بسم الله الرحمن الرحيم

﴿ قالوا سبحانك لا علم لنا إلا ما علمتنا إنك أنت العليم الحكيم ﴾

صدق الله العظيم

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Contents

List of Figures

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Recent corneal approaches in treatment of Presbyopia

Essay

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Introduction

Accommodation is a dioptric change in the power of the eye to see clearly at near. ***(Glasser, 2008).*** Although the amplitude of accommodation decreases steadily from later childhood, the speed and accuracy of the system within the available amplitude are little impaired until the age of about 40, when the amplitude falls below that needed for normal near work. ***(Charman, 2008).*** It is essential to differentiate between accommodative and pseudoccommodative effects, as both may have a positive impact on near visual acuity and reading performance ***(Klaproth, et al. 2011).***

Presbyopia, the gradual age-related loss of accommodation, occurs primarily through a gradual age-related stiffening of the lens. ***(Glasser, 2008).*** All people will be presbyopic by age 50. ***(Truscott, 2009).***

Because the cornea supplies the majority refractive power of the eye, corneal modifications can provide a powerful refractive effect, and modern surgical techniques allow surgeons to modify the cornea with extremely high degrees of precision. As a result, corneal surgery can often achieve more predictable refractive outcomes than IOL implantation, since IOL power calculations and lens positioning cannot be controlled to the same degree as corneal parameters, especially astigmatism. ***(Holladay, 2009).***

Presbyopia correction remains a great challenge in cataract and refractive surgery ***(Lichtinger and Rootman, 2012).*** A variety of different kinds of surgical procedures has been considered for restoring accommodation to the presbyopic eye ***(Glasser A, 2008).***

While symptomatic presbyopia has traditionally been treated with reading glasses or contact lenses, a number of surgical interventions and devices are being actively developed in an attempt to restore at least some level of accommodation ***(Strenk, et al. 2005).***

In addition to providing more predictable results, intracorneal procedures also eliminate some of the surgical risks associated with performing intraocular procedures. Intracorneal procedures entirely avoid complications such as posterior capsule opacification, and other risks are significantly reduced. For example, the risk of infection cannot be entirely eliminated, but corneal infections are typically less serious than endophthalmitis. ***(Holladay, 2009).*** Cornea laser surgeries are minimal invasive methods, but they provoke irreversible changes at cornea anatomy, whereas scleral surgery and clear lens extraction are more invasive techniques. The necessity to develop a minimal invasive, reversible, stable and safe surgical technique with an easy learning curve for patients between 45 and 60 years**. *(Pallikaris, 2011)***

PresbyLASIK is a new presbyopia-correcting surgery now undergoing clinical trials. This innovative procedure uses an excimer laser to create a multifocal ablation directly on the eye's clear front surface (cornea). This enables vision at multiple distances. ***(Kim, 2011)***

Presby Lasik is quite similar to a standard Lasik eye correction procedure, but of course there are a few slight differences. The surgery is also known as 'multifocal Lasik' because the overall object of the operation is the same as that of artificial multifocal lenses. ***(Tamayo, et al. 2009)***

An excimer laser reshapes the cornea into different zones for far-, near- and intermediate vision. Your brain then selects which zone it needs to see through to get the sharpest vision, depending on whether an object is near or far away. In each zone, allowing people with presbyopia to regain good vision at all distances – similar to how multifocal contact lenses correct presbyopia. Multifocal contact lenses (that rest on the surface of the eye) has the potential to move and cause visual distortions. Presby-Lasik on the other hand provides fixed, stationary zones directly on the eye's surface. ***(Tamayo, et al. 2009)***

A new approach based on the use of intracorneal inlays placed inside the stroma of the cornea is the intracorneal inlays. The concept of intracorneal inlays for the correction of presbyopia takes origins in 1964, when Barraquer6 developed keratophakia, a lamellar refractive procedure in which an alloplastic lenticule was placed at the interface of the free corneal cap and the stromal bed ***(Pallikaris, 2011)*** The intracorneal refractive inlay (Invue Lens) seems to be an effective surgical method for the corneal compensation of presbyopia in emmetropes aged between 45 and 60 years ***(Bouzoukis, et al. 2012).***

Simultaneous intracorneal inlay implantation and LASIK to treat presbyopia with emmetropia, hyperopia, or myopia was clinically safe and effective, yielding improvement in distance and near visual acuity. Patients were satisfied with decreased dependence on reading glasses . However, postoperative symptoms, such as dry eyes, halo, glare, or night-vision disturbances, occurred occasionally**. *(Tomita, et al. 2012)***

Aim of the work

The aim of this essay is to highlight recent corneal approaches in treatment of presbyopia.

Presbyopia and accommodation

Presbyopia is the reduction in the range of acccommodation and accommodative power, which occur with aging. It implies recession of the near point, while the far point is unaffected, so understanding accommodation is essential to understand presbyopia.

Accommodation refers to the process whereby changes in the diopteric power of the crystalline lens occur so that an in focus retinal image of a near object of regard is obtained and maintained at the high-resolution fovea ***(Ciuffreda, 1998).*** A variety of ideas have been proposed regarding how we see clearly at different distances. Some of them are as follows:

- Pupil size changes with the effort to see clearly at near. However, the depth of focus (approximately 1.00D total)for the smallest normal physiological pupil diameter (approximately 2.0-mm) in pre-presbyopiea can account for only a small portion of their accommodative amplitude.
- The anteroposterior position of the lens changes with variation in focal point. This could not be equal to the 15.00 D or so amplitude found in young children.
- Changes in the shape, and therefore power, of the crystalline lens allow objects at various distance to be focused on the retina. This is clearly the correct mechanism of the human accommodative process ***(Ciuffreda, 1998).***

  In 1856. In his monumental book of physiological optics, Helmholtz generated the most widely accepted theory of physical mechanism of accommodation **(Fig. 4).** Helmholtz stated that the ciliary muscle is relaxed when the eye is focused for distance. The relaxed ciliary muscle maintains the zonule under tension to flatten the crystalline lens for clear distance viewing. When the eye focuses on a near object, the ciliary muscle contracts and releases tension on the zonules. The release of zonular tension allows the crystalline lens to become more curved due to elastic forces in the lens. **Fincham in 1937** added additional experimental support to the accommodative theory of Helmholtz and also offered evidence that presbyopia was caused by the inability of the lens capsule to mould the hardened lens substance into the accommodative form. **Fisher in 1971 and Pau and Kranz in 1991** supported Fincham theory of presbyopia by showing that the lens hardens with age. In addition, Fisher found that Young's modulus of elasticity of the lens capsule decreases by half between youth and 60 years of age. This finding also supports Fincham theory of prsebyopia because a less elastic lens capsule would exerts less force on the hardening substance of the aging lens.

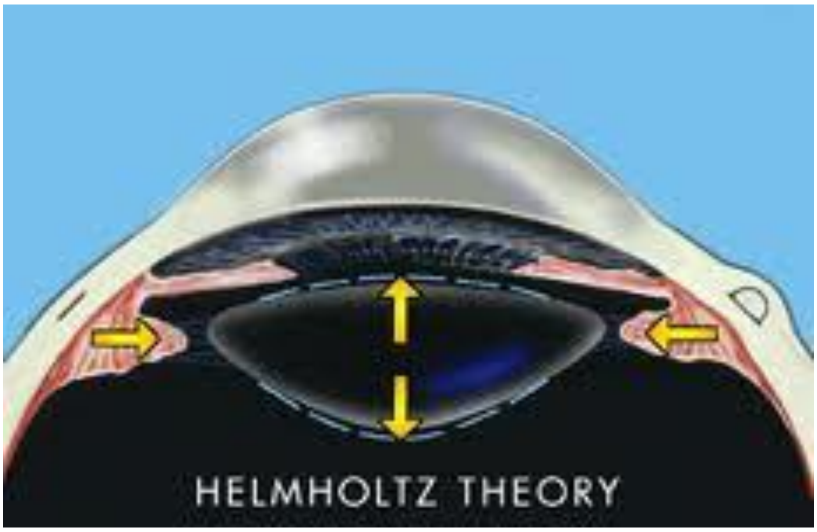

Fig.1: Helmholtz theory of accommodation ***(Ellis, 2000).***

The action of all parts of the ciliary muscle is to slacken the suspensory ligaments of the lens. This results in decreased tension on the capsule of the lens, which therefore becomes more convex. The circular fibers act directly as a sphincter diminishing the circumference of the ring formed by the ciliary body. This probably also applies to the radial portions of the muscle. The posterior attachments of the ciliary muscle, consisting largely of delicate elastic tissue. Seem to be admirably adapted to allow the posterior ends of the muscle to pass forward during contraction and to guide them back to their original positions on relaxation. All fibers of the muscle will thicken during contraction. The effect of this will be to increase the cross sectional diameter of the whole muscle so that the inner border of the muscle moves inward towards the outer edge of the lens. Thus the whole muscle will be in effect acts as a sphincter to the ciliary ring. In this connection it should be noted that the ciliary muscle is thickest approximately opposite the equator of the lens. It will therefore bulge mostly just where one would expect it to have the greatest effect on the zonular fibers. The lens acquires a parabolic shape during accommodation ***(Pau and Kranz, 1991).***

In **1992 Schacher** proposed a new theory for the mechanism of accommodation which states that the crystalline lens is under tension during accommodation. The anterior radial muscle fibers of the ciliary muscle arch towards the sclera during accommodation, increasing the tension on the equatorial zonules, while the posterior longitudinal and posterior radial muscular fibers move anteriorly, producing relaxation of the anterior and posterior zonules. The increased tension on the equator of the crystalline lens produces central steeping with peripheral flattening **(Fig. 2).** This