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Pathopia: A novel nomenclature for induced refractive errors

Emmanuel O. Megbelayin

Department of Ophthalmology, University of Uyo, Uyo, Nigeria

Abstract

Refractive error or ametropia is a distinct eye condition that relates to ocular optics. Refractive error is not a pathologic state, but rather a condition inherent in ocular physiology as a result of operating as a biological camera. Subsequently, any refractive error resulting from an ocular pathologic state could be termed induced refractive error. This article sets out to enrich existing lexicon on ocular optics by coining pathopia as the appropriate word to qualify induced refractive error. Literature on this subject was reviewed and observation made that there has not been a unique taxonomic grouping for ocular anomalies presenting as overt refractive errors. The result showed that ocular morbidity concealed by a refractive error poses a significant challenge to early intervention and is likely to lead to poor visual outcome. It is concluded that pathopia or induced refractive error is a secondary refractive error due to distortions or abnormalities in cornea, lens, or retino-choroidal-scleral (RCS) complex resulting in increment or decrement in axial length or eye's cumulative dioptric power.

Keywords: pathopia, ametropia, refractive errors.

Introduction

Refractive error or ametropia is a distinct eye condition that relates to ocular optics, vis-a-vis, the nature of incident light on the cornea, the dioptric response of cornea-lens complex and the extent of axial length[1-4]. In most instances, ametropia is not a pathologic state, but rather a condition inherent in ocular physiology as a result of operating as a biological camera. If every eye possesses a universal axial length of 24mm and dioptric power (summation of cornea and crystalline lens power) of 60.0 diopters, there would not be ametropia. Emmetropization fails to achieve emmetropia in instances linked with genetics[5,6], use-abuse theory[7], biological-statistical theory[8], socio-economic theory[9], environment[10], prematurity[11], nutritional status[12], near work[13,14], parents' level of education and intelligence[15,16]. It could be inferred that refractive error is a "primary" (being without any cause) ocular optical condition while any refractive error that results from an ocular pathologic state could be termed "secondary" or induced refractive error. In this article, this author coined ''pathopia'' to qualify induced or secondary refractive errors.

In summary, pathopia is a secondary or induced refractive error due to abnormalities in cornea, lens, or retino-choroidal-scleral complex (RCS) resulting in increment or decrement in axial length or eye's cumulative dioptric power.

Corresponding Author:

Emmanuel O. Megbelayin
Department of Ophthalmology, University of Uyo, Uyo, Nigeria.

favouredolu@yahoo.com

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Classification of pathopia (table 1)

i) Pathopic hypermetropia
ii) Pathopic myopia
iii) Pathopic astigmatism
iv) Functional pathopia or Presbyopia

Pathopic hypermetropia

The average adult ocular length is 24mm[17]. Induced or pathopic hypermetropia ensues if any ocular pathology results in shortened axial length (that is axial length becomes less than 24mm), for instance a sub-foveal pigment epithelial detachment or sub-foveal cystoid macular edema. It can also follow any ocular anomaly that results in reduced dioptric power with or without normal axial length, as it is the case with iatrogenic or traumatic aphakia, cornea plana. See tables 1 and 2 below for more examples and pathomechanisms.

Pathopic myopia

If any ocular pathology results in lengthened axial length, that is axial length more than 24mm. Sub-foveal staphyloma results in axial length greater than 24mm and hence results in pathopic myopia. If there is increased dioptric power, as seen in keratoconus, lenticonus, extra plus intraocular lens (IOL) from wrong biometry[18], induced or pathopic myopia ensues. See tables below for more examples and pathomechanisms.

Pathopic astigmatism

If any ocular pathology results in meridional alteration on the cornea or crystalline lens, axial length could either increase or decrease in a given meridian. If axial length decreases in a given meridian, a pathopic hypermetropic astigmatism results[19]. If axial length increases in a given meridian, a pathopic myopic astigmatism ensues. These scenarios could be seen pre- or post-operative pterygium excision, wrong suturing technique, either over tight or loose suturing. See tables 1 and 2 below for more examples and pathomechanisms.

Functional pathopia or presbyopia

Presbyopia is not considered a refractive error because it is due to a failed or failing accommodation as a result of aging processes resulting in recession of near point. Whereas, a refractive error is said to be present if parallel rays of light fail to converge on the fovea with accommodation relaxed[20]. Therefore, presbyopia may best be described as a functional pathopia since inadequacies in ocular functional elements such as ciliary body, ciliary zonules and anterior lens capsule culminate in failure of accommodation with age.

Table 1: Categorization of Pathopia Based on Aetiology

Pathopic myopia	Pathopic hyperopia	Pathopic astigmatism
• Orbital cellulitis • Scleritis • Choroiditis • Iritis • Lens: nuclear sclerosis, ageing, incipient cataract, dislocation forward. • Glaucoma • Retinal detachment • Drugs: arsenicals, sulfonamide, acetylzolamide, thiazide • Systemic diseases: malaria, jaundice, influenza, obesity, goiter, tuberculosis	• Atropinization • Neurological disorders affecting ciliary muscles • Trauma • Orbital tumours • Lens: hypoglycaemia, dislocation backward, aphakia	• Lid tumours or mass • Corneal ulcers • Poor corneal suturing • Stromal keratitis • Keratoconus • Lens tilt (trauma) • Buckling procedures for retinal detachment • Squint surgeries (tenotomy).

Table 2: Pathopia and Its Mechanisms

Structures	Anomalies	Mechanism of pathopia	Pathopic errors
Eye lid	Lid swelling: Chalazion, haemagiomas, tylosis	*Mechanical ptosis induced by a heavy lid leading to meridional sphero-cylindrical errors*	Astigmatism
Bulbar Conjunctiva	Pterygia, dermoid cyst, squamous cell carcinoma	*Conjunctival lesions encroach on cornea causing meridional distortion*	Astigmatism
Tarsal Conjunctiva	Giant papillae: exposed sutures, atopy	*Mechanical effects on cornea causing spherocylindrical errors*	Astigmatism/ myopia
Cornea	Keratoconus	*from conical corneal distortion*	Myopia/ astigmatism
Cornea	Ulcer	*Scarring*	Irregular astigmatism
Orbit	Intraorbital tumors	*Ocular compression*	Astigmatism/ hypermetropia
Lens	Hyperglycaemia	*Increased refractive index of the lens*	Myopia
Lens	Hypoglycaemia	*Decreased refractive index of the lens*	Hypermetropia
Lens	Subluxated	*Lens tilt causing meridional error*	Astigmatism
Lens	Aphakia	*Depletion of lenticular dioptric contribution*	Hypermetropia
Retina	Posterior staphyloma	Elongated axial length	Myopia
Retina	Macular edema, sub-foveal pigment epithelial detachment	*Decrease in effective axial length from macular bulging into the vitreous*	Hypermetropia
SYSTEMIC			
Jaundice, Influenza, Drugs (acetylzolamide, Thiazide, Sulfonamide)			Cause transient myopia

Discussion

From the above discussion, it could be deduced that not all patients with overt refractive errors have only refractive errors as some do actually have

background pathologies (pathopia). It should be borne in mind that secondary or induced refractive errors herein called pathopias, also do have some form of improvement with spectacle correction, howbeit unsatisfactorily. The age-long rule of thumb in differentiating primary refractive errors from ocular pathologies with a pin hole ensures ocular pathologies could be separated from refractive errors. If a pin hole visual acuity improves in pathopias, it would be minimal. Therefore, Refractive errors that cannot be corrected to 6/6 or 20/20 should arouse suspicion of possible pathopia.

In most instances, primary ametropia stabilizes at puberty or shortly after. Hence, a sudden onset of new or deteriorated refraction should prompt suspicion of a new onset of ocular pathology. Diabetes mellitus is a common metabolic disorder that may present first to the ophthalmologist as pathopia[21-23]. Because glycaemia state affects refraction, normoglycaemia is advised before dispensing refractive lens for diabetics.

Eye examination begins after a thorough history to rule out previous use of glasses, eye surgery, trauma, and systemic review based on the suspected ocular condition. After determining visual acuity (unaided, with pinhole and then with correction, if available,) a pen torch and slit lamp examination follow. Ocular adnexa is examined for masses, like chalazion exerting weight on the cornea thereby causing corneal distortion and meridional pathopia. Munson's sign may be done if keratoconus is suspected. Eyes might need to be dilated for direct and indirect ophthalmoscopy. Investigations like optical coherence tomography, for macular edema and B-scan, for posterior staphyloma could be necessary. When the cause of pathopia is , known treatment is initiated.

In conclusion, lying deep in some overt refractive cases are ocular pathologies. The clinician should have high index of suspicion when a hitherto emmetropic patient suddenly becomes ametropic. This scenario most times heralds an underlying new or worsening ocular pathology. Patients with unsatisfactory subjective refraction should have dilated fundoscopy for proper eye examination.

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