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SCIENTIFIC LETTERS

Definition of refractive errors for research studies: Spherical equivalent could not be enough

Currently many areas of the world are facing an epidemic of myopia.[1,2] The standardization of terminology, recently undertaken by the International Myopia Institute (IMI) members on defining and classifying myopia experts is not only positive, but necessary.[2] In addition, a simple but fundamental principle is that it should be clear not only what is defined as myopia, but the different refractive states of the eye, including emmetropia, hyperopia and astigmatisms.

However, the proposal made by IMI experts might not be the most suitable option, simply because it was based on a measurement that does not adequately describe the refractive error of a given eye: the spherical equivalent.[3] It is known that the presentation of the refractive state data of a group of eyes based solely on the spherical equivalent loses specificity and sensitivity of the refractive error calculation, because it lacks all the information on the astigmatic component of the optical system.[3] Two eyes with very different refractive errors may have the same spherical equivalent, and also eyes with negative spherical equivalent may have a hyperopic principal meridian (as in the case of many mixed astigmatisms), which makes it wrong to classify them as m̈yopicëyes.

Some multicomponent definitions to classify the refractive state of a given eye (analyzed using the negative cylinder notation) were coined by us.[4,5] The specific components of these definitions and the rationale for using them are explained below:

Emmetropia: An eye is emmetropic if it has a spherical equivalent of less than 0.50 Diopters in absolute value (that is, regardless of whether the blur is myopic or hyperopic). Additionally, it must have a maximum magnitude of astigmatism of 0.75 D. In this way, clinically significant mixed astigmatisms are excluded, which could have a spherical equivalent within the range ± 0.50 D (for example +2.00 −4.00 × 180).

Myopia: Both spherical myopic errors, and simple or compound myopic astigmatisms (except the very low ones included in the emmetropia group) are encompassed here. The value of the spherical equivalent must be −0.50 D or more negative, but additionally the value of the sphere (using the negative cylinder notation, as previously indicated) must be zero or less. In this way, high mixed astigmatisms that may have a negative spherical equivalent (for example +1.00 −5.00 × 180) are excluded. It seems appropriate that because the eyes with mixed astigmatisms have a hyperopic principal meridian, they are not considered within the myopia group.

Hyperopia: Both spherical hyperopic refractive errors, and simple or compound hyperopic astigmatisms are encompassed here (except the very low ones included in the emmetropia group). The value of the spherical equivalent must be +0.50 D or more positive, but additionally the absolute value of the cylinder must be less than or equal to the absolute value of the sphere. In this way, mixed astigmatisms that have a spherical equivalent of +0.50 D or more positive are excluded (for example +4.00 −5.00 × 180). It seems appropriate that because the eyes with mixed astigmatisms have a myopic principal meridian, they are not considered within the hyperopia group.

Mixed Astigmatism: All those eyes presenting the steepest principal meridian with myopic defocus and the orthogonal (flattest) principal meridian with hyperopic defocus, are encompassed here (except those with very low astigmatism that are included in the emmetropia group). Using the negative cylinder notation, the value of the sphere must be greater than zero (in order to exclude myopic astigmatisms) and the absolute value of the cylinder must be greater than the absolute value of the sphere (to thus exclude hyperopic astigmatisms), and, as indicated, the value of the negative cylinder must be −1.00 D or more negative.

On another note, there is the issue of defining the refractive error of an individual, whose two eyes can have any combination of refractive states. In our epidemiological studies to consider an individual as emmetropic, he/she should have emmetropia, according to the previous definition, in both eyes. If he/she presented ametropia in one eye, and emmetropia in the fellow eye, the individual was classified according to that refractive error. If a different type of refractive error was present in each eye, the individual was classified in the anisometropia group.[4,5]

An Excel spreadsheet that can be downloaded is attached as supplementary material, in which by entering the sphere and the cylinder, the classification of the ametropias according to what has been explained above is obtained both for eyes and for individuals. This calculator, designed by two of us (VG and AT), is for free use by researchers, providing that the user(s) cite this publication. These concepts are

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proposed to be applied in epidemiological studies, and not for the analysis of refractive surgery results.

These proposals undoubtedly lend themselves to academic discussion, but could offer important advantages in the characterization of refractive errors in epidemiological studies.

Conflicts of interest

The authors have no conflicts of interest to declare.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.optom.2020.10.003.

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