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Thyrotropin and prolactin response to ambient temperature in newborn infants

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Plasma TSH and PRL level was measured by RIA in 8 full-term newborn infants with mean birth weight of 3420 g (range 3000–4100 g) and mean gestational age of 39.0 weeks (range 38–40 weeks) at postnatal age of 3–4 days. Determinations were performed at neutral thermal environment (32°C) and after 1 h exposure to cold (28°C) and warm (37°C) environment.

In response to cold challenge, TSH and PRL increased significantly from 4.17 ± 0.28 mU/l and $4625 \pm$mU/l to 4.76 ± 0.21 mU/l ($p < 0.01$) and 5975 ± 944 mU/l ($p < 0.05$), respectively. When the newborns were placed in warm environment, both TSH and PRL fell significantly to 3.52 ± 0.4 mU/l ($p < 0.05$) and 3318 ± 759 mU/l ($p < 0.05$), respectively.

A weakly significant positive correlation was found between TSH and PRL levels suggesting that thermal stress in the newborn results in similar alterations in TSH and PRL, presumably through the same central mechanism.

Activity of the hypothalamic-pituitary-thyroid axis has been reported to vary considerably with changes in ambient temperature (6). Based on the observation that acute exposure to cold resulted in an increase of TSH and thyroxine (T_4) levels, the initial increase in TSH and the subsequent increase in T_4 observed immediately after birth has been attributed to the cooling effect of the extrauterine environment (1, 6, 7). It has also been claimed that the cold induced rise of TSH is due to the higher rate of hypothalamic TRH secretion (17) because TSH stimulation by cold could be suppressed by antiserum to TRH (26).

Furthermore, evidence has been provided to indicate that TRH may be the prolactin releasing factor of the hypothalamus, since TRH releases prolactin (PRL) by a direct action on the pituitary (4, 9, 11) and administration of TRH antiserum suppressed PRL secretion (12).

On the basis of these observations we have assumed that TSH and PRL may be released similarly in response to various ambient temperatures and their release may be mediated by the same central mechanism. To test this hypothesis the present study was designed to investigate plasma TSH and PRL levels in newborn infants kept in neutral thermal environment and then after exposure to acute cold and heat stress.

Material and Methods

The studies were carried out in 8 healthy, fullterm newborn infants with mean birth weight of 3420 g (range 3000–4100 g) and mean gestational age of 39.0 weeks (range 38–40 weeks).

Gestational age was calculated from the mother's menstrual history and was confirmed by physical examination of the infants. All infants were delivered vaginally with a one-minute Apgar score of 7 or more, and they were healthy during the whole perinatal period.

None of the subjects received anticonvulsant therapy and none had a family history of thyroid disorder. Breast milk was fed to the infants and 5% glucose in water added to ensure an adequate fluid intake.

Determinations were performed at the postnatal age of 3–4 days at 3 different ambient temperatures.

First, the unclothed infants were placed in an incubator providing neutral thermal environment (temperature 31–32°C; relative humidity 40–60%). Next, they were kept in a cool (temperature 28°C, relative humidity 40–60%) and, finally, in a warm environment (temperature 37°C, humidity 40–60%). After one hour exposure to each ambient condition, blood was taken from a scalp vein for TSH and PRL determination. Samples were centrifuged immediately, and the plasma was stored at —20°C until analysed. During the test periods, abdominal skin and rectal temperature were recorded continuously.

Informed parental consent was obtained for the study. Plasma TSH was measured by radioimmunoassay using Amersham kits according to the method of Martin and Landon (15). Plasma PRL measurements were made by radioimmunoassay using commercial kits manufactured by Serono. Results were expressed as mean ± SE and analysed using Student's paired *t*-test. When necessary, the correlation coefficient and the equation of regression were also calculated.

Results

Body temperature

At 32°C ambient temperature, rectal and abdominal skin temperatures were 36.77 ± 0.05 and 36.52 ± 0.05°C, respectively. When the newborn infants were placed in incubators of 28°C, their rectal and skin temperature declined to 36.45 ± 0.07°C and 36.21 ± 0.07°C ($p < 0.01$), respectively. At 37°C, however, both rectal and skin temperatures increased significantly to reach mean values of 37.31 ± 0.12 and 36.65 ± 0.10°C ($p < 0.01$). At the end of the exposure to the warm environment visible sweating occurred in 5 out of the 8 infants.

Hormone levels

Figure 1 shows plasma PRL and TSH levels measured at various ambient conditions. It can be seen that in response to cold challenge, TSH and PRL rose simultaneously from 4.17 ± 0.28 mU/l and 4625 ± 589 mU/l to 4.76 ± 0.21 mU/l ($p < 0.01$) and 5975 ± 944 mU/l ($p < 0.01$), respectively. In newborns placed in warm environment, both TSH and PRL fell significantly to the respective values of 3.52 ± 0.40 mU/l ($p < 0.05$) and 3318 ± 759 mU/l ($p < 0.05$). TSH ($p < 0.05$) and PRL ($p < 0.05$) were found to correlate inversely with the rectal temperature (Fig. 2) whereas TSH showed a weakly significant positive correlation with the PRL level ($p < 0.05$) (Fig. 3).

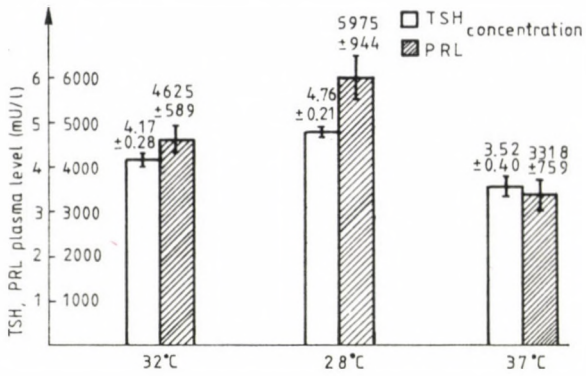

FIG. 1. Plasma TSH and PRL in newborn infants subjected to various ambient conditions

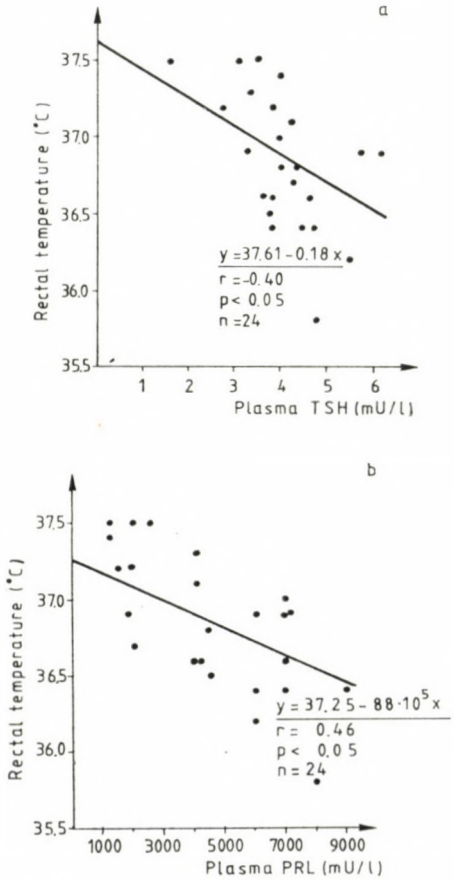

FIG. 2. Rectal temperature and plasma TSH *(a)* and PRL *(b)* in newborn infants subjected to various ambient conditions

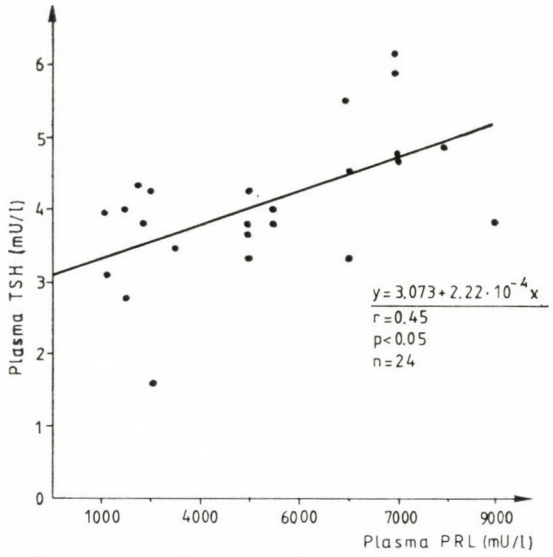

FIG. 3. Plasma TSH and PRL levels in **newborn infants subjected to various** ambient conditions

DISCUSSION

The present results are in good agreement with those previously reported showing that acute exposure of newborn infants to cold results in increased secretion of TSH within 30 min (6, 7, 22). Warm exposure of the newborn infants resulted in a fall of the plasma TSH level, as compared with the value measured in neutral thermal environment.

Few data are available concerning the influence of warm environment on pituitary-thyroid function. It has been suggested that heating produced histological signs of thyroid inactivity in various mammals (3, 8) reduced thyroid ^{131}I uptake (28) and resulted in a fall of the pituitary TSH content (13). O'Malley et al. (19) provided evidence that in patients with primary hypothyroidism heat reduced TSH production, and Sack et al. (21) observed that in newborn lambs delivered into water of 39°C the rise of TSH, T_3 and T_4 level generally seen after normal delivery could be prevented. The reason for the alteration in TSH in response to ambient temperature variation is not clear; changes in the hypothalamic control mechanism have been assumed to be responsible (1, 20).

The physiologic significance of the cold-induced activation of the thyroid is well documented (1, 5, 7, 27). It is involved in the metabolic response to cold of the newborn through the direct effect of thyroid hormones on metabolic heat production, or indirectly by potentiating the catecholamine-mediated non-shivering thermogenesis (14, 25).

Interpretation of the depressed thyroid function in neonates kept in warm environment is not so apparent. The metabolic rate of the newborn infants kept in an environment warmer than neutral is about 20% lower than under neutral conditions (24). This observation lends support to the possibility that the decrease of thyroid function may contribute to the reduction of metabolic heat production when the newborn infants are in a warm environment.

A further important point is that in response to temperature changes the plasma PRL level changed in a way similar to that of TSH (22). This finding is consistent with the observation that TSH and PRL levels increase simultaneously in newborn infants after birth or after TRH administration (4, 22).

The relationship between environmental temperature and the PRL level has not been entirely clarified. Several reports indicate that cold exposure suppresses the circulating PRL level in rats (18) and in cattle (23), but there are no such data available for the human newborn. There is some controversy concerning the effect of warm exposure since it was found that in response to a high ambient temperature plasma PRL either increases (16), or remains unchanged (10).

The clinical significance of our observations needs further studies to define the relationship of ambient temperature to the plasma PRL level in the neonatal period.

In view of the fact that PRL has been shown to enhance renal tubular reabsorption of salt and water it is tempting to speculate that in newborns suffering from neonatal cold injury the high level of cirulating PRL may contribute to œdema formation (2).

References

1. Abuid, JL, Klein, AH, Foley, TP, Larson, PR: Total and free triiodothyronine and thyroxine in early infancy. *J Clin Endocrinol Metab* 39:263, 1974
2. Behrman, RE: Neonatal cold injury. In: *Nelson Textbook of Pediatrics*, ed. VC Vaughan, RJ McKay, WE Nelson, 10th ed. Saunders, Philadelphia London 1975, p. 392
3. Cramer, W, Ludford, RJ: On cellular activity and cellular structure as studied in the thyroid gland. *J Physiol (Lond)* 61:398, 1926
4. Delitala, G: Thyrotropin, prolactin response to TRH in newborn patients. *Biol Neonate* 33:236, 1978
5. Erenberg, A, Phelps, D, Lam, R, Fisher, DA: Total and free thyroid hormone concentrations in the neonatal period. *Pediatrics* 53:211, 1974
6. Fisher, DA, Dussault, JH, Sack, J, Chopra, L: Ontogenesis of hypothalamic pituitary thyroid function and metabolism in man, sheep and rats. *Recent Prog Horm Res* 33:59, 1977
7. Fisher, DA, Odell, WD: Acute release of thyrotropin in the newborn. *J Clin Invest* 48:1670, 1969
8. Fishborn, KL: The effect of sudden alterations of temperature on the thyroid gland. *S Afr J Med Sci* 1:75, 1935
9. Foley, TP, Jacobs, LS, Hoffman, W, Daughaday, WH, Blizzard, RM: Human prolactin and thyrotropin concentrations in the serum of normal and hypopituitary children before and after administration of synthetic thyrotropin releasing hormones. *J Clin Invest* 51: 2143, 1972
10. Follenius, M, Brandenberger, G, Simeoni, M, Reinhardt, B: Plasma aldosterone, prolactin, and ACTH relationships in man during heat exposure. *Horm Metab Res* 11:180, 1979

11. Gujda, HJ, Friesen, HG: Serum prolactin levels in humans from birth to adult life. *Pediatr Res* 7:534, 1973
12. Koch, Y, Goldhaber, G, Fireman, I, For, U, Tal, E: Suppression of prolactin and thyrotropin secretion in the rat by antiserum to thyrotropin-releasing hormone. *Endocrinology* 100:1476, 1977
13. Kuschinsky, G: Über den Einfluss verchiedener Temperaturen auf die Sekretion des thyreotropen Hormons. *Hoppe-Seylers Arch Exp Pathol Pharmakol* 179:726, 1935
14. Le Blanc, J, Villemaire, A: Thyroxine and noradrenaline. Influence of noradrenaline sensitivity, cold resistance, and brown fat. *Am J Physiol* 218:1742, 1970
15. Martin, MJ, Landon, J: The use of an ammonium sulphate and dextran together with second antibody at the separation stage in radioimmunoassay. In: *Radioimmunassay in Clinical Biochemistry*, ed. Pasternak, CA, Heyden and Son Ltd., London 1975, p. 269
16. Mills, DE, Robertshaw, D: Response of plasma prolactin to changes in ambient temperature and humidity in man. *J Clin Endocrinol Metab* 52:279, 1981
17. Montoya, E, Seibel, MJ, Wilbert, JF: Thyrotropin-releasing hormone secretory physiology. Studies by radioimmunoassay and affinity chromatography. *Endocrinology* 96:1413, 1975
18. Mueller, GP, Chen, HT, Dibbert, JA, Chen, HJ, Meites, J: Effects of warm and cold temperatures on the release of TSH, GH, and prolactin in rats. *Proc Soc Exp Biol Med* 147:698, 1974
19. O'Malley, BP, Davies, TJ, Rosenthal, FD: TSH responses to temperature in primary hypothyroidism. *Clin Endocrinol (Oxf)* 13:87, 1980
20. Reichlin, S, Martin, JB, Mitnick, MA, Bowshaws, RL, Grimm, Y, Bollinger, J, Gordon, J, Malacara, J: The hypothalamus in pituitary thyroid regulation. *Recent Prog Horm Res* 28:229, 1972
21. Sack, J, Beaudry, M, De Lamater, PV, Oh, W, Fisher, DA: Umbilical cord cutting triggers hypertriidothyroninemia and nonshivering thermogenesis in the newborn lamb. *Pediatr Res* 10:169, 1976
22. Sack, J, Fisher, DA, Wang, CC: Serum thyrotropin, prolactin and growth hormone levels during the early neonatal period in the human infant. *J Pediatr* 89:298, 1976
23. Smith, VG, Hacker, RR, Brown, RG: Effects of alteration in ambient temperature on serum prolactin concentration in steers. *J Anim Sci* 44:645, 1977
24. Sulyok, E, Jéquier, E, Prod'hom, S: Thermal balance of the newborn infant in a heat-gaining environment. *Pediatr Res* 7:888, 1973
25. Swanson, HE: Interrelationships between thyroxine and adrenaline in the regulation of oxygen consumption in the albino rat. *Endocrinology* 59:217, 1956
26. Szabó, M, Frohman, LA: Suppression of cold-stimulated TSH by antiserum to TRH. *Endocrinology* 101:1023, 1977
27. Wilber, JF, Baum, D: Elevation of plasma TSH during surgical hypothermia. *J Clin Endocr* 31:372, 1970
28. Williams, RH, Jaffe, H, Kemp, C: Effect of severe stress upon thyroid function. *Am J Phys* 159:291 1949

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