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DIOPTRON- AND RETINOSCOPY - SUBJECTIVE DISCREPANCIES: EFFECT OF AGE

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Abstract—It was confirmed that the Dioptron II returned a mean spherical equivalent of the order of one-tenth of a dioptre more myopic than an independent subjective result. In contrast to data from another objective technique, retinoscopy, we found no evidence from a sample of 379 eyes that this discrepancy varied with age.

INTRODUCTION

In a recent article (French and Wood, 1982) we examined the validity of the Dioptron II in terms of the frequency with which its results differed by certain amounts from those of retinoscopies and subjectives. In passing, we also recorded that on average the instrument returned results of the order of 0.05 — 0.1 D more negative than for a corresponding subjective, findings consistent with those of Turnbull (1981). At that time we had not collated the age of our patients so that we were unable to comment on whether the differences varied as a function of age.

Millodot and O'Leary (1978), after reviewing the literature and presenting the independent results of three practitioners, concluded that the discrepancy between retinoscopy and subjective mean sphere-equivalents could be expressed as a linear relationship, with a maximum difference of 0.3-0.4 D for young patients, reducing to zero for those around 60 years of age before becoming negative for the eldest (Fig. 1). They hypothesized that this was due to the visible retinoscopic light being reflected from the internal limiting membrane in young eyes and from a layer posterior to the photoreceptors in older eyes.

An i. r. optometer, like the Dioptron, has the advantage that the measurement beam of light, being invisible to patients, does not distract them from any desired fixation target. On the other hand, this use of the i. r. brings with it some disadvantages. There is considerable evidence (Charman, 1980) that i. r. light passes through the region where visible light is absorbed by the receptors, before being reflected at the sclera underneath. As i. r. and visible light behave differently, optometers based upon the former will not give the same results as a subjective unless an appropriate correction is applied. Without this the eye will appear more myopic. Correction is also required for the longitudinal chromatic aberration of the eye (Tucker, 1974). One would assume that suitable empirical corrections have been incorporated into the Dioptron IPs programming and Munnerlyn (1978) quotes a figure of about + 0.6 D.

It is conceivable that the changes that occur with age will affect the discrepancy between the Dioptron's results and that of a subjective refraction, much as they appear to affect the discrepancy between retinoscopy and subjective (Millodot and O'Leary, 1978), but reflection of i. r. light at the sclera (Charman, 1980) would suggest that this is not so. The results of Turnbull (1981) appear to confirm this, as he failed to find any change with age.

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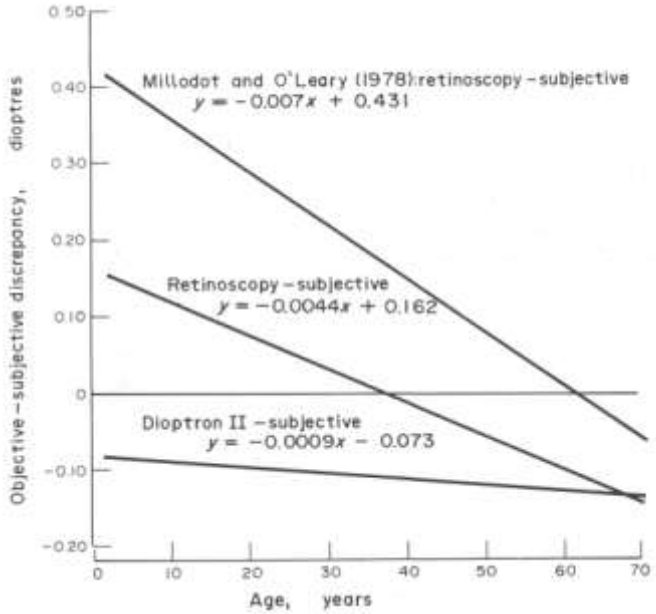

Fig. 1. Regression lines indicating the relationship between the discrepancy between objective and subjective measurements and age for our own data and that of Millodot and O'Leary (1978). In the regression equation, *y* is the discrepancy in dioptres between the mean sphere-equivalents given by the techniques and *x* is the age in years.

However, a question mark is raised over his results as he also failed to find the retinoscopy-subjective age-effect apparently established by Millodot and O'Leary (1978). In Turnbull's (1981) study, although the retinoscopy was carried out without knowledge of the Dioptron result, both were consulted by the optometrists before proceeding to the subjective. The influence of bias is pervasive and well-established (Rosenthal, 1966) and we wondered whether an age-trend might become apparent with the Dioptron - subjective data if the two were carried out independently. We set out to see whether we could resolve the conflict between the results of Turnbull (1981), and Millodot and O'Leary (1978).

METHOD

Our data and their method of collection are described in detail in French and Wood (1982). We had omitted to ask the ages of our patients, but for those patients who attended UMIST'S Open Clinic it was possible to recover this information by reference to the Clinic's files. Each eye had two Dioptron records, a retinoscopy and a subjective refraction with the last two being non-independent.

In the present analysis we excluded eyes for which there were no first-class Dioptron measurements. We defined these measurements as records with zero missed-measurement scans, a confidence factor of between zero and one, and a relation junction of less than + 180. Our analyses had shown that these results would be the most accurate and this screening would reduce the number of non-normal Dioptron errors creeping into the results [see French and Wood (1982)]. Such errors would vitiate any parametric statistics which we needed to use. Only first-class Dioptron records were used and each eye entered only once into the calculations.

RESULTS

The ages in our sample of eyes are given in Fig. 2. The Open Clinic caters virtually exclusively for UMIST students and staff and this is reflected in the sample's bimodal distribution. The majority of patients were in their late teens or early twenties and there were very few under 18 or over 65. Despite this, the distribution of ages remains legitimate and adequate for our purposes. We found that the proportion of first-, second- and third-class Dioptron measurements were very similar for those under and over 30 years of age (X^2 - 1.36, df = 2, n.s.).

An analysis of variance of the differences between retinoscopy and subjective mean spheres reveals a statistically significant effect due to age (F = 1.51, df = 49, 323, $P < 0.05$). A test for linear trend (Winer, 1962, p. 70) is also significant (F = 7.2, df = 1, 323, $P < 0.01$). The regression line which best fits the data is also shown in Fig. 1. By comparison with Millodot and O'Leary's (1978) line, it is flatter (slope of -0.0044 ± 0.0017 compared with - 0.007 D/year) and has a lowers-intercept. The average SD of the differences, at 0.48 D, was somewhat larger than Millodot and O'Leary's (1978) 0.24 - 0.41 D. Twelve per cent of the between-age variance in our study could be predicted from the linear regression equation. A test for deviation from linearity just missed statistical significance (F = 1.39, df = 48, 323, n.s.), but it was thought, anyway, that higher-order trends would not be particularly meaningful in view of the non-independence of our retinoscopy and subjective findings. These were not, therefore, pursued although Winer (1962, p. 74) states that when the degrees of freedom for the non-linear mean square estimate are large (as in this case) this may mask a significant higher-order component.

Analysis of the Dioptron-subjective differences just failed to reveal evidence of age involvement (F = 1.38, df = 49, 327, n.s.). In other words the results were consistent with a horizontal line indicating a Dioptron-subjective discrepancy of -0.10 D for all ages. Over *99%* of the between-age variation would have been attributable to non-linear trends had these proved significant, but there was no question of a significant linear trend. The average SD of the differences was 0.46 D. Their distribution appeared reasonably normal with a skewness of 0.2 and an excess of kurtosis of — 1.0, not seriously impugning

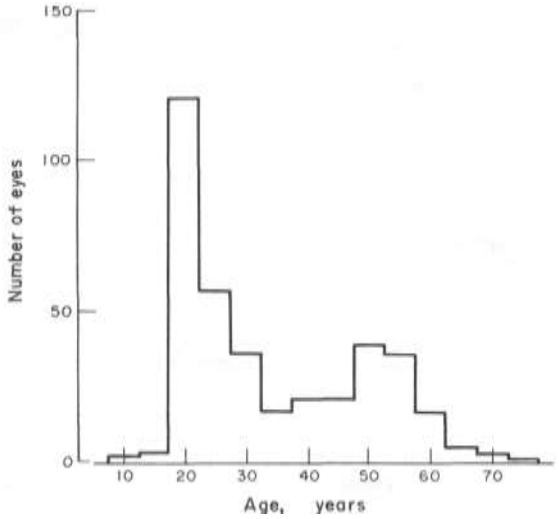

Fig. 2. Age distribution of eyes in the study, n = 379.

the parametric analysis assumptions.

DISCUSSION

Millodot and O'Leary's (1978) regression line was based on data from three clinicians and 1078 eyes whereas our own was based on the findings of 36 undergraduates and 379 eyes. Despite these differences it seems to us that the two may be compatible. We believe that the vertical displacement in Fig. 1 may be a reflection of the students' novitiate status with regard to retinoscopy. We formed the impression that the optometry supervisors paid less attention to formally correcting the retinoscopy results because they were not considered to be an end in themselves. The difference in slope is not large and may reflect a very small variation in the relative amount of reliance placed on the retinoscopies when carrying out the subjective. It is reasonable to assume that such variations do occur but whether they alone would be sufficient to account for Turnbull's (1981) results (400 eyes) is a moot point. Turnbull (1981) speculates that the difference between his and Millodot and O'Leary's (1978) results might be due to "different patterns of bias", presumably brought about by the inclusion of the Dioptron results for the refractionists to consult [see also Reimers *etal.* (1973)]. It should be noted that both Turnbull (1981), and Millodot and O'Leary (1978) grouped their eyes into decades before performing their analyses while we preferred an analysis of variance using the actual ages.

Despite these differences from Turnbull (1981), our results are strikingly similar to his with regard to the Dioptron - subjective discrepancies, where we both find no age-effect. On the face of it, Fig. 1 might be thought to suggest that the Dioptron II provides a better basis for a subjective than does a retinoscopy, but this is not necessarily so. The straight lines only show you the *average* position and take no account of reliability [see French and Wood (1982)]. However, it is particularly apparent that if we add a tenth of a dioptre to each Dioptron mean sphere then *on average* we obtain substantially the same result as the subjective, whereas with retinoscopy the position appears more complicated and one must provide a correction which varies with age. Both correction procedures are relatively simple and this does *not,* therefore, imply that the Dioptron is superior to a retinoscopy. Further, as Turnbull (1981) has pointed out, the discrepancies being discussed are small, so as to be of marginal clinical significance. He addressed himself specifically to the question of which provided the better objective procedure and came to the conclusion that neither held a clinical edge.

The lack of change in Dioptron — subjective discrepancy with age would appear to confirm Charman's (1980) view that it is the sclera which reflects the i. r. light. Clearly, its position relative to the receptive part of the retina remains constant during an individual's lifetime.

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