RESPIRATORY FUNCTION TESTS IN NORMAL ADULT CHINESE IN SINGAPORE

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INTRODUCTION

Many studies have been reported in recent years on the results of pulmonary function tests in the normal adult European and American population groups (ref. 1-13). Few such studies have been made on Chinese subjects (Peng, 1958, Wu and Yang, 1962), or other non-Caucasian subjects (14-18). The extrapolation of the results of the European studies for the prediction of normal data amongst the Chinese would be fraught with uncertainty. Indeed pulmonary tests on Asian or Chinese subjects would be of doubtful value until biological norms for these subjects are established. The purpose of this study is to obtain normal values for respiratory function measurements in subjects of Chinese origin locally domiciled in Singapore, and to compare these results with those obtained in various other studies on European subjects.

MATERIAL AND METHODS

The study was carried out entirely in the pulmonary function laboratory of the Tan Tock Seng Hospital, Singapore. It was confined to persons of Chinese ethnic group. A truly normal sample of the local material in the statistical sense of being representative of the general population of Chinese adults in Singapore would be almost impossible to attain. Indeed, in the available literature, few attempts have been made at the random selection of the experimental subjects from any defined population group.

For reasons of expediency, the study was limited to the professional and clerical members of the hospital staff. A total of 101 adult subjects ranging in age from 21 to 55 years agreed to enter the study. There were 50 male and 51 female subjects. The upper age limit was imposed by the choice of the population from which the material was drawn, since this age limit is also the usual retiring age of the male members of the hospital, and 45 is the usual retiring age for the women.

All the subjects were in good health and none were engaged in strenuous physical activity at the time. All were clinically free from cardiorespiratory disease and from any other disorder which could be expected to affect pulmonary function. All the subjects had normal chest roentgenograms within 6 months prior to the testing. A history of smoking was not a reason for the exclusion of the subject. There were, in fact, only 7 smokers among the males and none among the females.

All the tests, with the exception of the forced expiratory volume, were performed with the subjects seated. The total lung capacity (TLC) and its subdivisions were measured using the Collin's 9 litre helium residual volume apparatus. A base line tracing of quiet respiration was obtained. The subject was then told to inspire fully and exhale slowly and completely. This was repeated twice with an interval of one minute quiet breathing in between. From the three recordings, the best value for the vital capacity (VC) was noted. The expiratory reserve volume was calculated from the tracing. Functional residual capacity (FRC) was then measured by the closed circuit constant volume method. The residual volume (RV) was calculated by subtracting the expiratory reserve volume from the functional residual capacity. The forced expiratory spirogram was performed, with the subject in the standing position, on the Collin's recording Vitalometer. From the tracing, the forced expiratory volume in 0.75 sec. (FEV .75) and the maximal mid-expiratory flow rate (MMFR) were calculated. Three forced expiratory spirograms were done and the best value for the two indices taken.

All the gas volumes were corrected to body temperature, ambient pressure and saturated. Age was recorded to the last birthday; height and weight were measured without shoes and

TABLE I

MEANS, RANGES AND STANDARD DEVIATIONS OF NORMAL SUBJECTS ACCORDING TO SEX, AGE, BODY CHARACTERISTICS AND TYPE OF LUNG FUNCTION MEASUREMENT

Measurement	Male (50 Subjects)			Female (51 Subjects)		
	Mean	Range	Standard Deviation	Mean	Range	Standard Deviation
Age (years)	34.90	21—55	9.28	33.98	21—52	9.16
Height (ins.)	65.80	61—71	2.08	60.95	57.75—65.00	1.69
Weight (lbs.)	135.56	94—180	18.18	111.35	86—142	14.73
Body Surface Area (M^2)	1.69	1.48—1.97	0.11	1.47	1.29—1.72	0.10
V.C.	3.70	2.75—4.62	0.49	2.58	1.77—3.41	0.32
R.V.	1.56	0.75—2.73	0.38	1.28	0.64—2.02	0.28
T.L.C.	5.27	4.06—7.02	0.70	3.86	2.82—4.95	0.49
F.R.C.	2.90	1.83—4.36	0.57	2.18	1.46—3.27	0.41
R.V./T.L.C.%	29.42	16—39	4.97	32.88	21—42	4.71
F.E.V. 0.75 × 40	114.86	80—147	16.02	85.39	66—109	9.33
M.M.F.R.	4.37	2.95—6.00	0.78	3.52	1.99—4.72	0.57

recorded in inches and pounds respectively. The body surface area (BSA) was calculated using Dubois' formula, (Dubois, 1916).

Results and Statistical Analysis

Table I shows separately for males and females, the arithmetic mean, range and standard deviation for each of the lung function measurements as well as for each of the four physical characteristics to which the lung function measurements are related in a regression analysis.

The choice of the anthropometric variables used for this study was made quite arbitrarily as we had no fore knowledge which of such measurements would yield the best prediction equations in the present population. In the analysis, using techniques of multiple regression, all four independent variables were used initially, for deriving partial regression coefficients. Each of these coefficients was then tested to determine whether it was statistically significant at the 5% probability level. The final regression equation was derived by a process of systematically eliminating from the original four independent variables the least non-significant variable until only those independent variables remain which are statistically significant.

It may happen that every independent variable may thus be eliminated in the process and no regression equation is derivable. This actually happened during the computation of MMFR in males and FEV .75 in females.

The inclusion of BSA in the study did not prove to be very useful. No regression equation, save one, in our study contained BSA, and this only as an alternative to another equation utilizing height and weight together. This is the equation for FRC in males and as measured by the coefficient of multiple correlation R, both equations have the same prediction power.

The techniques that have been used for deriving multiple regression equations may differ in different studies. Kory *et al* (1961) for instance, calculated simple correlation coefficients relating age and each anthropometric measurement with the lung function measurement and finally chose age and height to calculate regression equations for VC, FEV .5 and FEV 1.0 because these two parameters consistently showed the highest correlations when compared with the other parameters studied viz. weight, chest circumference (maximum inspiration and expansion) and antero-posterior chest diameter (maximum inspiration and expansion).

In another paper (Johannsen and Erasmus, 1968), the regression equation was derived by a step by step process of adding on independent parameters until further additions do not significantly increase the variations explained by the equation.

Goldman and Becklake, (1959) used methods similar to those used in the present study for deriving predictions, except that they deliberately limited the number of independent variables in any equation to not more than two.

Our series of equations for male subjects usually contain the same partial regression coefficients as those for female subjects. The exceptions are the FEV .75 for females and the MMFR in males, both of which were not derivable from our data. The other exception is the age coefficient for females in the equation for VC. It contributed little to the further reduction of the residual variation, but has been retained because it is usually featured in the equations of other studies, and also it would facilitate comparison of the predicting value of the variable in male and female subjects. This would otherwise not be possible as the partial regression coefficients in any regression equation are inter-correlated, and the addition or removal of a variable could alter, sometimes considerably, the values of the various other terms in the equations.

DISCUSSION

The values of each of the terms in the regression equations that were computated from our data are given in Table II. The standard error of each regression coefficient is given in brackets.

The coefficient of multiple correlation *R* measures the goodness of fit of the multiple regression equation. This is given in the last column of Table II. A comparison of the *R* values of the equations in the two sexes shows that wherever it is possible to derive equations for both sexes, these values are consistently higher in the males. Thus better prediction equations are derivable from the data on male experimental subjects as compared to female subjects, and all the regression equations for female subjects (with the exception of FEV .75 which was not obtainable) showed rather poor predicting value. The variation explained by the regression equation accounted for 30%-48% of the total variation in male subjects, whereas in female subjects the range is spread out at a lower level from 11%-25%.

The residual standard deviation is given in Column 8 of Table II. These values are larger in males, but if they are measured in terms of the coefficient of variation, which relate the residual variation to the size of the mean value of the lung function measurement, then it can be seen that the coefficients of variation are smaller in males than in females.

A comparison of the age coefficients between the sexes showed that age has a greater influence on VC, RV and RV/TLC in the males than in the females. Age correlates negatively with VC, FEV .75 and MMFR but positively with RV and RV/TLC. In each case where a comparison is possible, the age variable of the male showed greater predicting value. As previously stated, the inclusion of the regression coefficient for age in the equation for VC in females improves the prediction capability to only a slight degree. It is interesting to note that whereas most papers show a relation of VC to age, some authors have given prediction equations for VC that did not include age (Johannsen and Erasmus, 1968). The regression equations also show the TLC and FRC to be independent of age and are in agreement with the results of other studies (Boren *et al*, 1966, Goldman and Becklake, 1959).

What has been said about the age variable for males as compared with females applies equally well to the height variable. In this instance, however, every equation featuring this variable showed a positive correlation between height and the lung function measurement i.e. VC, RV, TLC, FRC in both sexes and FEV .75 in males.

The partial regression coefficient for weight is featured only in the equations for RV, FRC, RV/TLC (both sexes) and MMFR (females only). Except for the last equation this coeffi-

TABLE II

PARTIAL REGRESSION EQUATION FOR EACH LUNG MEASUREMENT

Lung Measurement	Sex	Regression Coefficient with Standard Error				Constant	Residual Standard Deviation	Coefficient of Variation	*R*
		Age (Years)	Height (ins.)	Weight (lbs.)	Body Surface Area (M^2)				
1. Vital	M	—0.0156 (0.0061)	0.1224 (0.0273)	—	—	— 3.8022	0.3776	10.2%	0.66
Capacity	F	—0.0034 (0.0051)	0.0635 (0.0274)	—	—	— 1.1719	0.3277	12.7%	0.35
2. Residual	M	0.0198 (0.0051)	0.0898 (0.0236)	— 0.0084 (0.0026)	—	— 3.9104	0.3051	19.6%	0.58
Volume	F	0.0093 (0.0045)	0.0505 (0.0231)	— 0.0072 (0.0029)	—	— 1.3359	0.2585	20.2%	0.36
3. Total Lung	M	—	0.1861 (0.0017)	—	—	— 6.9841	0.5895	11.2%	0.55
Capacity	F	—	0.0962 (0.0015)	—	—	— 2.0075	0.4685	12.1%	0.33
4. Functional	M	—	0.2262 (0.0343)	—	- 2.7104 (0.6237)	— 7.4229	0.4059	14.0%	0.69
Residual	M	—	0.1745 (0.0289)	— 0.0144 (0.0033)	—	— 6.6441	0.4011	13.8%	0.69
Capacity	F	—	0.1021 (0.0316)	— 0.0118 (0.0036)	—	— 2.7218	0.3593	16.5%	0.50
5. Residual Volume/									
Total Lung	M	0.3180 (0.0597)	—	— 0.0940 (0.0305)	—	30.9367	3.8317	13.0%	0.65
Capacity × 100	F	0.1844 (0.0712)	—	— 0.1438 (0.0442)	—	42.6621	4.2771	13.0%	0.46
6. Forced Expiratory	M	—0.7386 (0.2069)	2.5679 (0.9268)	—	—	—28.1934	12.8246	11.2%	0.62
Volume 0.75 × 40	F	—	—	—	—	—	—	—	—
7. Maximal	M	—	—	—	—	—	—	—	—
Mid Expiratory									
Flow Rate	F	—0.0215 (0.0089)	—	0.0151 (0.0055)	—	2.5687	0.5230	14.9%	0.41

TABLE III

EQUATIONS DERIVED FROM A SELECTED EUROPEAN STUDY APPLIED TO THE DATA OF PRESENT STUDY AND COMPARED WITH THE EQUATIONS DERIVED FROM PRESENT STUDY—MALES

Lung Function Measurement	Equations from an European Study*	r*	R Present Study	Predicted Mean (Litres)	Observed Mean (Litres)	Predicted Mean —Observed Mean (Litres)
V.C.	−5.335 − 0.031 Age + 0.160 Ht.	0.65	0.66	4.09	3.70	+0.39
R.V.	−3.447 + 0.017 Age + 0.067 Ht.	0.40	0.58	1.56	1.56	+0.00
T.L.C.	−9.167 − 0.015 Age + 0.235 Ht.	0.53	0.55	5.79	5.25	+0.54
F.R.C.	−7.110 + 0.202 Ht. −1.792 BSA	0.67	0.69	3.16	2.90	+0.26
R.V./T.L.C.%	16.7 + 0.343 Age	0.53	0.65	28.67	29.42	−0.75
F.E.V. .75×40	(72.700 − 1.873Age+78.200 BSA) $\frac{85}{100}$	0.58	0.62	118.52	114.86	+3.66

* Data from Goldman, H.I. and Becklake, M.R. (1959)

cient is negative in both sexes. The weight variable exerts about the same negative influence on RV and FRC in males as compared with females, and to a somewhat greater extent in females in the case of RV/TLC.

Multiple regression equations constructed by Goldman and Becklake (1959) from studies made on European subjects are selected for comparison with the equations we have derived directly from our material. This was done by applying the European equations to each set of the relevant independent variable(s) in our study to derive predicted values for every individual to which the set of independent variable(s) refer. For each European equation a correlation coefficient r was then calculated, relating predicted lung function measurements to the observed lung function measurements. Thus we have for every R (the coefficient of multiple correlation derived from our own equation) an r value to compare, which was derived by applying the European equation to our material.

Tables III and IV, Columns 3 and 4 set our these correlation coefficients for males and females respectively. In each case, as could be expected, the R values of the present study were higher than the r values. For a number of equations i.e. VC, TLC, FRC and FEV .75 in men, and TLC and FRC in women, the two coefficients compare very well; but in the case of RV and RV/TLC in men, and VC, RV, and RV/TLC in women, our equations give appreciably higher correlation coefficient values than the European equations.

In order to give also some idea of how well the European equations fit the source data, we have set out in Table V a series of R values which could be compared with our own series of R values. For the men, our R values, with the exception of the FRC, are lower than those of Goldman and Becklake (1959), but are higher than those reported by Boren *et al*, (1966). In the women, all the R values obtainable from Goldman and Becklake (1959) were appreciably higher. These differences were not explicable in terms of differences in the formulation of the equations, and a more basic reason probably applies, arising from differences in the actual performance of the experimental subjects during the tests.

The mean of each set of values predicted from the equations of Goldman and Becklake (1959) were also calculated. These values are set out in Column 5 of Tables III and IV, for comparison with the observed means presented

TABLE IV

EQUATIONS DERIVED FROM A SELECTED EUROPEAN STUDY APPLIED TO PRESENT DATA AND COMPARED WITH THE EQUATIONS DERIVED FROM PRESENT STUDY—FEMALES

Lung Function Measurement	Equations from an European Study*	r*	R Present Study	Predicted Mean (Litres)	Observed Mean (Litres)	Predicted Mean —Observed Mean (Litres)
V.C.	$-4.36 - 0.018\ \text{Age} + 0.132\ \text{Ht.}$	0.11	0.35	3.07	2.58	+0.49
R.V.	$-3.90 + 0.009\ \text{Age} + 0.081\ \text{Ht.}$	0.24	0.36	1.34	1.28	+0.06
T.L.C.	$-7.49 - 0.008\ \text{Age} + 0.20\ \text{Ht.}$	0.32	0.33	4.43	3.86	+0.57
F.R.C.	$-4.74 + 0.135\ \text{Ht.} - 0.037\ \text{Wt.}$	0.47	0.50	2.61	2.18	+0.43
R.V./T.L.C.%	$21.7 + 0.265\ \text{Age}$	0.19	0.46	30.70%	32.88%	−2.18%

* Data from Goldman, H.I. and Becklake, M.R. (1959)

TABLE V

COEFFICIENT OF MULTIPLE CORRELATION R FOR THE PRESENT STUDY COMPARED WITH THOSE OBTAINED FROM OTHER STUDIES

MALES

Measurement	Goldman and Becklake (1959)	Present Study	Boren *et al* (1966)
V.C.	0.85	0.66	0.64
R.V.	0.63	0.58	0.33
T.L.C.	0.77	0.55	0.56
F.R.C.	0.57	0.69	0.36
R.V./T.L.C.	0.78	0.65	0.34
F.E.V. .75 × 40	0.86	0.62	0.53

FEMALES

Measurement	Goldman and Becklake (1959)	Present Study
V.C.	0.74	0.35
R.V.	0.55	0.36
T.L.C.	0.72	0.33
F.R.C.	0.61	0.50
R.V./T.L.C.	0.61	0.46
F.E.V. .75 × 40	0.80	—

in Column 6 of the same tables. (The observed means would of course be the same as the mean of the values predicted from our own equations).

The last column of Tables III and IV gives the difference between the observed mean and the predicted mean of each lung function measurement. From these results it is seen that the VC, TLC, and FRC predicted from the European equations are larger than the means observed in the local Chinese group studied, both for males as well as for females.

This method of applying European equations to the physical measurements of Chinese subjects in order to obtain predicted lung function values, in effect, transfers to the European subjects the physical measurements belonging to the Chinese group used in our study. Thus, the European subjects of both sexes with the same physical measurements as those of our study group are shown to have larger values for VC, TLC, and FRC. There is, however, no difference in the mean RV values of the two groups in both sexes. This is in accord with the results of Wu and Yang (1962) who found the RV of Chinese subjects to be less reduced than the VC when compared with the same measurements in European subjects. The consequence of this effect is the larger RV/TLC ratio in the Chinese as compared with Europeans.

The smaller FEV .75 in Chinese could possibly be due to the smaller VC as well as to some other unknown factors. It is interesting to note that for the females no significant correlation could be found between FEV .75 and the parameters studied.

SUMMARY

Respiratory function tests were performed on 50 normal adult male and 51 normal adult female Chinese in Singapore. These tests included the measurement of the total lung capacity and its subdivisions as well as of the forced expiratory volume and the maximal midexpiratory flow rate.

Formulae for predicting the various subdivisions of lung volume and the flow rates derived from age and body characteristics are presented. The findings in the present study are briefly discussed in relation to those reported on Caucasian subjects.

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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

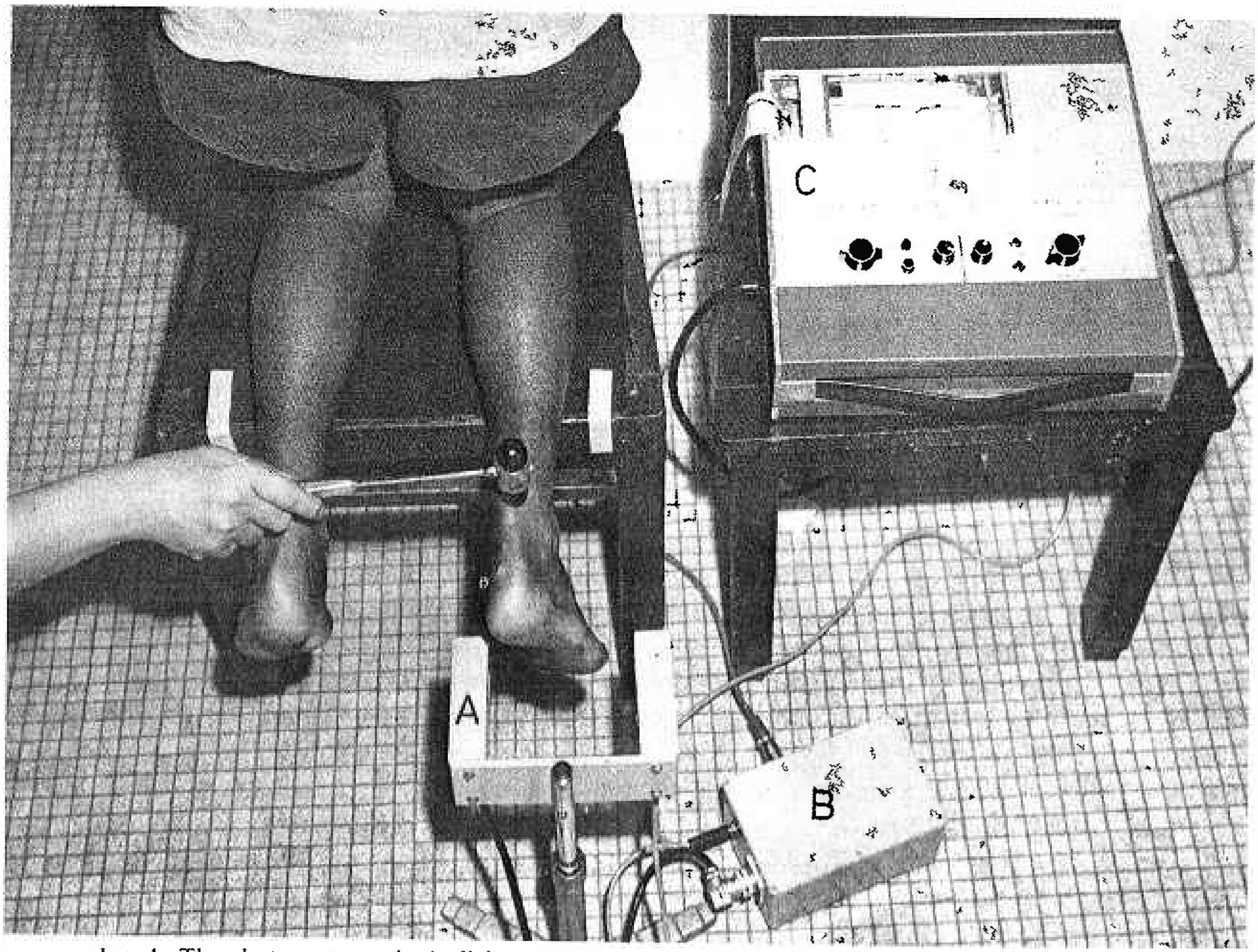

Fig. 1. The photomotograph. A: light source: B: photoelectric transducer: C: electrocardiograph.

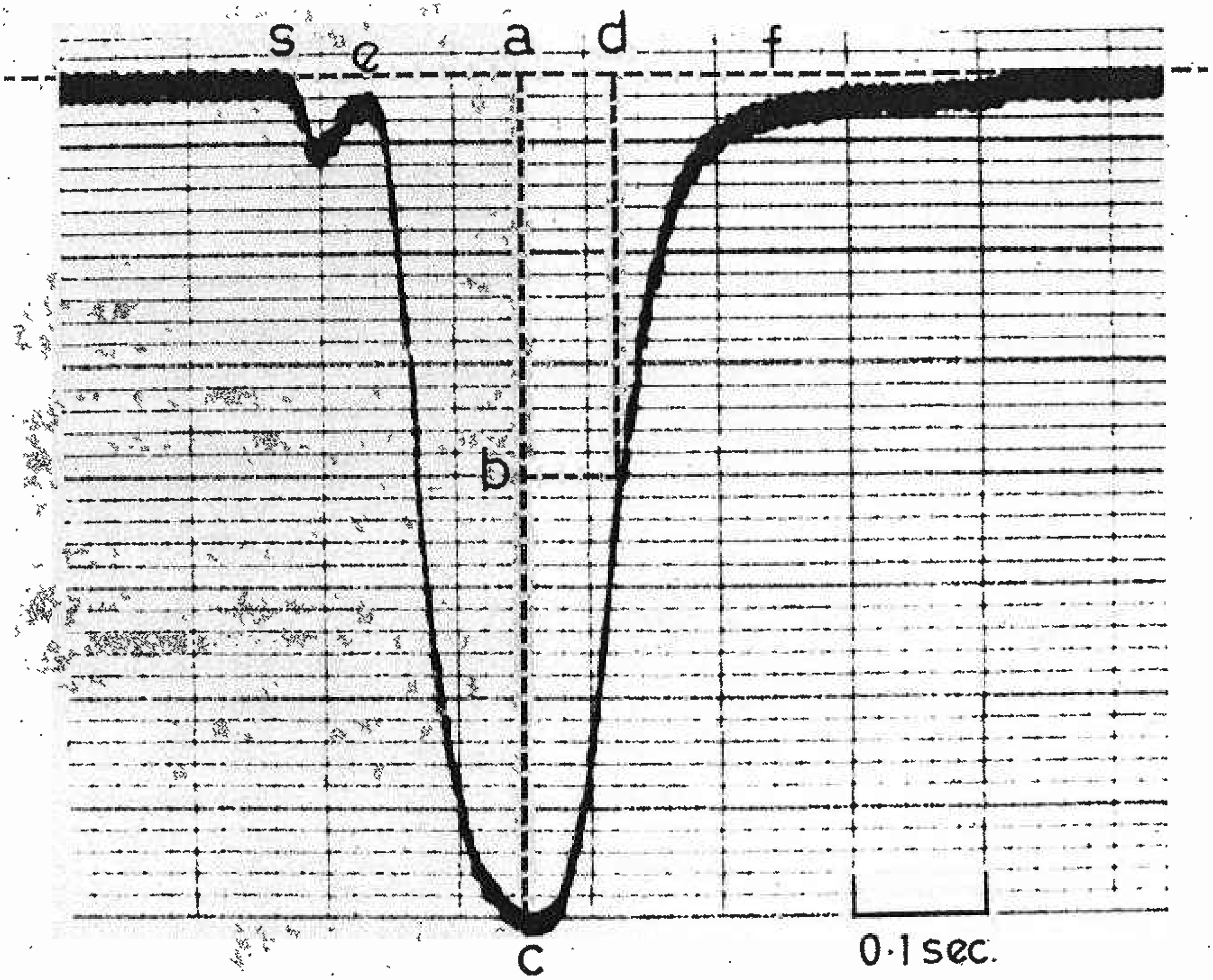

Fig. 2. A typical photomotogram ab=bc; se: stimulus artefact; ea: contraction phase; af: relaxation phase: sd is the tap to half relaxation time.

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 ± 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.

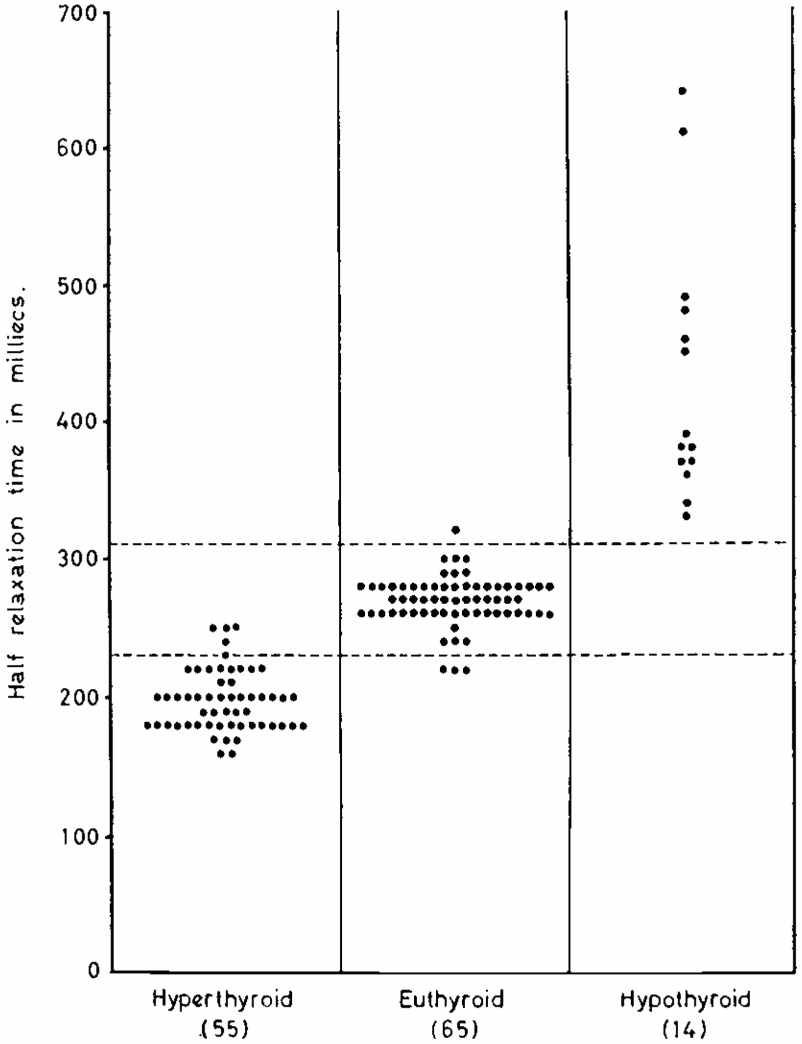

Fig. 3. Distribution of the Achilles tendon reflex time in euthyroid, hyperthyroid and hypothyroid patients. The dotted lines denote two standard deviations of the mean for the euthyroid group.

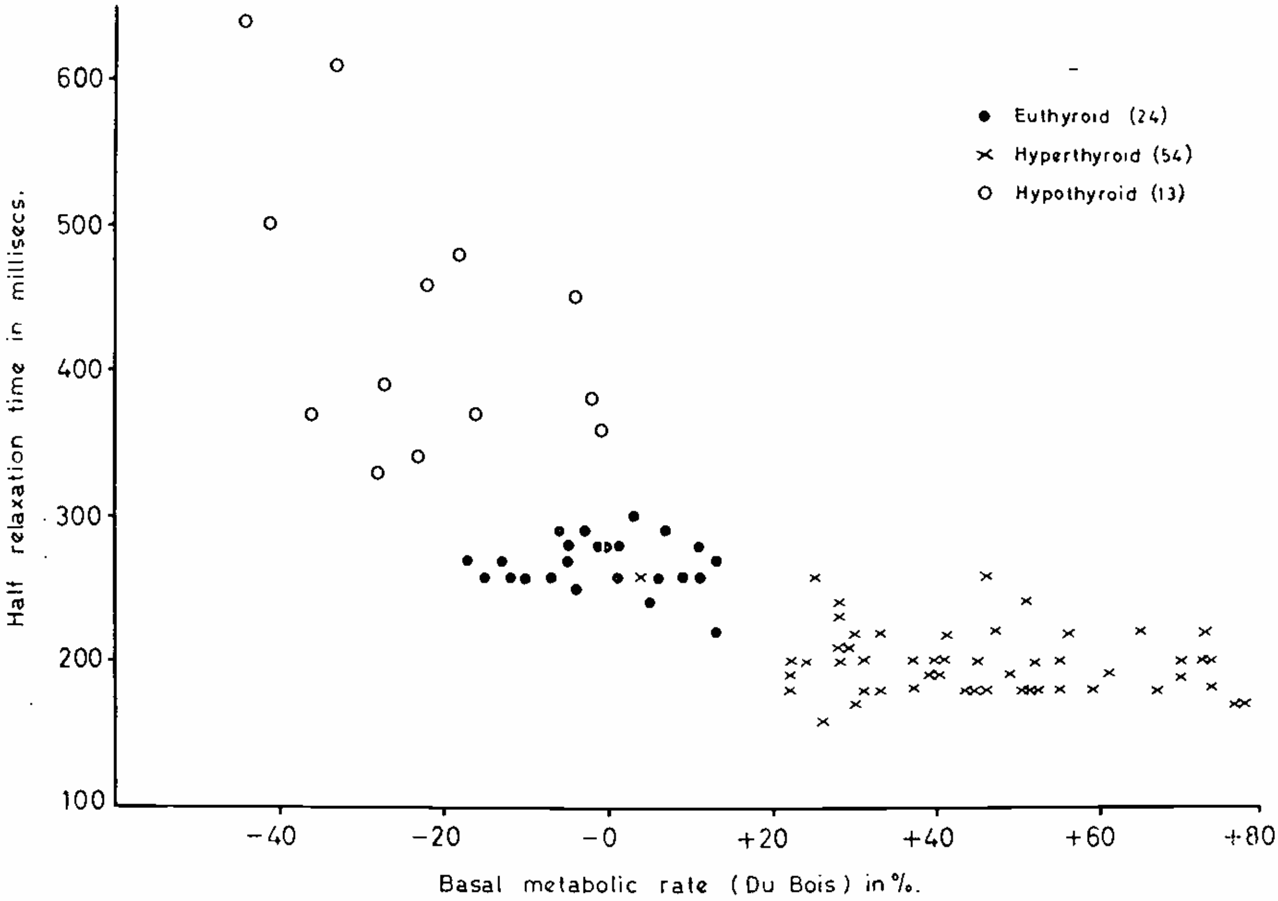

Fig. 4. Relationship between Achilles tendon reflex time and the basal metabolic rate.

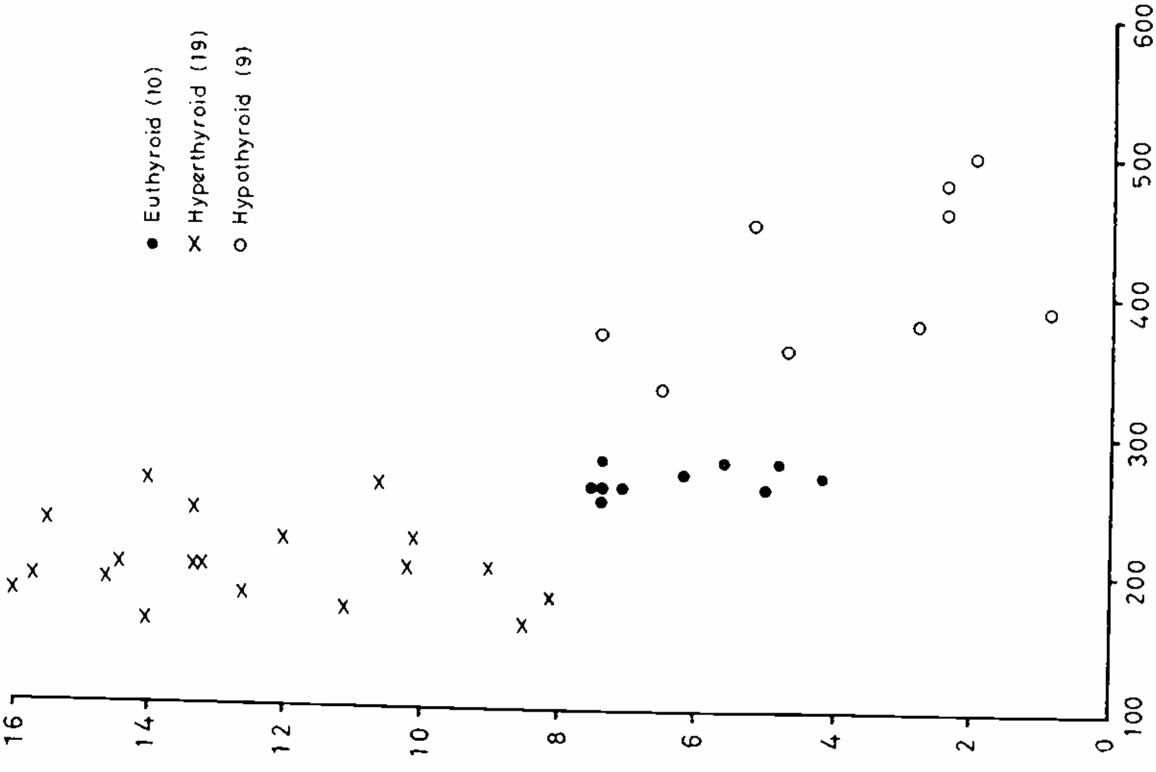

Fig. 5. Relationship between Achilles tendon reflex time and the serum protein bound iodine.

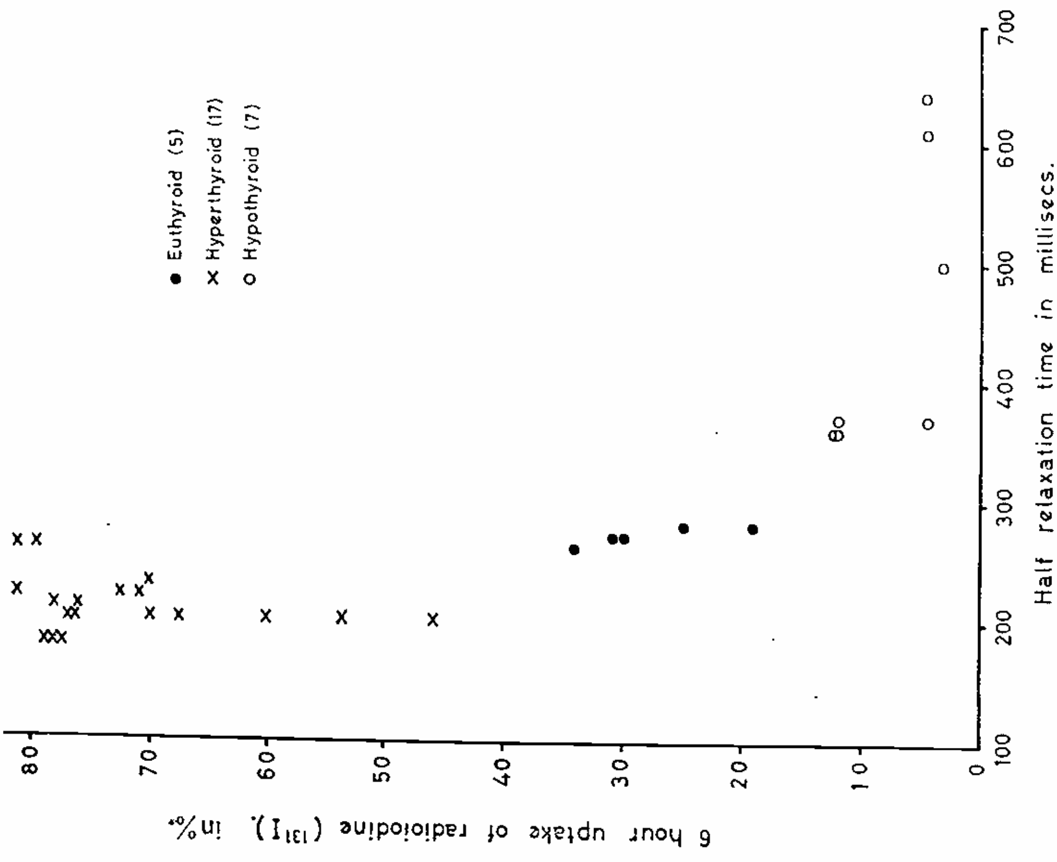

Fig. 6. Relationship between Achilles tendon reflex time and the thyroid gland radioiodine uptake.

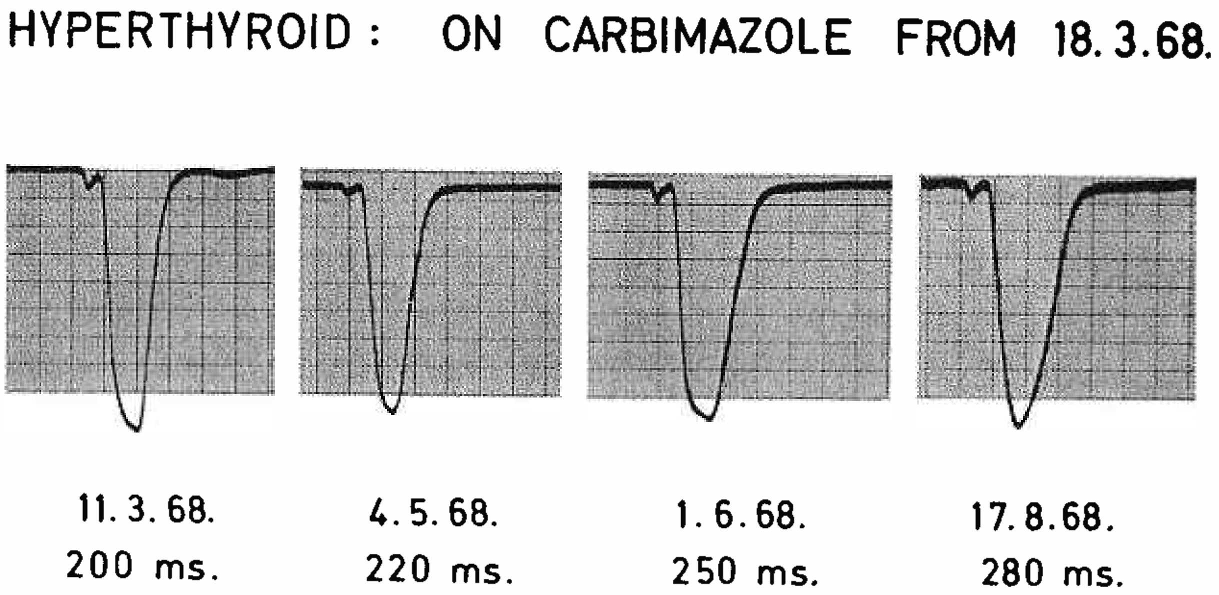

Fig. 7. Changes in the Achilles tendon reflex in a hyperthyroid patient following treatment.

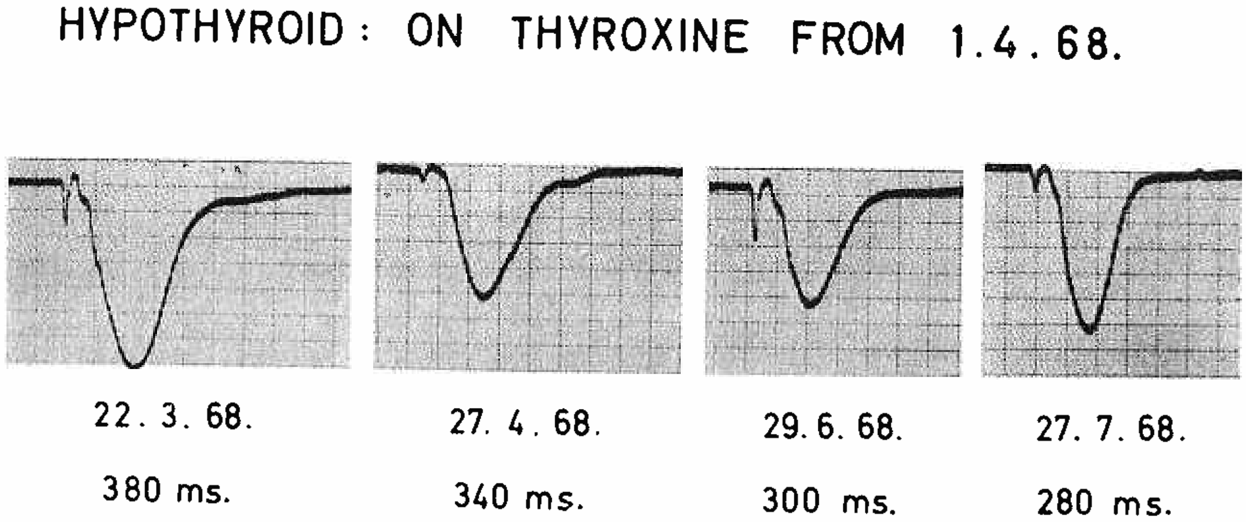

Fig. 8. Changes in the Achilles tendon reflex in a hypothyroid patient following treatment.

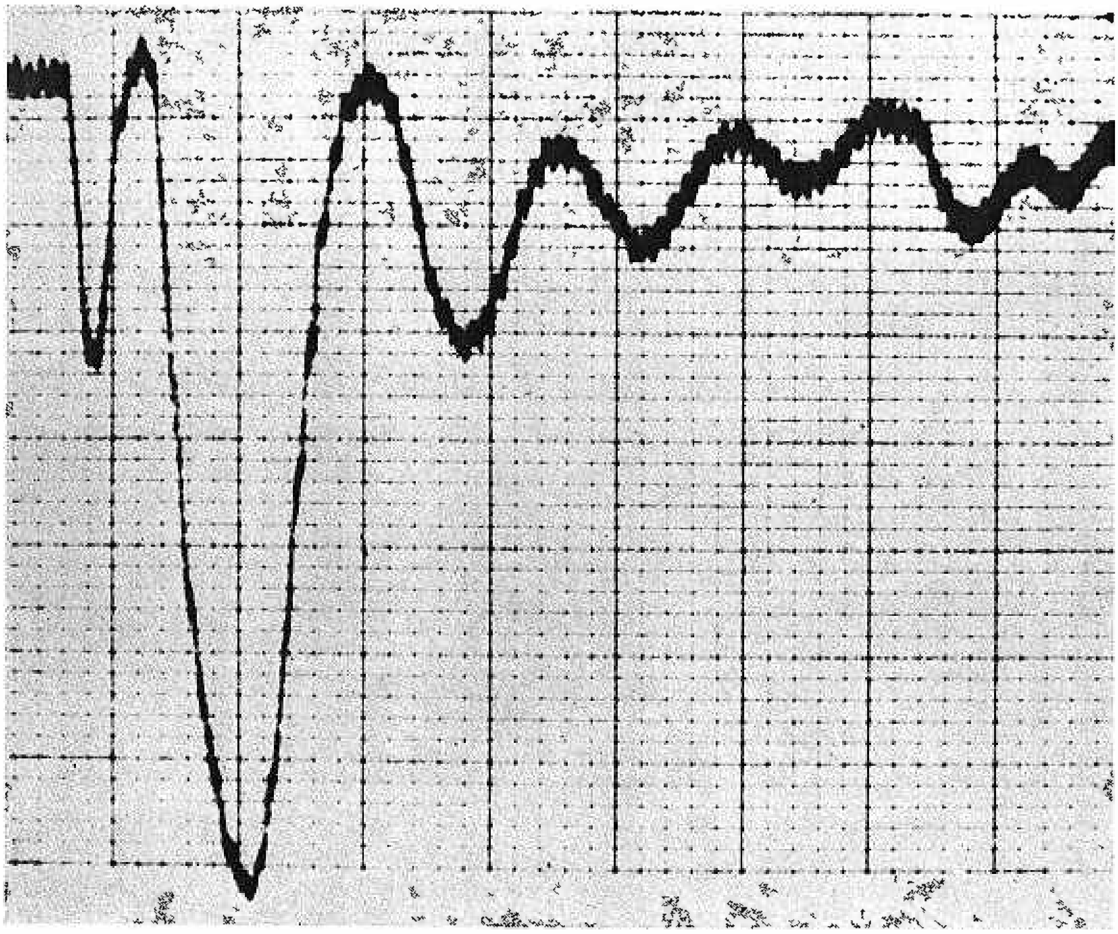

Fig. 9. Hyperthyroid photomotogram: brisk reflex with clonus.

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