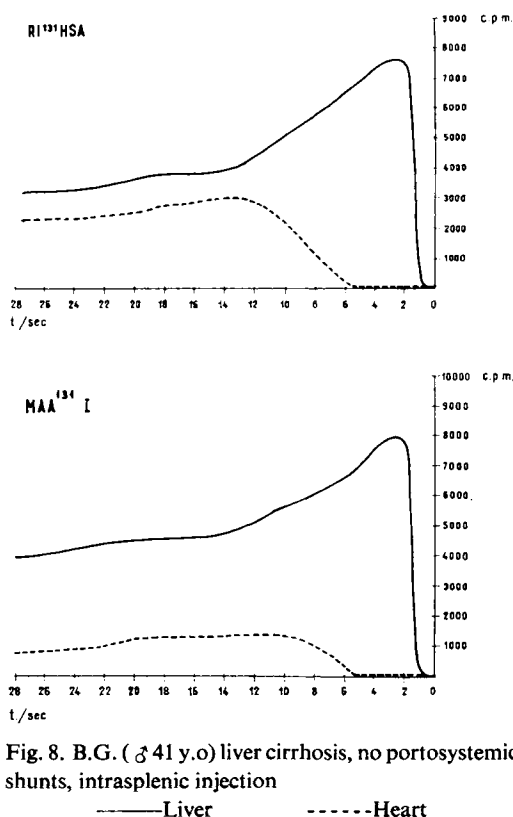


Fig. 8. B.G. (♂ 41 y.o.) liver cirrhosis, no portosystemic shunts, intrasplenic injection

— Liver      ----- Heart

passing hepatic sinusoids or bypassing the liver through the larger portosystemic channels.

### COMMENT

Our observations definitely confirm the existence of pulmonary arterio-venous shunts in cirrhotic patients. They are more conclusive than those obtained by others using radioactive gas (Fritts et al. 1960, Shaldon et al. 1961). In fact, by using  $\text{MAA}^{131}\text{I}$ , no error is possible owing to the presence of areas of pulmonary atelectasis or to defective diffusion processes across the capillary-alveolar membrane.

The results obtained after injection of  $\text{MAA}^{131}\text{I}$  into the limb arteries, the spleen, the splenic and mesenteric arteries, and the portal vein, demonstrate that the shunt phenomenon

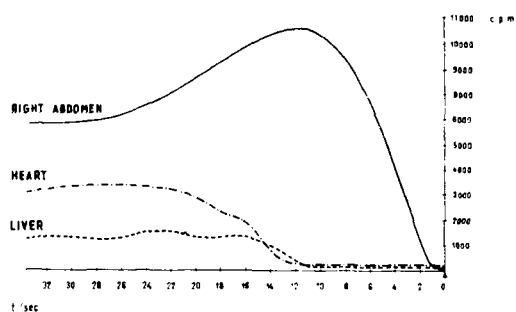


Fig. 10. F.G. (♂ 64 y.o.)- liver cirrhosis, injection of  $\text{MAA}^{131}\text{I}$  (20  $\mu\text{c}$ ) in superior mesenteric artery, large porto-systemic shunts

in cirrhotic patients is not limited to the pulmonary area, but also involves the peripheral and splanchnic circulations.

### ACKNOWLEDGEMENT

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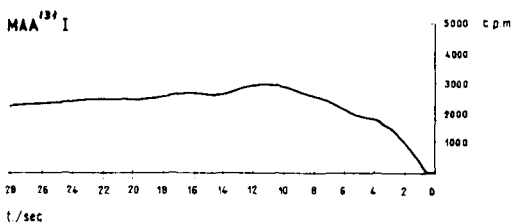
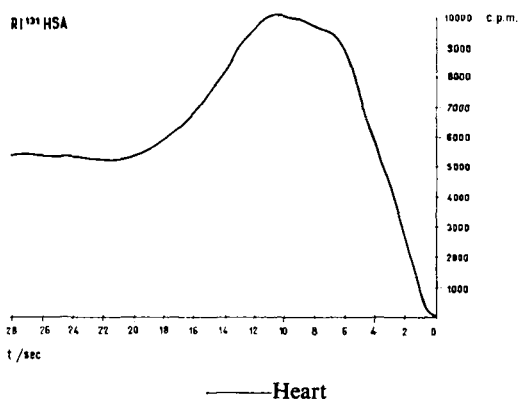


Fig. 9. T.R. (♂56 y.o.) liver cirrhosis, injection in left portal vein

—Heart

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