Plasma catecholamines and plasma renin activity at birth and during the first days of life

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Summary

1. Plasma noradrenaline and adrenaline concentrations and plasma renin activity were measured in 21 mothers at delivery and in their babies at birth (umbilical cord blood) and on days 1 and 5 of extrauterine life.

2. At birth plasma renin activity was significantly higher in the newborn than in mothers. Plasma renin activity increased further, but not significantly, on day 1 of life and significantly decreased on day 5. On day 5, 10 min head-up tilting caused no change in plasma renin activity.

3. Plasma noradrenaline in the newborn was higher than in mothers at birth and significantly decreased thereafter. Plasma adrenaline levels at birth were similar in the newborn and their mothers and significantly lower in the newborn in subsequent days. Tilting caused no increase in either plasma adrenaline or noradrenaline levels.

4. No correlation was found between plasma noradrenaline and adrenaline levels and plasma renin activity, or between noradrenaline, adrenaline or plasma renin activity and blood pressure.

Key words: catecholamines, newborn infants, plasma renin activity.

Introduction

The degree of function of the sympathetic system and its homeostatic role in newborn infants are still controversial. The high levels of plasma renin activity (PRA) at birth had suggested that the renin—angiotensin system could be the dominant mechanism in blood pressure and water homeostasis at birth. The time course of PRA changes during the first days of life has been previously investigated with partly divergent results (Brown, Davies, Doak, Lever & Robertson, 1966; Hayduck, Krause, Huenges & Unbehaun, 1972; Marshall, Barlett, Sheehan, Maurer, Ellenberger, Blumberg & Needleman, 1976).

Measurements of plasma catecholamine levels in the newborn have been limited to the first 2 days of extrauterine life (Eliot, Lam, Leake, Hobel & Fisher, 1980) and no study has been reported in which both circulating catecholamines and renin at birth were simultaneously measured in babies and in their mothers.

The aims of our study were: (1) to study plasma catecholamine levels and renin activity in the same infants between delivery and day 5 of extrauterine life; (2) to measure the changes induced by head-up tilting in circulating catecholamines and PRA as indices of the responsiveness of the sympathetic and renin systems in the newborn; (3) to look for possible correlations between any of these biochemical parameters and blood pressure.

Materials and methods

Plasma catecholamines and PRA in 21 full-term and vaginally delivered infants were measured in mixed umbilical cord blood at birth and in peripheral venous blood in days 1 and 5 of extrauterine life. A venous blood sample was taken from the mothers at the moment of delivery. All vaginal deliveries were spontaneous and the pregnancies had been uncomplicated. All the infants had 1-min Apgar score of 8 or more at birth. Blood samples were taken on days 1 and 5 of life only from newborn infants with uncomplicated hospital course. On day 5, a blood sample was also collected after 10 min of head-up tilting at 50°.

Plasma noradrenaline and adrenaline were determined by a sensitive radioenzymatic method.
(Da Prada & Zürcher, 1976). PRA was measured by the radioimmunological method of Haber, Hoerner, Page, Kliman & Purnode (1969) with personal modifications. Blood (1-5 ml) was sufficient for both determinations and, except at birth, it was taken by antecubital venepuncture, with a minimum of disturbance for the infants. Blood pressure was recorded indirectly with an oscillometric method (Dinamap apparatus). Statutory analyses were by Student's t-test.

Results

Plasma renin activity (Table 1)

PRA was significantly higher in the umbilical cord blood (12.33 ± 1.61 ng h⁻¹ ml⁻¹) than in the mother's peripheral venous blood (5.64 ± 0.73 ng h⁻¹ ml⁻¹), simultaneously taken at delivery. Twenty to 24 h later the PRA in peripheral venous blood of the newborn was slightly, although not significantly, higher (16.78 ± 2.47 ng h⁻¹ ml⁻¹) than it was the previous day in the mixed umbilical cord blood. On day 5 of extrauterine life PRA was significantly lower (4.87 ± 0.79 ng h⁻¹ ml⁻¹) than on day 1, and remained unchanged after 10 min of tilting (4.68 ± 1.26 ng h⁻¹ ml⁻¹).

Plasma catecholamines (Table 1)

Plasma noradrenaline (NA) at birth was significantly higher in the umbilical cord blood (1.047 ± 0.256 ng/ml) than in the mother's peripheral venous blood (0.320 ± 0.017 ng/ml). Twenty to 24 h later the NA concentration in the newborn babies' venous blood was significantly lower (0.382 ± 0.032 ng/ml). On day 5 of life the NA levels were similar in the supine (0.446 ± 0.070 ng/ml) and upright (0.444 ± 0.054 ng/ml) positions and slightly but not significantly higher than on day 1.

Plasma adrenaline levels at delivery were similar in newborn babies (0.133 ± 0.027 ng/ml) and their mothers (0.145 ± 0.035 ng/ml). Adrenaline levels in peripheral blood were almost identical on day 1 (0.032 ± 0.010 ng/ml) and on day 5 of life in both the supine (0.035 ± 0.010 ng/ml) and upright (0.038 ± 0.010 ng/ml) position and significantly lower than values at birth.

Blood pressure and heart rate

Supine blood pressure significantly (P < 0.05) increased between day 1 (68 ± 2/37 ± 2 mmHg) and day 5 of life (82 ± 3/46 ± 2 mmHg) without any significant increase in heart rate (from 125 ± 3 to 130 ± 3 beats/min). Ten-minute tilting caused no change in systolic or diastolic blood pressure (80 ± 3/46 ± 2 mmHg) and a slight but significant increase in heart rate (from 130 ± 3 to 136 ± 2 beats/min). No correlation was found between plasma NA or adrenaline and PRA, or between NA, adrenaline or PRA and blood pressure at any time studied.

Discussion

The present study shows that plasma NA concentrations and PRA are both markedly higher in mixed cord blood from vaginally delivered infants than in peripheral venous blood taken at the same time from their mothers or than those values reported for the adult population (Brunner, Laragh, Baer, Newton, Goodwin, Krakoff, Bard & Bühlter, 1972; Bühlter, Da Prada, Haefely & Picotti, 1978). Plasma adrenaline values in cord blood are higher than those reported for unstressed adults (Bühlter et al.,

<table>
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<tr>
<th>Table 1. Plasma renin activity and plasma catecholamine concentrations in blood of mothers and their newborn infants</th>
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<td>No.</td>
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<td>Mothers at delivery Babies</td>
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<td>At delivery</td>
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<td>Day 1</td>
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<td>Day 5, supine</td>
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<td>Day 5, upright</td>
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<td>(n = 12)</td>
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Means ± SE of values measured in the subjects and under the conditions indicated in the left column are shown. Asterisks indicate that means were significantly different from those in the row above: * P < 0.05; ** P < 0.01.
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1978), but similar to those measured in the mothers at delivery.

PRA on day 1 was high, declined between days 1 and 5 of extrauterine life, but was still high in the 5-day infant as compared with adults. Plasma NA and adrenaline levels in peripheral venous blood of newborn infants were lower 20–24 h after birth, NA values being somewhat elevated in respect to resting values found in adults.

Levels of plasma catecholamines at birth higher than those found in the present study have been reported by Lagercranz & Bistoletti (1973) and Nakai & Yamada (1978), whereas similar PRA increases had been found by Brown et al. (1966), Hayduck et al. (1972) and Marshall et al. (1976). The present finding that plasma NA and PRA are both consistently higher in umbilical cord blood than in the mother's blood at delivery indicates that NA and renin in newborn plasma cannot be entirely of maternal origin. The slow decrease in PRA in the first days of life, with values on day 5 still higher than in the adult population, is also not consistent with a maternal origin of the substance. Our data do not rule out the possibility that the high levels of adrenaline, NA and PRA measured in the newborn cord blood are due to delivery stress, as suggested by Lagercranz & Bistoletti (1973) for catecholamines. On the other hand, the high levels of PRA in cord blood must have some additional explanation besides delivery stress, since PRA is still markedly elevated in newborn infants up to 5 days after birth.

The evidence that plasma NA in cord blood is at least partially of foetal origin indicates that the neurosympathetic system at birth is capable of producing and releasing its final transmitter. Moreover, since resting plasma NA and adrenaline concentrations in 1–5 day infants are comparable with those found in adults (Eliot, Klein, Glatz, Lam, Nathanelez & Fisher, 1980), efficient sympatho–adrenal release of catecholamines since the first days of life appears likely. However, we still lack data on the re-uptake; metabolism and clearance from plasma of released catecholamines in newborn infants.

In contrast to the adult (Brown, Davies, Lever & Robertson, 1964; Rosenthal, Birch, Osikowska & Sever, 1978), upright tilting of newborn infants did not increase plasma NA or PRA. The failure of a passive orthostatic stimulus to elicit a neurosympathetic response in the newborn could be interpreted in several ways. For instance, there may be incomplete anatomical and/or functional development of the nervous structures involved in the baroreceptive reflex(es) at birth. The ontogenic development of orthostatic reflexes might be completed later in life, perhaps when the infant achieves active upright posture. An alternative explanation may be that arterial baroreceptors are not sensitive enough to detect the small gravitational changes likely to occur in the newborn. The unchanged blood pressure values in our infants during tilting indicate that pressor homeostasis was maintained by some adaptive mechanism other than reflexly increased catecholamines and renin release. Indeed, the mechanisms controlling blood pressure at birth are still unclear.

In the present study no correlation was found between plasma NA, adrenaline or PRA and pressure values. However, the importance of a single factor in a complex phenomenon such as blood pressure regulation is unlikely to be identified by correlation analysis only.

References


