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Effect of portacaval anastomosis on renal blood flow in cirrhosis—preliminary results

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Summary

The established end-to-side portacaval shunt is not effective in normalizing the decreased renal blood flow in patients with cirrhosis of the liver. The ability of the side-to-side shunt to offer this effect remains to be decided, and will be so when patients with this type of shunt are added to this study.

FUNCTIONAL renal failure is a frequent and important complication of liver failure. The clinical features of the syndrome are well characterized but the aetiology still remains a puzzle. That the condition is indeed functional has been proved by the reversibility of the impairment of renal function by transplantation of such kidneys to recipients without liver disease (Koppel *et al.*, 1969) and recently by the transplantation of healthy livers to patients with liver failure complicated with impairment of renal function of the present nature (Iwatsuki *et al.*, 1974). In this latter condition the patient's own kidneys regain normal function.

The renal hypoperfusion as a consequence of an active renal vasoconstriction seems to be the keystone in the pathogenesis of functional renal failure (FRF) in cirrhosis. However, in the cirrhotic patient with ascites and oedema but without renal failure, the renal blood flow is often decreased although to a minor degree. Even in cirrhotic patients without clinical signs of sodium and water retention the renal perfusion is less than in controls. Recently, similar hypoperfusion of the kidneys has been found to be present in patients with extrahepatic portal hypertension.

How this reduction in renal blood flow is initiated or sustained is unknown. The hypotheses of the aetiology have been concentrated on two main issues. Firstly, can the reduced renal blood flow be explained exclusively by the insufficient liver? For example, a vasoactive agent expelled from, or not inactivated in the sick liver. Epstein *et al.* (1970), in their xenon wash-out curves, found irregularities not seen in controls and ascribed these to circulating amines. Treatment of hepatic coma with L-dopa seemed promising because the renal function also seemed to benefit (Fischer and Baldessarini, 1971). This, too, suggested that amines might in some way contribute to the renal hypoperfusion. Recently, endotoxins have been incriminated (Wilkinson *et al.*, 1974). Secondly, can the decreased renal blood flow be explained by the altered haemodynamic seen in cirrhosis? That is to say, can a reflex vasoconstriction secondary to portal hypertension as such, or secondary to a postulated diminished 'effective circulating plasma volume' be due to splanchnic pooling? Animal experiments by Onnis, Shumacker and Bounous (1962) and Hori, Austen and McDermott (1965) which included clamping individual arteries of the coeliac axis, and crush stimulation of the autonomic nerve-plexus around the hepatic artery, have shown that a reflex vasoconstriction in the kidneys can be produced in this way. The renal hypoperfusion seen in animal experiments including artificial portal hypertension and the transient improvement in the renal blood flow by infusion of plasma expanders in cirrhotic patients tend to favour the postulated diminished 'effective circulating plasma volume' as being the cause (Reynolds, Lieberman and Redeker, 1967).

The reports of the effect of portacaval anastomosis on FRF in cirrhosis are conflicting, ranging from claims of direct improvement (Schroeder, Numann and Chamberlain, 1970) to other claims that it initiates FRF (Garrett, Voorhees and Sommers, 1970). The present study was undertaken to investigate the influence of (1) the augmented portal pressure and (2) the postulated 'diminished effective circulating plasma volume' on the renal blood flow in patients with cirrhosis of the liver.

Six patients with cirrhosis and portal hypertension have undergone haemodynamic investigation before and 2 months after portal decompression. All patients had the diagnosis verified by liver biopsy. Oesophageal varices before and sufficient shunt function after operation were seen in all patients by transsplenic-portal venography. All patients had experienced at least one haemorrhage needing transfusion. All except one had had an end-to-side portacaval shunt. In one patient who had a spleno-renal shunt the renal blood flow was measured in the right kidney. None of the patients had ascites at the time of investigation, and azotaemia and oliguria were not present. None of the patients had a history of renal or cardiac disease.

Besides the usual biochemical parameters for liver function, serum creatinine and blood, and urine electrolytes, the programme consisted of transsplenic-venoportography, hepatic vein catheterization, renal 133-xenon wash-out, endogenous creatinine clearance, right-sided cardiac catheterization with measurement of cardiac output either by the dye dilution technique or Fick's principle. Plasma and blood volumes were measured with Evans' Blue and RIHSA. The renal 133-xenon wash-out curves were run for 20 min and repeated twice as 3 min-curves. The mean renal blood flow was calculated as an average of the initial slope in the three curves (Thorburn *et al.*, 1963). The programme is now supplemented by the measurement of total hepatic blood flow with the ICG method, However, this has only been done in one of the six patients.

The result of the shunt on the splenic pressure was a significant fall ($P < 0{\cdot}001$; average 31–16 mmHg). A considerable decrease in pressure was observed in all patients, but not in all was the splenic pressure completely normalized (Fig. 1; Table 1).

Liver function was unchanged in four of five patients tested for galactose elimination capacity (Table 1).

The plasma volume in one patient was lower after surgery, otherwise it was increased or unchanged; average plasma volume being 3·50 litres before and 3·65 litres after operation. There was no significant change in this parameter in the five patients in whom this was measured (Table 1). Cardiac output, on the other hand, was without exception greater after the anastomosis operation than before. The average value being 5·15 l/min before and 6·85 l/min after operation, with an average increase of 33% of preoperative values (Fig. 2; Table 1).

The shunt caused no significant change in the pulse rate which maintained an average of 80/min before and after the operation.

In most patients, the increase in cardiac output was caused exclusively by an increase in stroke volume, which on the average increased from 67 ml

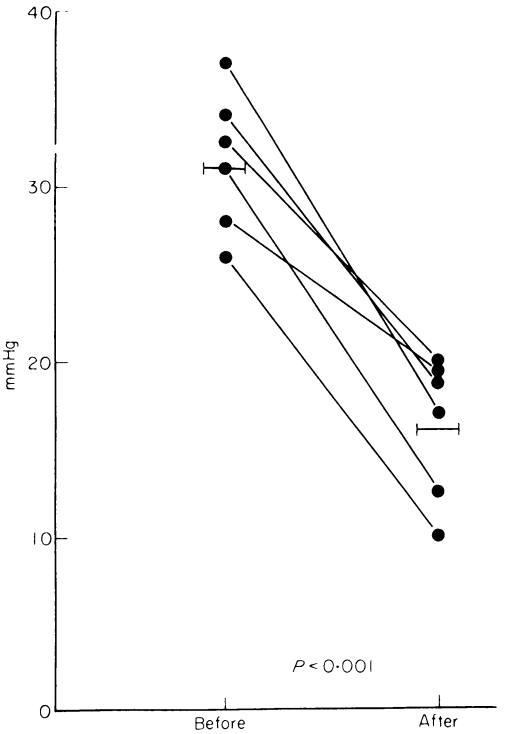

FIG. 1. Splenic pressure before and after P–C shunt.

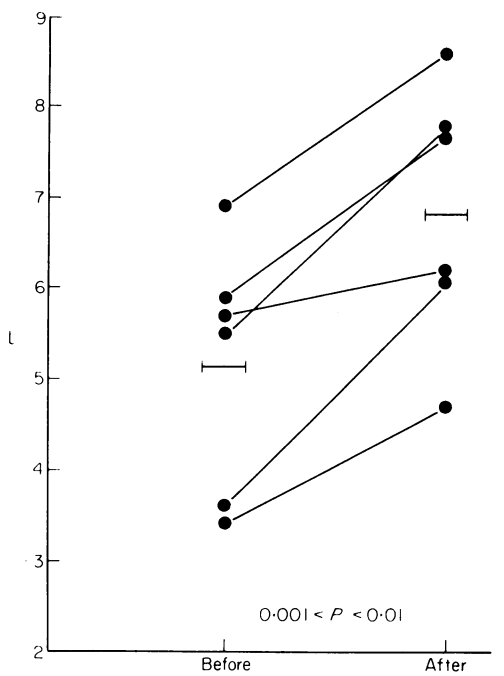

FIG. 2. Cardiac output before and after P–C shunt.

TABLE 1. Effect of portacaval shunt on haemodynamic parameters

	Before shunt		After shunt	
	Mean ± s.d.	Range	Mean ± s.d.	Range
Splenic pressure (mmHg)	31 ± 4	26–36	16 ± 4	10–20
Galactose elimination capacity (mg/min/kg)	5·2 ± 2·0	3–7·9	4·1 ± 1·2	2·6–5·5
Plasma volume (ml/kg)	3·50 ± 0·59	2·6–4·2	3·65 ± 0·36	3·1–4·1
Cardiac output (l/min)	5·15 ± 1·37	3·3–6·8	6·85 ± 1·49	4·5–8·5
Stroke volume (ml)	67 ± 22	38–86	88 ± 27	48–122
Renal blood flow (ml/g/min)	2·85 ± 1·13	1·0–3·9	2·50 ± 1·00	1·1–3·9

to 88 ml ($P < 0·02$), which, parallel to the cardiac output, was an increase of 34% of preshunt value (Table 1).

The total peripheral resistance decreased in all but one patient. Average fall was 25% of preoperative resistance ($P < 0·02$).

There was no significant change in mean arterial blood pressure, and none was observed in the mean renal blood flow of the six patients; the flow was 2·85 ml/g/min before the shunt operation and 2·50 ml/g/min ($P > 0·10$) after. Likewise, the renal vascular resistance was unchanged by the portacaval shunt. However, in seven normal controls the mean renal blood flow was significantly higher ($P < 0·05$; average, 4·45 ml/g/min) (Fig. 3; Table 1).

Other haemodynamic parameters which were grossly unchanged were pressures in the right atrium, wedged pulmonary artery pressures, and wedged hepatic vein pressures. In only one patient was the total hepatic blood flow measured, when it fell from 1·41 l/min to 0·47 l/min, i.e. a decrease of two-thirds on the pre-shunt flow.

The beneficial effect of portacaval anastomosis of therapy-resistant ascites is described in the literature, most often this has been side-to-side shunts. After seeing the improvement in urine volume and creatinine clearance in one cirrhotic patient with FRF who had received such a shunt, Schroeder *et al.* (1970) suggested that this had caused a redistribution in plasma volume normalizing the 'effective circulating plasma volume', thus leading to the improved renal function.

This study does not establish a relation between recovery of renal perfusion and portacaval anastomosis. This could be due to a number of reasons.

The end-to-side shunt should be just as capable of relieving the splanchnic pooling as normalizing the 'effective circulating plasma volume'. This is apparently done in the study but, however, not reflected in an improved perfusion in the kidneys of these patients. If there is a true 'decreased effective circulating plasma volume', it is possible that a fraction of the plasma volume before shunt surgery is trapped in the splanchnic area, and that a fraction of equal order after surgery runs idle in the shunt, and in this way is equally ineffective in the circulation.

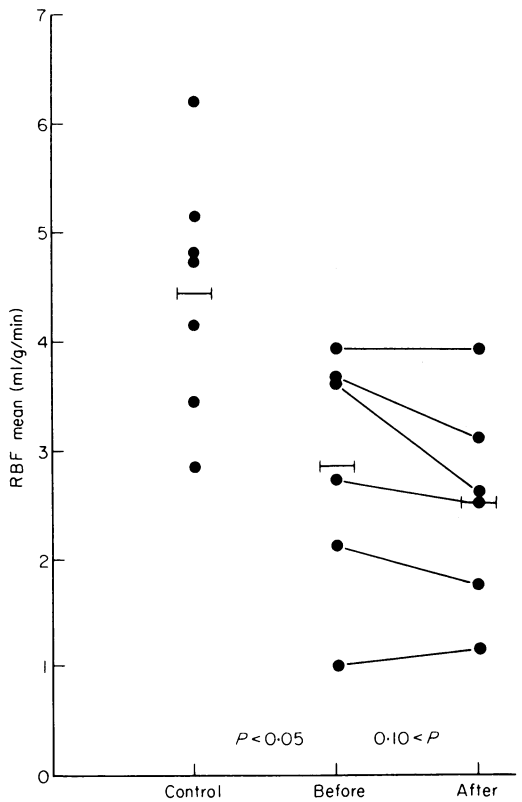

FIG. 3. Mean renal blood flow before and after P–C shunt.

The elevated intrahepatic pressure might be responsible for the neurovascular reflex which increases the renal vascular resistance. We still do not know if

the side-to-side shunt could restore normal renal blood flow by relieving this pressure.

The clinical impression that the status of the liver function ultimately determines the outcome in non-shunted patients with low renal blood flow inclines one to believe in the theory of circulating vasoactive agents. It is probably true to say that the concentration of these agents would not have been changed by the portacaval anastomosis, since the liver function in our patients was grossly unchanged.

Another question arises from these results. When the pressure gradient falls across the splanchnic vessels, it seems peculiar that they do not contract to keep the vascular resistance at a level similar to that before operation. It might be that after a long period of dilatation during portal hypertension, they are unable to contract in a normal manner.

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