RECENT LINES IN THE MANAGEMENT OF PRESBYOPIA

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CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ASCRS	**:**	American Society of Cataract and Refractive Surgery
CK	**:**	Conductive Keratoplasty
D	**:**	Diopter
FDA	**:**	Food and Drug Administration
HPRK	**:**	Hyperopic Photo-refractive Keratotomy
IOL	**:**	Intra Ocular Lens
IOP	**:**	Intra Ocular Pressure
LASIK	**:**	Laser assisted in situ keratomileusis
LRI	**:**	Limbal Relaxing Incision
LTK	**:**	Laser Thermal Keratoplasty
MIP26	**:**	Major Interinsic Protein 26
MRSE	**:**	Mean Refractive Spherical Equivalent
PACT	**:**	Pressure and Accommodation Restoration by Cilliary Translocation
PML	**:**	Peipheral Multi-focal LASIK
PRK	**:**	Photo Refractive Keratotomy
RK	**:**	Radial Keratotomy
SEB	**:**	Scleral Expansion Bands
UCVA	**:**	Uncorrected Visual Acuity

INTRODUCTION

Everybody who lives beyond 45 years is bound to experience presbyopia. In some cases, the effects of presbyopia begin even sooner. There has been a push to discover technologies that cure presbyopia rather than mask its effects. Until 10 years ago, people tended to accept presbyopia as a part of life and were content wearing spectacles to treat the accommodative error. With the advent of laser in situ keratomileusis LASIK, and then premium refractive IOLs, however, patients with presbyopia started to demand more correction.

A range of options for presbyopia correction is available:

A lens based solution will be the most appropriate solution for the majority of patients. It includes: Blended reading vision with monofocal IOLs, Accommodating IOLs and Pseudoaccommodating or multifocal IOLs

Other, less invasive techniques are becoming available that seek to improve uncorrected near vision by altering the eye's refractive power at the cornea. It includes: excimer laser refractive ablation, corneal inlay devices, and conductive keratoplasty.

Accommodative Scleral procedures consist of scleral incisions (anterior ciliary sclerotomy) and scleral expansion bands

Recently, a laser procedure called pressure and accommodation restoration by ciliary translocation (PACT) has shown promise as a noninvasive, laser-based intervention that restores accommodation.

AIM OF THE WORK

To review and discuss the recent lines in the management of presbyopia, highlighting the differences between the different approaches including advantages and disadvantages.

ANATOMY OF THE LENS

The adult human lens is an asymmetric oblate spheroid that does not possess nerves, blood vessels, or connective tissue.(1) The lens is located behind the iris and pupil in the anterior compartment of the eye. The anterior surface is in contact with the aqueous on the corneal side; the posterior surface is in contact with the vitreous. The anterior pole of the lens and the front of the cornea are separated by approximately 3.5mm.(2)

The lens is held in place by the zonular fibers (suspensory ligaments), which run between the lens and the ciliary body. These zonular fibers, which originate from the region of the ciliary epithelium, are a series of fibrillin-rich fibers that converge in a circular zone on the lens. Both an anterior and a posterior sheet meet the capsule 1–2mm from the equator and are embedded into the outer part of the capsule (1–2μm deep). It also is thought that a series of fibers meets the capsule at the equator. (3)

Histologically the lens consists of three major components:
Capsule, epithelium, and lens substance (Fig. 1).

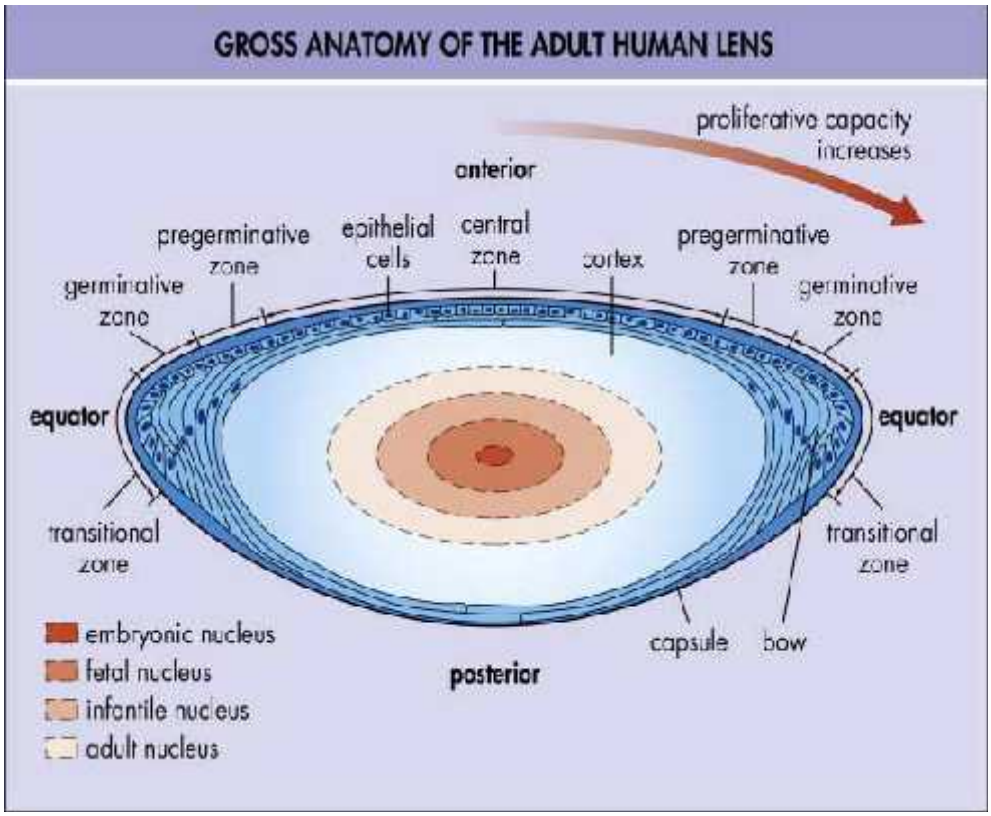

Fig. (1): Gross anatomy of the adult human lens.

The Capsule:

The lens is ensheathed by an elastic acellular envelope, which serves to contain the epithelial cells and fibers as a structural unit and allows the passage of small molecules both into and out of the lens. The thickness of the capsule depends upon the region of the capsule being measured (Fig. 2) and, except for the posterior capsule, increases with the age of the individual.[(4)]

The lens capsule is composed of a number of lamellae stacked on top of each other. The lamellae are narrowest near the outside of the capsule and widest near the cell mass.[(5)] Major structural proteins and a small amount of fibronectin are found

within the lamellae.[6] This structure is continuously synthesized and represents one of the thickest basement membranes in the body. The capsule is produced anteriorly by the lens epithelium and posteriorly by the elongating fiber cells.

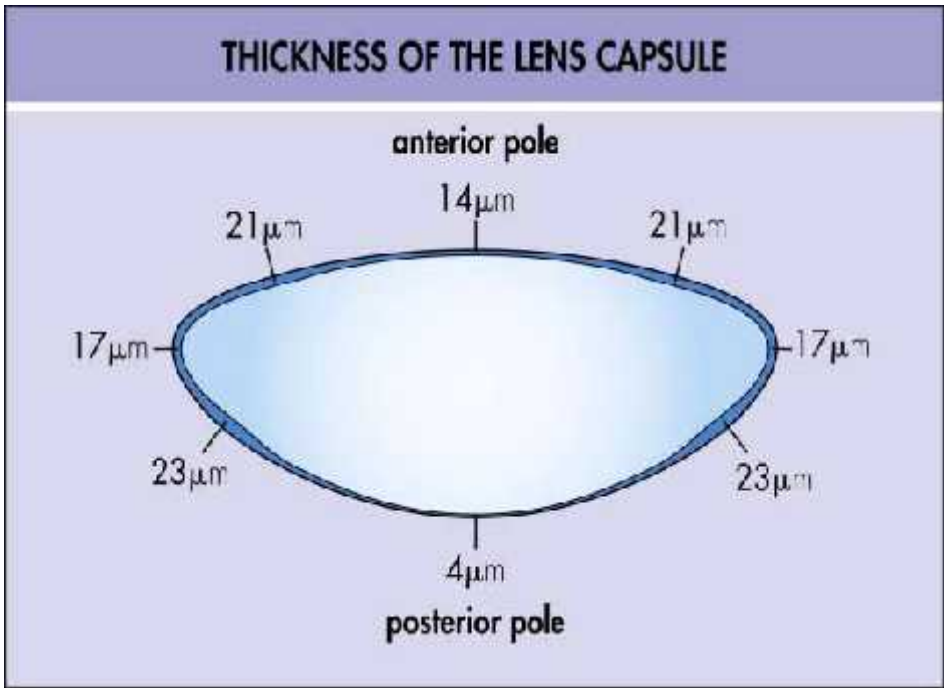

Fig. (2): Thickness of lens capsule.

Epithelial Cells:

The lens epithelium arises as a single layer of cells beneath the anterior capsule and extends to the equatorial lens bow. These cells have a cuboidal shape, being approximately 10μm high and 15μm wide. Their basal surface adheres to the capsule, whereas their anterior surface abuts the newly formed elongating lens fibers. Lens epithelial cells have large, indented nuclei and a normal array of organelles. They also contain dense bodies and glycogen particles. The lateral membranes of epithelial cells (membranes in contact with the adjacent epithelial cells) are

highly tortuous and attachment to adjacent cells occurs by adhesion complexes located in the lateral membranes that include both desmosomes and tight junctions.(7)

Lens epithelial cells contain the three main groups of cytoskeletal elements, which are microfilaments (actin), intermediate filaments (vimentin), and microtubules (tubulin). These cytoskeletal elements form a network that provides structural support, controls cell shape and volume ensures intracellular compartmentalization and movement of organelles, enables cell movement, distributes mechanical stress, and mediates chromosome movement during cell division.(8)

Epithelial cell density is greatest in the central zone, a region in which cells normally do not proliferate. Cells in this zone are the largest epithelial cells found in the lens. The proliferative capacity of epithelial cells is greatest at the equator (Fig. 1). Cells in the germinative equatorial zone are dividing constantly; newly formed cells are forced into the transitional zone where they elongate and differentiate to form the fiber mass of the lens. (9)

Lens Substance

The lens substance, which constitutes the main mass of the lens, is composed of densely packed lens cell cytoplasm (fibers) with very little extracellular space. The adult lens substance consists of the nucleus and the cortex, two regions that often are histologically indistinct. (10)

Although the size of these two regions is age dependent, studies of lenses with an average age of 61years indicate that the nucleus accounts for approximately 84% of the diameter and thickness of the lens and the cortex for the remaining 16%.[10]

The nucleus is further subdivided into embryonic, fetal, infantile, and adult nuclei (Fig. 1). The embryonic nucleus contains the original primary lens fiber cells that are formed in the lens vesicle. The rest of the nuclei are composed of secondary fibers, which are added concentrically at the different stages of growth by encircling the previously formed nucleus. The cortex, which is located peripherally, is composed of all the secondary fibers continuously formed after sexual maturation. The region between the hardened embryonic and fetal nuclear core and the soft cortex (i.e., the fibers added to form the infantile and adult nuclei) sometimes is referred to as the epinucleus.[4]

Fibers are formed constantly throughout life by the elongation of lens epithelial cells at the equator. Initially, transitional columnar cells are formed but, once long enough, the anterior end moves forward beneath the anterior epithelial cell layer and the posterior end is pushed backward along the posterior capsule. The ends of this U-shaped fiber run toward the poles of both capsular surfaces.[4]

Once fully matured, the fiber detaches from the anterior epithelium and the posterior capsule. Each new layer of secondary fibers formed at the periphery of the lens constitutes a new growth shell.