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(Figure 26 is adapted from an illustration in Hirsch's paper.)

THE TONOMETER OF SCHIÖTZ*

BY

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SCHIÖTZ' tonometer is known to us all, and it is unnecessary to describe the instrument; but as to its method of application, there are one or two points to which I wish to draw attention.

Devised by Prof. Schiötz, of Christiania, in 1905, and first used in this country in 1911, there are now eleven years during which

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workers with the instrument have had the opportunity of recording their experience from both a theoretical and practical point of view, and we should therefore be at this date in a position to say something of its value in our daily work.

The work done with the instrument in the laboratory by Priestley Smith, has resulted in his advising us as follows.—“when a tonometric observation is recorded, it is the *reading*, and not the supposed equivalent in mm. Hg. which should be stated. The reading is a fact, the other is an inference which may be correct or incorrect.”

Few of us are in a position to question this advice, and coming from so experienced and trustworthy a source, we should accept it, and when using the instrument bear in mind the fact that we are working and thinking in the terms of the instrument, and not in terms which may be regarded as absolute.

From a practical point of view, however, it seems to me that the value of the instrument suffers on this account no depreciation in the hands of those who work regularly with it, and that provided we have a more or less agreed normal base-line on which to work, and at the same time realise that the units with which we record our findings are but units, and not strictly comparable with any standard units obtained in the laboratory, we must conclude that we have in our hands a piece of mechanism which by its value is worthy of a prominent place in the consulting-room.

The majority of those who have published their experiences appear to have felt the necessity of determining the measurements of the normal eye before proceeding further, and an examination of the results given shows agreement, within narrow limits, for the average normal measurement, and more or less agreement for the limits within which the tension of an eye in health may lie.

The average of these findings, from eight publications at my disposal, works out as follows:—

Average normal reading = 19.1. Limits of normal tension = 12.3 to 26.1 (Schiötz' original findings, being 20 and 15 to 25 respectively).

None of these findings, except one, is based on the examination of more than 100 cases, and most on less than that, and this, then, is my excuse for presenting to you my own results of the examination of 1,001 normal eyes.

The task—I purposely call it so—was begun in 1911, after about four months' experience with the instrument, and was completed early in 1913, and, to be accurate, occupied nearly two years.

The tabulated results, copies of which I hand round, were shown at the Oxford Congress in 1913. They have not been published for the reason that they but confirmed more or less the findings of other writers, but as I have now realized that those findings were based on not more than 100 results or little over (118 greatest

number), I feel that the results of 1,001 are eligible for wider notice.

The patients were ordinary hospital out-patients who presented themselves with symptoms referable to refraction error, and in no case was glaucoma suspected or other disease thought to be present, although such may have existed.

The results have been tabulated according to sex, age, and refraction error, and, in addition, I have worked out the percentage of eyes with readings of over 25 and under 15, and certain percentages where there was a difference between the two eyes.

The youngest case examined was aged 7 and the oldest 88.

In the first decade the average is distinctly higher than in any other, and in the sixth decade the number is higher than that of the others, owing to two cases, one being 24, and the other 28.25, neither of which can be positively said not to be incipient glaucoma.

The average of the whole is 20.06.

The lowest recorded result was 11.5 and was observed in two eyes in different patients; one a myope in both eyes and the other a hypermetrope in both eyes, the fellow eyes being 17.5 and 14 respectively.

In 1.7 per cent. only was the tension under 15.

The highest recorded was 30, 4 eyes in 3 patients, and the percentage of over 25 was 3.4.

A difference between the two eyes of the same patient was noted in 21.2 per cent. (a number much lower than that given by another observer), the difference varying from 0.5 to 7.5 and averaging 2.43.

The incidence of cases in which a difference in the reading in the two eyes occurred worked out according to decades, together with the average difference in each decade, gives the following information.—That in the first decade of life a difference is most likely to be found, whilst the last decade comes next, and the decade in which a difference is least likely to be found is that between 40 and 50, or the early presbyopic stage. The average difference is found to be highest between 50 and 60, and 60 and 70, and lowest from 30 to 40, the first decade also showing a low average difference (*vide* tables for figures).

Averaging my own figures with those of other observers, we have:—

The average normal reading = 19.58.

The limits of normal reading = 11.9 to 28.55, remembering that only 1.17 per cent. of cases show readings lower than 15, and 3.4 per cent. over 25. The latter for practical clinical use is the more important, and personally I am inclined to think that the figure 3.4 per cent. is too high, and that any reading over 25, except in the first decade of life, is so suspicious that it should be regarded as indicative of glaucoma until subsequent observation disproves the diagnosis.

Briefly, I wish now to refer to a few points in the method of application of the tonometer.

1. What drug should be used to anæsthetise the eye? Schiötz advises holocaine because it does not dilate the pupil, and in this I feel sure he is right. Some use cocaine, but we must remember that it is just in the doubtful cases that the tonometer is of most use to us in diagnosis and when a dilated pupil may prove disastrous. When therefore it is possible to obtain holocaine, why run risks?

2. The effects of malposition on the cornea have been well shown in the diagrams by Priestley Smith (*Ophthal. Rev.*, March, 1915), and it is so clear that the tonometer must be placed on the centre of the cornea with the eye looking directly upwards that comment is needless.

3. As to where a patient should direct his gaze is not an unimportant item, for the effect of convergence upon the eye has been shown by Hine (*Trans. Ophthal. Soc.*, XXXVI, 1916, p. 226) to be to raise the reading slightly. It is well to note, however, that his results were obtained on only 13 cases, although the average effect is as much as 4.9 readings on the chart.

My own procedure has always been to direct the patient to look at the ceiling, but if unable to fix well, to look at a hand or object held at 1 metre above the patient.

If it is borne in mind that convergence may give a slightly higher reading, the value of taking a reading with the eyes directed towards a near object is not much diminished.

As to the number of readings which should be taken to arrive at a given estimation, the matter is well put by Ballantyne when he says our aim should be to take our first reading accurately and smartly.

Next comes the question as to the value of the instrument in practical use where it is necessary to estimate the tension in cases in which an increase over the normal exists or is suspected.

Let us imagine ourselves sitting in the consulting-room, ready to deal with cases as they present themselves, within easy reach of the tonometer, and then let us ask ourselves the question:—What are the cases in which we are likely to use it and what information will it give us?

The best answer lies, I think, in an examination of the case books, and with this object I have reviewed 70 consecutive cases (private ones, as the records are more easily at hand and fuller) in which I have found that I have had occasion to use the tonometer.

Of these 70 cases, 42 have been cases of undoubted glaucoma, mostly chronic, a few acute; most have been operated on and there has been no question as to the diagnosis.

In all of these the tonometer has given a reading of over 25, and although some have been as low as 27 or 28, and have been lowered

below 25 by the use of miotics, subsequent observation of the cases has shown them to be indisputable examples of glaucoma.

Many other readings have been taken in the course of each case and have proved of infinite value in estimating the condition of the eye and its behaviour as regards miotics and the effect of fistulisation.

In the cases in which apparently only one eye was affected with glaucoma and the other was, at the time at any rate, free from any suspicion of the disease, the reading in the good eye was consistently below 25.

There remain now the 28 cases in which the aid of the tonometer was invoked, and which have not, up to the present at any rate, proved to be glaucoma.

All the cases were over the age of 40, and readings were thought necessary on account of symptoms suspicious of glaucoma, although in none were signs present, for central vision was normal, there were no field alterations, and there was no increase of the blind spot. The symptoms were, for example: undue ocular fatigue and pain on near work; inability to read for any length of time; smarting of the eyes with lachrimation, without anything being present to account for such complaints, and notwithstanding an accurate correction of refraction error, and, further, an undue rapidity in the increase of presbyopia.

It is unnecessary here to point out that we look to such an instrument as the tonometer to give us help in diagnosing glaucoma in its prodromal stages. Its aid is of a different kind when, for example, such symptoms are present as to indicate oedema of the cornea, where the diagnosis can be made beforehand.

Now of these 28 cases, which were only suspected ones, 18 gave readings below 25, and call for no further comment, whilst the remaining 10 gave readings of 25 and over at one time or another.

Five of these ten cases subsequently proved to be examples of arterio-sclerosis with high blood-pressure, and it is interesting to note that four of the five gave readings well over 25, the highest being 32.5.

Against this I have records of one case which gave a reading of 32.5 in each eye, but without any evidence of arterio-sclerosis.

As to the five cases in which arterio-sclerosis was present, the condition was not suspected at the time, but developed later, *i.e.*, in the course of years; three of the cases have been watched over periods of from 6 to 11 years, and it has been during that time that they have developed symptoms referable to high-blood pressure and have been treated for this by their own medical advisers. Under such treatment the ocular tension showed a gradual fall.

It may be that a percentage of these patients will develop actual signs of glaucoma later.

Some of them have been seen fairly recently and their ocular condition is satisfactory; others, I have been told by friends and relatives, continue to progress smoothly; whilst some have perhaps already been operated on for glaucoma by hands other than mine.

Table showing the results of the estimation of the intra-ocular pressure by the Tonometer of Schiötz in 1,001 normal eyes.

Age by decades.	Sex.	Emmetropia.	Mixed astig.	Hypermetropia	Hypermetropia.	Myopia.	Myop. astig.	Averages.	Averages according to decades.
1—10	M. ¹⁰		² 19'50	⁸ 23'00				21'25	¹² 23'75
	F. ²		² 26'25					26'25	
11—20	M. ⁹⁶	¹⁴ 19'73	⁷ 21'14	³² 19'98	¹² 21'42	²¹ 21'36	¹⁰ 18'30	20'32	²⁵⁹ 20'69
	F. ¹⁶³	²⁸ 20'57	²⁸ 20'78	³⁹ 21'50	⁵⁰ 19'80	¹³ 21'53	⁵ 22'25	21'07	
21—30	M. ⁶⁸	¹⁸ 18'83	⁶ 17'33	⁹ 20'18	¹⁶ 18'50	¹⁴ 20'64	⁵ 17'40	18'81	²²⁴ 19'30
	F. ¹⁵⁶	⁴⁶ 19'28	²⁰ 20'10	³⁰ 19'00	⁴³ 19'84	¹¹ 21'77	⁶ 18'83	19'80	
31—40	M. ⁴⁷	¹⁷ 20'59	² 17'28	¹⁷ 20'14	¹⁰ 19'65	¹ 17'50		19'03	¹⁵⁹ 19'13
	F. ¹¹²	²⁴ 19'87	⁵ 18'90	⁴⁹ 19'53	²⁹ 19'58	⁵ 18'30		19'23	
41—50	M. ⁵⁵	²⁶ 20'80		²¹ 17'96	⁶ 20'66	² 15'00		18'85	¹⁸⁰ 19'26
	F. ¹²⁵	³¹ 20'77	¹³ 21'73	⁵⁵ 21'14	¹⁶ 19'98	⁶ 17'60	⁴ 17'12	19'72	
51—60	M. ³³	²⁰ 21'76		¹¹ 18'43	² 24'00			21'39	¹¹³ 21'47
	F. ⁸⁰	²⁶ 20'80	⁵ 21'60	⁴⁰ 20'09	⁶ 20'58	² 28'25	¹ 18'00	21'55	
61—70 and over	M. ¹⁴	¹² 20'29		² 18'75				19'52	⁵⁴ 19'59
	F. ⁴⁰	¹⁶ 19'43	² 25'00	¹⁸ 19'69		² 16'25	² 18'00	19'67	
Averages according to refraction		²⁷⁸ 20'22	⁹² 20'87	³³¹ 19'95	¹⁹⁰ 20'40	⁷⁷ 16'25	³³ 18'55	1,001 cases 20'06 average	

The small figures in each space represent the number of eyes "tonometrised."

**Percentage of cases (according to decades) showing a
difference of reading in the two eyes**

1 — 10	50 per cent.	51 — 60	41·67 per cent.
61 — 70	42·28 „	31 — 40	41·03 „
and over		21 — 30	35·54 „
11 — 20	43·38 „	41 — 50	32·99 „

Average differences according to decades

51 — 60	3·41	21 — 30	2·35
61 — 70	3·04	11 — 20	2·11
and over		1 — 10	2·4
41 — 50	2·59	31 — 40	2·02

A NEW OPERATION FOR PTOSIS

BY

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I HAVE practised, during the last four or five years, an operation for ptosis which, in suitable cases, has yielded so much more pleasing results than those I have ever been able to obtain by former methods, that a description of it may perhaps be justified.

Few will dispute that ptosis operations, however successful they may be reckoned surgically, rarely quite realize an artist's ideal from the æsthetic point of view. Gratifying immediate results, it is true, are obtained from artificial tendons, but a very natural prejudice exists against foreign bodies left in the organism. Strange to say, with the exception of Wray's punctures (for slight ptosis), and the little practised Motais group of operations, nearly all the procedures advocated in the present day, attack the tendon from the skin side, which mode of approach must, in itself, make for æsthetic loss, owing to the derangement of so many important structures, namely:

(1) The *skin*, whose natural folds cannot be disarranged without impairment of symmetry and beauty.

(2) The *areolar tissue*, which never recovers its original lissomeness after operative interference.

(3) The *orbicularis muscle*, which like all other muscles, acts best in the state of nature.

(4) The *orbital fascia*, which, being the suspensory ligament of the eyelid, is not improved by a large hole made in it.

(5) The numerous delicate *strands* which the levator tendon gives off to the skin, and of which many cannot fail to be severed or damaged.

Contrast with this the simplicity of approach from behind, after the precedent set, about the year 1858, by Sir William Bowman.