THE ACHILLES TENDON REFLEX TIME AS A PARAMETER OF THYROID FUNCTION

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In 1884 William Ord reported that the tendon reflexes were prolonged in myxoedema. The first attempt to record this phenomenon quantitatively was made by Chaney in 1924; he constructed a simple mechanical device to measure the Achilles tendon reflex. The shortening of the tendon reflex time in thyrotoxicosis was reported by Fournier in 1929. The next major contribution was made by Lambert, Underdahl, Beckett and Mederos (1951) when they reported a correlation between the thyroid status and Achilles tendon reflex time. Subsequently a number of workers have reported on the value of the Achilles tendon reflex time as a parameter of thyroid function (Lawson, 1958; Gilson, 1959; Sherman, Goldberg and Larson, 1963; Rivers, Furth and Becker, 1965; Nuki and Bayliss, 1968).

At least nine instruments have been devised to measure the Achilles tendon reflex (Rivers *et al*, 1965); of these the most widely used are the kinenometer (Lawson, 1958) and the photomotograph (Gilson, 1959).

This paper describes our initial experience of photomotography in thyroid dysfunction.

METHODS AND PATIENTS

The photomotograph consists of a light source connected to an electrocardiograph via a photoelectric transducer (Fig. 1). Movement of the sole of the foot produced by percussion of the Achilles tendon interrupts the light path and the electrocardiograph writes a tracing (a photomotogram). The electrocardiographic paper moves at a speed of 50 mm./sec. The

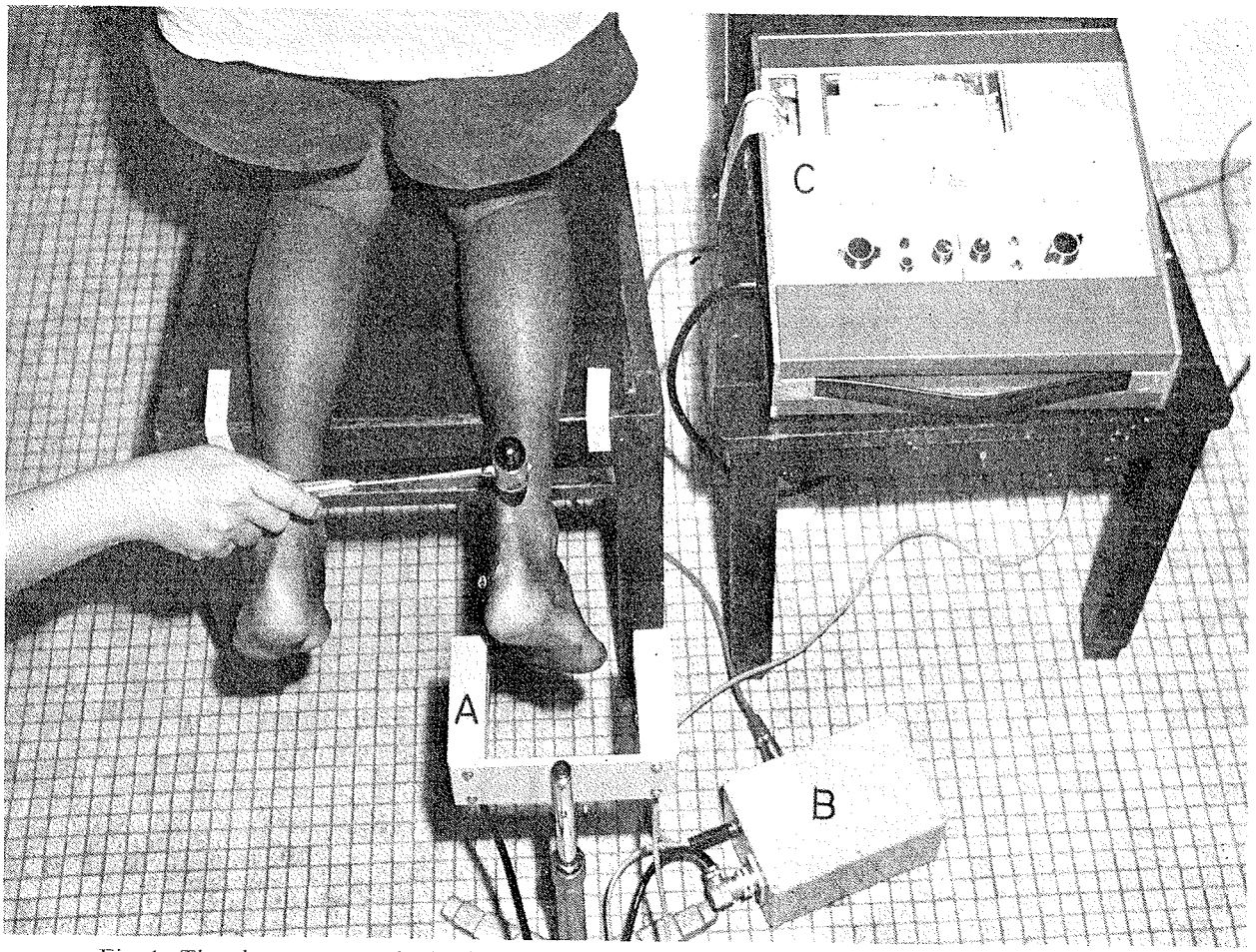

Fig. 1. The photomotograph. A: light source; B: photoelectric transducer; C: electrocardiograph.

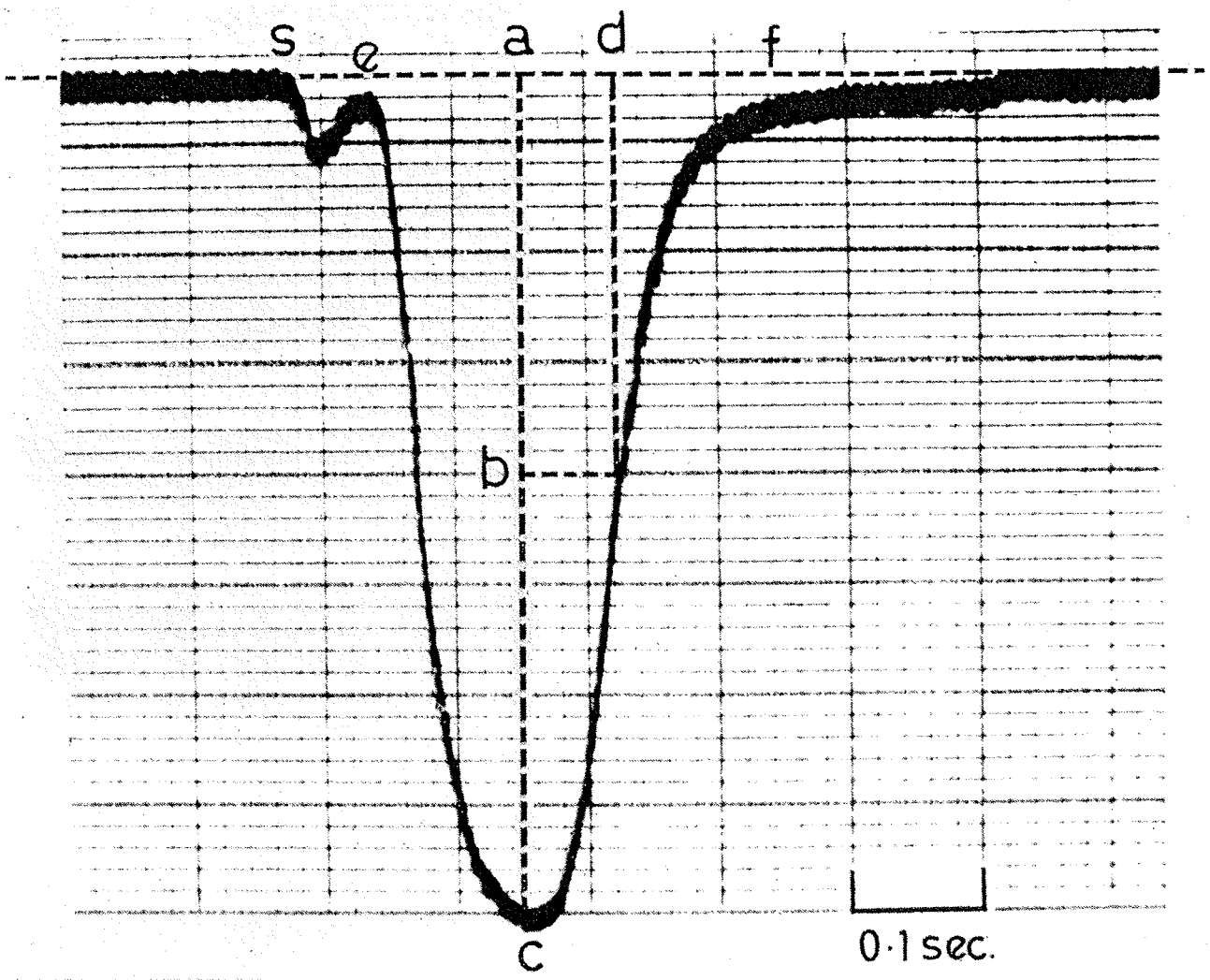

Fig. 2. A typical photomotogram ab=bc; se: stimulus artefact; ea: contraction phase; af: relaxation phase: sd is the tap to half relaxation time.

sensitivity of the electrocardiograph is calibrated to give 1 cm. deflection with 1 millivolt; this can be increased in patients with sluggish reflexes.

A typical photomotogram is shown in Fig. 2. The main contraction-relaxation curve is preceded by a small stimulus artefact. Because the beginning of contraction and the end of relaxation are not always sharp points, the time between the stimulus and the point where the muscle is halfway relaxed—"tap to half-relaxation time" is generally measured (Gilson, 1959; Sherman *et al*, 1963; Nuki and Bayliss, 1968). The tap to half-relaxation time of the Achilles tendon reflex shall subsequently be referred to as the reflex time.

In each patient, tracings were obtained from both feet. A representative tracing from each foot was mounted and the average reflex time to the nearest 10 milliseconds was obtained. There is no significant difference in the reflex time of the left and right foot.

The thyroid status of each patient was based on clinical examination and laboratory investigations which included the serum cholesterol, basal metabolic rate (Du Bois), the serum protein bound iodine, the thyroid gland uptake of radioiodine, the urinary excretion of radioiodine and the plasma protein bound radioiodine.

Tracings were recorded from 134 cases.

RESULTS

The thyroid status, sex, mean age and age range of the 134 cases are shown in Table I.

Of the 65 euthyroid cases, 15 were healthy medical personel and 50 were referred for investigation of thyroid function. The mean reflex time was 270 milliseconds and the range (mean ± 2 standard deviations) was 230-310 milliseconds (Table II). The mean reflex time of the male (30 patients) and female (35 patients) were similar. In 24 patients above 40 years of

age, the mean reflex time did not differ significantly from the 41 below the age of 40 years. 6.1% of the euthyroid patients have reflex time outside the euthyroid range; 4.6% were in the hyperthyroid range while 1.5% were in the hypothyroid range (Table III and Fig. 3).

The mean reflex time of the 55 hyperthyroid patients was 200 milliseconds and the range was 150-250 milliseconds (Table II). The mean reflex time in the hyperthyroid group differed significantly from that in the euthyroid group ($p<0.0005$). 9% of the hyperthyroid patients had reflex time in the euthyroid range (Table III and Fig. 3).

In the smaller hypothyroid group (14 patients) the mean reflex time was 460 milliseconds. This is significantly longer than that of the euthyroid group ($0.0005<p<0.0025$). The range was 260-660 milliseconds; this was larger than in the euthyroid and hyperthyroid patients (Table II). None of the hypothyroid patients had reflex time outside the hypothyroid range (Table III and Fig. 3).

The curvilinear relationship between the thyroid status and the basal metabolic rate, serum protein bound iodine and 6 hour uptake of radioiodine by the thyroid gland are shown in Figs. 4, 5 and 6.

The changes in the reflex time following treatment in a hyperthyroid and hypothyroid patient are shown in Figs. 7 and 8.

DISCUSSION

Although the Achilles tendon reflex time has been generally accepted as a useful confirmatory sign in thyroid dysfunction, its value as a diagnostic test has only been explored recently (Lambert *et al*, 1951; Lawson, 1958; Sherman *et al*, 1963; Nuki and Bayliss, 1968). The advantages of the reflex time as a parameter of thyroid function are: (1) It can be performed quickly with relatively simple equipment, with results available immediately; (2) It is a painless procedure and can be repeated at will: this is useful in following patients being treated; (3) It is unaffected by diet and drugs which affect other thyroid function tests and (4) It can be done in pregnant women and children.

The usefulness of the reflex time in thyroid disorders have varied from worker to worker. Some find that as many as 78% of their hyperthyroid and 38% of their hypothyroid patients have reflex time within the euthyroid range (Rivers *et al*, 1965) whereas others find complete differentiation between hypothyroid and euthyroid patients and that only 10% of hyperthyroid patients have normal reflex time (Mann, 1962; Abraham, Atkinson and Roscoe, 1966). Our findings are in accord with the latter workers. This wide variation in findings is probably due to bias in selection of cases rather than to differences in technique (Nuki and Bayliss, 1968).

The reflex time as a parameter of thyroid function is also limited by the finding that it is altered in conditions such as leg oedema, diabetes mellitus, neuro-syphilis, myasthenia gravis, schizophrenia, hypokalemia, peripheral vascular disease, puerperium, sprue, pernicious anaemia and drug therapy with amphetamine, cortisone, oestrogens, salicylates and bromides. Neurological disorders do not limit the usefulness of the test to the extent that might be expected. Lawson (1958) and Sherman (1963) found that various neurological and muscular disorders did not alter the reflex time significantly. The test, of course, cannot be done if the ankle jerk is absent.

In hypothyroidism "the reflexes show a characteristic slowness of the relaxation phase" (Cecil and Loeb, 1967; Duncan, 1964). Our findings differ from this teaching but are in accordance with those of Sherman (1963) in that both the contraction and relaxation phases are prolonged (Fig. 8). It is in myotonia that the contraction phase is normal while the relaxation phase is very prolonged (Cheah and Toh, 1969).

In hyperthyroidism, not only is the ankle reflex very brisk but often characteristic clonic contractions are recorded (Fig. 9).

CONCLUSION AND SUMMARY

The mean Achilles tendon reflex time in 65 euthyroid, 55 hyperthyroid and 14 hypothyroid patients is 270, 200 and 460 milliseconds respectively.

The reflex time is a useful parameter of thyroid function. Its advantages are (1) it is simple, inexpensive, painless and can be done quickly and repeatedly; (2) it is not influenced by diet and drugs that affect other thyroid function tests; (3) it can be done in pregnant women and children and (4) it is useful in following hypothyroid and hyperthyroid patients during treatment. Its disadvantages are (1) lack of specificity; (2) cannot be done when the ankle jerk is absent and (3) lack of sensitivity when compared to the more elaborate thyroid function tests.

TABLE I

Thyroid Status	Male	Female	Total	Mean Age and Range (yrs.)
Euthyroid	30	35	65	35 (19-62)
Hyperthyroid	21	34	55	37 (19-66)
Hypothyroid	4	10	14	49 (23-62)

Thyroid status, sex, mean age and age range in the 134 patients.

TABLE II

Thyroid Status	Mean in Millisecs	Standard Deviation (S.D.)	Range*	Coefficient of Variation	P Value
Euthyroid (65)	270	18	230-310	6.8%	
Hyperthyroid (55)	200	23	150-250	11.5%	< 0.0005
Hypothyroid (14)	460	100	260-660	27.4%	< 0.0025

*Range = mean $\pm$ 2 S.D.

The Achilles tendon reflex time in the euthyroid, hyperthyroid and hypothyroid groups.

TABLE III

Thyroid Status	Half Relaxation Time in Millisecs		
	<230	230-310	>310
Euthyroid (65)	4.6%	93.9%	1.5%
Hyperthyroid (55)	91%	9%	0%
Hypothyroid (14)	0%	0%	100%

Percentage of patients having Achilles tendon reflex time outside the normal range.

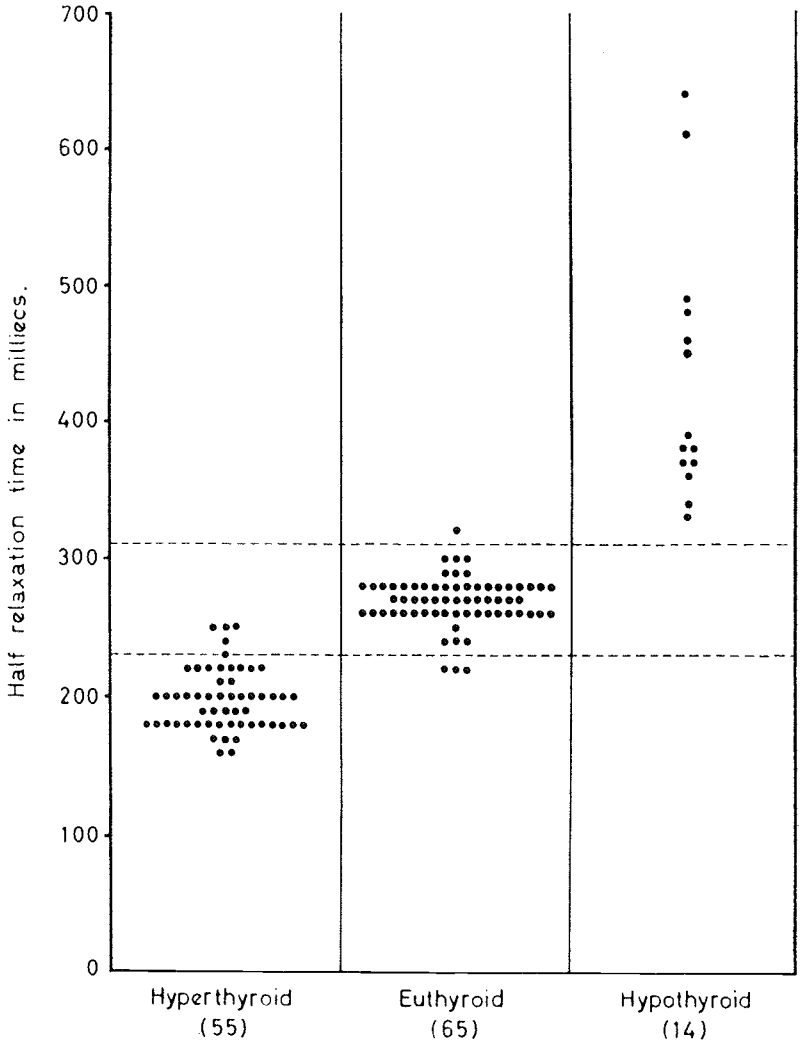

Fig. 3. Distribution of the Achilles tendon reflex time in euthyroid, hyperthyroid and hypothyroid patients. The dotted lines denote two standard deviations of the mean for the euthyroid group.

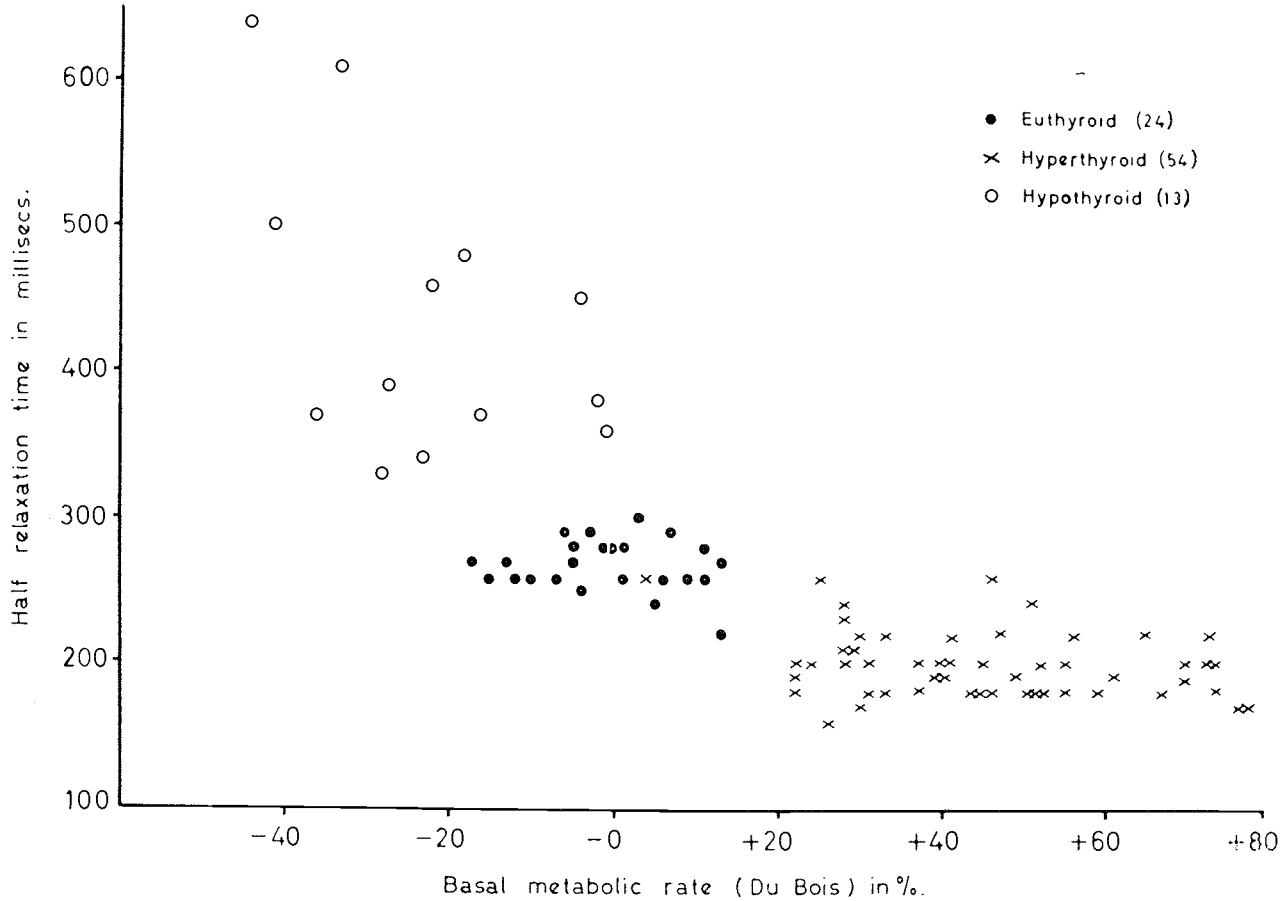

Fig. 4. Relationship between Achilles tendon reflex time and the basal metabolic rate.

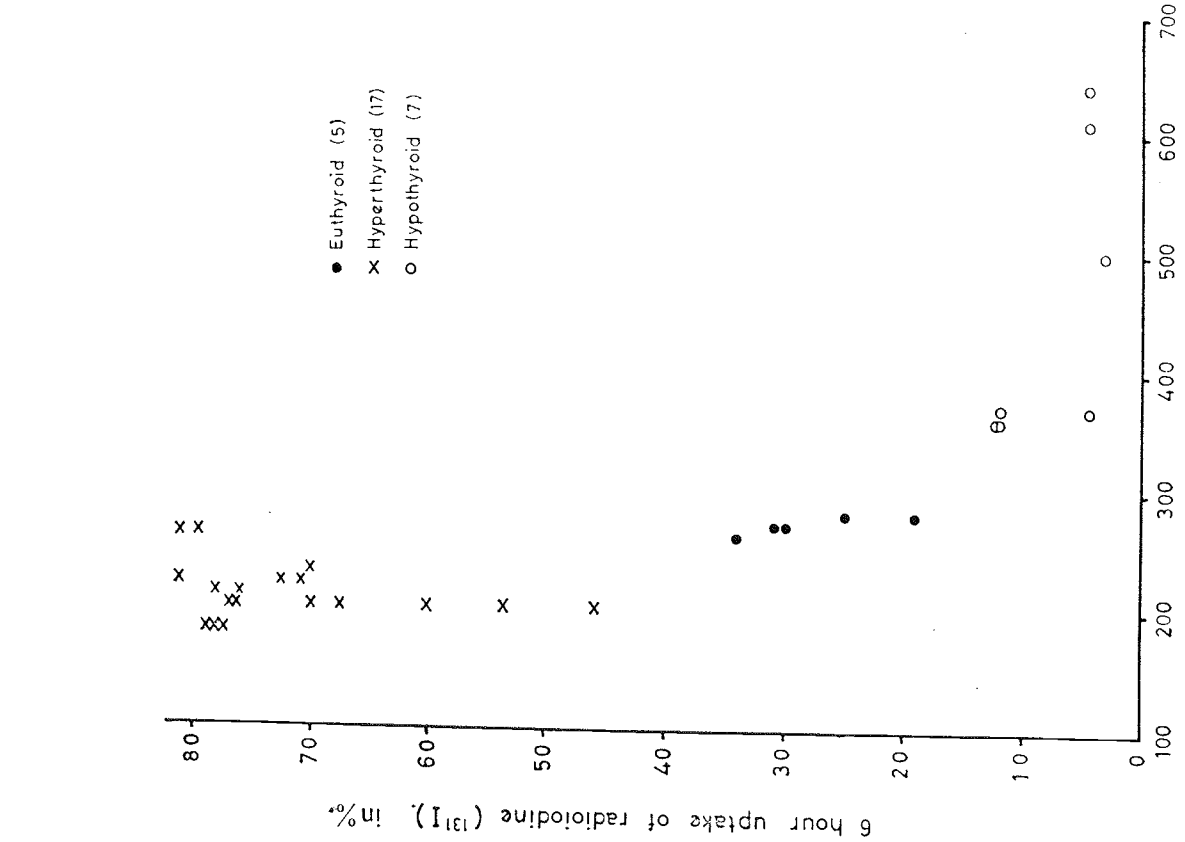

Fig. 6. Relationship between Achilles tendon reflex time and the thyroid gland radioiodine uptake.

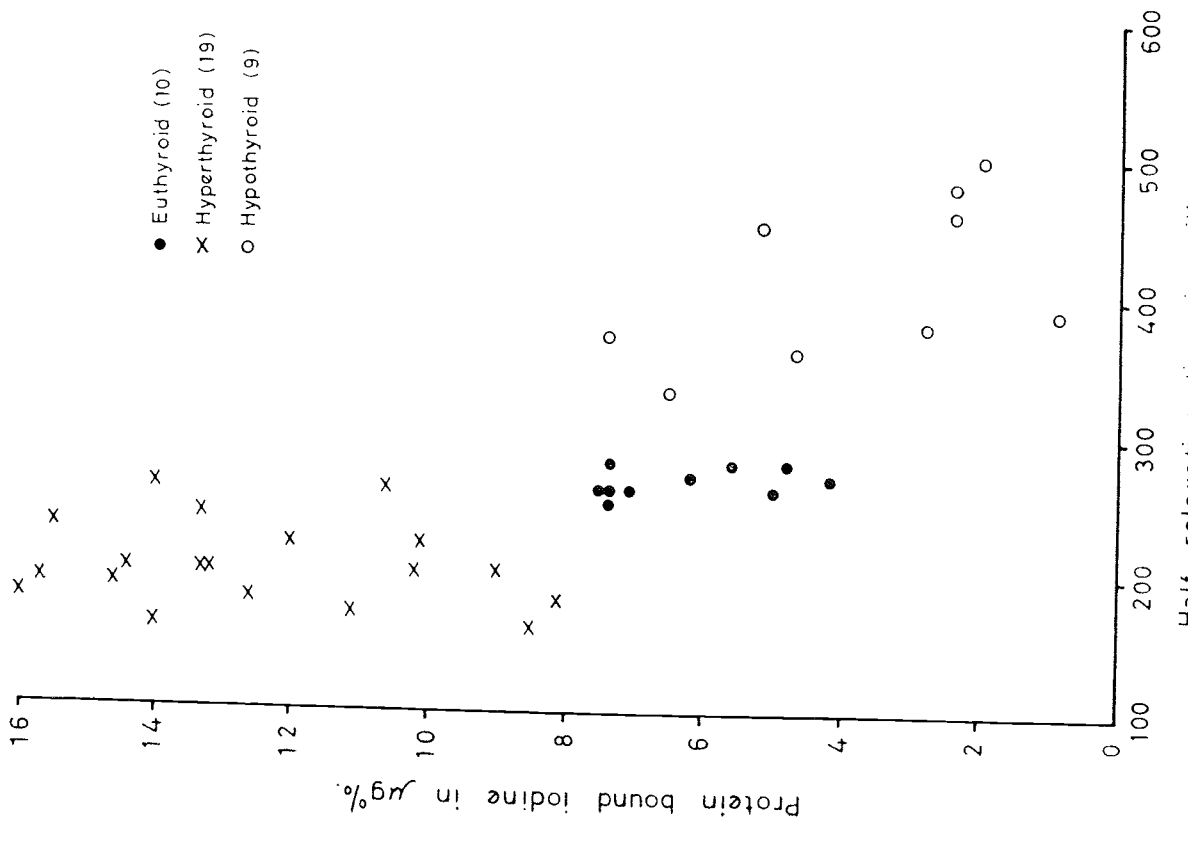

Fig. 5. Relationship between Achilles tendon reflex time and the serum protein bound iodine.

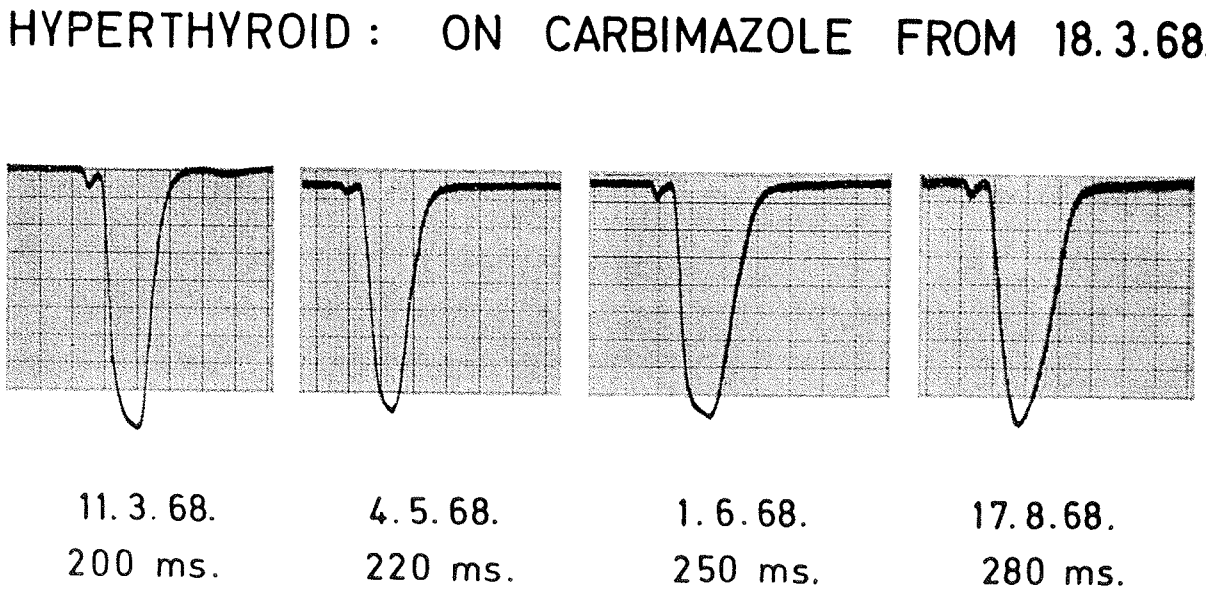

Fig. 7. Changes in the Achilles tendon reflex in a hyperthyroid patient following treatment.

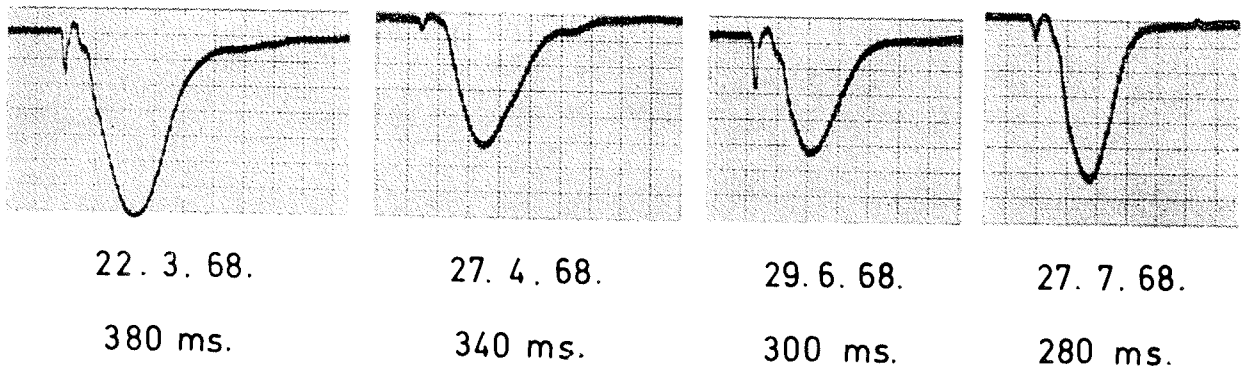

Fig. 8. Changes in the Achilles tendon reflex in a hypothyroid patient following treatment.

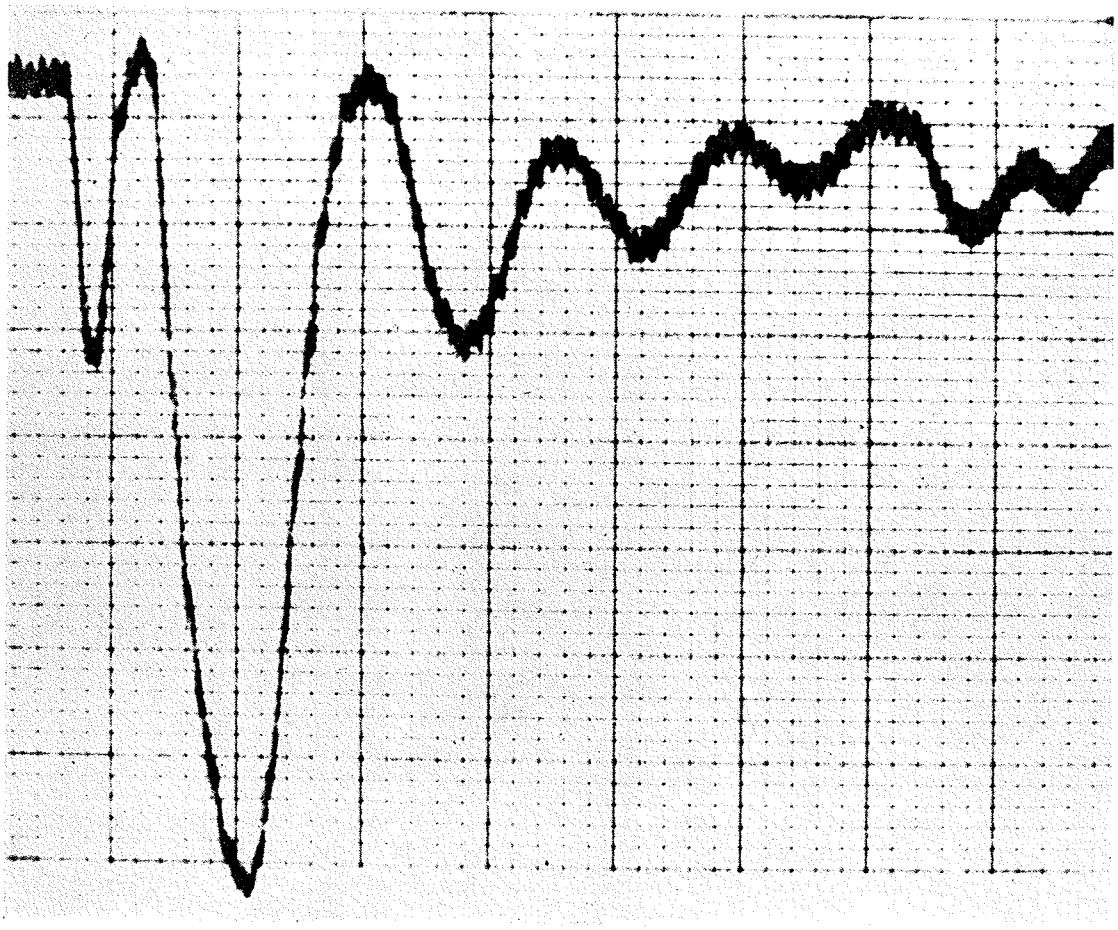

Fig. 9. Hyperthyroid photomotogram: brisk reflex with clonus.

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