STRENGTH OF THE ORBICULARIS OCULI*

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It was considered that some ophthalmic disorders may be correlated with variations in the strength of the orbicularis oculi. To gain some idea of the variations to be found in the strength of this muscle, a random sample of patients coming for refraction and a group of medical student volunteers were examined. Those cases were excluded which might be supposed to have some impairment of orbicularis function. It was thought that the range of findings might be not inconsiderable, that conclusions could only be drawn from relatively large numbers, and that comparison of small numbers making up sub-groups within the main body of personnel tested would not be of value.

It was found that the range of findings was even wider than anticipated; in fact so wide that the original object of the investigation to establish a norm (*viz.* a minimum and maximum between which *all* normal values would lie, values lying outside implying pathology)—obviously could not be fulfilled. Notwithstanding this negative aspect of the findings, this paper is presented to introduce a new instrument and to indicate its possible usefulness and limitations in non-ophthalmic medicine. The results are presented in outline.

Instrument

This is essentially a piston and cylinder connected to a pair of specula that are introduced into the palpebral fissure. The specula are forced together by the power of the patient's lids closing, and an air pressure is developed inside the cylinder head to oppose and overcome this (Figs 1 and 2).

FIG. 1.—Instrument assembled for use.

FIG. 2.—Specula detached for sterilization.

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The instrument was standardized against weights on two occasions, the second being used to check the first. Fig. 3 indicates the relation of readings to grams weight. Relevant measurements are:

Bore of cylinder	...	...	...	...	0.365 in.
Length of cylinder stroke	...	...	...	...	0.812 in.
Length of cylinder piston	...	...	...	...	0.550 in.
Size of specula	...	...	...	...	0.315 × 0.500 in.

FIG. 3.—Calibration of dynamometer against weights. Dots and crosses indicate results obtained on two different occasions separated by a six months interval.

Method

The instrument is held in one hand and carefully introduced whilst the lids are manipulated with the other (Fig. 4). The subject is asked to close the eye gently, thus engaging the two specula with his lids. The cylinder is connected to a pump, an air reservoir, and a mercury manometer. The subject is then asked to squeeze his eye shut with all possible force, and the pressure in the instrument is increased until the piston just moves—*i.e.* the lids just part. The piston is tapped back with a finger and should then immediately come out again. It is at this point that the reading is taken, it being assumed that the force generated in the cylinder is

FIG. 4.—Arrangement of the apparatus for use.

equal to that exerted by the muscle. The subject must be encouraged in his efforts all the time.

Material

Group 1.—190-odd routine refraction cases seen at Moorfields Eye Hospital.

Group 2.—99 volunteer medical students.

Group 3.—7 medical students on whom serial readings were taken on different days.

Results (mm. Hg)

Group 1 (Table I).—Analysis failed to show any regular relation between refraction and the readings obtained. A slight possibility remains that such a relationship could be demonstrated either with trained subjects or larger numbers.

TABLE I
SUMMARY OF MEAN READINGS IN EACH DECADE IN GROUP I

Decade	Males					Females				
	Number of Cases	Right *	Left †	Mean	Range	Number of Cases	Right *	Left †	Mean	Range
Second	4	158	139	149	97-190	15	140	123	132	90-115
Third	17	164	161	163	85-220	13	147	151	149	88-240
Fourth	15	122	120	121	59-260	16	134	124	129	66-210
Fifth	16	141	134	138	64-240	33	135	122	129	62-212
Sixth	9	153	145	149	110-205	24	119	106	113	47-210
Seventh	9	136	137	137	88-220	14	131	133	132	80-180
Eighth	5	138	130	134	90-210	3	138	122	130	46-190
Total...				141					120	

*Mean of right eyes = 137

†Mean of left eyes = 130

*Mean readings (compounded right and left, male and female) comparing the 3rd-7th decades are set out in Table III.

Group 2.—The range of readings obtained is indicated in Fig. 5 (overleaf), and a comparison of the males and females in Fig. 6 (overleaf).

Group 3 (Table II, opposite).—Two or three readings were taken on any given occasion. The mean and actual readings are given. In addition, readings were taken for the orbicularis oris—the method being comparable to that used for the orbicularis oculi—but the lips were pursed against the specula. Case 6 was female, the rest were males.

Inferences

(1) **A Normal Value**—The results in the group of medical students indicate that an average reading lies between 120-140 mm. Hg with a wide range of readings above and below; this figure is obtained in apparently normal subjects. This well brought out by Fig. 5 (overleaf).

(2) Variations

(a) *Age*—Only in the 3rd-7th decades are the numbers sufficient to make

TABLE II
RESULTS IN GROUP 3

Case No.		Actual Readings				Mean Readings			
		Day 1	Day 2	Day 3	Day 4	Day 1	Day 2	Day 3	Day 4
1	Right Left Mouth	120 116 118 94 88	138 114 116 80 86 170 180	132 104 115 105 96 82 240 245	126 108 86 98 236 226	118 91	123 83 175	117 94 242	117 92 231
2	Right Left Mouth	144 120 124 115 124 116	160 150 128 118 230 235	168 110 120 130 118 220 246		129 118	155 123 232	133 124 233	
3	Right Left Mouth	142 155 120 130 210 214	155 136 155 135 228 238	174 148 154 172 168 282 260	124 138 148 146 125 130 226 218	148 125 212	145 145 233	159 170 271	137 117 218
4	Right Left Mouth	125 126 124 130	166 156 154 138 136 250 215	156 132 142 132 215 230	130 144 116 118 216 220	125 127	159 137 232	144 137 222	137 117 218
5	Right Left Mouth	170 158 128 128	190 172 130 138 300 288	160 168 136 126 260 238		164 128	181 134 294	164 131 249	
6	Right Left Mouth	136 138 105 105	138 156 85 95	188 202 138 130 280 260	150 162 140 142 226 204	137 105	147 90	195 134 270	156 141 215
7	Right Left Mouth	166 135 146 118 132 138	110 96 112 104 102 198 228	124 132 112 118 284 288	118 125 82 94 268 278	149 129	105 103 213	128 115 286	121 88 273

TABLE III
VARIATION OF READINGS WITH
AGE OF PATIENTS

Decade	No. of Cases	Mean Readings
3rd	30	157
4th	31	125
5th	49	132
6th	33	122
7th	23	134

tentative comparisons. The figures in Table III do not reveal the expected variation with age. The high average in the 3rd decade (compared with 124 in the 99 medical students) makes one suspect some undetermined heterogeneous factor.

(b) *Sex*.—Both Groups 1 and 2 show that the orbicularis oculi tends to be stronger in males than females.

(c) *Side*.—There is no consistent preponderance of right over left among the medical students. The figures in the other groups are not considered reliable in this respect as the right side was always done first and a fatigue factor may have entered into the second reading on the left side. On the other hand, among the students, in cases where there was a marked difference between the two sides, the results were generally checked after a few minutes—the machine being pumped up to about two-thirds of the expected reading and the left side done first, so tending to reduce the fatigue factor.

FIG. 5.—Mean strength of orbicularis oculi in 99 students (60 male and 39 female).

(d) *Period.*—Serial readings showed that readings obtained on different days may be consistent or variable, depending on the subject. Indeed, some variation—generally not great—may be shown in different readings on the same day. Of the seven students, two gave fairly consistent readings (1 and 5), three gave readings that were broadly of the same order (2, 3, and 4), and two gave irregular readings (6 and 7). One of the most irregular (6) was the only female.

Comment

(1) It must be emphasized that the normal values noted above are based on results obtained from inexperienced subjects at a first testing. Possibly—in fact, very probably—a different average would be obtained with trained subjects.

(2) Müller and Droescher (1938) gave the strengths of the orbicularis oculi obtained by using a dynamometer working on a spring principle. An average reading of 160 G (this series 60–70 G) with a range of 134–209 G (this series 15–145 G)

was found. The greatest difference between the two sides was 25 G (this series, 30 G—in a man who admitted slight epiphora on the weaker side and also had chronic antral trouble on that side). Springs that measure large ranges of small forces are unreliable, and the figures obtained with an instrument working on this principle probably reflect this fact. Further, a sudden thrust is measured with a spring-type instrument, whereas the air dynamometer requires a thrust which is sustained to some degree. Notwithstanding this, the air-type instrument can be used (by previously mounting the pressure) to measure a thrust. The difference (generally a higher reading) does not compare with the difference between Müller and Droescher's series of figures and our own. Also the exact size of the spring instrument—in

FIG. 6.—Mean strength of orbicularis oculi in 60 males and 39 females. The number of females has been scaled up 50 per cent. for sake of comparison.

particular of the specula—is not described.

(3) Although it had been anticipated at the inception of this investigation that a wide range of not necessarily repeatable results would be obtained (the subject's volitional powers being on test as well as his muscle power), the extreme range of variation actually obtained (50–186 mm. Hg) was a surprise. It meant that no lower limit of normal could be proposed, and that normals and known abnormals tended to overlap in this particular determination. Therefore, it was decided to curtail the much wider investigation to establish a norm as originally envisaged. The foregoing implies that any single determination in an individual can have but limited significance; but, although this is true, it is also true that the comparison of bulk determinations in given clinical groups may yield interesting data.

(4) The data obtained in a given individual, provided each reading is confirmed by taking an average of two or three determinations, may be revealing by estimating the response of a given patient to such drugs as prostigmine and muscle relaxants.

Limitations of the Method

(1) A defect of the instrument is that the point at which the piston “fires off” varies with the rate of rise of pressure in the cylinder. In using it the operator always made an effort to make the rate of increase of pressure fairly even.

(2) It is possible that the operator may influence the reading if he does hold the instrument so as to avoid interfering with lid function.

(3) Tilting the instrument may possibly vary the results. In practice, it was found that the instrument tends to sit at a definite tilt, and this may vary with different patients—presumably depending on facial contour.

(4) The instrument may give different readings if inserted in different parts of the palpebral fissure. In all the determinations given above, the specula were engaged at the medial canthus just lateral to the puncta.

(5) There is a slight shear in the piston movement.

(6) Some subjects tend to extend the *point d'appui* of their lid margins up the shank of the instrument as in them the shanks tend to be buried.

It is considered that all the above possible sources of error are insignificant compared with the errors that are intrinsic in any experimental clinical investigation in man where the volition of the subject plays a part. This must be the major source of unreliability—for even the measurements of the strength of the orbicularis oris are variable, and most of the above limitations do not apply in dealing with this muscle.

By slight variations in technique and by redesigning the instrument, factors 1, 2, 3, 4, and 5 could be reduced or nullified. In fact it was decided to stick to one technique and one instrument rather than introduce more variables and make the investigation unduly prolonged.

Summary

An instrument designed to measure the strength of the orbicularis oculi is described.

In 99 medical students, an average finding of 120–140 mm. Hg (60–70 g. weight) was obtained with a wide range on either side of the mean.

A sex variation was found—males being slightly stronger than females.

No consistent variation with age was found.

No general right- or left-sided preponderance was found.

It is considered that the instrument may prove useful in estimating the effects of drugs on the orbicularis oculi, and in following the course of recovery in cases of such disorders as Bell's palsy.

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REFERENCES

MULLER, H. K., and DROESCHER, J. (1938). *Ber. ophthal. Ges. Heidelberg*, **52**, 438.