Systemic Cardiovascular and Renal Hemodynamic Alterations during Peridural Anesthesia in Normal Man

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High peridural blocks with 2 per cent lidocaine were studied in 20 normal volunteers 21 to 43 years of age. Epinephrine 1:200,000 was incorporated into the local anesthetic solution used to produce blocks in ten of the subjects. The following control measurements were made: mean arterial pressure, central venous pressure, cardiac rate, output and stroke volume, total peripheral resistance, *p*H $Paco_2$, Pao_2, glomerular filtration rate (GFR) and effective renal plasma flow (ERPF). These measurements were repeated at 15-minute intervals until cutaneous analgesia disappeared. With lidocaine alone, there were no significant systemic cardiovascular changes, although maximum decreases of 9 per cent in GFR and 15 per cent in ERPF were seen. Epinephrine caused highly significant cardiovascular changes attributable to beta-receptor stimulation. The maximum changes were: mean arterial pressure −21 per cent, cardiac rate +26 per cent, cardiac output +68 per cent, stroke volume +34 per cent, total peripheral resistance −49 per cent, GFR −11 per cent, and ERPF −26 per cent. The differences between GFR values in the two groups were not significant, but the greater decrease in ERPF when epinephrine was added was significant and was due primarily to decrease in mean arterial pressure. (Key words: Peridural anesthesia; Renal hemodynamics; Glomerular filtration rate; Effective renal plasma flow; Lidocaine; Epinephrine and lidocaine.)

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RECENTLY we documented the systemic cardiovascular and respiratory changes which accompany high peridural anesthesia, both with and without epinephrine in the local anesthetic solution.[1,2] The present study was performed to define the effects of high peridural anesthesia on renal function in normal man.

Methods and Materials

Twenty healthy male volunteers 21 to 43 years of age were studied. They had fasted for at least eight hours and had received no medication. The study was explained to each subject in detail and written consent was obtained. With the subject under local anesthesia, catheters were inserted percutaneously into the brachial artery and basilic vein and advanced into the subclavian artery and superior vena cava, respectively. Arterial and venous pressures were measured with Statham strain gauges and recorded continuously on a Gilson GME polygraph, as was the ECG. A vinyl catheter was inserted via the paramedian approach into the lumbar peridural space through an 18-gauge, thin-walled, short-beveled peridural needle. An 18-Fr. Foley catheter with a 5-ml bag was inserted into the bladder.

Estimates of glomerular filtratiton rate (GFR) and effective renal plasma flow (ERPF) were made simultaneously as follows. Each subject received 5,000 μg of stable cyanocobalamin 15 to 20 minutes prior to the clearance studies in order to saturate the binding sites for cyanocobalamin. To a sterile multidose vial containing another 5,000 μg of the stable cyanocobalamin, 0.015 microcuries of ^{57}Co-cyanocobalamin and 0.3 microcuries of ^{125}I-Hippuran/Kg body weight were added. After thorough mixing, a fourth of of this solution was injected as a priming dose. The remaining three-fourths was added to 350 ml of physiologic saline solution; a sustaining infusion was administered at rates of 0.03 millimicrocuries and 0.6 millimicrocuries/kg/min of ^{57}Co-cyanocobalamin and ^{125}I-Hippuran, respectively (1 ml/min).[3] Mannitol, five per cent in 0.3 per cent sodium chloride solution, was administered intravenously at a rate of 10 ml/min to obtain a brisk diuresis of about 8 to 12 ml urine/min.

After a 30-to-40 minute period for rest and equilibration, renal clearances were begun. Three 15-minute control clearance periods were obtained for each subject. Urine was collected from the indwelling bladder catheter by applying suprapubic pressure, and air washouts were used to insure complete emptying of the bladder; arterial blood samples were drawn at the midpoints of the clearance periods. At the end of the control clearance periods, control mean arterial pressure, cardiac rate and cardiac output measurements were made.

Cardiac output was determined by the indicator dilution technique with indocyanine green. The area under the dye curve was measured planimetrically.[4] Arterial blood was sampled anaerobically and P_{O_2} and *p*H were determined with a modified Clark electrode and an Astrup *p*H electrode, respectively. We calculated Pa_{CO_2} by the tonometric method of Astrup. Stroke volume was determined from cardiac output and cardiac rate. Total peripheral resistance is represented by the formula:

$$\text{TPR units (dynes/sec/cm}^{-5}) = \frac{\text{mean arterial blood pressure (mm Hg)} \times 1{,}332}{\text{cardiac output (ml/sec)}}$$

All cardiovascular and renal measurements were made while the subject was supine.

Following control measurements a peridural block to a T5 sensory level was achieved with 16 to 20 ml of 2 per cent lidocaine hydrochloride (Xylocaine); the amount of the dose was related to the size of the subject. Epinephrine (1:200,000 solution; 80 to 100 μg) was incorporated in the local anesthetic solution administered to ten of the subjects. Cardiovascular and blood gas measurements and renal clearances were repeated every 15 minutes until cutaneous analgesia disappeared. Mean duration of the peridual block was 2.72 hours with epinephrine (range 2.0 to 3.5 hours), and 2.48 hours without epinephrine (range 2.0 to 3.0 hours).

Radioactivity of plasma and urine and renal clearances of the ^{57}Co-cyanocobalamin and ^{125}I-Hippuran (GFR and ERPF) were determined according to the method of Cutler and Glatte.[3] Renal clearance values were corrected to 1.73 m.^{2} of body surface area.

Effective renal blood flow (ERBF) was calculated as:

$$\text{ERBF} = \frac{\text{clearance of } ^{125}\text{I-Hippuran}}{1 - \text{Hct}}$$

Renal vascular resistance (RVR) was calculated as:

$$\text{RVR} = \frac{\text{MAP (mm Hg)}}{\text{ERBF (ml/min)}}$$

Cardiovascular and blood gas measurements and the renal clearance measurements were converted to mean percentage changes from mean control values. The significance of each change was determined by Student's *t* test.

Results

The results are summarized in figures 1 to 3 and tables 1 and 2. Cardiovascular changes were slight with epidural block without epinephrine in the local anesthetic solution but

TABLE 1. Cardiovascular, Renal and Blood Gas

Event	Mean Arterial Pressure (mm Hg)	Central Venous Pressure (cm H_2O)†	Cardiac Output (l/min)	Cardiac Rate (beats/min)	Stroke Volume (ml/min)	Total Peripheral Resistance (dynes/sec/cm^{-5})
Control	102.8 ± 3.3	9.0 ± 0.5	7.35 ± 0.3	64.6 ± 1.4	114.1 ± 5.5	1137.4 ± 62.0
T5	−2.6 ± 1.8	7.5 ± 0.9	+2.60 ± 5.1	+6.7 ± 2.7	−4.3 ± 3.1	−2.5 ± 5.7
½ hour	−3.5 ± 1.8	7.4 ± 0.8	+1.8 ± 4.3	+6.2 ± 3.2	−4.2 ± 2.7	−3.3 ± 4.9
¾ hour	−4.1 ± 2.2	7.9 ± 0.7	−1.1 ± 4.5	+1.8 ± 2.0	−3.4 ± 3.4	−0.4 ± 6.0
1 hour	−3.6 ± 2.0	8.1 ± 0.6	−7.1 ± 3.3	−2.1 ± 3.4	−5.2 ± 1.9	+5.3 ± 5.1
1¼ hours	−0.3 ± 2.1	8.6 ± 0.6	−5.3 ± 2.7	−0.9 ± 2.9	−4.2 ± 2.2	+6.1 ± 4.5
1½ hours	+1.3 ± 2.3	9.3 ± 0.7	−4.3 ± 4.2	+1.4 ± 2.6	−5.9 ± 2.7	+7.9 ± 5.6
1¾ hours	+2.6 ± 1.9	8.5 ± 0.6	−3.4 ± 3.9	+1.1 ± 2.8	−4.7 ± 2.2	+7.9 ± 5.4
2 hours	+3.4 ± 2.5	8.8 ± 0.7	−5.9 ± 3.2	+0.1 ± 2.7	−6.1 ± 1.7	+11.5 ± 5.7
2¼ hours	+4.5 ± 2.3	8.1 ± 1.0	−0.7 ± 4.4	+3.4 ± 3.1	−4.3 ± 2.6	+7.0 ± 5.5
2½ hours	+10.3 ± 3.3	6.4 ± 0.6	−7.7 ± 8.2	+2.1 ± 4.5	−10.2 ± 4.6	+23.1 ± 13.0
2¾ hours	+10.5 ± 2.9	6.8 ± 0.8	+3.3 ± 8.6	+1.6 ± 7.2	−9.2 ± 1.8	+20.8 ± 10.6
3 hours	+9.0 ± 4.5	7.8 ± 0.3	+1.7 ± 11.5	+9.3 ± 3.5	−7.4 ± 8.5	+8.9 ± 16.5

* Mean percentage changes from the control values ± standard errors of means.
† Means ± standard errors of means.

highly significant when epinephrine was present. Mean arterial pressure, total peripheral resistance and central venous pressure decreased as much as 21, 49, and 57 per cent, respectively. The maximum increases in cardiac rate, cardiac output and stroke volume were 26, 68, and 34 per cent, respectively. Only slight changes in blood gas measurements were observed, and only one of these was significant (tables 1 and 2). These cardiovascular and blood gas results were the same as those we reported previously.[1]

^{57}Co-CYANOCOBALAMIN (GLOMERULAR FILTRATION RATE (FIG. 1, TABLES 1 AND 2)

Peridural blocks with and without epinephrine had no significantly different effects on glomeular filtration rate (GRF). Peridural block without epinephrine produced a moderate though significant decrease in GFR for the first 60 minutes. Although not significant, a similar decrease was produced by peridural block with epinephrine. During both blocks,

TABLE 2. Cardiovascular, Renal, and Blood Gas

Event	Mean Arterial Pressure (mm Hg)	Central Venous Pressure (cm H_2O)†	Cardiac Output (l/min)	Cardiac Rate (beats/min)	Stroke Volume (ml/min)	Total Peripheral Resistance (dynes/sec/cm^{-5})
Control	101.5 ± 2.6	6.5 ± 0.8	5.86 ± 0.3	63.0 ± 1.9	92.6 ± 3.9	1421.7 ± 84.1
T5	−15.5 ± 2.2	3.9 ± 0.7	+68.4 ± 5.6	+25.7 ± 4.2	+33.8 ± 3.7	−49.1 ± 2.0
½ hour	−21.1 ± 3.3	2.8 ± 0.8	+58.5 ± 6.6	+25.6 ± 4.3	+26.8 ± 4.9	−49.0 ± 3.7
¾ hour	−18.4 ± 3.4	3.1 ± 1.0	+40.3 ± 6.3	+14.3 ± 3.6	+22.4 ± 4.6	−40.6 ± 3.7
1 hour	−16.4 ± 3.5	2.9 ± 0.7	+30.8 ± 4.8	+11.4 ± 3.0	+17.8 ± 4.1	−35.3 ± 3.5
1¼ hours	−15.6 ± 3.1	2.8 ± 0.9	+28.9 ± 6.5	+11.7 ± 3.1	+15.0 ± 3.9	−33.3 ± 3.8
1½ hours	−13.6 ± 2.2	4.2 ± 1.0	+24.1 ± 4.8	+9.8 ± 3.0	+13.3 ± 3.5	−29.4 ± 3.5
1¾ hours	−10.0 ± 2.6	5.6 ± 1.3	+20.2 ± 4.9	+8.9 ± 3.2	+10.5 ± 2.5	−24.1 ± 3.6
2 hours	−7.0 ± 2.9	5.7 ± 1.0	+23.3 ± 4.9	+8.4 ± 2.9	+14.2 ± 4.2	−24.0 ± 2.7
2¼ hours	−3.4 ± 2.7	5.8 ± 1.2	+16.5 ± 5.6	+8.8 ± 3.5	+7.0 ± 3.3	−14.2 ± 4.6
2½ hours	+0.6 ± 1.2	6.1 ± 1.2	+17.4 ± 3.7	+9.2 ± 2.1	+7.7 ± 3.0	−11.6 ± 2.7
2¾ hours	+4.0 ± 2.4	3.5 ± 1.0	+17.4 ± 4.9	+9.4 ± 3.5	+7.3 ± 2.5	−9.4 ± 4.3
3 hours	+5.6 ± 1.5	6.7 ± 1.4	+16.5 ± 8.9	+7.6 ± 4.5	+7.9 ± 4.7	−7.5 ± 6.2
3½ hours	+7.0 ± 3.7	4.3 ± 0.9	+11.4 ± 4.6	+9.0 ± 2.6	+2.5 ± 3.5	−7.6 ± 7.5

* Mean percentage changes from the control values ± standard errors of means.
† Means ± standard errors of means.

Values during Peridural Anesthesia without epinephrine*

Glomerular Filtration Rate (ml/min)	Effective Renal Plasma Flow (ml/min)	Effective Renal Blood Flow (ml/min)	Renal Vascular Resistance (mm Hg/l/min)	Pao2† (mm Hg)	Paco2† (mm Hg)	pH†
101.7 ± 4.9	580.9 ± 38.1	958.4 ± 64.5	111.2 ± 7.7	85.0 ± 2.1	31.9 ± 1.3	7.363 ± 0.012
−6.7 ± 2.7	−6.1 ± 2.7	−6.6 ± 2.6	+4.9 ± 3.4	87.1 ± 2.6	31.9 ± 0.8	7.364 ± 0.014
−8.6 ± 2.4	−14.5 ± 2.8	−14.2 ± 2.4	+12.8 ± 4.1	83.0 ± 3.5	31.8 ± 1.5	7.356 ± 0.013
−6.7 ± 2.3	−9.5 ± 2.2	−9.9 ± 2.5	+ 7.1 ± 3.6	84.7 ± 4.5	32.3 ± 0.7	7.351 ± 0.008
−7.9 ± 2.1	−3.6 ± 3.2	−3.9 ± 3.5	+1.1 ± 3.1	88.9 ± 3.5	31.7 ± 0.8	7.358 ± 0.015
−5.0 ± 2.4	−7.8 ± 3.4	−8.6 ± 3.3	+9.8 ± 3.6	85.0 ± 2.9	31.7 ± 0.9	7.363 ± 0.012
−2.5 ± 2.9	−1.6 ± 4.1	−3.0 ± 4.3	+5.8 ± 4.1	86.4 ± 2.7	32.5 ± 1.0	7.359 ± 0.015
−6.1 ± 2.7	−4.9 ± 3.6	−6.8 ± 3.6	+9.4 ± 4.3	87.4 ± 3.7	31.3 ± 0.6	7.354 ± 0.013
−6.7 ± 3.5	−7.1 ± 4.6	−9.3 ± 4.4	+15.5 ± 5.0	85.6 ± 4.4	32.1 ± 0.7	7.353 ± 0.009
−4.2 ± 3.4	+0.5 ± 3.7	−1.4 ± 3.4	+6.5 ± 3.4	88.9 ± 2.7	31.5 ± 0.9	7.363 ± 0.016
−0.4 ± 1.2	+5.1 ± 8.7	+3.6 ± 9.0	+8.5 ± 8.2	87.0 ± 1.7	30.6 ± 1.4	7.360 ± 0.016
−6.0 ± 6.0	−7.1 ± 11.3	−9.2 ± 10.6	+15.1 ± 7.7	87.3 ± 3.8	31.8 ± 3.8	7.353 ± 0.022
+0.3 ± 6.4	−1.4 ± 10.8	−4.3 ± 10.5	+15.0 ± 7.4	86.5 ± 1.5	32.5 ± 1.0	7.365 ± 0.007

GFR remained below the control level but gradually returned toward control.

^{125}I-Hippuran (ERPF) (Fig. 2, Tables 1 and 2)

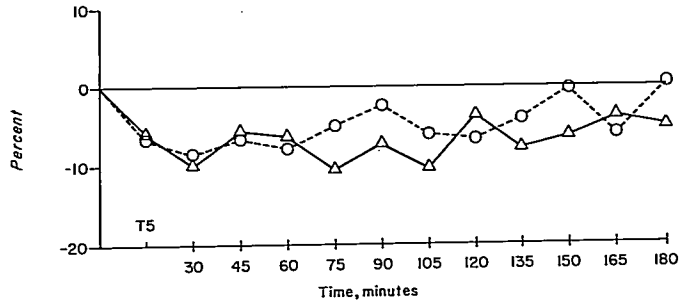
Peridural block without epinephrine decreased the effective renal plasma flow 6 to 15 per cent for the first 45 minutes; this was followed by a recovery to control level. These changes were highly significant, $P < 0.05$–0.001. Peridural block with epinephrine decreased ERPF even more (14 to 26 per cent) during the same time, with greater significance.

Effective Renal Blood Flow (Tables 1 and 2)

Because the hematocrit did not change significantly, the effects of both the presence and the absence of epinephrine on effective renal blood flow were almost identical to those observed with effective renal plasma flow.

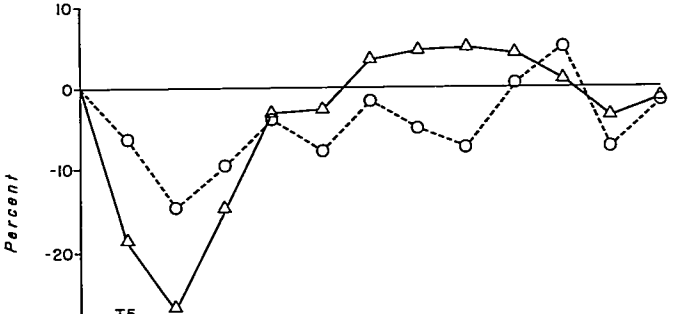
Values during Peridural Anesthesia with Epinephrine*

Glomerular Filtration Rate (ml/min)	Effective Renal Plasma Flow (ml/min)	Effective Renal Blood Flow (ml/min)	Renal Vascular Resistance (mm Hg/l/min)	Pao2† (mm Hg)	Paco2† (mm Hg)	pH†
106.3 ± 4.5	574.7 ± 41.6	1041.4 ± 26.3	94.0 ± 4.4	87.0 ± 2.6	34.8 ± 1.2	7.386 ± 0.008
−6.0 ± 3.3	−18.2 ± 4.4	−18.1 ± 8.5	+10.3 ± 18.2	91.9 ± 2.3	34.7 ± 1.2	7.371 ± 0.009
−10.0 ± 3.7	−26.4 ± 1.6	−26.5 + 2.4	+2.6 ± 4.8	88.4 ± 2.4	34.2 ± 1.5	7.368 ± 0.016
−5.7 ± 5.4	−14.3 ± 2.6	−15.5 ± 5.4	−4.8 ± 9.1	87.1 ± 2.5	35.5 ± 1.6	7.368 ± 0.015
−6.4 ± 3.0	−3.2 ± 2.9	−3.4 ± 3.6	−17.3 ± 6.5	91.9 ± 2.6	35.6 ± 1.5	7.360 ± 0.009
−10.6 ± 4.1	−2.9 ± 4.4	−8.9 ± 8.0	−5.4 ± 16.1	89.9 ± 3.2	35.5 ± 1.5	7.357 ± 0.017
−7.3 ± 3.7	+3.9 ± 5.1	−1.9 + 8.0	−9.8 ± 10.1	88.4 ± 2.9	35.2 ± 0.8	7.362 ± 0.012
−10.3 ± 2.4	+4.4 ± 3.3	+0.2 ± 4.4	−9.5 ± 6.8	90.0 ± 2.4	37.0 ± 1.3	7.364 ± 0.012
−3.7 ± 3.6	+4.9 ± 2.7	−1.2 ± 4.5	−5.5 + 4.3	91.1 ± 3.1	35.7 ± 0.9	7.367 ± 0.010
−7.9 ± 1.7	+4.2 ± 3.0	−2.3 ± 4.5	+1.2 ± 6.9	91.4 ± 1.7	35.5 ± 0.6	7.359 ± 0.012
−6.5 ± 1.8	+1.0 ± 3.1	−2.5 ± 2.4	+4.6 ± 5.0	90.3 ± 2.7	34.3 ± 0.9	7.373 ± 0.007
−1.8 ± 3.8	−3.8 ± 3.7	−9.5 ± 3.3	+19.1 ± 8.2	88.4 ± 4.1	34.6 ± 1.0	7.371 ± 0.014
−5.0 ± 3.2	−1.9 ± 3.7	−8.4 ± 6.3	+16.3 ± 7.4	88.8 ± 3.8	33.6 ± 0.4	7.367 ± 0.013
−1.8 ± 3.6	−4.6 ± 3.0	−14.6 ± 7.0	+12.2 ± 6.5	89.3 ± 2.3	33.2 ± 0.2	7.370 ± 0.012



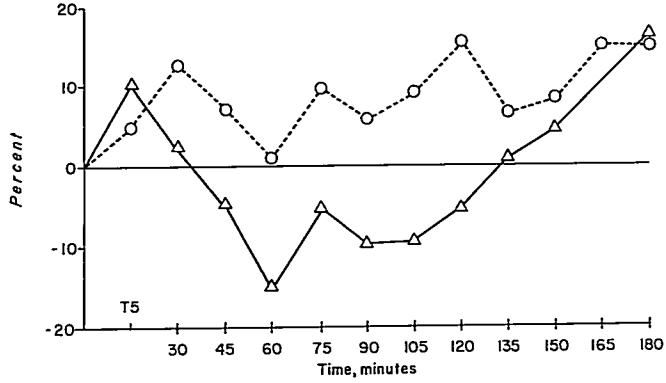
without epinephrine	*	**	*	**	NS	NS	NS	NS	NS	NS	NS	NS
with epinephrine	NS	*	NS	NS	*	NS	**	NS	**	**	NS	NS
without vs with	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

FIG. 1. Mean percentage change in glomerular filtration rate from mean control value, represented as zero, during peridural anesthesia without epinephrine, O----O, and during peridural anesthesia with epinephrine, △——△. T_5 represents the value when the sensory level reached the fifth thoracic dermatome. *** = $P < 0.001$; ** = $P < 0.01$; * = $P < 0.05$; NS = not significant.



without epinephrine	*	***	**	NS	*	NS	NS	NS	NS	NS	NS	NS
with epinephrine	**	***	***	NS	NS	NS	NS	NS	NS	NS	NS	NS
without vs with	*	**	NS	NS	NS	NS	NS	*	NS	NS	NS	NS

FIG. 2. Mean percentage change in effective renal plasma flow from mean control value, represented as zero, during peridural anesthesia without epinephrine, O----O, and during peridural anesthesia with epinephrine, △——△. T_5 represents the value when the sensory level reached the fifth thoracic dermatome. *** = $P < 0.001$; ** = $P < 0.01$; * = $P < 0.05$; NS = not significant.



without epinephrine	NS	*	NS	NS	*	NS	NS	*	NS	NS	NS	NS
with epinephrine	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS		NS
without vs with	NS	NS	NS	*	NS	NS	*	*	NS	NS		NS

FIG. 3. Mean percentage change in renal vascular resistance from mean control value, represented as zero, during peridural anesthesia without epinephrine, O----O, and during peridural anesthesia with epinephrine, Δ——Δ. T_5 represents the value when the sensory level reached the fifth thoracic dermatome. *** = $P < 0.001$; ** = $P < 0.01$; * = $P < 0.05$; NS = not significant.

RENAL VASCULAR RESISTANCE (FIG. 3, TABLES 1 AND 2)

Renal vascular resistance during peridural anesthesia alone tended to be greater than during the control period. With epinephrine, peridural anesthesia decreased renal vascular resistance, except for a slight initial increase.

Discussion

The systemic cardiovascular effects of peridural block with and without epinephrine were similar to those reported previously and will not be elaborated upon here.[1,2] In brief, the minor cardiovascular changes observed during peridural block without epinephrine probably resulted from the accompanying sympathetic blockade. The highly significant changes observed during peridural block with epinephrine are attributable to the beta-receptor-stimulating effects of epinephrine: increases in cardiac rate, output, and stroke volume, and decreases in mean arterial pressure, total peripheral resistance and central venous pressure.

The renal clearance measurements indicate that the slight insignificant decrease in ^{57}Co-cyanocobalamin clearance (GFR) represents autoregulation by the kidney in an attempt to compensate for the decrease in mean arterial preessure. Although mean arterial pressure decreased more during peridural block with epinephrine than without (a consequence of both sympathetic block and the beta effect of epinephrine), the ^{57}Co-cyanocobalamin clearances were similar during both blocks. This agrees with the findings of Shipley and Study[5] that a reduction in mean arterial pressure eventually is accompanied by reductions in both GFR and renal plasma flow and, again in keeping with their results, GFR decreased less than ERPF with a given reduction in mean arterial pressure. Thus, in contrast to its effects on systemic cardiovascular parameters and renal plasma flow, the addition of epinephrine to the local anesthetic solu-

tion had no significant effect on glomerular filtration rate. With blood pressure change of this degree and the amount of epinephrine used, the kidney was able to compensate via autoregulation.

Peridural block without epinephrine slightly decreased effective renal plasma flow, probably a consequence of the slight decrease in mean arterial pressure and slight increase in renal vascular resistance (table 1). Peridural block with epinephrine (1:200,000) decreased renal plasma flow even more. This was probably a consequence of the reduction in mean arterial pressure (maximum −21 per cent); changes in calculated renal vascular resistance were insignificant (table 2). Combos, Smythe, and Smith reported a decrease in renal plasma flow (PAH clearance) with the intravenous infusion of small amounts of epinephrine (0.1 to 0.2 μg/kg/min).[6, 7, 8] A renal vasoconstrictor effect of epinephrine undoubtedly was not the explanation for the decrease in effective renal plasma flow in this study, because the amount of epinephrine used was small (80 to 100 μg) and the calculated renal vascular resistance was not increased except for an insignificant initial rise.

We have demonstrated that the systemic cardiovascular effects of peridural block without epinephrine are similar to those during spinal anesthesia.[2] The changes in GFR and ERPF observed here during peridural block without epinephrine are strikingly similar to those reported many years ago by Smith and Rovenstine, working with spinal anesthesia, and more recently by Kennedy *et al.* as part of a comprehensive study of cardiovascular and renal hemodynamics.[9, 10] Smith and Rovenstine observed mean decreases in GFR and ERPF of 10 and 4 per cent, respectively, and we found the GFR and ERPF to be reduced 10 and 7 per cent with high spinal anesthesia. Thus, the decreases of 6 to 8 per cent and 6 to 14 per cent in GFR and ERPF in this study during peridural block without epinephrine are similar to the effects of spinal anesthesia on the renal vasculature.

In anesthetized dogs hypertonic mannitol increases renal blood flow and decreases renal vascular resistance.[11, 12, 13] The effects of hypertonic mannitol in normal man are variable.[14, 15] Isotonic mannitol was used in this study solely to provide large volumes of urine. Further, it was used in the same fashion both in the control period, 45 minutes, and during the anesthesia which followed. Because the clearance values returned to normal by the end of the anesthesia, we concluded that the changes observed were probably due to the anesthetics.

It is well known that significant elevations of plasma concentrations of lidocaine occur following peridural injection of the drug,[16, 17] but the effects of these increased plasma concentrations on renal hemodynamics in man are not known. Measurements of plasma lidocaine concentrations were not made in this study. Further studies are indicated.

[57]Co-cyanocobalamin (Racobalamin-57) and [125]I-Hippuran (Hippuran-125) supplied courtesy of Abbott Laboratories, North Chicago, Illinois.

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Obstetrical Anesthesia

CARDIAC OUTPUT IN LABOR Cardiovascular dynamics during labor and delivery were evaluated in 23 patients. Ten received "local" analgesia (paracervical or pudendal block) and 13, caudal anesthesia. Arterial pressure, central venous pressure, cardiac output, heart rate, intrauterine pressure, stroke volume, and blood volume changes were all investigated. Caudal anesthesia prevented the increase in cardiac output at delivery. Turning the patient from the supine to the lateral position, in both groups, resulted in relief of vena caval obstruction and increase in cardiac output. *(Ueland, K., and Hansen, J. M.: Maternal Cardiovascular Dynamics: III, Labor and Delivery under Local and Caudal Analgesia, Amer. J. Obstet. Gynec. 103: 1 (Jan.) 1969).* ABSTRACTER'S COMMENT: Here we have objective evidence why peridural anesthesia is indicated for the cardiac patient in labor.

ACID-BASE STUDIES AT BIRTH Acid-base measurements of cord blood at birth and femoral vein blood one hour after birth were made in 65 full-term infants, born of normal mothers. One-minute Apgar score was assessed. Either regional anesthesia or no anesthesia was used for delivery. The mean umbilical artery *p*H for those delivering spontaneously or with elective low forceps was 7.22. The mean umbilical artery *p*H in infants delivered after midforceps rotation was 7.16. Umbilical artery *p*H tended to be lower in the longer labors. There was a correlation between length of second stage and umbilical artery *p*H. Despite significant differences in umbilical artery *p*H at birth in some of the infants, all groups reached essentially the same acid-base status at one hour. This was thought to be because no depressant anesthetic drugs were used. *(Clark, R. B., and others: Neonatal Acid-Base Studies: I. Effect of Normal Labor and Obstetric Manipulation, Obstet. Gynec. 33: 23 (Jan.) 1969.)*