ARTERIOVENOUS DIFFERENCE: A SYSTEMATIC ERROR OF EARLY PHASE THYROIDAL CLEARANCE MEASUREMENT

H. W. Gray, A. Pack, R. G. Bessent, and W. R. Greig

Glasgow Royal Infirmary and, Regional Department of Clinical Physics and Bioengineering, Glasgow, Scotland

A significant arteriovenous difference in plasma ^{131}I concentration has been noted at early intervals following intravenous ^{131}I administration. It is suggested that the phenomenon of the falling ^{131}I thyroidal clearance, found when venous blood is used for clearance calculation, results from this systematic error.

The thyroidal clearance of intravenously administered ^{131}I is known to be higher in the first few minutes after administration than at later times (*1–3*). Explaining this phenomenon, Rall and co-authors (*4*) have described the normal thyroid in terms of an open, three-compartment model and have distinguished between the *unidirectional* and the *net* clearance rates. The unidirectional clearance corresponds to the initial flux of ^{131}I ions from the blood to the thyroidal iodide pool whereas the net clearance represents the balance between the ^{131}I ions entering and leaving the thyroidal iodide pool at later times.

We have studied the arteriovenous difference following intravenous ^{131}I in euthyroid and thyrotoxic patients to investigate the basic assumption of previous workers who had shown that intravenously administered ^{131}I is mixed homogeneously within the vascular compartment within 2 min of administration. The results and their interpretation are discussed.

METHOD

Five men patients were studied. Three were euthyroid and had a 4-in. Teflon arterial catheter in the (R) brachial artery for respiratory investigation. None was in respiratory failure. Two untreated thyrotoxic patients had a (R) brachial arterial catheter inserted by an experienced operator. Following the intravenous administration of 25 μCi ^{131}I to each subject in the (R) arm, simultaneous arterial and venous blood samples were taken at various intervals of 1–28 min following the isotope dose. Venous samples were taken from a small venous cannula in the (L) arm. Plasma aliquots (2 ml) were counted for ^{131}I in a well scintillation counter.

The thyroidal ^{131}I uptake curve was followed in the two thyrotoxic patients by a directional counting and recording system described previously (*5*). The extrathyroidal radioactivity (ETA) of ^{131}I was then measured in each patient by repeating the 25 μCi dose of ^{131}I 5 min after 100 mg of intravenous sodium

Received Oct. 17, 1972; original accepted Nov. 8, 1972.

For reprints contact: H. W. Gray, University Dept. of Medicine, Royal Infirmary, 86 Castle St., Glasgow G4 OSF, Scotland.

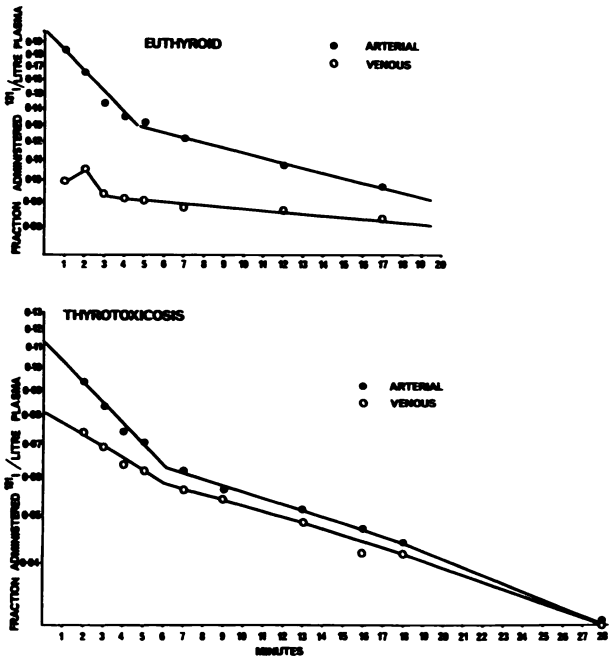

FIG. 1. Arterial and venous plasma concentrations of ^{131}I following intravenous isotope administration in euthyroid and thyrotoxic subject.

TABLE 1. THYROIDAL ^{131}I CLEARANCE (ML/MIN)

Time postinjection (min)	Subject 1		Subject 2	
	Arterial	Venous	Arterial	Venous
2–6	73	88	81	97
6–10	68	71	80	88
10–22	68	70	71	71

perchlorate. The increased radioactivity in the system was considered extrathyroidal, and subtraction from the initial uptake curve allowed quantitation of the rate of thyroidal uptake.

We have previously found the error in this type of clearance measurement to be 20–25% (*5*).

RESULTS

The decay curve of arterial and venous plasma ^{131}I radioactivities in a euthyroid and thyrotoxic subject are shown in Fig. 1. Similar curves were seen in the other three subjects studied. The feature in both curves is the significant arteriovenous difference in the first 6 min. Thereafter, the arteriovenous difference is less pronounced in both subjects and ceases to exist in the thyrotoxic patient at 28 min.

The thyroidal ^{131}I clearance, measured in the two thyrotoxic patients at various times following intravenous ^{131}I, is shown in Table 1. The calculation has been made using the arterial and venous plasma ^{131}I radioactivities separately. The use of venous plasma samples are seen to give a deceptively high initial clearance value.

DISCUSSION

The thyroid gland is exposed to a concentration of ^{131}I, approximately that in arterial blood. It has been assumed by previous authors (*1–4*) that homogeneous mixing of an intravenous dose of ^{131}I occurs within 2 min of administration, thus allowing the use of venous plasma samples after 2 min to approximate the arterial blood perfusing the thyroid. We have shown that this assumption is invalid and that the systematic error of arteriovenous difference could result in the phenomenon of falling thyroidal ^{131}I clearance.

ACKNOWLEDGMENTS

We gratefully acknowledge the assistance of L. Hooper and M. A. Gibson.

REFERENCES

1. SCHULTZ AL, ZIEVE L: Thyroid clearance, uptake and rate of uptake of radioiodine in hyperthyroidism. *J Lab Clin Med* 50: 335–347, 1957

2. KOUTRAS DA, SFONTOURIS J: Comparison of the early thyroidal iodide clearance with estimates obtained at later intervals. *J Endocr* 35: 135–143, 1966

3. YAMAMOTO Y, MORIYA S, HORIUCHI Y: Iodide outflow from the thyroid: its relation to plasma inorganic iodide concentration. *J Clin Endocr and Met* 29: 265–272, 1969

4. RALL JE, ROBBINS J, LEWALLEN CG: In *The Hormones,* Pincus G, Thimann EV, Astwood EB, eds, New York, Academic Press, vol V, 1964, pp 159–439

5. GRAY HW, HOOPER LA, GREIG WR: A method for reducing extrathyroidal neck radioactivity, use of a special collimated scintillation detector. *J Nucl Med* 13: 693–694, 1972