Haemodynamics of stable renal transplant recipients

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Summary

1. Haemodynamics, blood volume, plasma renin concentration and creatinine clearance were evaluated in 24 stable renal transplant recipients.

2. The mean cardiac index of the transplant recipients was not different from that of the normal subjects.

3. The transplant recipients comprised eight hypertensive and 16 normotensive patients. The mean cardiac index was the same in eight hypertensive and 16 normotensive patients. Thus the hypertension of stable renal transplant recipients is sustained by a high total peripheral resistance.

4. The mean blood volume, plasma renin concentration and creatinine clearance were similar in eight hypertensive and 16 normotensive patients. Therefore the hypertension of stable renal transplant recipients is not related to blood volume expansion, elevated peripheral renin or low creatinine clearance. The cause of the elevated total peripheral resistance in hypertension in stable renal transplant recipients remains to be elucidated.

Key words: blood volume, cardiac output, hypertension, renal transplantation, renin, total peripheral resistance.

Introduction

Many clinical studies on possible causes of hypertension after renal transplantation have been reported (Popovitzer, Pinnggera, Katz, Corman, Robinette, Lanois, Halgrimson & Starzl, 1973; Sampson, Kirdani, Sandberg & Murphy, 1973; Grünfeld, Kleinknecht, Moreau, 1975; Bachy, Alexandre & Van Ypersele DeStrihou, 1976; Jacquot, Idatte, Bedrossian, Weiss, Safar & Barietz, 1978; Rao, Gupta, Butt, Kountz & Friedman, 1978; Pollini, Guttmann, Beaudoin, Morehouse, Klassen & Knaack, 1979). However, haemodynamic studies in stable renal transplant recipients are limited (Tuckman, Benninger & Reubi, 1973). A knowledge of the haemodynamic changes in stable transplant recipients with normal and elevated blood pressure is important for an understanding of the underlying pathophysiological mechanisms (Kim, Onesti, Schwartz, Chinitz & Swartz, 1972; Hall, 1978).

It is the purpose of the present paper to report the haemodynamic changes in stable renal transplant recipients with normal or elevated blood pressure.

Methods

Twenty-four stable renal transplant recipients were studied. There were 14 males and 10 females. The age ranged from 17 to 55 years with a mean of 35 years. Of the 24 patients studied, 16 were normotensive and eight were hypertensive. The groups of hypertensive and normotensive patients were of comparable age and sex. Thirteen of the 16 normotensive patients and six of the eight hypertensive renal transplant recipients had bilateral nephrectomy before renal transplantation. All patients studied were on less than 10 mg of prednisone daily and had serum creatinine concentrations of less than 177 μmol/l and packed cell volume greater than 30%. None of the patients had renal artery stenosis. All antihypertensive medications were discontinued at least 2 weeks before the haemodynamic studies. Studies were performed after an average of 13 months of successful renal transplantation.
The control group included 25 normal subjects. Fourteen were males and 11 were females. The mean age was 37 years.

Studies were conducted in the morning, in the supine position, after 1 h of bed rest. Cardiac output was determined by the dye-dilution technique with indocyanine green. Every cardiac output reported represents the average of at least three determinations. Arterial blood pressure was measured from the brachial artery with a Statham strain-gauge transducer. Mean arterial pressure was obtained by electronic integration. Total peripheral resistance index was calculated from mean arterial pressure and cardiac index (K. E. Kim et al., 1972).

Plasma volume was determined with 131I-labelled albumin. Blood volume was calculated from plasma volume and large-vessel packed cell volume.

Plasma renin concentration was measured by the method of Gould, Goodman, DeWof, Onesti & Swartz (1979).

**Results**

Comparison of cardiac index in renal transplant recipients and normotensive subjects

In the 24 renal transplant recipients, the mean cardiac index was 3·40 ± 0·9 litres min⁻¹ m⁻² (mean ± SE). In the 25 normal subjects, the mean cardiac index was 3·59 ± 0·13 litres min⁻¹ m⁻². The difference is not significant. After a successful renal transplantation, the packed cell volume of all 24 transplant recipients increased from a mean volume of 21% to a mean of 35%. The mean packed cell volume of the 25 normal subjects was 43%.

Haemodynamic comparison between hypertensive and normotensive renal transplant recipients

Of 24 renal transplant recipients, eight patients were hypertensive and 16 patients were normotensive.

The average mean arterial pressure of the hypertensive patients was 124 ± 4 mmHg and the average mean arterial pressure of the normotensive patients was 88 ± 2 mmHg.

Mean cardiac index was 3·67 ± 0·21 litres min⁻¹ m⁻² in the hypertensive patients and 3·54 ± 0·18 litres min⁻¹ m⁻² in the normotensive patients. The difference is not significant. The mean packed cell volume was 34·1 ± 1·4% in the hypertensive patients and 35·6 ± 0·9% in the normotensive patients. The mean heart rate was 70 ± 3 beats/min in both groups. The mean stroke index was 53 ± 3 ml/stroke per m² in the hypertensive patients and 50 ± 2 ml/stroke per m² in the normotensive subjects. The mean total peripheral resistance index was 2743 ± 159 dynes s cm⁻⁵ per m² in the hypertensive renal transplant recipients and 2033 ± 85 dynes s cm⁻⁵ per m² in the normotensive renal transplant recipients. The difference is highly significant (P < 0·001).

Comparison of blood volume, plasma renin concentration and creatinine clearance in hypertensive and normotensive transplant recipients

The mean blood volume was 76 ± 4 ml/kg body weight in the hypertensive patients and 80 ± 4 ml/kg body weight in the normotensive patients. The difference is not significant.

The mean plasma renin concentration was 0·26 ± 0·06 × 10⁻⁴ Goldblatt unit in the hypertensive patients and 0·29 ± 0·07 × 10⁻⁴ Goldblatt unit in the normotensive patients. The mean 24 h urinary sodium excretion at the time of sampling plasma renin concentration was 127 mmol in the hypertensive patients and 119 mmol in the normotensive patients.

There were no significant differences in creatinine clearance between the two groups. The mean creatinine clearance was 81 ± 10 ml/min ranging from 57 to 130 ml/min in the hypertensive patients and 78 ± 7 ml/min ranging from 42 to 134 ml/min in the normotensive patients.

Discussion

It has been shown that hypertension in end-stage renal disease and the anephric state is associated with a high cardiac output and a high total peripheral resistance (K. E. Kim et al., 1972) and the major factor responsible for high cardiac output is anaemia (Neff, Kim, Persoff, Onesti & Swartz, 1971; Kim, Onesti & Swartz, 1975). Mean packed cell volume in all 24 patients increased from 21% to 35% after a successful renal transplantation. The mean cardiac index of the 24 transplant recipients was similar when compared with that of the 25 normal subjects matched by age and sex. This finding indicates that an increase in packed cell volume after a successful transplantation normalizes cardiac index. The comparative evaluation of the haemodynamic pattern of the hypertensive transplant recipients versus the normotensive transplant recipients shows that cardiac index, heart rate and stroke index were entirely similar in the two groups. Thus the hypertension of the stable renal transplant recipients is sustained by a high total peripheral resistance.
Hypertension after renal transplantation has been ascribed to graft rejection (Popovitzer et al., 1973; Grünfeld et al., 1975; Bachy et al., 1976), high dose of glucocorticoids (Popovitzer et al., 1973), arterial stenosis of the transplanted kidney (Grünfeld et al., 1975; Bachy et al., 1976; Pollini et al., 1979) and the presence of the patient's own kidneys (Grünfeld et al., 1975). All these causal factors were excluded in our study by patient selection.

The data obtained in this study do not allow for identification of the mechanism of hypertension in stable renal transplant recipients. Little information is available regarding the relationship between blood pressure and blood volume in stable renal transplant recipients. Blood volume was similar in the hypertensive and normotensive groups in our study. A high plasma renin activity has been implicated in hypertension after renal transplantation (West, Turcotte & Vander, 1969; Pollini et al., 1979). Plasma renin concentration was similar in the hypertensive and the normotensive groups. Our findings are in agreement with Sampson et al. (1973). The influence of renal function on post-transplant hypertension cannot be precisely appreciated by our study because we deliberately selected patients with good function. However, their creatinine clearances were widely scattered, ranging from 42 to 134 ml/min. The mean and range of creatinine clearance were similar in the hypertensive and the normotensive groups.

The hypertension of stable renal transplant recipients is sustained by a high total peripheral resistance which is not related to blood volume expansion, elevated peripheral renin or low creatinine clearance. The cause of this elevated peripheral resistance remains to be elucidated.

References


