Posterior Capsular Opacification Following Anterior Capsule Polishing: A Quantitative Analysis Using Open Access Systematic Capsule Assessment (OSCA)

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Abstract

Today, cataract surgery has become a technically advanced and very standardized procedure. Posterior capsule opacification is the most common post-operative problem, which results in a decrease of the visual acuity. In our study, we have evaluated the effect of anterior capsule polishing on the development of PCO.

In this study, a comparison was made between two groups. In group one polishing of the anterior capsule using Koch aspiration cannula (Geuder) was done. In group two, phacoemulsification was completed without polishing of the anterior capsule. The two groups were compared in terms of V.A, IOP and severity of PCO which was assessed both clinically and objectively using Open Access Systematic Capsule Assessment (OSCA) program.

This study proved that polishing of the anterior capsule is effective in decreasing the severity rather than prevention of PCO. This was evidenced by the fact that average (OSCA) score in group 1 following first month is 1.0012 versus 1.6949 in group 2 (P value = 0.0006). Following 6 months values were 1.29781 & 1.8169 respectively (P value = 0.1574), denoting statistically significant difference between OSCA values after first month that turned to be statistically non-significant after six months period.

Key Words:

Anatomy Pathology, Pathogenesis, PCO analysis systems, Imaging systems of PCO, Analysis of digital PCO image, Prevention of PCO, Lazer treatment

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List of Abbreviations

AQUA : Automated Quantification of After-cataract.

BCVA : Best Corrected Visual Acuity.

BU : Brightness Unit.

EAS : Anterior Eye Segment Analysis System.

EPCO : Evaluation Of Posterior Capsule Opacification.

FGF : Fibroblast Growth Factor.

HGF : Hepatocyte Growth Factor.

IOL : Intraocular Lens.

LECs : Lens Epithelial Cells.

OCT : Optical Coherence Tomography.

OU : Opacity Unit.

OSCA : Open-Access Systematic Capsule Assessment

PCO : Posterior Capsular Opacification.

PCT : Posterior Capsular Thickness.

PMMA : Polymethylmethacrylate.

POCO : Posterior Capsule Opacification software.

POCOman: manual POCO.

PXF :Pseudoexfoliation Syndrome.

ROI : Region of Interest.

RP : Retinitis Pigmentosa.

SD : Standard Deviation.

TGF : Transforming Growth Factor.

VA : Visual Acuity.

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Introduction

Cataract extraction is the most common ophthalmic surgical procedure. Posterior capsule opacification is the most common problem post-op, which results in a decrease of the visual acuity, preferably treated by Nd:YAG laser posterior capsulotomy. Although this is a routine procedure, it would be very beneficial for every patient if the posterior capsular bag was not opened by capsulotomy, as this procedure destroys the natural barrier between anterior and posterior segments. The majority of attempts with lens designs and materials for accommodative lenses rely on intact capsular bag ***(Wolfram, 2010).***

Therefore, the intraoperative removal of the LECs from the anterior lens capsule is becoming increasingly important in cataract surgery to minimize the chances of occurrence of PCO. Several approaches have been devised, such as scratcher, vacuum cleaning, cryo coagulation, wet field coagulation, ultrasound techniques, and chemical application ***(Shah et al, 2009***).

Accurate PCO analysis is important for measuring the effect of treatments that aim to reduce PCO such as intraoperative pharmaceutical treatments or varying types of surgical techniques. It is also an important tool for comparing rates of PCO between the many available lenses ***(Dhillon et al, 2002)***.

Systems used vary from those using simple slit lamp analysis observation and subjective grading by the observer , to much more complex computerized analysis of digital images obtained with specialized photographic equipment ***(Barman et al, 2000***). Clinical studies to investigate methods to reduce the incidence and severity of PCO require a technique that can reliably and reproducibly measure PCO ***(Bender et al, 2004).***

Aim of Work

The aim of this study is to objectively evaluate the use of anterior capsule mechanical polishing, during phacoemlsification, in reducing the development of PCO. A computerized objective system for analysis of PCO images (Open-access Systematic Capsule Assessment System (OSCA)) will be used.

Anatomy of the lens capsule and epithelium

The lens capsule:

The lens capsule is the ensheathing elastic basement membrane that helps to maintain epithelial cells and lens fibers as one unit. The capsule is produced anteriorly by the basal membrane of the epithelial cells while posteriorly it is produced by the basal membrane of elongating fiber cells ***(Forrestre et al, 1996)***.

It begins as a thin structure increasing in thickness until approximately the age of 35 years ***(Olson, 1985).***

The capsule of the lens forms a transparent, homogenous, highly elastic envelope. Normally the capsule is thickest (12-21 microns) anteriorly over the lens epithelial cells. It averages 9 to 17 microns in the equatorial zone, and is thinnest (2 to 9 microns) posteriorly ***(Spencer, 1985).***

The capsule of the lens is made up of two layers; the capsule proper, which represents the main portion of the membrane, and the more superficially located, very delicate and attenuated Zonular lamella (***Duke-Elder, 1963).***

In histologic sections, the capsule is non-cellular and homogenous. It stains positively with periodic acid-schiff (PAS) indicating the presence of sulphated mucopolysaccharide component. It is dissolved in collagenase indicating a collagen component ***(Rafferty, 1985).***

Under electron microscope, the capsule appears to have a relatively amorphous appearance in which the lamellar structure is suggested by coarse scattered filamentous elements. There are up to 40 lamellae, each of which is about 40nm in thickness. The lamellae are formed of fine fibrils as seen under higher resolution ***(Fisher and Hayes, 1979).***

The capsule is basically formed of type IV collagen but also contain type I and III collagens in addition to other extracellular matrix components as laminin, fibronectin, heparin sulphate proteoglycan entactin and vitronectin ***(Dische and Zelmenis, 1965)***.

Epithelial cells:

The lens epithelium arises as a single layer of cells beneath the anterior capsule and extending to the equator of the lens. There is no corresponding posterior layer since the posterior embryonic epithelium is involved in the formation of the primary lens fibers ***(Anthony et al, 1997).***

The basal surface of the epithelial cells adheres to the capsule. The rest of the cell membrane is relatively complex. The lateral margin shows undulations whereas the apical membrane shows interdigitations with the underlying lens fibers. The cells are attached to each others by desmosomes and to the underlying capsule by hemidesmosomes ***(Bron et al, 1997).***

The cells are polygonal (in surface view) cuboidal (in sagittal section), being approximately 10 microns high and 15 microns wide ***(Anthony et al, 1997).***

By electron microscope the epithelial cells show few organelles as rough endoplasmic reticulum, Golgi apparatus, free ribosomes and small mitochondria lying in coarse granular cytoplasm ***(Yeh et al, 1986; Rafferty and Scholz, 1989).***

The central cells are located near the anterior pole. They are polygonal with rounded nuclei that show no mitotic figures except when stimulated mechanically ***(Bron et el, 1997).***

Pathogenesis of posterior capsule opacification

Capular opacification is a misnomer as it is not really an opacification of the lens capsule but an opaque material that lines the capsule rendering it non transparent ***(Pandey et al, 2004).***

Posterior capsule opacification is due to presence of remnants or regenerated lens epithelial cells following cataract surgery that migrate centrally to opacify and reduce visual acuity. Sources that produce visual opacification are: (1) remnant epithelial cells from the equatorial lens bow and (2) dislodged cortical fibres.

The equatorial lens bow become germinal centers that have an inclination to grow along the posterior capsule after surgery to form epithelial pearls on the posterior capsule ***(Legler et al, 1993).***

Cuboidal cells making up the anterior epithelium lining the anterior capsule can transform into fibrocyte-like cells. These cells can proliferate but do not migrate ***(Apple et al, 1992 and Marc Antionio et al, 1999).***