VALUES FOR THYROID UPTAKE OF I^{131} AND PROTEIN-BOUND IODINE IN "NORMAL" INDIVIDUALS FROM BIRTH TO TWENTY YEARS[1]

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Introduction

IN 1938 Hertz (5), using radioactive iodine, studied thyroid function in rabbits and humans. Since then an abundance of data on this subject have been published. However, there still exists scant data concerning thyroid uptake of I^{131} and values for protein-bound iodine among individuals demonstrated to be euthyroid. Some data referable to thyroid function of "normal" persons have been derived through studies concerned with abnormal thyroid function (4). The most systematic study of thyroid function using I^{131} in growing individuals was conducted by Oliner (7).

Thyroid uptake studies with I^{131} measure the ability of the thyroid gland to gather iodide. Protein-bound iodine expresses a distribution of "hormonal" iodine in the blood. These determinations offer evidence of thyroid function. Data gathered from studies of I^{131} and protein-bound iodine permit comparison of thyroid activity among large numbers of known euthyroid individuals.

Material and Method

All persons studied were free from organic disease and were "normal." The majority of subjects were well known in a routine pediatric practice. Some of the older individuals were healthy undergraduates at the Evanston Hospital School of Nursing. All of the persons demonstrated skeletal maturation consistent with their chronological age (3). Protein-bound iodine values were determined and unusually high or low values were repeated for verification and checked with butanol extractable iodine studies (1). Observations of thyroid uptake of I^{131} were carried out by using 25 microcuries of radioactive material in children up to the age of 6 years and 50 microcuries of radioactive material in older individuals. Gamma studies were made in a routine manner at 24-hour intervals.

Data

Results of this study are presented in Charts and Graphs (figs. 1-3) with accompanying legends. Values for thyroid uptake of I^{131} and protein-bound iodine in euthyroid individuals, from birth to 20 years, are shown in Figure 1C through 2D. Values of protein-bound iodine from 10 pregnant women, beyond the age of 20 years and at term, are available for comparison with the protein-bound iodine values from the cord blood of their infants (fig. 1B). Other data (fig. 1D) show increased values for thyroid uptake of I^{131} in the very young infant as opposed to lower values obtained during childhood and adolescence.

Our results are not in agreement with those of others (2, 6) who have reported butanol extractable iodine and the protein-bound iodine of infants' venous blood at birth as similar to that of their mothers at term. Our data demonstrate a distinct rise in the protein-bound iodine level of infants during their first few days of life.

Discussion

The physiological basis for increased thyroid uptake of I^{131} and the increased quantities of protein-bound iodine present in the infant soon after birth are as yet unexplained. Profound physiological changes occur when the umbilical cord is severed. The fetus becomes a nonparasitic one. Such a fundamental change requires adjustments by respiratory, cardiovascular, gastrointestinal, musculoskeletal and other systems. The thermoregulatory system, intimately associated

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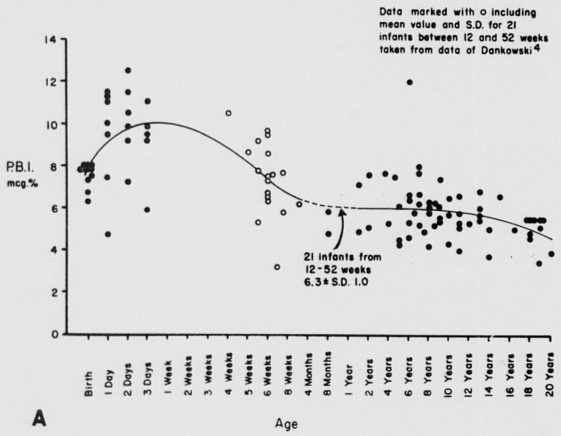

GROUP I - Mothers at Term and their Infants

Mother	Age	P.B.I. at Delivery	Newborn	Sex	P.B.I. Cord Blood	Wt.(lbs.)
De	26	8.7	De	F	8.0	$9\frac{5}{}$
He	26	7.0	He	F	7.3	$7\frac{3}{}$
Ki	23	7.5	Ki	M	7.8	$7\frac{3}{}$
Me	34	7.9	Me	M	7.8	$7\frac{14}{}$
Pe	21	7.8	Pe	M	7.8	$8\frac{3}{}$
Ra	25	7.1	Ra	F	7.8	$8\frac{5}{}$
Sn	26	12.2	Sn	F	6.3	$7\frac{8}{}$
Sw	32	10.5	Sw	F	8.0	$7\frac{3}{}$
Te	31	5.0	Te	M	6.7	$7\frac{8}{}$
Wa	39	7.5	Wa	M	8.0	$7\frac{9}{}$

B

GROUP II - Newborn Infants

Name	Sex	Age	I^{131}	PBI	BMR	Bone Age
Ho	M	4 hours	100%	7.5	–	Newborn
Ra	F	1day	88%	7.4	–	Newborn
Tr	M	1day	96%	4.7	–	Newborn
Cr	M	1day	100%	11.3	–	Newborn
Be	F	1day	66%	10.0	–	1month
Za	F	1day	99%	9.5	–	3months
We	M	1day	74%	11.0	–	Newborn
Sp	M	1day	56%	11.5	–	Newborn
St	F	2days	72%	10.5	–	Newborn
Bu	M	2days	37%	12.5	–	1-2months
Ne	F	2days	76%	11.5	–	Newborn
Vo	F	2days	100%	9.2	–	Newborn
Me	F	2days	69%	7.2	–	1-2months
Ti	F	2days	30%	9.9	–	Newborn
Pa	F	3days	65%	11.0	–	1-2months
Jo	M	3days	90%	9.5	–	Newborn
Bo	M	3days	58%	5.9	–	Newborn
Ma	F	3days	73%	9.9	–	Newborn
Fr	F	3days	75%	9.3	–	Newborn

C

Average Infant
2 days old
I^{131} -75% (30% - 100%)
PBI - 9.4 (4.7 - 11.5)
Bone Age - Newborn

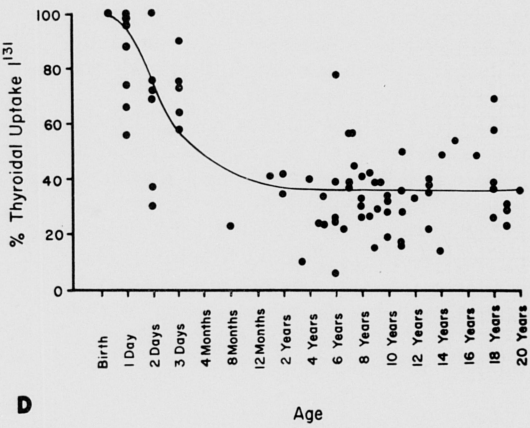

Fig. 1. A, Scatter graph and curve show values of protein-bound iodine in "normal" individuals from birth through 20 years. B, Values for protein-bound iodine from "normal" mothers and infants at time of birth. C, Values of uptake of I^{131} and protein-bound iodine from "normal" infants: 4 hours to 3 days old. D, Uptake of I^{131} by thyroid gland in "normal" individuals from birth through 20 years.

with thyroid activity, is triggered to new activity as the fetus leaves its controlled intra-uterine existence. We have as yet unpublished evidence that the newborn is relatively deficient in thyroxin-binding protein. By the third day of life, this protein factor is increasing. (This or any one of these factors may be responsible for the increased thyroid activity during the neonatal period.)

Small amounts of maternal thyroxin cross the placental membrane during pregnancy. With the onset of labor, this extra-fetal supply of thyroxin is abruptly withdrawn. The immediate post-birth condition of the infant should appear to be hypothyroid. Unexplained by such simple placental transfer are the increased values of I^{131} and the rise of protein-bound iodine occurring soon after birth.

We have been interested in the histology of the placenta as it is related to transplacental migration of certain blood components. The placental anatomy in lower orders of animals is such that the maternal-fetal circulation appears to be

GROUP III - Children 8 Months - 5 Years

Name	Sex	Age	I^{131}	PBI	BMR	Ht (in.)	Wt (lbs.)	Bone Age
No	M	8mo.	23%	4.8	–	–	22¾	6 mo.
Sp	F	1½ yrs.	41%	4.9	–	–	–	18 mo.
Be	F	1½	–	7.1	–	–	–	18 mo.
Wi	M	2	35%	5.1	–	–	–	–
Ne	M	2	42%	7.6	–	–	–	–
Wi	F	3½	10%	7.7	–	–	–	3½ yrs.
Ti	M	4	40%	5.3	–	–	–	4 yrs.
Ba	F	4½	24%	7.5	–	–	–	4½ yrs.
Wi	M	5	–	4.5	–	–	–	–
Re	M	5	34%	4.3	+8%	46	43¾	3½ yrs.
Pa	F	5	23%	6.1	+20%	46	40	5-5½ yrs.

Average Child

3+ years

I^{131} - 30% (10% - 42%)

PBI - 5.9 (4.3 - 7.7)

A

GROUP IV - Children 6 - 9 Years

Name	Sex	Age	I^{131}	PBI	BMR	Ht (in.)	Wt (lbs.)	Bone Age
Ku	F	6	78%	6.6	–	–	–	6 yrs.
Ru	F	6	26%	5.3	–	43¼	34½	5½-6 yrs.
Th	F	6	39%	4.6	–	–	–	6 yrs.
Sa	M	6	25%	6.4	–	48¾	53	6 yrs.
Al	M	6	6%	12.0	–	48	50	6 yrs.
Wi	M	6½	22%	5.8	–	–	–	6½ yrs.
Sc	M	7	57%	6.7	–	–	–	6 yrs.
Ho	F	7	–	8.0	–	–	–	7 yrs.
Ba	F	7	39%	6.2	–	47	42	–
An	M	7	37%	5.2	–	–	–	–
My	F	7	57%	6.7	–	47	43	7 yrs.
Be	M	7½	45%	4.9	+11%	53¼	68¼	7½ yrs.
Pa	F	8	26%	5.8	+13%	48¾	70¼	8½-9 yrs.
Ne	M	8	41%	4.2	–	49	52	7 yrs.
Al	M	8	30%	6.1	–	52	62	8 yrs.
Eg	M	8	33%	6.3	–	50	73	8 yrs.
We	M	8½	42%	6.3	–	–	70	8½ yrs.
Ko	F	8½	26%	5.2	–	–	–	8 yrs.
Ru	F	9	39%	6.1	–	50½	67	9 yrs.
Te	M	9	15%	5.4	–	–	–	7½ yrs.
St	M	9	39%	5.5	–	–	69	9 yrs.
De	M	9	29%	7.4	–	57	98	9 yrs.

Average Child

7.5 years

I^{131} - 34.3% (6% - 78%)

PBI - 6.2 (4.2 - 12)

B

GROUP V - Children 10 - 14 Years

Name	Sex	Age	I^{131}	PBI	BMR	Ht (in.)	Wt (lbs.)	Bone Age
Ph	M	10	34%	4.3	+1%	59½	82	10 yrs.
Al	M	10	28%	6.5	+8%	55	73	10 yrs.
Fr	M	10	19%	5.7	+4%	54	67	–
Mo	M	10	32%	–	+4%	53½	79	–
Bo	M	11	36%	5.1	+2%	59½	106	11 yrs.
Al	M	11	16%	6.6	+17%	58¼	77¾	11 yrs.
Sm	M	11	50%	5.3	-7%	58½	91½	11 yrs.
Sc	M	11	17%	5.8	0%	53¾	60	9½ yrs.
La	F	11	28%	4.0	+2%	63½	113	–
Sl	M	12	33%	5.3	–	–	–	–
Ca	F	13	35%	6.0	–	–	–	13 yrs.
Al	M	13	22%	5.7	+4%	60½	89	13 yrs.
Ho	M	13	39%	6.8	+10%	60	108	13 yrs.
Pe	M	13	40%	5.4	+11%	67¾	135	13 yrs.
Al	M	14	14%	3.7	-6%	71¼	134	14 yrs.
Hu	F	14	49%	5.0	+1%	60	112½	–

Average Child

11.7 years

I^{131} - 30.8% (14% - 50%)

PBI - 5.4 (3.7 - 6.8)

BMR - (-11% - +18%)

C

GROUP VI - Adolescents 15-20 Years

Name	Sex	Age	I^{131}	PBI	BMR	Ht (in.)	Wt (lbs.)	Bone Age
Vo	M	15	54%	6.6	–	65	184	15 yrs.
Qu	F	16½	49%	5.0	-20%	62¾	130½	15 yrs.
Sl	F	18	26%	4.6	–	62½	121	–
Ch	F	18	37%	5.5	–	–	–	Young Adult
Br	F	18	39%	5.5	–	–	–	Young Adult
El	F	18	58%	5.5	–	–	–	Young Adult
Ni	F	18	69%	4.8	–	–	–	Young Adult
Fe	F	19	29%	5.1	-18%	67	130	Young Adult
Ri	F	19	23%	5.5	- 9%	64¾	139½	Young Adult
Vo	F	19	31%	3.4	–	–	–	Young Adult
Co	F	19	–	5.5	- 8%	–	–	Young Adult
Di	F	20	36%	3.9	- 6%	68	126¼	Young Adult

Average Adolescent

18+ years

I^{131} - 41% (23% - 69%)

PBI - 5.0 (3.4 - 6.6)

D

Fig. 2. A, Values for uptake of I^{131} and protein-bound iodine in "normal" children: age 8 months through 5 years. B, Values for uptake of I^{131} and protein-bound iodine in "normal" children: age 6 through 9 years. C, Values for uptake of I^{131} and protein-bound iodine in "normal" children: age 10 through 14 years. D, Values for I^{131} and protein-bound iodine in "normal" adolescents: age 15 through 20 years.

considerably less intimate than that of primates. We feel that when maternal-fetal circulation becomes less intimate, differences in values between protein-bound iodine levels of mothers and their offspring should be observed. Values of protein-bound iodine among cows and calves were determined in an attempt to evaluate the transfer of thyroxin across the placental barrier. Values for protein-bound iodine from 6 registered Holstein calves between 2 days and 4 months of age have been compared with those of 6 pregnant, non-lactating, registered Holstein cows between 2 and 7 years of age (fig. 3).

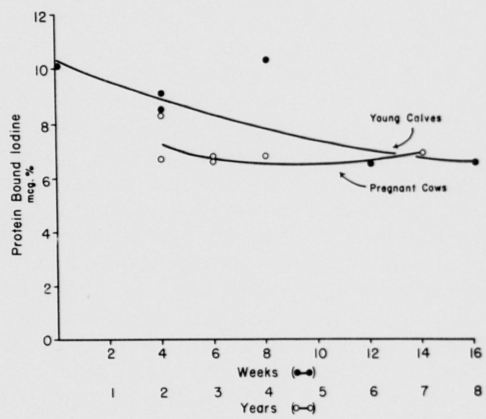

Fig. 3. Values for protein-bound iodine in registered Holstein pregnant cows and calves.

Summary

1. Charts and graphs indicate values of thyroid uptake of I^{131} and values for protein-bound iodine. Serums were from 90 euthyroid individuals between birth and 20 years of age. In addition, protein-bound iodine values of 10 pregnant women at term, and beyond the age of 20 years, are available for comparison with their infants.
2. Increased thyroid activity in the neonatal period is described.
3. Graphs and charts demonstrate "normal values" of protein-bound iodine and thyroid uptake of I^{131} from birth to 20 years.
4. Physiological implications of increased thyroid activity soon after birth are discussed.
5. The role of placental histology in the transmigration of blood substances is discussed.

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