Acta Paediatrica Academiae Scientiarum Hungaricae, Vol. 18 (3–4), pp. 311 – 314 (1977)

Effective thyroxine ratio in newborn infants during exchange transfusion

By

F. PÉTER, I. ILYÉS and J. KECSKÉS

Department of Paediatrics, University Medical School, Debrecen, Hungary

Received April, 29th, 1977

The effect of blood exchange transfusion on the thyroid has been studied by serially establishing the effective thyroxine ratio (ETR). The ETR value is slightly increased in the newborn infant and the level is further augmented by blood exchange. Since the ETR level is lower in the transfused blood than in the blood of the newborn, the finding points to the good thyroid hormone producing capacity of the neonate.

It has been known for long that the serum protein-bound iodine (SPBI) and the butanol-extractable iodine (BEI) levels are increased in the first days of life [2, 5]. The cause of the finding was then shown to be the increased thyroid hormone binding capacity (TBC) of the serum proteins [7, 12, 13], though the thyroid gland of the newborn shows hyperfunction by the iodine uptake test [8] as well as histologically [14, 16]. The slight neonatal hyperthyroidism was finally corroborated by determining the serum free T_4 and T_3 contents [3, 6].

In view of its considerable influence on homeostasis, it seemed interesting to study the influence on the thyroid household of an exchange transfusion. This the more so as after the only investigation into the subject [17] it has been recognized that the effective thyroxine ratio (ETR) [9, 10, 15] was especially suited for studying the function of the thyroid gland in the perinatal period [1, 4, 11].

Material and Method

The material consisted of 10 infants, 6 males and 4 females ranging in age from 1 to 5 days and in weight from 1100 to 2700 g. Three of the babies were full-term and 7 preterm. The babies received a total of 12 exchange transfusions indicated by severe hyperbilirubinaemia. The dose of preserved blood was 200 ml/kg.

Blood samples were obtained from the neonates at the beginning of each 200 ml and at the end of the exchange transfusion and from each 200 ml bottle of blood. Thus, a total of 31 neonate blood samples and 19 bottle samples were tested.

ETR was determined with the Res-O-Mat ETR kit (Mallinckrodt). The basis of the method is to establish the serum total T_4 level by competitive protein binding and to determine the free capacity of thyroid binding globulin (TBG) by labelled hormone.

For statistical evaluation, Student's *t*-test was used.

Results

Mean values $\pm$ S.D. are shown in Table I.

TABLE I

Mean ETR values ± S.D. in newborn and preserved blood

Blood sample	No.	ETR level Mean ± S.D.
Neonatal		
Pre-exchange	12	1.05 ± 0.1
After first 200 ml	12	1.12 ± 0.08
After second 200 ml	7	1.14 ± 0.28
Preserved		
First 200 ml	12	0.96 ± 0.09
Second 200 ml	7	0.99 ± 0.11

In the samples obtained prior to exchange transfusion, in two cases the ETR proved to be higher than the normal upper limit (Fig. 1) but the mean ETR did not reach the hyperthyroid level, although it exceeded the cord blood value (Table II). After infusing the first bottle, the mean approached the normal upper limit, while half of the individual cases attained the hyperthyroid level. In two-thirds of the individual cases an increase, while in one third a very slight decrease occurred. After transfusing the second bottle the mean value was still somewhat higher but the scatter was wider and in the majority of the cases a decrease was observed (Fig. 2). It was remarkable that the mean ETR was low in the samples of preserved blood.

When analysing the individual values for age, body weight, maturity and body temperature, no close connection could be observed.

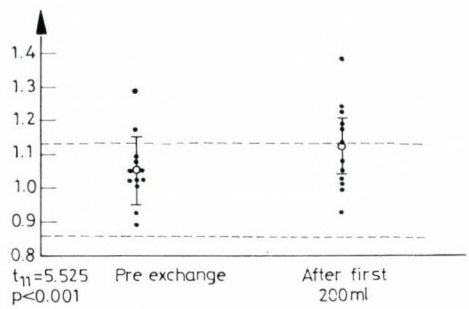

FIG. 1. ETR after transfusion of first 200 ml of blood

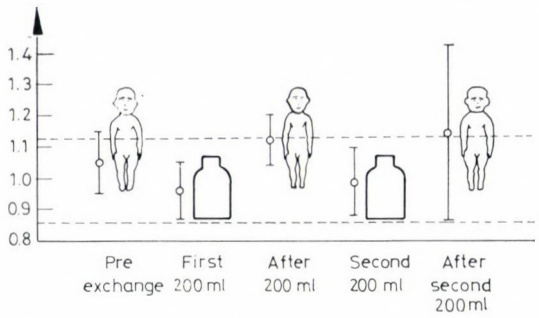

FIG. 2. Mean ETR ± S. D. in blood of the newborns and in preserved blood during exchange transfusion

DISCUSSION

As described in our earlier study [11], on the first days of life the ETR was somewhat higher than in cord blood. The mean remained below the normal upper limit and, even in individual cases, it seldom reached the hyperthyroid zone. Recently, similar results have been reported by other authors [1, 4].

Some 15 years ago it was found [17] that the low BEI values of neonates at the end of the exchange transfusion increased shortly after it and stabilized at the high pre-exchange level. This was ascribed to the low BEI content of the blood used for exchange and by the increased thyroid function of neonates.

Determination of ETR is particularly suitable for studying the effect of blood exchange on the thyroid household, since the value is not affected by changes of the binding proteins. Such changes must namely be expected from the use of blood from adult donors.

In our material, the mean ETR increased during the blood exchange transfusion and in half of the cases the value attained the hyperthyroid level is spite of the fact that in the transfused blood the ETR was low almost without exception. Thus, the T_4 produced by the baby must have been responsible for the increase. This is an additional proof of the fact that the newborn baby has an independent and well-reacting thyroid household

TABLE II

ETR values in cord and newborn blood

Blood sample	No.	ETR level Mean ± S.D.	Range
Cord	10	0.99±0.08	0.86—1.2
Newborn	12	1.05±0.1	0.89—1.28

and its capacity to secrete hormones can be related to this weight category as well.

References

1. Brien, T. G., Fay, J. A., Griffin, E. A.: Thyroid status in the newborn infant. Effective thyroxine ratio and free thyroxine index. Arch. Dis. Child. **49**, 225 (1974).
2. Danowsky, T. S., Jounorsoton, S. Y., Price, W. C., McKelvy, M., Stevensson, S. S., McCuskey, E. R.: Protein bound iodine in infancy from birth to one year of age. Pediatrics **7**, 240 (1951).
3. Erenberg, A., Phelps, D., Lam, R., Fischer, D. A.: Total and free thyroid hormone concentrations in the neonatal period. Pediatrics **53**, 211 (1974).
4. Koivisto, M., Similä, S., Haarpalathe, J., Reinela, M.: Thyroid function assay using the effective thyroxine ratio (ETR) in infancy. Scand. J. clin. Invest. **33**, 105 (1974).
5. Man, E. B., Pickering, D. E., Walker, J., Cooke, R. E.: Butanol extractable iodine in serum of infants. Pediatrics **9**, 32 (1952).
6. Marks, J. F., Hamlin, M., Zack, P.: Neonatal thyroid function. II. Free thyroxine in infancy. J. Pediat. **68**, 559 (1966).
7. Marks, J., Wolfson, J., Klein, R.: Neonatal thyroid function: erythrocyte T_3 uptake in early infancy. J. Pediat. **58**, 32 (1961).
8. Middlesworth, L. van: Radioactive iodine uptake of normal newborn infants. Amer. J. Dis. Child. **88**, 439 (1954).
9. Mincey, E. K., Thorson, S. C., Brown, I. L.: A new in vitro blood test for determining thyroid status: The effective thyroxine ratio. Clin. Biochem. **4**, 216 (1971).
10. Mincey, E. K., Thorson, S. C., Brown, I. L., Morrison, R. T., McIntosh, H. W.: A new parameter of thyroid function: the effective thyroxine ratio. J. nucl. Med. **13**, 165 (1972).
11. Péter, F., Ilyés I., Kecskés, J.: Neonatal thyroid household. Abstracts of the 6th Congr. Hung. Soc. Endocr. Metab. Pécs, 1973. p. 31.
12. Péter, F., Lampé, L., Asztalos, M.: Untersuchungen mit dem Hamolsky Test. II. Beiträge zum Studium der Schilddrüsentätigkeit bei Neugeborenen. Mschr. Kinderheilk. **112**, 62 (1964).
13. Spaffordt, N. R., Carr, E. A. Jr., Lowrey, G. H., Beierwaltes, W. H.: J^{131} labeled triiodothyronine erythrocyte uptake of mothers and newborn infants. Amer. J. Dis. Child. **100**, 844 (1960).
14. Sugiyama, S.: The embryology of the human thyroid gland including ultimobranchial body and others related. Ergebn. Anat. Entwickl.-Gesch. **44**, 222 (1971).
15. Thorson, S. C., Mincey, E. K., McIntosh, H. W., Morrison, R. T.: Evaluation of a new in vitro blood test for determining thyroid status: the effective tyroxine ratio. Brit. med. J. **2**, 67 (1972).
16. Watzka, M.: Physiologische Veränderungen der Schilddrüse. Z. mikr.-anat. Forsch. **36**, 67 (1934).
17. Westphal, M., Man, E. B.: Serum butanol extractable iodine following exchange transfusion. J. clin. Endocr. **22**, 452 (1962).

F. Péter, M. D.
Buda Regional Children's Hospital
H-1277 Budapest, Pf. 14