Effects of Posture on Limb Blood Flow in Late Pregnancy

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Summary

Arm and leg blood flow was measured in 40 patients in late pregnancy in the supine and left lateral positions, and the changes were contrasted with changes found in 15 patients investigated in the early puerperium. A significant reduction in leg flow occurred in the pregnant subjects when the supine position was assumed. A further 30 patients in late pregnancy had leg flow measured in the following positions: left lateral, supine, right lateral, and the two mid-positions. Leg flow significantly increased on moving from the supine to all other positions except the right intermediate position, indicating that a leftward tilt is more effective in preventing caval compression.

Introduction

It is well known that in the last few weeks of pregnancy in the supine position the gravid uterus exerts pressure on the inferior vena cava often causing complete occlusion. In this event blood from the lower part of the body returns to the heart by way of a collateral circulation (Kerr *et al.*, 1964). The adequacy of this collateral flow determines whether or not a fall in venous return, and therefore cardiac output, will occur.

The first part of this investigation was undertaken to assess the effect that the supine position had on the blood flow in the limbs of women in the last four weeks of pregnancy. Any substantial reduction in lower limb flow would indicate occlusion of the inferior vena cava associated with restriction of venous return.

Further measurements were made in another series of patients to assess the effect of various positions on the degree of obstruction to leg flow. In particular, information was sought about positions similar to those advocated for prevention of caval compression during caesarean section.

Patients and Methods

Forty healthy women attending an antenatal clinic were studied. All were more than 36 weeks pregnant and had given their consent to the study. None were suffering from cardiovascular disease or hypertensive disease of pregnancy.

Limb blood flow was measured using a modification of the strain-gauge method of Whitney (Whitney, 1953). Silicone rubber mercury thread strain gauges were placed around the maximum circumference of the right calf and forearm to a constant resting tension, and the limb was supported to allow muscular relaxation and prevent distortion of the gauges. Simultaneous changes of gauge length on the two limbs were estimated using two bridge circuits (Brakkee, 1966). Calibration was by the introduction of a known resistance into the bridge circuit (Burger *et al.*, 1959). Venous occlusion was produced by cuffs placed on the upper arm and thigh, which were rapidly inflated intermittently to a pressure of 40 mm Hg from a servo-controlled supply system.

Five measurements of limb flow were made with the patient in the supine position, which were repeated after turning the patient into the left lateral position and adjusting the limb supports. A final five readings were taken on returning the patient to the supine position. Flow values were calculated from the rate of change in gauge resistance and expressed in ml/100 ml tissue/min (Brakkee, 1966).

Fifteen puerperal patients were investigated in the same way within four days of delivery for comparison.

A second series of 30 hospital inpatients in late pregnancy (over 36 weeks) had leg flow measured in the same way in the following five positions: left lateral, at 45° between left lateral and supine (left 45°), supine, at 45° between right lateral and supine (right 45°), and right lateral. These patients had been admitted to hospital because of instability of the fetal lie or distance from hospital or to await elective surgery for cephalopelvic disproportion. In none of these patients was there any evidence of cardiorespiratory disease.

Changes in blood flow with posture within each group were compared using the paired Student's *t* test.

Results

The results of the first series are shown in the table. In the pregnant patients blood flow in the legs increased from an average of 2·36 ml/100 ml/min to an average of 5·15 ml/100 ml/min on turning from the supine to the lateral position and

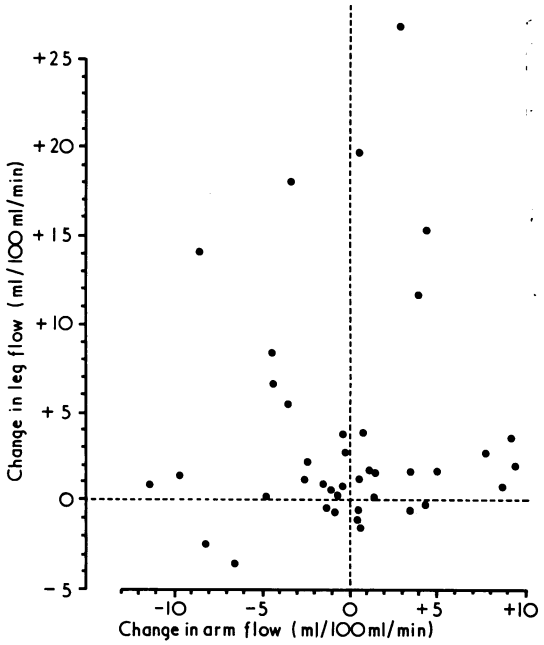

FIG. 1—Relation of changes in arm flow to changes in leg flow on moving from supine to left lateral position in 40 pregnant patients.

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Mean Changes (±S.E.) in Flow in Arm and Leg with Alteration of Posture in 40 Pregnant Patients and 15 Puerperal Patients. Results expressed in ml/100 ml/min

	Arm			Leg		
	Supine	Left Lateral	Supine	Supine	Left Lateral	Supine
Pregnant subjects	8·39 ± 1·04	7·98 ± 0·89	7·85 ± 1·10	2·36 ± 0·26	5·15 ± 0·93	1·82 ± 0·19
Puerperal subjects	5·49 ± 0·67	4·68 ± 0·62	6·58 ± 1·26	4·07 ± 0·48	3·32 ± 0·53	4·05 ± 0·52

decreased to the original low flow on resuming the supine position. The differences in the flow in the lateral and supine positions were statistically significant ($P < 0{\cdot}01$).

Of the 40 pregnant women studied 28 had reductions of leg flow when lying supine, 11 showed no change in leg flow with posture, and one woman had a slightly higher leg flow when supine. One patient showed the supine hypotensive syndrome. As might be expected the leg flow, which was 5·17 ml/100 ml/min in the left lateral position, fell to 0·92 ml/100 ml/min in the supine position.

There was no evidence of consistent changes in arm blood flow (fig. 1).

In the puerperal group leg flow was slightly greater in the supine position, being 4·07 ml/100 ml/min in contrast to 3·32 ml/100 ml/min in the left lateral position. This change was not statistically significant and there were no significant changes in forearm flow.

The means (± S.E.) of the leg flows in the second series of patients in the five positions studied are shown in fig. 2. With the exception of the right 45° position all the changes in flow from the supine position were significant. It is evident, however, that the left positions resulted in a greater increase in leg flow, with the left lateral position resulting in a mean 97% increase in leg flow. This proportional change in flow was of the same degree as occurred in our first series of patients.

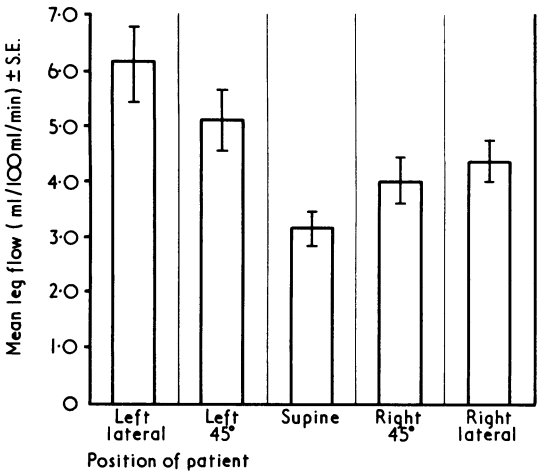

FIG. 2—Relation of position to mean leg flow in 30 patients in late pregnancy.

Discussion

Venous pressure within the abdominal vena cava is known to be high in the supine position during late pregnancy (Scott and Kerr, 1963). Evidence suggests that occulsion of the vena cava occurs in almost all subjects in the supine position (Kerr *et al.*, 1964). The venous return is by the paravertebral and azygos system of veins. This collateral drainage may not be sufficient to carry the flow normally accommodated by the unobstructed vena cava. In such circumstances leg blood flow will fall. In some 2% of women the sudden fall in venous return (and therefore cardiac output) on assuming the supine posture leads to a vasovagal reflex causing hypotension—the so-called supine hypotensive syndrome (Lees *et al.*, 1967).

A reduction of leg blood flow in the supine position was found in 28 out of the 40 cases studied. It is reasonable to infer that in these cases the supine position led to a decreased cardiac output. They represent a group where hypotension is likely if the mechanisms of circulatory compensation are disturbed—for example, by epidural block or by general anaesthesia. It is also probable that the supine position impairs uterine perfusion.

Possibly alterations in leg flow and cardiac output would lead to compensatory changes in vascular resistance in the arms, but no consistent changes in arm flow were seen. The values for arm flow in the pregnant subjects were slightly lower than those reported by Spetz (1964). The conditions of Spetz's study, using volume plethysmography to measure only arm flow on subjects recumbent in bed might well have accounted for the higher flows. In addition, a systematic difference between the two methods of measurements has been reported (Burger *et al.*, 1959).

Crawford *et al.* (1972) have shown that a 15° lateral tilt during caesarean section under general anaesthesia causes less fetal acidosis than the supine position. In their study a right tilt was predominantly used as this was preferred by the surgeon though it was realized that it would probably be less effective than a left tilt.

Some degree of lateral tilting is becoming routine in many centres for caesarean section, and our results indicate that a considerable advantage can accrue to the patient (and the fetus) because of less caval occlusion and an increase in cardiac output. From interpolation of the flow data in the five positions it seems that a leftward tilt would be more effective.

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