

A STUDY WITH RADIOACTIVE IODINE ON THYROID FUNCTION IN VITAMIN (A) DEFICIENT PIGS

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SUMMARY

The results indicate that vitamin A deficiency has a marked depressing effect on the activity of the thyroid. It is seen that vitamin A deficient pigs have a much lower thyroid activity than the control have.

It is evident that although the rate constants and the U give some indications of thyroid activity, they are not nearly as good as a base for comparison as are the estimated values of thyroid secretion rates.

It is also seen that the average secretion rate is higher in the Danish landrace than it is in the Black and White breed, indicating a breed difference in thyroid activity.

Earlier investigations by Jungherr *et al* (1950) have indicated hyperplasia of the thyroid glands in vitamin A deficient bull calves. Fraps *et al* (1958) claimed that insufficient as well as excessive intakes of vitamin A lowered the release of thyroid ¹³¹I. However these methods are indirect ones and do not estimate the thyroid secretion quite well.

Palludan and Sorensen (1962) have found indication that vitamin A deficiency may effect the thyroid secretion rate in pigs.

The following is a further study of the influence of vitamin A deficiency on thyroid activity in pigs.

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Experimental

Animal.—Seven female pigs of two different breeds were used for the experiment.

(a) *Danish Landrace*: Four litter mates, born at the 3rd of June 1962. Three (No. 22, 25 and 30) were vitamin A depleted while the fourth one (No. 28) was the control.

(b) *Black and White*: Three litter mates, born at the 10th of May 1962 were chosen. Two (No. 142 and 143) were vitamin A deficient while the third animal (No. 144) was the control.

Feeding :

Each pig received a daily ration consisting of 1.8 kg. barley 250. gm. powdered skimmed milk and 20 gm. mineral mixture (50% dicalcium phosphate - 30% calcium carbonate - 18% sodium chloride 1.9% Fe SO_4 - 0.1% copper sulphate.) All the pigs were fed a vitamin A free diet from the 16th of August 1962. The control animal (No. 28 & 144) were given a daily dose of vitamin A equals 0.5 million i.u. from the 3rd of January 1963.

Thyroid secretion rate was estimated after the intravenous injection of 0.33 mc. of I^{131} in each pig on the 4th of February 1963 by the method developed at the department of physiology, endocrinology and bloodgrouping Sorensen & Moustgard (1957) and Sorensen (1958).

The rate constant for thyroid hormone secretion was calculated from external measurements of thyroid I^{131} following intravenous injection of 0.33 mc. of carrier free NaI^{131} .

For the external measurements, a high efficient x-ray counter was used, brought in contact with the skin of the neck at the region of maximum activity. The count rate thus obtained is compared to that obtained from a known amount of a radioactive iodine of injected dose.

In blood serum samples, drawn during experimental period concentrations of PBI were determined. Protein from 2 ml serum was precipitated by zinc sulphate and sodium hydroxide washed three times with water and dried in vacuum at -20°C . The radioactivity was measured and converted to percent of dose by comparison with the count rate obtained from dried serum protein with a known amount of I^{131} . Concentration of serum PBI were determined in the same samples, and the average concentration during experimental period is applied to the calculation of thyroid secretion rate.

The following table summarizes the symbols and their definitions which are commonly used in the thyroid study :—

Symbol	Indicator of	Definition
K_1	Rate constant for thyroid uptake.	Fraction of plasma iodide cleared per hour by the thyroid gland.
K_2	Rate constant for secretion	Fraction of plasma iodide, cleared per hour by the kidneys.
K_4	Rate constant for hormone secretion.	Fraction of thyroidal iodine, released as hormone per hour.
K_t	Disappearance rate of thyroidal I^{131} .	Decline in thyroid radioactivity per hour.
U	Maximum thyroidal uptake.	Fraction of plasma iodide, accumulated by the thyroid gland, % dose.
PBI	Concentration of thyroid hormone.	Concentration of serum protein-bound iodine, $\mu\text{g}/100$ ml. (8%).
PBI^{131}	Concentration of hormone- I^{131}	Concentration of serum protein-bound I^{131} , % dose/100 ml.
$\frac{\text{U}^{131}}{\text{PBI}}$	Maximum PBI^{131}	Concentration of serum PBI^{131} , calculated at initial time, % dose/100 ml.
t	Time.	Time after injection, hours.

The rate constants mentioned above are the slopes of the curves for the semilogarithmic plot of the specific activity-time relations U and $UPBI$ are the intersection between the ordinates and the descending parts of these curves (see fig. 1 & 2).

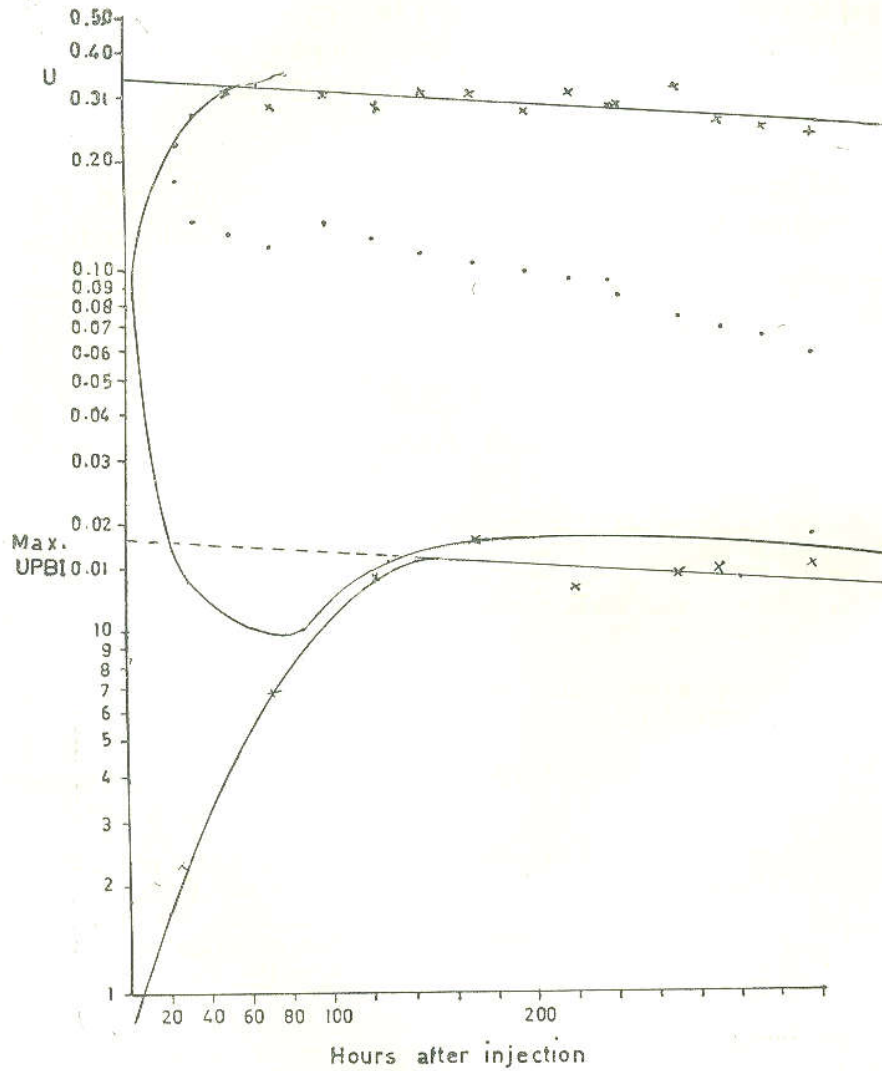


FIG. 1.—Activity measurements and the Specific activity time relations of PBI in blood serum of pig. No. 22.

The calculation of the rate constant for hormone secretion, K_4 is based on the assumption that all iodine is liberated from thyroid hormone, when it is utilized. K_4 is obtained by correcting the disappearance rate K'_4 for uptake of iodide by the equation:

$$K_4 = \frac{K'_4}{1 - U}$$

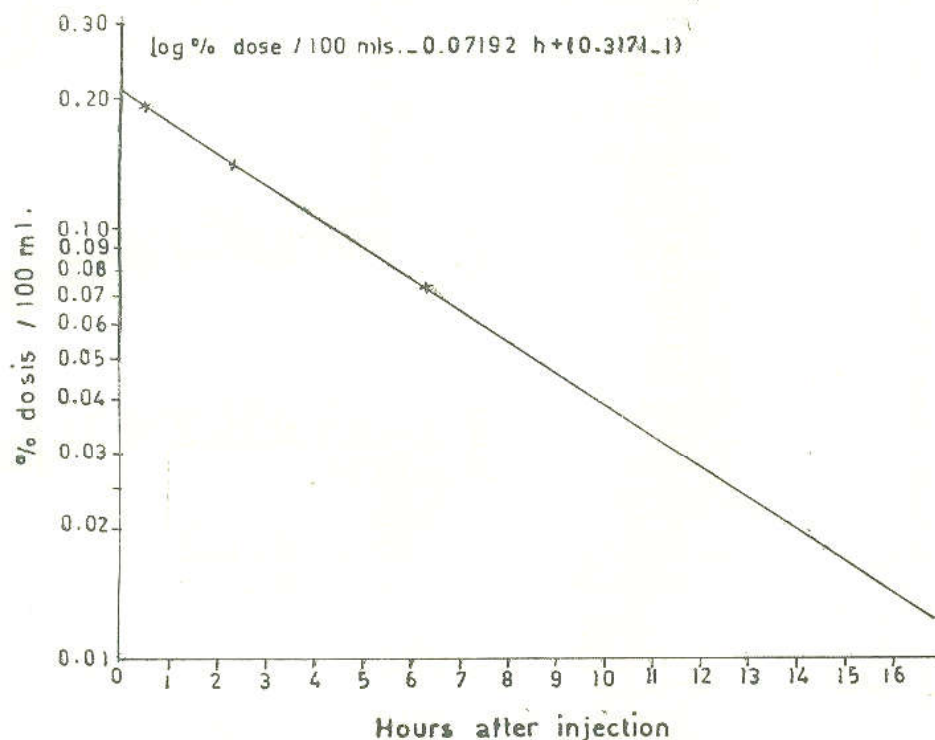


FIG. 2.—The Regression line between the time after injection and concentration of Plasma I^{131} .

Results and Discussion

Figures 1 & 2 show the results of the *in vivo* activity measurements and the specific activity-time relations of PBI in blood serum of pig No. 22. The intersection between the ordinate and the upper curve (fig. 1), that is the curve of *in vivo* measurements, shows the maximum uptake of radioactivity by the thyroid gland, the U . Figure 2 clarify the maximum PBI¹³¹ the UPBI¹³¹

TABLE 1.—Showing the Results of Investigating Thyroid Secretion Rate in Seven Normal Pigs.

Breed	Animal No.	Animal Weight Kg.	K_1	K_2	U	K_1^T	K_2	PBI ¹³¹	Thyroid secretion rate*		
									Per ani- mal	Per 100 body Weight	
Danish Landrace . . .	22	113	0.056	0.110	34	0.00094	0.00142	2.5	0.0182	0.24	0.22
	25	114	0.088	0.114	44	0.00083	0.00147	2.3	0.0266	0.21	0.19
	30	100	0.062	0.083	43	0.00100	0.00175	2.4	0.0268	0.25	0.25
Black and White . . .	28	110	0.113	0.107	51	0.00163	0.00331	2.9	0.0141	1.28	1.19
	142	111	0.060	0.122	33	0.000355	0.00053	1.6	0.0153	0.07	0.07
	143	118	0.045	0.083	35	0.000675	0.00104	2.0	0.0174	0.15	0.13
	144	102	0.048	0.109	31	0.000774	0.00112	2.3	0.0081	0.36	0.35

* Corrected linearly with body weight.

The curves obtained by the graphical presentation of the results obtained from other pigs are similar to these, differing only by the slope of the lines and the maxima.

From these curves and determination of the total PBI, the rate constants and the thyroid secretion rate are calculated and the results collected in table 1. It is evident from the table that although the rate constants and the U give some indications of thyroid activity, they are not nearly as good a base for comparison as are the estimated values of thyroid secretion rates.

It is seen that the average secretion rate is higher in the Danish Landrace than it is in the Black and White breed; indicating a breed difference in thyroid activity.

However, the most striking difference is those occurring between the control and the vitamin A deficient pigs. It is seen that the vitamin A deficient pigs have a much lower thyroid activity than the control have.

In the Danish Landrace, the thyroid secretion rate is 0.2 to 0.3 mg. hour in the vitamin A deficient pigs whereas the control had a thyroid secretion rate of 1.35. The corresponding values for the Black and White breed are 0.07 and 0.15 compared with 0.44 mg./hour.

The results indicate that vitamin A deficiency has a marked depressing effect on the activity of the thyroid.

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الملخص

استخدام اليود المشع (I ١٣١) لدراسة العلاقة بين نشاط الغدة الدرقية ونقص فيتامين (أ) في الخنازير

أجريت التجربة على سبعة من إناث الخنازير من سلالتين مختلفتين ، وغذى كل حيوان من حيوانات التجارب يوميا على عليقة خالية من فيتامين (أ) تتكون من ١,٨ كجم شعير ، ٢٥٠ جم لبن فرز مجفف ، ٢٠ جم مخلوط معدني يتكون من ٥٠٪ فوسفات كالسيوم ثنائي + ٣٠٪ كربونات كالسيوم + ١٨٪ كلوريد صوديوم + ١,٩٪ كبريتات الحديد + ٠,١٪ كبريتات النحاس .

أما حيوانات المقارنة فقد أضيف إلى عليقة كل منها جرعة من فيتامين أ تساوى -١- مليون وحدة دولية .

ولقد قدر إفراز الغدة الدرقية بعد حقن كل حيوان بمقدار ٣٣ و٠ ملليكورى من اليود المشع في الوريد . وأثبتت النتائج أن نقص فيتامين (أ) له تأثير واضح في خفض نشاط الغدة الدرقية حيث وجد نقص واضح في إفراز الغدة الدرقية للخنازير التي غذيت على عليقة خالية من فيتامين (أ) بمقارنتها بحيوانات المقارنة .

ولقد وجد أنه بالرغم من أن مقياس سرعة تخلص البلازما من اليود في الساعة وكذلك مقياس نسبة اليود بالبلازما كنتيجة لنشاط الغدة الدرقية يعطيان فكرة ليست رديئة عن نشاط الغدة الدرقية إلا أنهما غير كافيين بالمرّة للحكم بدقة ولذلك يجب قياس إفراز الغدة الدرقية الحقيقي في الجسم وكذلك قياس الكمية الممثلة منها داخل الجسم .

كما أوضحت النتائج أن إفراز الغدة الدرقية يخضع لعوامل الوراثة حيث إنه وجد أنه يختلف من سلالة إلى أخرى في نفس الحيوان .