

Refractometers, the New Standard in Studies on Refraction

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Refractive Studies, Norms of the Past

In 1968 I prepared and started my thesis study on “Prematurity and the Eye” [1]. A Danish cohort of prematures born between 1959 and 1961 were examined around the age of 10 years and compared with full-term controls. The aim of the study was to assess the ophthalmic cost of prematurity. The preliminary focus was inter alia on refraction and refractive parameters, and my advisors emphasized no less than “best contemporary methods”. This was discussed in detail in the thesis (1), as also in a later Danish thesis on myopia progression in school children [2].

Duke-Elder dominated the thinking of that era. He attached importance to sciascopy and keratometry, but primarily as guidance for subjective testing whenever this was feasible [3]. Small deviations in instrument focus and working distance influence the streak retinoscopy reading and errors easily occur. Therefore, the final proof is best given by subjective testing using a visual testing chart at a distance of 5–6 m. The observant individual will recognize the marginal blur that occurs when +0.25 excess spherical power is added to full neutralization in the trial frame.

The next issue in focus was the use of cycloplegics. In strabismus, esotropia in particular, the demand for full atropinization (eye drops or ointment over several days) by and large had been withheld. Eventually, the new short-acting eyedrops (Mydracyl; Cyclopentolate) were used for current diagnostic evaluation, and were also widely accepted for population studies of refraction. Classic atropine would invalidate visual function possibly for weeks, which was not acceptable. For glass prescription, the full atropine value is probably unphysiologic and will often prove stronger than corresponding to best relaxation when back to normal, without eye drops. Repeated cyclopentolate eye drops eventually became a kind of standard given 30–40 min before retinoscopy, preferably followed by subsequent subjective testing. In doubtful cases, a follow-up examination in the natural state might be needed, in particular where spectacle correction seemed relevant.

Iris color also deserves mention. The short-acting cycloplegics seem effective especially in populations where grey and blue iris color predominate. The cycloplegic effect is reduced when eyes are dark and heavily pigmented; compare for instance the Teheran eye study, where even presbyopic hyperopes demonstrate significant residual accommodation [4].

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A third demand was to examine under as free conditions as possible. Visual testing should be in free space, not in elaborate set-ups with machines in front of the eyes. My professor then even regarded the mere setting of a trial frame on the bridge of the nose as possibly triggering some accommodation effort. If so, for the study in its early phase hopefully this would be solved by the cycloplegics actually given.

All considered, eye lesions were the exception in my above-mentioned historical thesis study group of 10 year olds (n=539), and the children generally cooperated satisfactorily when subjectively tested in the clinic [1]. The critical point was ultrasound oculometry, which for obvious reasons was last on the examining program. To the immediate dislike of many 10-year-olds, a contact glass had to be applied under local anesthesia. Under mild mental guidance, however, including support from one of the parents holding hands, most participants could manage. The axial measurements of eye components eventually allowed characterization of the specific features of myopia of prematurity. A size deficit was further documented when comparing the predominantly quite healthy premature as a group to the full terms. Emmetropia of prematures thus presented a significantly shorter axial length and a more curved cornea, although with a broad overlap [1,5].

The Present Study on Surviving Prematures at Age 4 Years

In a recent article in *Eye*, we discussed the value of the handheld Retinomax refractometer for screening purposes based on a

study of pre-school children [6]. Extremely premature children (with a gestational age at delivery <28 weeks; n=178) were compared with 56 matched full-term controls with regard to general development and to functional ability of eye and brain [7,8]. All children were examined just having reached the age of 4 years. This early age implied that, for most participants, subjective testing for refraction could not be trusted, and stationary refractometers would be rejected by many. Best choice thus was the handheld Retinomax, with recordings before cyclopentolate 1% as well as after administration of the eye drops. Some participants already had glasses, and glasses were also tested in cases where significant ametropia was suggested. Generally, however, the cycloplegic Retinomax value was accepted as the refractive value of the individual.

The interested reader should consult the original papers, where detection of amblyopia also was an issue [6]. For the present commentary, emphasis is restricted to the possible usefulness of the initial non-cycloplegic instrumental readings. We thus looked for systematic myopia-directed deviations compared with the final refraction values. In particular, we addressed the practical question whether certain cut off values before eye drops might be indicative. Obviously this would be useful when screening childhood populations without access to eye drops, to separate those in need of a pediatric ophthalmic evaluation from the normal population.

Subtracting the final individual refractive recording from the initial value expressed the instrument-induced myopization in the sample. Values actually ranged from 0 to 6.9 dioptres, but showed no significant relation to degree and sign of ametropia or to amblyopia. The average instrument-related myopization was 1.9 D. Our results did not support un-medicated shortcuts in study design when dealing with early childhood screening for ophthalmic deviations that would require medical attention.

Our conclusion, in short: Retinomax evaluation of refractive value seemed useful, and probably also reliable, when performed under cycloplegia. In contrast, without cycloplegics, even significant ametropia may escape detection.

Discussion

Reliable subjective visual and refractive testing demands experience and skills on behalf of the examiner, and also presupposes cooperation of the child (time taken; discomfort; accept vs. rejection). For cohort examinations at pre-school level, age alone may prove prohibitive, and modern refractometers are obvious alternatives. When examining handicap groups, more drop-outs are to be expected for subjective testing as well as for refractometer approaches.

Among the automated refractometers, the handheld Retinomax seems to be the most flexible, and it has gained high popularity in

pediatric ophthalmology clinics. It is a small device and thus less disturbing for the child, and possibly also reduces the amount of instrument-induced myopia. This however is unpredictable and only cycloplegics can provide the answer.

Some equipment has visual tests as a built-in option. This represents an even more unnatural situation when compared with free space visual testing. In our study of 4-year-olds, there was high compliance using a logMar chart for children at 3 m distance, in free space. In a quiet setting, our experience is that this approach can be carried out in most such children. It also gives more information about the overall function than when relying on a machine situation. In an investigation of myopic Danish school children aged 10-12 years, a mean difference of 0.17 D was reported between cycloplegic refractometer and subjective recordings, with a mean instrument-induced myopia of 0.36 D [2].

A final comment on the skill of performing retinoscopy. In Danish eye clinics, this ability is markedly on the decline, partly because it is regarded as "altmodisch" by many young colleagues. With access to modern refractometers, do you simply need to master it? Admittedly, among the modern equipments, the Retinomax is particularly suited for examining infants and toddlers. In experienced hands, however, cycloplegic retinoscopy still seems unsurpassed for bedside screening of refraction, and further information is obtained about clearness of refracting media. In particular, this author emphasizes the usefulness when screening for early myopia of prematurity. The reversed movement of light in the pupil immediately signals myopic refraction. It is not necessary to disturb with interposed glasses during the procedure, and the free hand can be used to gently hold the lids. The distance to the eye for neutralization of the movement of the fundal light reflex can even immediately be converted to a diopter value.

Conclusion

With regard to best handling of refractive studies in childhood cohorts, changes in norms over half a century are discussed. Modern refractometers have gained a foothold, and for many colleagues, the classic Duke-Elder recommendations seem outdated [3]. Whenever feasible, however, subjective confirmation of best glasses has remained best final proof. Retinoscopy may be a further useful procedure, and obviously it is best choice where refractometers are rejected. The handheld Retinomax autorefractometer has been used for preschool ophthalmic screening purposes in several studies, including non-cycloplegic settings. Instrument-induced myopization however makes cycloplegia mandatory for best approximation regarding refraction, and with consequences also for discovering amblyopia.

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