Traitement par vitrectomie (pars plana) de la luxation de fragments cristalliniens après phacoémulsification

Durakovic, Orhideja

How to cite

DURAKOVIC, Orhideja. Traitement par vitrectomie (pars plana) de la luxation de fragments cristalliniens après phacoémulsification. Doctoral Thesis, 2008. doi: 10.13097/archive-ouverte/unige:690

This publication URL: https://archive-ouverte.unige.ch/unige:690
Publication DOI: 10.13097/archive-ouverte/unige:690

UNIVERSITÉ DE GENÈVE **FACULTÉ DE MÉDECINE**

Section de Médicine Clinique

Département des Neurosciences Cliniques et Dermatologie

Service d'Ophtalmologie

Thèse préparée sous la direction du Professeur Dr Constantin J. POURNARAS

TRAITEMENT PAR VITRECTOMIE (*PARS PLANA*) DE LA LUXATION DE FRAGMENTS CRISTALLINIENS APRÈS PHACOÉMULSIFICATION

Thèse

Présentée à la Faculté de Médecine de l'Université de Genève
pour obtenir le grade de Docteur en médecine

Par
ORHIDEJA DURAKOVIC
De
Skopje (Macédoine)

Thèse No 10555

GENÈVE
2008

UNIVERSITÉ
DE GENÈVE

FACULTÉ DE MÉDECINE

DOCTORAT EN MEDECINE

Thèse de :

Madame Orhideja DURAKOVIC
originaire de Skopje (Macédoine)

Intitulée :

TRAITEMENT PAR VITRECTOMIE (*PARS PLANA*) DE LA LUXATION DE FRAGMENTS CRISTALLINIENS APRES PHACOEMULSIFICATION

La Faculté de médecine, sur le préavis de Monsieur Constantin J. POURNARAS, professeur associé au Département des Neurosciences Cliniques et Dermatologie, autorise l'impression *de la présente thèse, sans prétendre par là émettre d'opinion sur les propositions qui y sont* énoncées.

Genève, le 19 septembre 2008

Thèse n° **10555**

Jean-Louis Carpentier
Doyen

N.B. - La thèse doit porter la déclaration précédente et remplir les conditions énumérées dans les "Informations relatives à la présentation des thèses de doctorat à l'Université de Genève".

Tout particulièrement, ma thèse est dédiée

En souvenir du beau sourire de MON TRÈS CHER FRÈRE GOGO, qui aujourd'hui encore me guide

A mes parents, pour leurs amour

A mes enfants et mon époux

REMERCIEMENTS

Je tiens à exprimer ma reconnaissance au *Professeur C.J. POURNARAS,* à qui j'adresse ma profonde gratitude pour l'encouragement, les conseils et le temps précieux qu'il m'a consacrés pour la réalisation de mon travail de thèse.

J'adresse également tous mes remerciements au *Professeur A.B. SAFRAN*, pour qui j'ai la plus haute considération, lequel m'a offert l'opportunité de poursuivre ma formation, en ophtalmologie dans la Clinique d'ophtalmologie de l'Université de Genève durant quatre ans et demie. C'est donc grâce à lui, j'ai eu le privilège particulier de perfectionner mes connaissances lors de mes études.

Un grand merci également au *Professeur A. ROTH* pour m'avoir donné cette opportunité en m'engageant à la Clinique d'ophtalmologie de l'Université de Genève, en 1997.

De même, je tiens à remercier de tout cœur mon cher collègue *Ioannis PETROPOULOS* pour son soutien permanent, ses encouragements et son appui précieux quant aux analyses des résultats.

Je remercie ma collègue *N. DANG-BURGENER* pour sa collaboration.

Enfin, je saisis l'occasion à remercier chaleureusement tout le personnel de l'administration de la Clinique d'ophtalmologie de Genève.

Ce travail a été pour moi un challenge particulier et un renfort de mes connaissances, lors duquel Science et émotions se sont continuellement mêlés.

Sans le soutien de nombreuses personnes, il m'aurait été difficile de le mener à terme. Je tiens donc, par ces quelques mots, à leur témoigner toute ma reconnaissance

RÉSUMÉ

Le but de l'étude est d'évaluer les résultats et le taux de complications de la vitrectomie par la pars plana dans le traitement d'une luxation postérieure de fragments cristalliniens survenue lors de l'opération de la cataracte par phacoémulsification. La vitrectomie est le traitement de choix pour la luxation postérieure de fragments cristalliniens, permettant d'enlever le matériel cristallinien retenu et de restaurer la vision dans un grand nombre de cas.

L'étude a inclus 41 patients ayant subi une vitrectomie suite à une phacoémulsification entre 1997 et 2006 dans notre clinique.

Après un suivi postopératoire variant entre 1 et 48 mois, l'acuité visuelle s'est améliorée chez 56% des patients. L'intervalle entre la phacoémulsification et la vitrectomie n'a pas influencé le résultat final. En revanche, la vitrectomie effectuée par un chirurgien spécialisé permet d'obtenir des résultats anatomiques et fonctionnels plus relevants.

Cette étude démontre l'efficacité des techniques de vitrectomie postérieure effectuée pour une luxation cristallinienne, autant sur l'amélioration fonctionnelle que la prévention des complications.

INTRODUCTION

La luxation de fragments cristalliniens dans le corps vitré est l'une des complications les plus sévères de la phacoémulsification. Son incidence est estimée entre 0,2% et 1,5% (Lai, Kwok et al. 2005). Elle peut provoquer une inflammation intraoculaire majeure, capable de mener à un œdème cornéen, un œdème maculaire cystoïde, une opacification du vitré, une hémorragie vitréenne, un glaucome aigu ou chronique, ou encore à un décollement de la rétine (Kim, Flynn et al. 1994; Borne, Tasman et al. 1996; Margherio, Margherio et al. 1997; Yeo, Charteris et al. 1999; Kageyama, Ayaki et al. 2001; Stewart 2007)

La vitrectomie par la pars plana (ou vitrectomie postérieure) apparaît comme le traitement de choix pour la luxation postérieure de fragments cristalliniens, permettant d'enlever le matériel cristallinien retenu et de restaurer la vision dans un grand nombre de cas (Kim, Flynn et al. 1994; Smiddy, Guererro et al. 2003)

Le but de cette étude est d'évaluer les résultats et le taux de complications de la vitrectomie par la pars plana dans le traitement d'une luxation postérieure de fragments cristalliniens survenue lors d'une phacoémulsification, et de comparer ces paramètres entre les interventions effectuées par des chirurgiens du segment antérieur et celles effectuées par des chirurgiens vitréo-rétiniens confirmés. Un objectif supplémentaire est d'investiguer, sur la base des données disponibles, s'il existe un intervalle optimal entre la phacoémulsification et la vitrectomie.

Nous avons étudié 10 années de données médicales de la Clinique d'Ophtalmologie des Hôpitaux Universitaires de Genève, concernant tous les yeux opérés de vitrectomie par la pars plana pour une luxation postérieure de fragments cristalliniens survenue lors d’une phacoémulsification, de janvier 1997 à décembre 2006. Les patients dont le suivi était inférieur à un mois ont été exclus de l’étude.

Les paramètres suivants ont été étudiés : l’âge et le genre des patients, les pathologies oculaires préexistantes, les détails de l’opération de la cataracte, les détails de la vitrectomie par la pars plana, l’acuité visuelle pré- et post-opératoire, et les complications per- et post-opératoires. En outre, le fait de savoir si la vitrectomie postérieure avait été effectuée par le chirurgien de la cataracte ou par un chirurgien vitréo-rétinien a été pris en considération, ainsi que l’intervalle entre l’opération de la cataracte et la vitrectomie postérieure. Concernant cet intervalle, trois groupes différents ont été formés : un groupe « 0 à 1 jour », impliquant les patients opérés de vitrectomie lors de la même intervention que la phacoémulsification ou le lendemain ; un groupe « 2 à 7 jours », contenant les patients ayant eu la vitrectomie dans la première semaine suivant la phacoémulsification, et un groupe « >7 jours », composé des patients chez lesquels la vitrectomie postérieure a été effectuée ultérieurement à la première semaine suivant la phacoémulsification.

Dans chaque cas, une vitrectomie standard de trois voies a été effectuée par la pars plana. Après la fixation sclérale du tube de perfusion et la préparation d’une voie pour le stripper et d’une voie pour l’endo-photo-illumination, une vitrectomie centrale a d’abord été réalisée. Toutes les opacités capsulaires et/ou les résidus cristalliniens corticaux à l’équateur ont été enlevés avec le stripper. Ensuite, un décollement postérieur du vitré a été provoqué s’il n’était pas présent. D’éventuelles tractions vitréo-rétiniennes au niveau du cristallin luxé ont été relâchées, et les fragments cristalliniens ont été enlevés, soit par l’aspiration du stripper, soit en utilisant un « loop ». Une indentation sclérale a ensuite été effectuée, dans le but de permettre l’élimination de la base du vitré, la dissection des tractions vitréo-rétiniennes et la détection d’éventuelles brèches rétiniennes ;

ces dernières ont été traitées par cryothérapie ou par photo-coagulation au laser. En fin d'opération, une implantation secondaire ou fixation sclérale de lentille intraoculaire a été réalisée, si ceci n'avait pas été fait lors de la phacoémulsification.

Trois niveaux différents d'acuité visuelle ont été définis, l'acuité visuelle étant exprimée en unités décimales : vision basse (acuité visuelle <0.1) ; vision modérée (acuité visuelle entre 0.1 et 0.5) ; et vision bonne (acuité visuelle >0.5). Les effets de différents paramètres sur le résultat visuel postopératoire, y compris l'expertise du chirurgien pour la chirurgie vitréo-rétinienne, l'intervalle jusqu'à la vitrectomie, et l'âge des patients, a été évalué.

L'étude a pris en considération 41 patients consécutifs, opérés de vitrectomie par la pars plana pour une luxation postérieure de fragments cristalliniens lors d'une phacoémulsification unilatérale. L'âge moyen était de 78 ans (entre 40 et 95 ans). Dix-huit hommes (44%) et 23 femmes (56%) étaient inclus. L'œil droit était atteint dans 15 cas (37%), l'œil gauche dans 26 cas (63%).

Parmi ces 41 patients, 32 (78%) ont été opérés par un chirurgien vitréo-rétinien confirmé, tandis que chez 9 patients (22%) la vitrectomie postérieure a été effectuée par le chirurgien du segment antérieur. En outre, concernant l'intervalle entre la phacoémulsification et la vitrectomie postérieure, 14 patients (34%) ont subi la vitrectomie lors de la même opération que la phacoémulsification ou le lendemain (groupe « 0 à 1 jour »), 13 patients (32%) ont été vitrectomisés dans la première semaine après la phacoémulsification (groupe « 2 à 7 jours »), et 14 patients (34%) ont été soumis à l'opération vitréo-rétinienne au-delà du 7ème jour suivant la phacoémulsification (groupe « >7 jours »). Le suivi moyen post-opératoire était de 10 mois (entre 1 et 48 mois).

Dans cette étude, la technique de vitrectomie par la pars plana pour une luxation postérieure de fragments cristalliniens survenue lors d'une phacoémulsifaction a démontré des résultats favorables ; en effet, elle a permis une augmentation de l'acuité visuelle chez plus de la moitié des patients (56%) lors de leur dernière visite. Fait remarquable, chez plus d'un tiers des patients (37%), l'acuité visuelle s'est améliorée d'au moins 3 lignes, et presqu'un tiers des patients (29%) a atteint une acuité visuelle supérieure à 0.5. Ces résultats sont compatibles avec plusieurs études précédentes, qui ont établi que la vitrectomie par la pars plana était le traitement de choix pour la luxation postérieure du cristallin lors d'une opération de la cataracte.

Selon cette étude, une vision basse (<0.1) était due principalement à un décollement de la rétine associé ou non à un œdème cornéen persistant ou à un œdème maculaire cystoïde, alors qu'une vision modérée (entre 0.1 et 0.5) était obtenue en absence d'un décollement de rétine malgré la présence de pathologies affectant le segment antérieur, comme un œdème cornéen persistant, un œdème maculaire cystoïde, ou un glaucome.

L'intervalle idéal entre l'opération de la cataracte et la chirurgie vitréo-rétinienne pour retirer des fragments cristalliniens luxés demeure inconnue. D'après certaines études précédentes, le résultat visuel semble être meilleur lorsque la vitrectomie est effectuée pendant la première semaine après l'opération de la cataracte (Tommila and Immonen 1995) ou au cours de la même intervention que cette dernière (Kageyama, Ayaki et al. 2001). En revanche, d'autres études n'ont pas trouvé de corrélation entre le résultat visuel et l'intervalle séparant les deux opérations (Blodi, Flynn et al. 1992; Gilliland, Hutton et al. 1992; Kim, Flynn et al. 1994; Borne, Tasman et al. 1996; Margherio, Margherio et al. 1997), (Kwok, Li et al. 2002; Ho and Zaman 2007)

Dans notre étude, l'intervalle entre la phacoémulsification et la vitrectomie postérieure n'a montré de corrélation ni avec le résultat visuel ni avec le nombre de complications postopératoires.

L'absence de macrophages dans des échantillons de liquide intraoculaire obtenus pendant les trois premiers jours suivant l'opération de la cataracte (Wilkinson and Green 2001) et l'observation d'une activité cellulaire inflammatoire plus faible chez les patients opérés de vitrectomie précoce (pendant la première semaine) (Yeo, Charteris et al. 1999) soutiennent l'hypothèse qu'une vitrectomie précoce pourrait prévenir des complications tardives (Stewart 2007). Les études qui montrent une absence de corrélation entre l'intervalle séparant les opérations et le résultat visuel pourraient elles être biaisées par une tendance à opérer plus rapidement les yeux présentant de plus gros volumes de fragments, ou par une inflammation intraoculaire plus marquée (Yeo, Charteris et al. 1999). C'est pourquoi des études randomisées et contrôlées prospectives seraient nécessaires pour déterminer l'intervalle idéal entre l'opération de la cataracte et la vitrectomie postérieure. Étant donné la rareté des cas et les problèmes éthiques posés par un tel protocole expérimental, de telles études n'ont toutefois pas de probabilité de se réaliser.

Notre travail pose également la question de savoir si le résultat postopératoire d'une vitrectomie postérieure effectuée pour une luxation cristallinienne est influencé par l'expérience de l'opérateur dans le domaine de la chirurgie vitréo-rétinienne. Cette question n'a pas trouvé de réponse adéquate dans les études précédentes. Selon nos résultats, plus de patients opérés de vitrectomie par le chirurgien de la cataracte avaient une vision finale basse (<0.1) que ceux opérés par un chirurgien vitréo-rétinien. En outre, ces derniers patients présentaient plus souvent une amélioration de la vision en postopératoire. Quant aux complications postopératoires, elles étaient plus fréquentes lors d'une vitrectomie effectuée par le chirurgien de la cataracte, en particulier s'agissant du décollement de la rétine. La spécialisation du chirurgien a donc joué un rôle important dans l'évolution postopératoire des cas de cette série.

Le risque de brèches rétiniennes et, par conséquent, de décollement de la rétine après une vitrectomie par la pars plana effectuée pour une luxation cristallinienne a pour origine le vitré périphérique et de sa capacité d'appliquer sur la rétine des tractions liées à la présence des fragments cristalliniens (Singh and Stewart 2006). Une ablation méticuleuse du vitré périphérique au moyen du stripper avant d'enlever les fragments prévient les tractions indésirables et permet de libérer les fragments luxés de leurs attaches à la périphérie rétinienne. Par rapport à un chirurgien du segment antérieur, un chirurgien vitréo-rétinien confirmé maîtrise mieux cette manipulation délicate, ce serait une des causes du meilleur résultat postopératoire.

En conclusion, dans cette série de 41 patients présentant une luxation postérieure de fragments cristalliniens survenue lors d'une phacoémulsification, la vitrectomie par la pars plana a démontré des résultats favorables en général, aussi bien au niveau fonctionnel qu'anatomique. L'intervalle entre la phacoémulsification et la vitrectomie par la pars plana n'a pas influencé le résultat visuel final. En revanche, la spécialisation du chirurgien dans ce domaine pour la réalisation de la vitrectomie a donné des résultats visuels supérieurs et un taux de complication postopératoire inférieur par rapport aux cas opérés par le chirurgien de la cataracte. Il est donc préférable d'adresser les cas de luxation postérieure de fragments cristalliniens à un chirurgien vitréo-rétinien confirmé.

CONTENTS

FIRST PART

SECOND PART

FIRST PART

1 INTRODUCTION TO THE BASIC SCIENCES

1.1 ANATOMY OF NORMAL CRYSTALLINE LENS

General description of the lens

The crystalline lens is a transparent, biconvex structure in the eye located behind the iris and the pupil and anterior to the vitreous body. It constitutes an important part of the refractive media of the eye and its main role is to focus light onto the retina. It also serves the function of accommodation, which enables near vision, by properly adjusting its size.

The crystalline lens is encased in a capsular-like bag and suspended in position by a ring of attaching fibers called *zonule of Zinn*. The zonule of Zinn consists of delicate yet strong fibers that support and attach the lens to the ciliary body.

Regarding topography, the center points on its anterior and posterior surfaces are referred as the *anterior and posterior poles*, respectively. A line joining the poles forms the *axis* of the lens. The marginal circumference of the lens is called the *equator*.

The crystalline lens has no blood supply or innervations after fetal development and it depends entirely upon the aqueous humor to meet its metabolic requirements and to carry off its wastes.

Structure of the lens

The lens is composed of three parts:
- An elastic capsule
- A lens epithelium, and
- The lens fibers (Snell 1998)

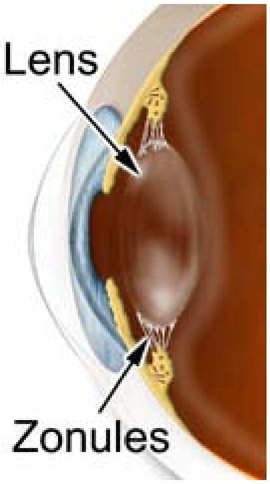


Figure 1- 1: Vertical section of the eye

Capsule of the lens

The lens capsule is an elastic and transparent basement membrane that envelops the entire lens. It is composed of type IV collagen laid down by the epithelial cells. The capsule contains the lens substance and is capable of molding it during accommodative changes. The outer layer of the lens capsule, the *zonular lamella*, also serves as the point of attachment of the zonular fibers. (Fig.1-1)

The inner surface of the anterior part of the capsule is in direct contact with the lens epithelium, while posteriorly it contacts the superficial lens fiber cells.

The lens capsule is thickest in the anterior and posterior pre-equatorial zones (measuring about 20 µm) and thinnest in the region of the central posterior pole (measuring about 3 µm). As a result, the lens naturally tends towards a rounder and more globular configuration, a shape it must assume for the eye to focus at a near distance. Moreover, the central posterior pole appears as the weakest part of the lens capsule, a fact with potential risk of posterior dislocation of the lens during cataract surgery.

The lens capsule serves as a diffusion barrier and is freely permeable to low-molecular-weight compounds but restricts the passage of large colloidal particles.

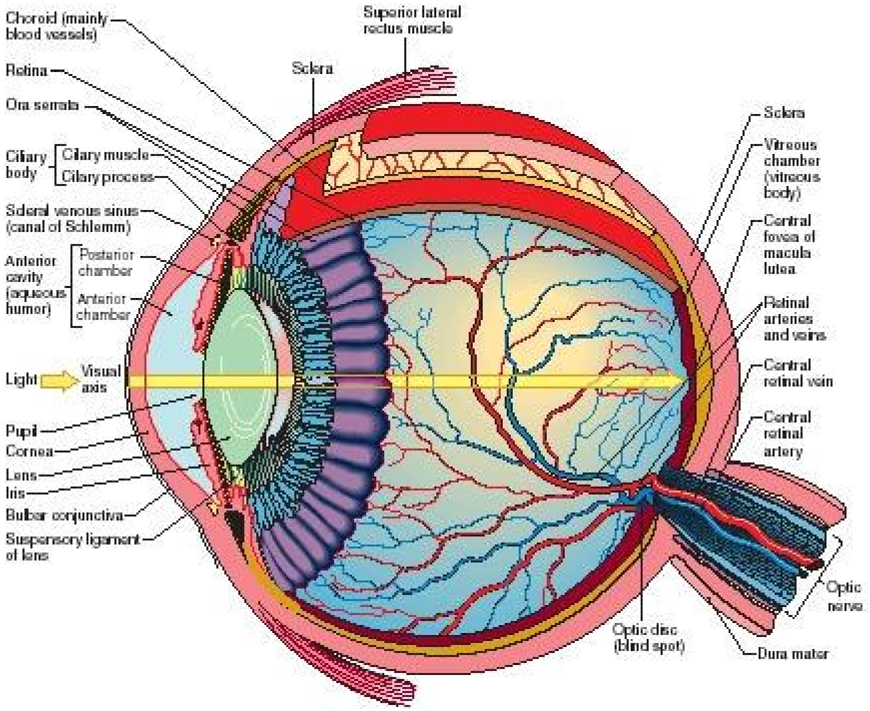


Figure 1-2: Vertical section of the right eye shown from the nasal side

Lens epithelium

The lens epithelium lies beneath the capsule (Fig. 1-4) and it is confined to the anterior surface of the lens. It is cuboidal in structure. At the equator, these cells elongate and form columnar cells, which become arranged in meridional rows. It is at the equator that the lens epithelial cells are transformed into lens fibers. (Fig.1-3)

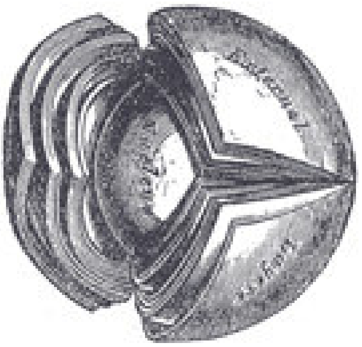


Figure 1-3 .The crystalline lens hardened and divided. A section through the margin of the lens is presented, showing the transition of the epithelium into the lens fibers. (Gray 2000)

The function of the lens epithelium is twofold. The cells located at the equator are actively dividing and differentiating into lens fibers (Fig 1-4). The remaining, more centrally placed cells are involved in the transport of substances from the aqueous humor to the interior of the lens, and also in the secretion of the capsular material.

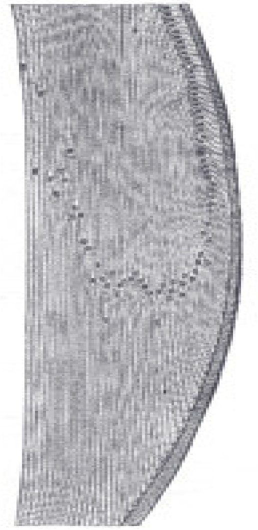


Figure 1-4 Section through the margin of the lens, showing the transition of the epithelium into the lens fibers. (Gray 2000)

Lens fibers

The lens fibers constitute the main mass of the lens. They are formed throughout life by the multiplication and differentiation of the lens epithelial cells at the equator (Fig 1-5). During this transformation, no cells are lost from the lens: as new fibers are laid down, they crowd and compact the previously formed fibers, with the oldest layers being the most central. The oldest of these, constituting the embryonic and fetal lens nuclei, have been produced in embryonic life and persist in the center or ***nucleus*** of the lens. The outermost fibers are the most recently formed and make up the ***cortex*** of the lens. Thus, a lens cut on section has a laminated appearance (Fig 1-5).

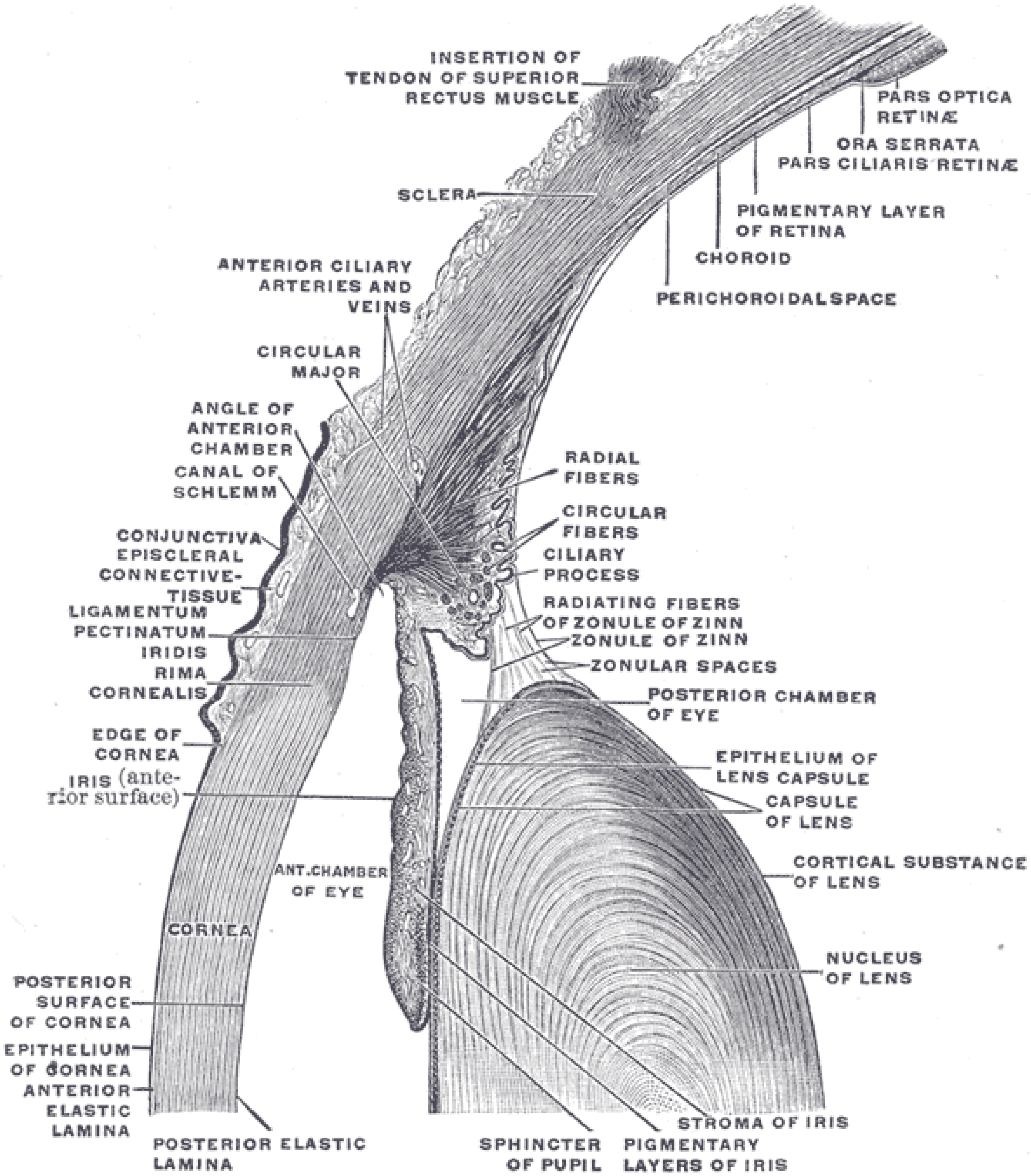


Figure1-5 Anterior part of the eye, including Cornea, Iris, Ciliary body, Zonular fibers and the Lens structure

At the lens equator, the lens fibers elongate the anterior (apical) part of each fiber extending forward and the posterior (basal) part extending backward. The anterior and posterior ends of the fibers unite with each other at suture lines, which in the fetus have the form of an erect Y on the anterior surface and an inverted Y on the posterior surface (Fig 4). In addition to the Y-sutures located within the lens nucleus, multiple optical demarcation zones may be visible by slit lamp biomicroscopy. (Liesegang 2001-2002)

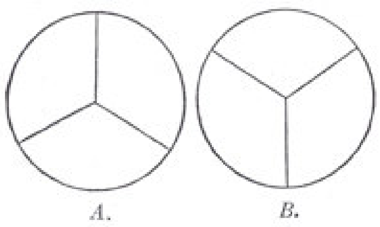


Figure 1-6: Diagram to show the direction and arrangement of the radiating lines on the front and back of the fetal lens. ***A.*** From the front. ***B.*** From the back. (Gray 2000)

During development, the lens fiber cells lose their nuclei and the cytoplasmic organelles become specialized for the production of lens proteins, known as *crystallins*. They constitute up to 60% of the lens fiber mass. The high refractive index of the lens is due to crystallins.

The cells of the lens are filled with transparent proteins called crystallins. The average concentration of lens proteins is about twice than that of other intracellular proteins and is thought to play a structural role in the lens. It is about 5 mm thick and has a diameter of about 9 mm for an adult human (though these figures can vary). The proteins are arranged in approximately 20,000 thin concentric layers, with a refractive index (for visible wavelengths) varying from approximately 1.406 in the central layers down to 1.386 in the less dense cortex of the lens. This index gradient enhances the optical power of the lens.

The α-crystallin is a major protein of the lens and a member of the small heat shock protein family of molecular chaperones. This protein, composed of two gene products, αA and αB, plays important roles in the lens and other tissues. Mutations in αA and αB-crystallins form the basis of several hereditary cataracts.

The lens contributes about 15-20 diopters of the approximately 60 diopters of convergent refractive power of the average human eye. (The remaining 40 diopters occur at the air-cornea interface).

The lens is flexible and its curvature is controlled by ciliary muscles, through the zonules. By changing the curvature of the lens, one can focus the eye on objects at different distances from it. This process is called accommodation. The lens continually grows throughout life, laying new cells over the old cells resulting in a stiffer lens. The lens gradually loses its accommodation ability as the individual ages; the loss of the individual’s focusing ability is termed presbyopia. (Apple 1985; Liesegang 2001)

Zonular fibers (zonule of Zinn)

The crystalline lens is held in position by a series of delicate, radially arranged fibers, collectively known as the *suspensory ligament of the lens*, or *zonule*. (Fig.1-5)

Zonular fibers are a ring of delicate homogeneous transparent fibrils which run from the inner surface of the ciliary body to the equatorial zone of the lens. (Fig.1-7)

Fibers pass backwards from the whole width of each bay between two ciliary processes. They are particularly concentrated at the posterior ends of the processes.

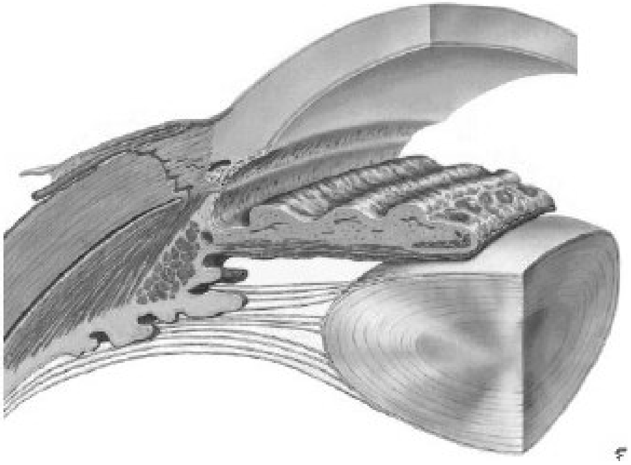


Figure 1-7 Schematic representation of zonular fibers .Three band of fibers are visible:

Upper:Preequatorial zonular fibers
Midle:Equatorial zonular fibers
Lower:Posteqatorial zonular fibers

The fibers run parallel to the ciliary epithelium, a thin cleft separating them from the cells. As the fibers pass across the surface, small fibrils break from the main masse of fibers and turn toward the epithelium.

In addition of this anterior to posterior lines of insertion, there is a line at which the zonular fibers attach running about the circumference of the lens approximately 1.5 mm anterior to the equator. A second line runs similarly about the circumference of the lens approximately 1 mm posterior to the equator of the lens.

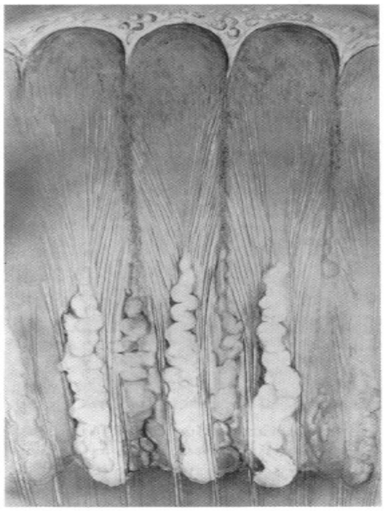


Figure 1-8 Zonules in relation with the ciliary processes and the ora serrata. (McCulloch 1954)

In the region of the bay of the ora serrata, the zonular fibers terminate in two structures. (Fig 1-9).As these fibers come to their posterior ends, they break into minute fibrils. Many of the fibrils turn towards the ciliary epithelium and insert between the epithelial cells. Other fibrils show no tendency to turn towards the ciliary epithelium but extend into the adjacent vitreous. The point where an individual zonule fibril ends can not be defined.

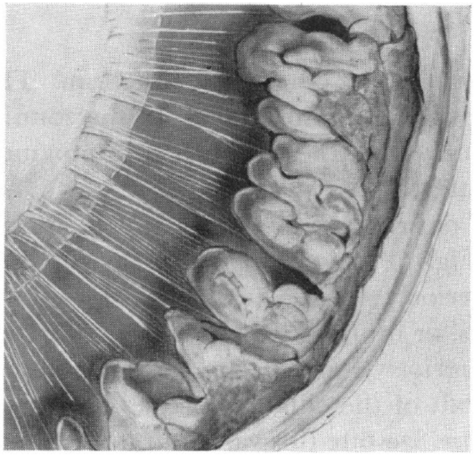


Figure 1-9.The processes are protruding well anterior to the zonule .Where the angle of view is direct the clefts among the fibers which contain the processes are visible. The small mounds on the lens are due to fixation, but they show the groups of insertions lying opposite the processes.

The zonular fibers hold the lens in place and function to change the focusing power of the eye by changing the tension of the fibers by contraction and relaxation of the ciliary muscle.

Their exact origin and nature are still a matter of dispute.

They have been some descriptions of the fibrils as arising from the vitreous.

Some authors support that they are secreted by and are attached to the ciliary epithelium or the internal limiting membrane, others that they are simply a modification of the vitreous (McCulloch 1954)

The most posterior fibrils come from the ora serrata, the most anterior from the heads of the ciliary processes.

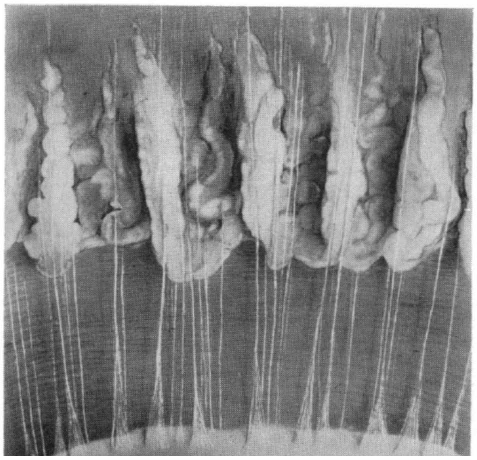


Figure1-10 This is from a man of sixty-eight years; a child would show many more fibers. The light is coming from the right and the fibers ale illuminated against the right side of each process. The grouping of the fibers on the lens opposite the processes and the terminal fibrils at the lens can be seen.

The majority, however, arise from a slight ridge known as the *posterior zonular border* which lies 1.5 mm in front of the ora serrata and imitates the indentations of the ora serrata. (Wolff 1940)

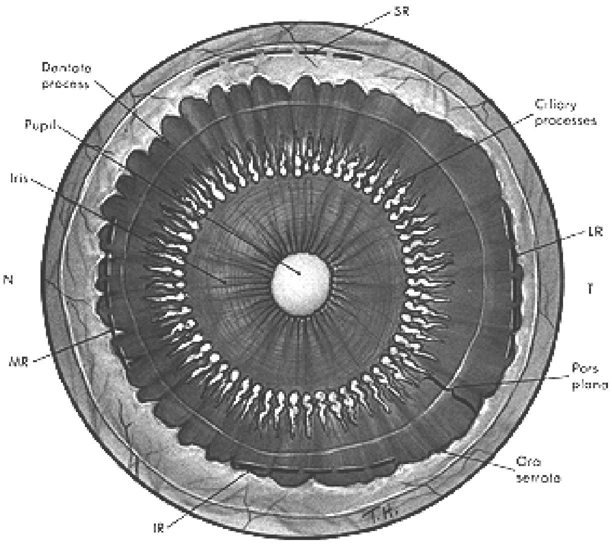


Figure 1-11 Peripheral retina from posterior, with lens removed. The termination of the retina (ora serrata) varies slightly in different processes of the peripheral retina (see text). The dentate processes of the retina extend anteriorly, and the bays of the pars plana extend posteriorly to create a serrated appearance. The insertions of the rectus muscles are close to the ora, as shown. SR, superior rectus; LR, lateral rectus; IR, inferior rectus; MR, medial rectus; T, temporal; N, nasal

The fibers are 5-30μm in diameter. Ultra structurally, the fibers are made up of strands, or fibrils, 8-10 nm in diameter with 12’14nm banding.

The zonule of Zinn as a whole forms a ring somewhat triangular on meridian section. It fixes the lens and enables the ciliary muscle to act on it. In accommodation the zonular fibers are slackened, there is less tension on the capsule of the lens, which therefore becomes more convex. (Fig.1-7)

The fibrils can be seen with the slit-lamp in case of congenital dislocation of lens or absence of the iris. Also with the removal of the iris when viewed from in front, or the vitreous when looked at from the back, the individual bundles of fibrils can be seen passing from the ciliary body to the lens.

The relation of the zonule to the anterior body of the vitreous:

The canal of Petit is the space between the zonule and the face of the vitreous. It ends axially where the vitreous attaches to the lens and at the sides where the vitreous attaches to the ciliary body.

Some fibers pass from anterior face of the vitreous and ends at the capsule of the lens - Wieger's capsulo-hyaloid adhesion. (Wolff 1940).As the face of the vitreous is traced towards the ora serrata it approaches the zonule and comes to lay in contact with the zonular fibers over the pars plana ciliaris. In the bays of the ora serrata the zonular fibers are not present.

Also some fibers pass from the front of the vitreous to the capsule of the lens (Wieger’s ligamentum hyaloidea capsulare). These are, however, very weak and easily torn, i.e. they do not prevent the lens from being removed with its capsule.

Chemistry

Zonular fibers are not attacked by collagenase but they are by trypsin (Davson 1990) whilst their amino acid composition differs from that of the collagen, especially in the absence of hydroxyproline and hydroxylysine, and the presence of large amounts of cysteine; this may have some pathological interest for the Marfan syndrome associated with homocystinuria, i.e the incomplete formation or tearing of the zonular fibers leading to ectopia lentis (Buddecke and Wollensak 1966)

1.2 ANATOMY OF THE VITREOUS BODY

The vitreous body is a gel structure that fills the posterior cavity of the globe. It thus occupies four-fifths of the eyeball and lies between the lens and the retina. The vitreous is a transparent gel having a denser cortex and a more liquid center. Chemically, the vitreous contains amino acids, soluble proteins, salts and ascorbic acid. Collagen is the major structural protein component of the vitreous; the other major component is hyaluronic acid.

The vitreous base straddles the ora serrata, extending 1.5-2.0 mm anteriorly and 1.0-3.0 mm posteriorly. It cannot be separated mechanically from the underlying retina. The vitreous cortex is the outer lining of the vitreous. Anterior to the Vitreous base it is called the anterior Vitreous cortex. Posterior to the Vitreous base it is called the posterior Vitreous cortex and is adherent to the basal lamina of the internal limiting membrane of the retina. With aging, spontaneous separation of the posterior Vitreous cortex from the retina occurs.

The cortex of the vitreous is attached at a several points around its circumference to neighboring structures. In the region of the pars plana of the ciliary body and the adjacent ora serrata is is an attachment that is known as the *vitreous base.* The vitreous is also attached to the neural part of the retina, especially at the margin of the optic disc. Behind the lens, the vitreous is attached to the lens (Fig.1.2) along the periphery of the hyaloid fossa; this attachment is particularly firm in the young and weakens with age

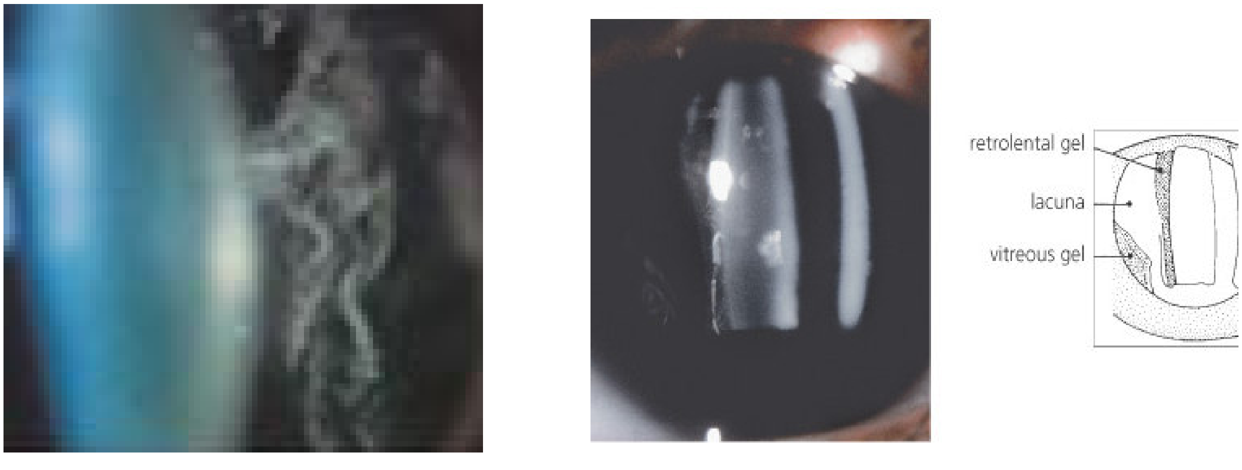


Figure 1.2 Vitreous Gel (gel fibrils)(Spalton 2005)

The vitreous is colorless, transparent gel consisting of 98 % water. It has a refractive index of 1.33, which is nearly the same as that of aqueous humor.

At adolescence, the vitreous begins to undergo a physical change. There is a decrease in the volume of the gel and an increase in the liquid volume. This process of liquefaction begins in the central vitreous and progresses with age. It may lead to vitreous detachment and predispose to retinal detachment. (Liesegang 2001)

1.3 ANATOMY OF THE RETINA.

General anatomy of the retina.

The retina is a delicate, diaphanous tissue that measures about 0.1 mm in thickness at the ora, 0.2 mm at the equator, and 0.56 mm adjacent to the optic nerve head. The internal aspect of the retina is in contact with the vitreous body and its external aspect is adjacent to but separated from the retinal pigment epithelium (RPE) by a potential space, called the intraretinal space. Posteriorly, all retinal layers except the nerve fiber layer terminate at the optic nerve head. Peripherally, the sensory retina extends to the ora serrata, where it is continuous with the nonpigmented ciliary epithelium of the pars plana (Fig.1-11). Although the retina conforms to the shape of the adjacent pigment epithelium and underlying sclera, it is firmly attached to the pigment epithelium in only two areas: the optic disc and the ora serrata. Attachments elsewhere are weak and subject to disruption due to relatively trivial forces. Attachments between vitreous and retina also occur.

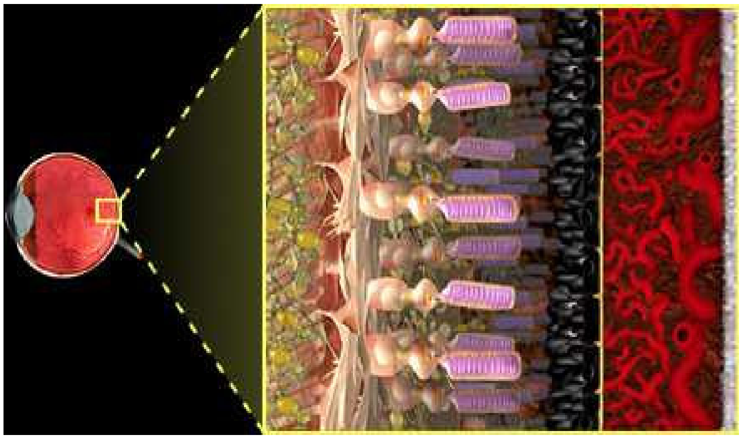


Figure 1-13 *Anatomy of the retina: photoreceptors, RPE, Bruch's membrane, Choroid,Sclera Central retina (from left to right); http://www.macula.org/anatomy/*

The central retina (area centralis) or macular region is defined histologically as that area of the posterior retina having at least two layers of nuclei in the ganglion cell layer. Grossly and clinically (ophthalmoscopically), the border of this area is less clearly defined. The fovea is a zone 1.5 mm in diameter centered about 4.0 mm temporal and 0.8 mm inferior to the center of the optic nerve head (see Fig.1-14).

The inner retinal surface of the fovea is concave due to thinning of the inner retinal layers, the average retinal thickness of the fovea is about 0.25 mm, roughly half that of the adjacent posterior retina. The nerve fiber, ganglion cell, and inner plexiform layers are absent from the fovea. The inner nuclear layer is reduced to a double row of cells at the edge of the fovea and is absent within the fovea. The central 0.57-mm-diameter photoreceptor layer of the fovea is composed entirely of cones. Almost all of the blood vessels in this part of the retina are capillaries, and the central capillary-free zone in the macula is about 0.4 mm in diameter. (Fig.1-14)

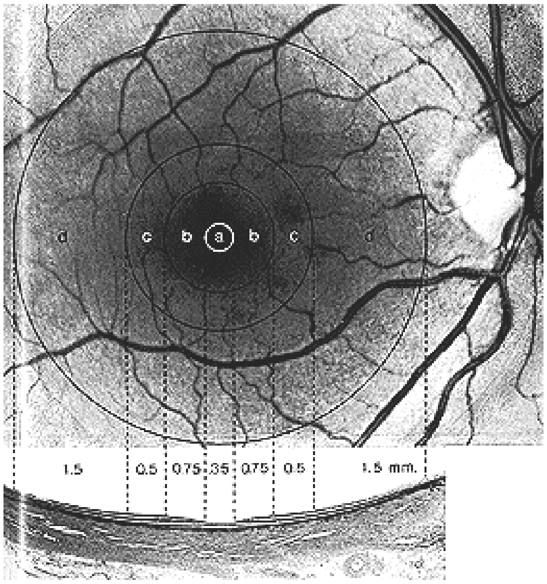


Fig.1-14 Clinical and correlated histopathologic views of the macular region. Fundus photographs shows foveola (a), fovea (b), parafoveal area (c), and perifoveal regions

Peripheral retina

The peripheral retina gradually becomes attenuated as it approaches the ora serrata, where it terminates and becomes continuous with the nonpigmented epithelium of the pars plana. The ora serrata measures 2.1 mm in width temporally and 0.7 to 0.8 mm nasally. The term ora serrata refers to the serrated appearance of this zone, with so-called dentate processes, or teeth, encroaching anteriorly on the pars plana of the ciliary body, and intervening bays that represent posterior extensions of the pars plana (Fig. 1-11). The greatest number of dentate processes and bays is found in the superonasal quadrant, with a progressive decrease in number in the inferonasal, superotemporal, and inferotemporal quadrants.

Morphology of the retina

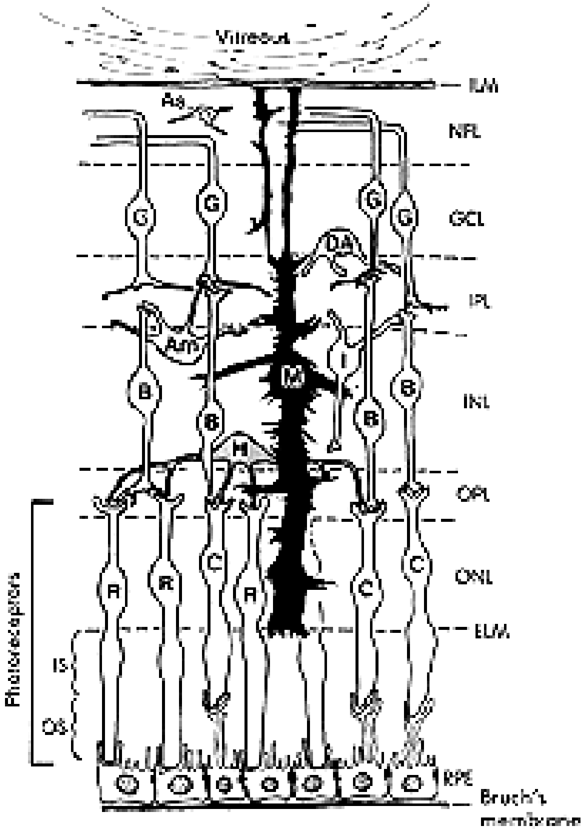


Figure 1-15. Schematic diagram of cell types and histologic layers in the human retina. Retinal layers are labeled as in Fig. 4. Also shown are Bruch's membrane (considered as the innermost layer of the choroid, but in fact the basement membrane of the RPE) and the edge of the vitreous. The basic relationship between rod (R) and cone (C) photoreceptors as well as bipolar (B), horizontal (H), amacrine (Am), inner plexiform cell (I), displaced amacrine (DA), and ganglion (G) neurons is depicted. Note that the Müller cell (M) extends almost the width of the retina; the apical processes of the Müller cell form the external limiting membrane (ELM), while the foot processes of the Müller cell partially form the inner limiting membrane (ILM). Astrocytes (As) are found primarily in the nerve fiber layer (NFL).

The general features of retinal histology are well known from classic works by Ramσn y Cajal; La rétine des vertebras-1892, Polyak, SL:The retina 1941 , and, more recently, (Hogan 1971) Recent advancements in electron microscopy, immunocytochemistry, and intracellular horseradish peroxidase (HRP) injections have helped determine the synaptic connections within the retina and have led to a better understanding of the functional architecture of the retina. The neurons of the retina are divided into three layers: (1) the most external (the outer, or scleral, layer) is the photoreceptor cell layer, which includes the outer and inner segments and the layer of photoreceptor cell bodies (or outer nuclear layer), (2) the layer of intermediate neurons (or inner nuclear layer), and (3) the layer of ganglion cells. The synapses are confined to the two synaptic, or plexiform, layers--the outer and inner plexiform layers.

2. PATHOLOGY OF CRYSTALLINE LENS

2.1. CATARACTS

Cataract is defined as any opacification of the lens, regardless of cause, size or location.

A cataract usually begins small and has little effect on vision, but as it grows and clouds more of the lens you may find that performing normal tasks, such as reading and driving, become more difficult. (Fig 2.1)

Figure 2-1 Normal vision (left) Vision trough a cataract (right)

They are the leading cause of visual loss among adults 55 and older. Eye injuries, certain medications, and diseases such as diabetes have also been known to cause cataracts.

Symptoms of a Cataract May Include:

- Increased nearsightedness
- Sensitivity to light and glare, especially while driving at night
- Blurred vision
- Distorted images in either eye
- Changes in the way you see colors, or colors seem faded
- Cloudy, filmy or fuzzy vision
- Double vision
- Frequent changes in your eyeglass prescription

- Changes in the color of the pupil
- Poor night vision

Figure 2-2 Eye without cataract Eye with cataract

Etiologic classification of the cataract

ACQUIRED CATARACTS

I. Age –related cataract

  - Subcapsular cataract
  - Nuclear cataract
  - Cortical cataract
  - Christmas tree (uncommon)

II. Cataract in systemic diseases

- Diabetes mellitus
- Myotonic dystrophy
- Atopic dermatitis
- Neurofibromatosis 2

III. Secondary cataract

- Chronic anterior uveitis
- Acute congestive angle closure
- High myopia
- Hereditary fundus dystrophy

  -. Retinitis pigmentosa

  -. Leber congenital amaurosis

  -. Gyrate atrophy

  - Stickler syndrome

IV. Congenital cataract

- Genetic mutation
- Chromosomal abnormalities (Down syndrome)
- Metabolic disorder

  1. Galactosemia

    2. Lowe syndrome
    3. Other (hypoparathyroidism, mannosidosis, Fabry disease, hypocalcemia, etc)

- Intrauterine infection
    1. Congenital rubella
    2. Other (toxoplasmosis, CMV, herpes simplex, varicella)

V. Drug induced cataract

VI. Traumatic cataract

VII. Other injury – induced cataract

- Radiation
- Chemical injury
- Metallosis (iron cooper)
- Electrical injury

I. Age –related cataract

1.Epidemiology

Age –related cataract is the most common cause of visual impairment in adults, usually starting after age 50, but sometimes they can begin at a younger age. Even though a cataract can start to form in your 50's, vision problems may not occur until much later.

It cause reversible blindness in more than 15 million people worldwide, and this figure is projected to reach 40 million by year 2025. (Liesegang 2001)

2. Pathophysiology of cataract

The pathophysiology of age-related cataracts is multifactorial and not completely understood. As the lens ages, it increases in weight and thickness and decreases in accommodative power. As new layers of cortical fibers are formed concentrically, the lens nucleus undergoes compression and hardening (nuclear sclerosis). Cristallins (lens proteins) are changed by chemical modification and aggregation into high molecular-weight proteins.

The result proteins aggregate and cause abrupt fluctuations in the refractive index of the lens, scatter light rays, and reduced transparency. Chemical modification of nuclear lens proteins also produced progressive pigmentation. The lens takes on a yellow or brownish hue with advancing age. Other age related changes in the lens include decreased concentrations of glutathione and potassium, increased concentrations of sodium and calcium, and increased hydration.

Experimental evidence suggests that the lens is susceptible to damage from ultraviolet radiation in the UV-B range of 290-320 nm. Some studies indicate that long-term exposure to UV from sun exposure is associated with an increased risk of cortical and posterior subcapsular cataract. The UV induces an increase of free radicals as well as chemical changes of the crystalline structure.

3 Types of age related cataract

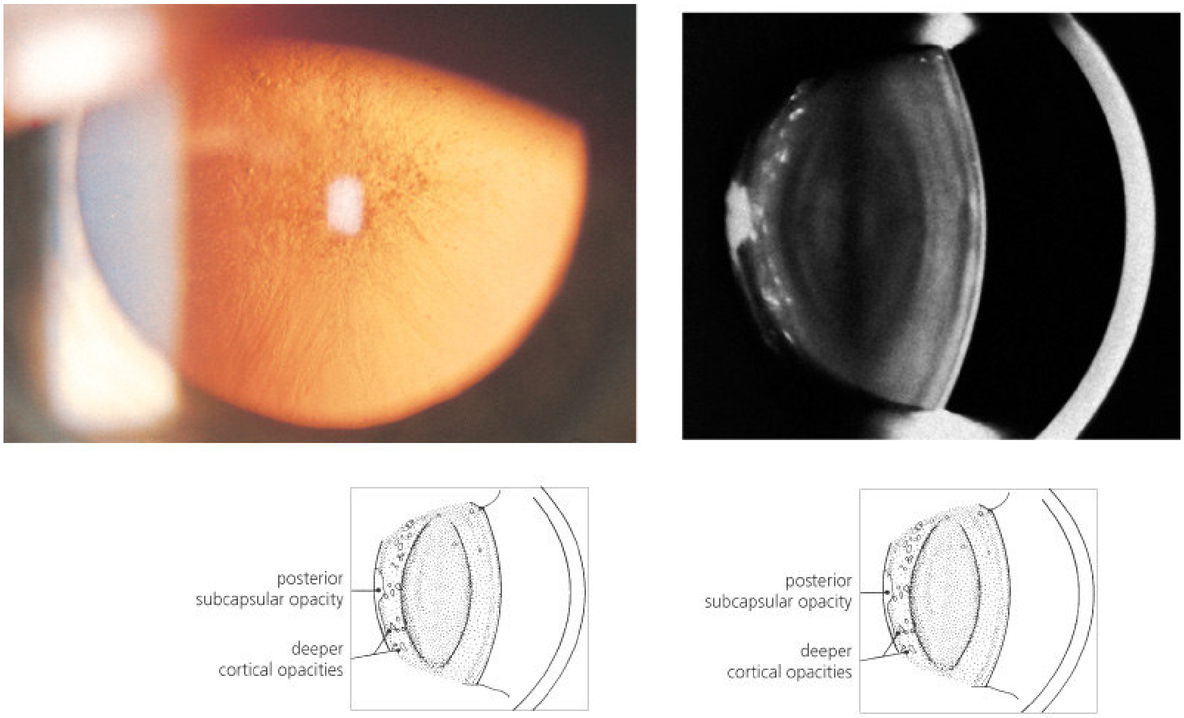
The three main types of cataract are posterior subcapsular cataracts, nuclear, and cortical cataracts.

- *Posterior Subcapsular Cataracts*

Posterior subcapsular or cupuliform, cataracts are often seen in patients younger than those presenting with nuclear or cortical cataracts.

Posterior subcapsular cataracts are located in the posterior cortical layer and are usually axial. (Fig. 2-4) The first indication of posterior subcapsular cataract formation is a subtle iridescent sheen in the posterior cortical layers visible with the slit lamp. In later stages, granular opacities and a plaquelike opacity of the posterior subcapsular cortex appear. (Fig. 2-4)

The patient often complains of glare and poor vision under bright lighting conditions because the posterior subcapsular cataract obscures more of the pupillary aperture when miosis is induced by bright lights, accommodation or miotics. Near visual acuity tends to be reduced more than distance visual acuity.

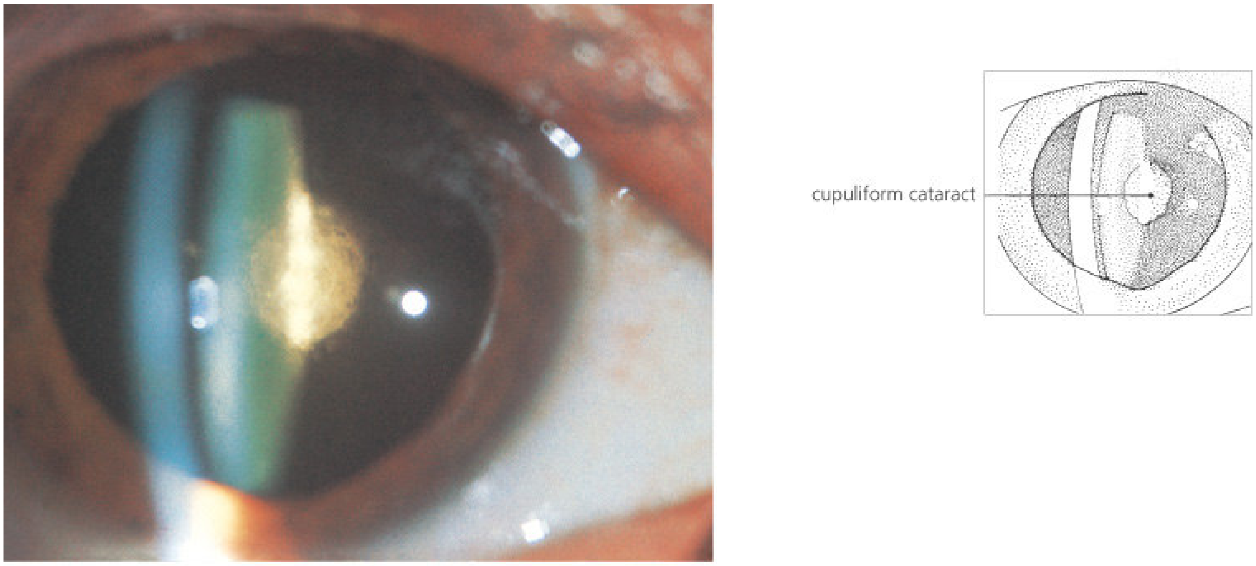


© 2005 Elsevier Ltd. Spalton et al: Atlas of Clinical Ophthalmology 3e

Figure 2-3 Posterior: Subcapsular cataract. (Spalton 2005)

Slit-lamp detection of posterior subcapsular cataracts can best be accomplished through dilated pupil. Retroillumination is also helpful.

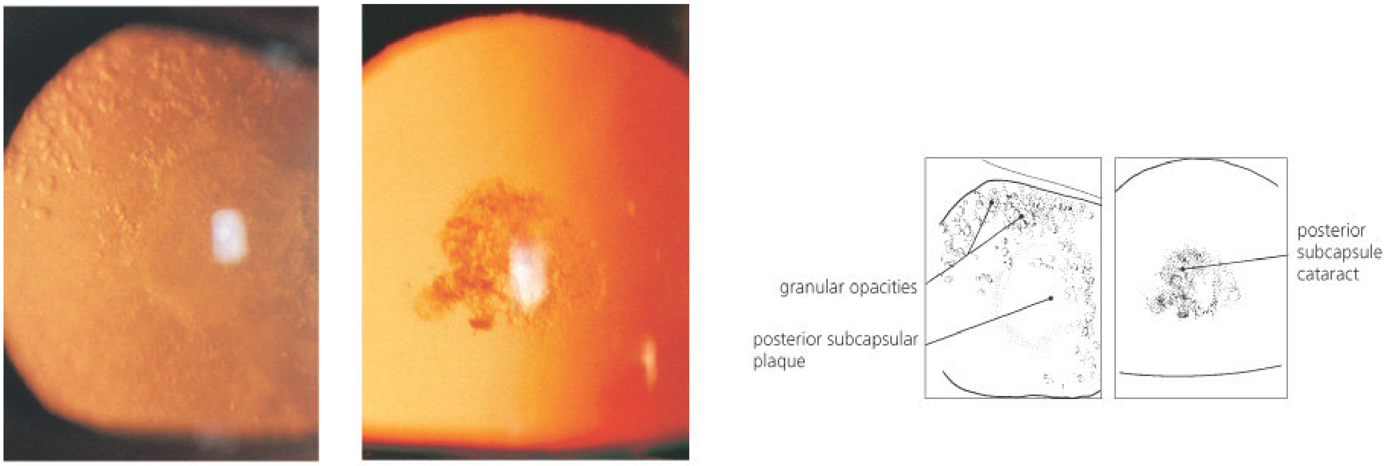
In addition to being one of the main types of age-related cataract, posterior subcapsular cataract can occur as a result of trauma, systemic or topical corticosteroid use, inflammation, and exposure to ionizing radiation



© 2005 Elsevier Ltd. Spalton et al: Atlas of Clinical Ophthalmology 3e

Figure 2-4: Senilposterior subcapsular cataract-appears as a collection of opacities in the posterior subcapsular region of the posterior pole.(Spalton 2005)

Histopathologically, posterior subcapsular cataract is associated with posterior migration of the lens epithelial cells in the posterior subcapsular area. (Kuzak 1999);



© 2005 Elsevier Ltd. Spalton et al: Atlas of Clinical Ophthalmology 3e

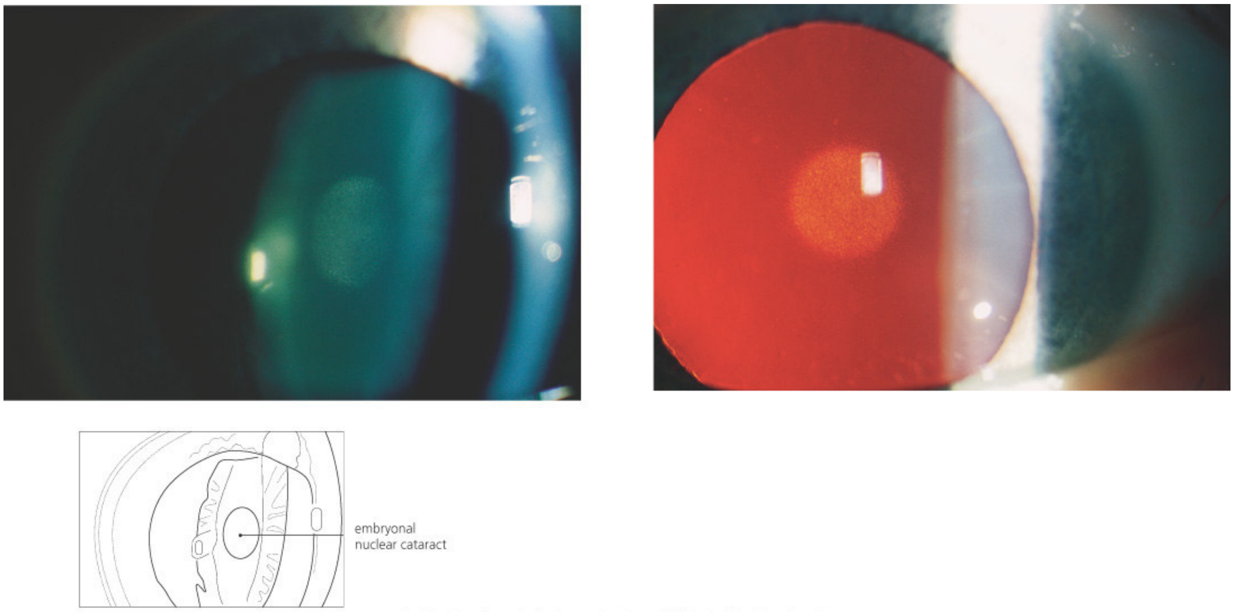
Figure 2-5 Plaque of opacities at the posterior pole Posterior subcapsular cataract. (Spalton 2005)

- *Nuclear Cataract*

Some degree of nuclear sclerosis and yellowing is considered physiologically normal in adult patients past middle age. In general, this condition interferes only minimally with visual function.

An excessive amount of sclerosis, yellowing is called a nuclear cataract, and it causes a central opacity.(Fig 2-6).The degree of sclerosis, yellowing, and opacification is evaluated with a slit-lamp biomicroscope and by examining the red reflex with the pupil dilated.

Nuclear cataractts tend to progress slowly. Although they are usually bilateral, they may be asymmetric. Nuclear cataracts typically cause greater impairment of distance vision than of near vision. In the early stages, the progressive hardening of the lens nucleus commonly causes an increase in the refractive index of the lens and thus a myopic shift in refraction, sometimes known as lenticular myopia. In



© 2005 Elsevier Ltd. Spalton et al: Atlas of Clinical Ophthalmology 3e

Figure 2-6 Nuclear Cataract (Spalton 2005) some cases, the myopic shift transiently enables other wise presbyopic individuals to read

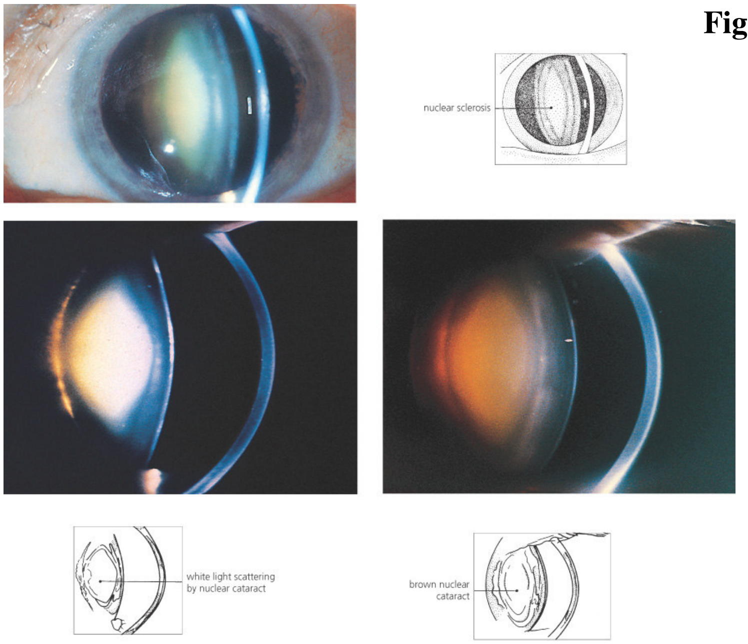
In very advanced cases the lens nucleus becomes opaque and brown and is called a brunescent nuclear cataract (Fig .2-7)

Some cataract formation affects predominantly the lens cortex.

Changes in the ionic composition of the lens cortex and subsequent changes in hydration of the lens fibers lead to cortical opacification. (Fig.2-8)

- *Cortical Cataract*

Cortical cataracts (also called cuneiform opacities) are usually bilateral but are often asymmetric. Their effect on visual function varies greatly, depending on the location of the opacification relative to the visual axis. A common symptom of cortical cataracts is glare from intense locale light sources such car headlights.



© 2005 Elsevier Ltd. Spalton et al: Atlas of Clinical Ophthalmology 3e

Figure 2-7 Age related nuclear cataract- -

- *upper*-Nuclear sclerosis
- *down left*-white light scattening by nuclear cataract
- *down right*-brown nuclear cataract(Spalton 2005)

Cortical cataracts vary greatly in their rate of progression; some cortical opacity remains unchanged for prolonged periods, while others progress rapidly.

The first signs of cortical cataract formation visible with the slit-lamp biomicroscope are vacuoles and water clefts in the anterior or posterior cortex. The cortical lamellae may be separated by fluid. Wedge-shaped opacities (often called cortical spokes or cuneiform opacities) form near the periphery of the lens, with the pointed end of the opacities oriented toward the center. The cortical spokes appear as white opacities when viewed with the slit-lamp biomicroscope and as dark shadows when viewed by retroillumination. The wedge-shaped may enlarge and coalesce to form large cortical opacities. As the lens continues to take up water, it may swell and become an intumescent cortical cataract. When the entire cortex from the capsule to the nucleus becomes white and opaque, the cataract is said to be mature.

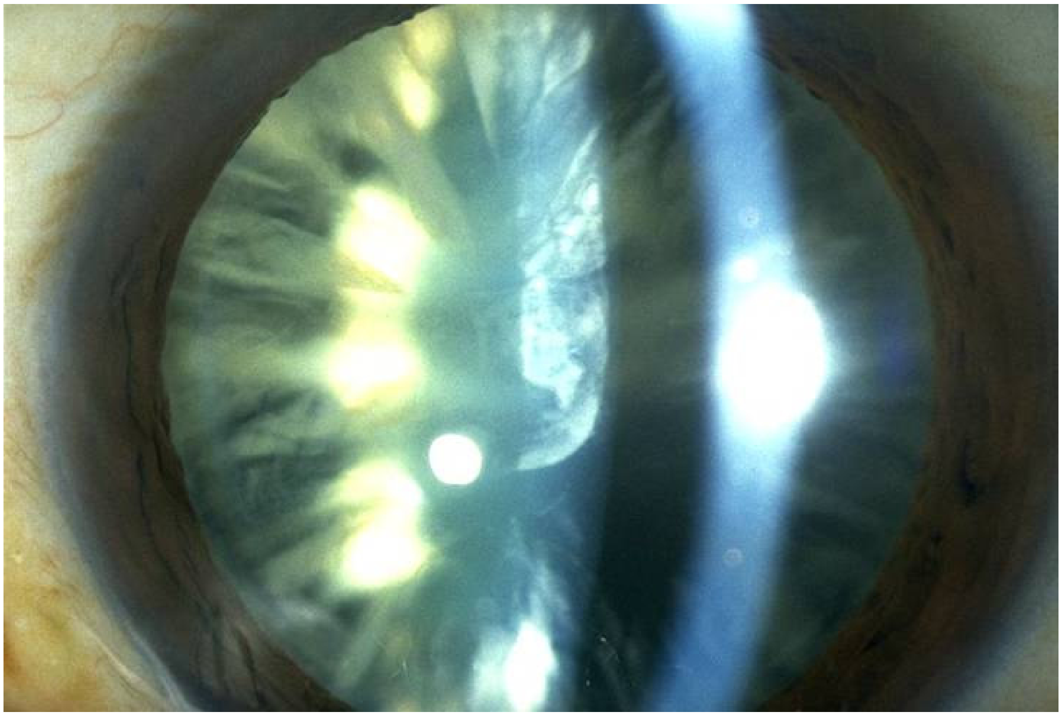


Figure 2-8 Cortical cataract. (Spalton 2005)

A hypermature cataract occurs when degenerated cortical material leaks through the lens capsule, leaving the capsule wrinkled and shrunken. A Morgagnian cataract occurs when further liquefaction of the cortex allows free movement of the nucleus within the capsular bag.

Histopathologically, cortical cataracts are characterized by hydropic swelling of the lens fibers. Globules of eosinophilic material (Morgagnian globules) are observed in slitlike spaces between lens fibers. (Liesegang 2001)

4.Evolution of age-related cataracts

The earliest histologic feature of cortical protein degeneration is fiber swelling, referred to as bladder cells and Morgagnian globules. Bladder cells are swollen, nucleated lens cells, and Morgagnian globules are spherical clumps of degenerating lens protein. These changes are first seen in the peripheral, subcapsular cortex. As lens proteins degenerate they liquefy, and such cataracts are referred to as hypermature. Liquefied lens material may or may not leak out of the lens capsule. Leakage of lens material through an intact capsule typically results in a lymphocytic-plasmacytic inflammatory response called phacolytic uveitis. Mineralization is seen in extremely advanced cataracts, particularly in the lens capsule. Epithelial changes include posterior migration of epithelium, fibrous pseudometaplasia (lens epithelial cells can undergo fibrous metaplasia to function as fibroblasts) and subcapsular fibroplasias.

Fibrous metaplasia of lens epithelium also occurs with chronicity and causes capsule fibrosis and wrinkling. As newly secreted collagen matures and contracts, the lens capsule becomes wrinkled.

II.Cataract in systemic diseases

Several systemic diseases, such as diabetes mellitus, myotonic dystrophy, atopic dermatitis, and neurofibromatosis 2, may be accompanied by cataract.

III. Secondary cataracts

A secondary cataract develops as a result of some other primary ocular disease.

Chronic anterior uveitis is the most common cause of secondary cataract. The incidence is related to the duration and activity of intraocular inflammation that results in prolonged breakdown of the blood- aqueous and blood-vitreous barrier. The use of steroids, topically and systemically is also important. If the inflammation persists, posterior and anterior opacities develop and may progress to maturity.

IV. Congenital cataract – the most common cause is genetic mutation, usually autosomal dominant .Half of those are with bilateral opacities.

Figure 2-9 Congenital cataract(Spalton 2005)

V. Drug-Induced Lens Changes

A number of drugs such as corticosteroids, phenothiazines, miotics, and amidarone can cause cataracts.(Liesegang 2001)

Long-term use of corticosteroids may cause posterior subcapsular cataracts. Their incidence is related to dose and duration of treatment and individual susceptibility to corticosteroid-induced posterior subcapsular cataracts appears to vary. Cataract formation has been reported following administration of corticosteroids by several routes: systemic, topical, subconjuctival, and nasal spray.

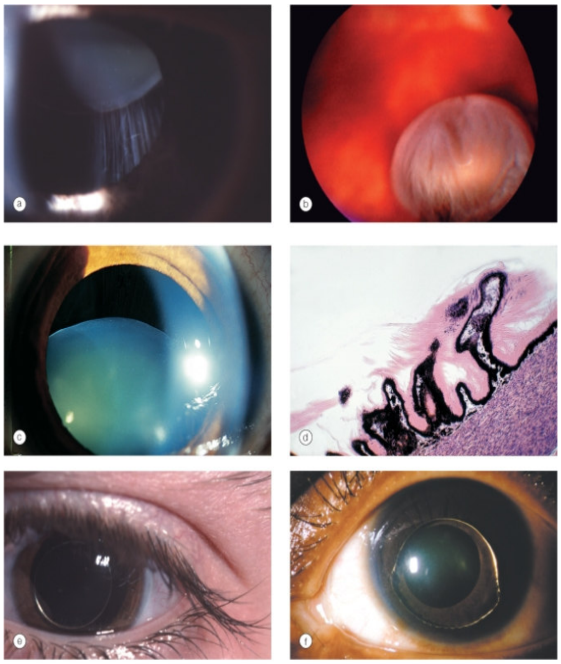
VI. Traumatic cataract

Traumatic lens damage may be caused by mechanical injury (perforating injury or contusion), radiation (infrared or ultraviolet), electrical current, or chemicals. (Liesegang 2001)

Blunt injury to the eye can sometimes cause pigment from the pupillary ruff to be imprinted onto the anterior surface of the lens in a so-called *Vossius ring*.

2.2 ECTOPIA LENTIS

.



© 2007 Elsevier Ltd. Kanski: Clinical Ophthalmology 6e

Figure 2-10 Ectopia lentis Subluxation is most frequently superotemporal, but may be in any meridian.The lens may dislocate into the anterior chamber or vitreous 1. Marfan sy.(a) Superotemporal subluxation with intact zonule (b) Dislocation into the vitreous s 2.Homocystinuria(c) inferior subluxation with zonular disintegration (d) histology shows matted zonular fibreslying over the ciliary epithelim 3,Weill-Marchesani sy (e) microspherophakia (f) dislocation into the anterior chamber (Kanski 2006)

Ectopia lentis refers to a displacement of the lens from its normal position (Fig 2-10). The lens may be completely dislocated, rendering the pupil aphakic (luxated), or partially displaced, still remaining in the pupillary area (subluxated). Ectopia lentis may be hereditary or acquired. Acquired causes include trauma, a large eye (i.e. high myopia, buphthalmos), anterior uveal tumors and hypermature cataract

Acquired ectopia lentis

During a blunt injury to the eye, rapid expansion of the globe in an equatorial plane can follow compression. This rapid equatorial expansion can disrupt the zonular fibers, causing dislocation or subluxation of the lens. The lens may be dislocated in any direction, including posteriorly into the vitreous cavity or anteriorly into the anterior chamber. (Liesegang 2001)

Symptoms and signs of traumatic lens subluxation include fluctuation of vision impaired, monocular diplopia, and high astigmatism Often iridodonesis or phacodonesis is present. In some case blunt trauma causes, both dislocation and cataract formation. (Kanski 2006)

<u>Without systemic associations</u>

1. **Familial ectopia lentis** is characterized by bilateral symmetrical superotemporal displacement. Inherited in an autosomal dominant fashion, it may manifest congenitally or later in life.
2. **Ectopia lentis et pupillae** is a rare, congenital, bilateral, autosomal recessive disorder characterized by displacement of the pupil and the lens in opposite directions. The pupils are small, slit like and dilate poorly.
3. **Aniridia** is occasionally associated with ectopia lentis.

With systemic associations

Marfan syndrome

Marfan syndrome (Fig 2-10) is a widespread autosomal dominant disorder of connective tissue due to mutation of the fibrillin gene on chromosome 15q.

1. **Ectopia lentis**, bilateral and symmetrical, is present in 80% of cases. Subluxation is most frequently **superotemporal**, but may be in any meridian. Because the zonule is frequently intact, accommodation is retained, although rarely the lens may dislocate into the anterior chamber or vitreous. The lens may also be microspherophakic.
2. **Angle anomaly** is present in 75% of cases.
3. **Retinal detachment** associated with lattice degeneration and high axial myopia is the most serious complication.

Homocystinuria

Homocystinuria is an autosomal recessive inborn error of metabolism in which decreased hepatic activity of cystathionine beta-synthetase results in systemic accumulation of homocysteine and methionine.

1. **Systemic features** include skeletal anomalies with a Marfanoid habitus, fair hair and a tendency to thrombotoc episodes. It is important to know that giving a general anesthetic without prior knowledge of the diagnosis of homocystinuria can be life-threatening.
2. **Ectopia lentis**, typically **inferonasal**, usually occurs by the age of 10 years. The zonule, which normally contains high levels of cysteine, often disintegrates so that accommodation is lost. Secondary angle-closure may

occur as a result of pupil block caused by lens incarceration to the pupil, or a total dislocation into the anterior chamber. (Nelson and Maumenee 1982)

Weil-Marchesani syndrome

Weil-Marchesani syndrome is a rare systemic connective tissue disease, conceptually the converse of Marfan syndrome. Inheritance may be autosomal dominant or autosomal recessive.

1. **Systemic features** include short stature, brachydactyly with stiff joints and mental handicap.
2. **Ectopia lentis**, bilateral and **inferior**, occurs in about 50% of cases during the "teens" or early twenties. Spherophakia is common and the lens may be dislocated into the anterior chamber causing pupil block angle-closure.
3. **Other features** include an angle anomaly, asymmetrical axial lengths and presenile vitreous liquefaction.

Miscellaneous conditions

Other rare conditions that may cause ectopia lentis are the following:

- Hyperlysinemia
- Sulphite oxidase deficiency
- Stickler syndrome
- Ehlers-Danlos syndrome

Management

The main complications of ectopia lentis are (a) refractive error (lenticular myopia), (b) optical distortion due to astigmatism and/or lens edge effect, (c) glaucoma and, rarely (d) lens-induced uveitis.

1. **Spectacle correction** may correct astigmatism induced by lens tilt or edge effect in eyes with mild subluxation. Aphakic correction may also afford good visual results if a significant portion of the visual axis is aphakic in the undilated state.(Kanski 2006)
2. **Surgical removal** of the lens, using closed intraocular microsurgical techniques, is indicated for intractable ametropia, meridional amblyopia, cataract, lens-induced glaucoma, uveitis or endothelial touch.

3. CATARACT SURGERY

Types of Cataract surgery:

3.1 Intracapsular cataract Extraction

Intracapsular cataract extraction (**ICCE**) involves the removal of the lens and the surrounding lens capsule in one piece. The lens is then replaced with an artificial intraocular implant of appropriate power which remains permanently in the eye. The procedure has a relatively high rate of complications due to the large incision required and pressure placed on the vitreous body, thus is rarely performed in countries where operating microscopes and high-technology equipment are readily available. Cryoextraction is a form of ICCE that freezes the lens with a cryogenic substance such as liquid nitrogen (Fig.3-1).

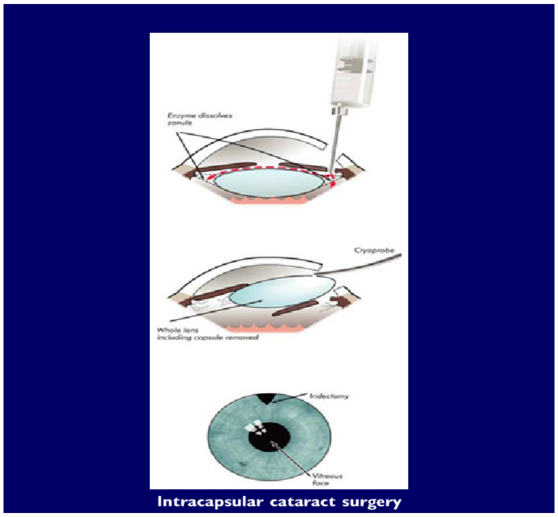


Figure 3-1 Intracapsular cataract surgery (middle: whole lens including capsule removed) .(Khaw 2004).

Although it is now used primarily for the removal of subluxated lenses, it was the favored form of cataract extraction from the late 1960s to the early 1980s.

Advantages

Although it has generally been superseded by ECCE, the advantages of ICCE include

- Removal of the entire lens, leaving no capsule behind to opacify or require additional surgery
- Less sophisticated instrumentation is required allowing ICCE to be performed in a wide range of conditions around the world
- Visual rehabilitation usually possible soon after surgery with +10.00D temporary spectacles

Disadvantages

The disadvantages of ICCE compared to ECCE are significant. ICCE is therefore used only in special cases of important zonular dehiscence. The larger ICCE incision, 160'-180", is associated with the following risks:

- Vitreous incarceration
- Increased risk of retinal detachment
- Increased risk of cystoid macular edema
- Delayed healing
- Delayed visual rehabilitation
- Significant induced astigmatism
- Iris incarceration
- Postoperative wound leaks with inadvertent filtration

History

Samuel Sharp, who expressed a cataract lens, capsule intact, through a limbal incision using pressure from his thumb, was among the first to successfully perform intracapsular cataract extraction. He practiced this method in London in 1753.

Indications

ICCE is particularly useful in case in which preservation of the posterior capsule is unlikely (dislocated lenses or extreme phacodonesis); intracapsular cataract extraction may be preferred method.

Procedure

After inserting an eyelid speculum to part the eyelids and placing a superior bridle suture beneath the superior rectus tendon to stabilize the globe, the surgeon creates either a fornix-based or limbal-based conjunctival flap. Wet-field cautery is typically used for hemostasis. A scleral support ring may be needed in young patients or high myopes to avoid scleral collapse when the lens is extracted and in patients with deep-set eyes to improve exposure. The peripheral corneal section or limbal incision with a conjunctival flap must be large enough to accommodate the intact lens and the extraction instrument. It usually measures 160°-180° (12-14mm length). Cryoextraction became the procedure of choice in all cases in which an ICCE was desired.

To facilitate rapid and precise wound closure, preplaced sutures are passed across the wound and then pulled out of the groove. If an IOL is to be inserted, the preplaced sutures are positioned across the wound leaving a 6-7 mm gap superiorly, through which the IOL can be passed. In order to create a more secure two-plane incision, the surgeon uses a sharp micro knife to enter the anterior chamber in a beveled plane. The wound is then enlarged with either the microknife scissors.

A peripheral iridectomy is routinely created for ICCE to avoid postoperative pupillary block from the intact vitreous face or from an angle-supported lens implant. A cellulose sponge is used to dry the anterior lens surface to facilitate cryoadhesion. Then the cryoprobe on the midperiphery of the superior pole of the lens until cryoadhesion occurs.

The cataract is removed through the wound by gently elevating the lens and moving it from side to side to strip the zonular attachment. As the lens is extracted, the iris is reposited and the anterior wound margin is released. The wound is then closed by pulling up and trying the pre-placed sutures.

If an anterior chamber IOL is to be inserted, the pupil is constricted with either acetylcholine or carbachol, and the anterior chamber is filled with either air or viscoelastic. The inferior haptic of the anterior chamber IOL is passed between the preplaced sutures into the inferior chamber angle. A forceps or lens hook is used to place the superior IOL haptic in the superior chamber angle. The viscoelastic or air is then removed and replaced with sterile balanced salts solution, and the wound is closed with additional 10-0 nylon sutures.(Liesegang 2001)

Postoperative Course

If the eye has been left aphakic, it can be corrected approximately with a +10 to +12 D lens, or a +4 D lens can be used as a telescope.

Because ICCE requires a larger incision, achieving a stable refraction usually takes longer after ICCE than after ECCE or phacoemulsification techniques, which require smaller incisions.

3.2. Extracapsular Cataract Extraction with Nucleus Expression

Prior to the refinement of modern extracapsular cataract surgery, the complete removal of the lens and its capsule through intracapsular cataract extraction was the preferred surgical technique. The development of better operating microscopes, more advanced surgical aspiration systems, and more sophisticated lens intraocular implants has caused extracapsular cataract extraction (ECCE) to replace ICCE almost entirely in most parts of the world.

ECCE involves removal of the lens nucleus and cortex through an opening in the anterior capsule, leaving the posterior capsule in place. This technique has a number of advantages over ICCE. Because it is performed through a smaller incision, it is generally

- Less traumatic to the corneal endothelium
- Associated with less induced astigmatism
- A more stable and secure wound

In addition, the posterior capsule is intact, which

- Reduces the risk of intraoperative vitreous loss
- Allows better anatomical position for IOL fixation
- Reduces the incidence of cystoid macular edema, retinal detachment, and corneal edema
- Reduces the vitreous mobility that occurs with saccadic movements (endophtalmodonesis)
- Provides a barrier restricting the exchange of the some molecules between aqueous and vitreous
- Reduces bacterial access to the vitreous cavity for endophtalmitis
- Eliminates the short and long term complications associated with vitreous adherence to the iris, cornea
- Reduces the complications of the rupture of the capsule

Contraindications

ECCE requires zonal integrity for the selective removal of the nucleus and cortical material. Therefore, when zonule appears insufficient to allow safe removal of the cataract through extracapsular surgery, ICCE or pars plana lensectomy should be considered. (Liesegang 2001)

Procedure

Pupillary dilatation is important to the success of ECCE. Cycloplegic / mydriatic drops, administered preoperatively, effectively dilate the pupil, while topical nonsteroidal anti-inflammatory drops can help to maintain dilatation during surgery.

Incision

Extracapsular cataract extraction requires a midlimbal chord length of 8-12 mm, significantly smaller than the incision needed for ICCE. The initial incision usually consists of the limbal groove, fashioned with a round-tipped steel blade, sharp micro knife, or diamond knife. Some surgeons prefer a slightly more posterior incision with anterior dissection creating scleral flap of tunnel. A stab incision is made into the anterior chamber in preparation for an anterior capsulotomy, and the cystotome is inserted to begin the procedure. The anterior chamber depth can be stabilized by viscoelastic agents, air bubble, or continuous fluid irrigations.

Anterior capsulotomy

The two main functions of the anterior capsulotomy are to permit removal of the cataract and to provide stabilization for the IOL. There are many techniques for opening the anterior capsule. A sharp cystotome or bent needle may be used to makes a series of connected punctures or small tears in a circle to create the “can-opener capsulotomy”. Alternatively, a smooth capsulorrhexis may be created by making a puncture or small tear. The edge of this tear is then grasped with the cystotome tip or with a forceps and pulled around smoothly, removing a circular portion of anterior capsule (Fig.3-4 and Fig.3-6b). This technique provides greater structural integrity for the lens capsule to maintain implant stability and centration. If a small capsulorrhexis is created and manual expression is planned, relaxing incisions in the superior aspect of the capsulorrhexis are often performed to allow the nucleus adequate room to exit the capsule during expression. After the capsulotomy is completed, the wound is widened to allow safe passage of the nucleus through the incision.(Liesegang 2001)

Nucleus removal

They are many different techniques for the removal of the nucleus. Manual expression involves pressing of the inferior cornea to the tip of the superior pole of the nucleus up out of capsular bag. Additional counter-pressure on the globe from an instrument holding the sclera posterior to the wound will express the nucleus from the chamber. The nucleus is removed from the eye by loosening and elevating it from the capsule with the hook or irrigating cannula, then supporting it on the lens loop, spoon or vectis that will slide or irrigate it out of the chamber.

The wound is partially sutured to allow deepening of the chamber with irrigation. The lens cortex is than grasped and aspirated under direct visualization in the pupillary space or withdrawn from the chamber using the aspiration cannula. The posterior capsule may be polished with an abrasive –tipped irrigation cannula, “squeegee” or vacuumed clean using low aspiration to remove epithelial and cortical particles from the capsule surface (Liesegang 2001).

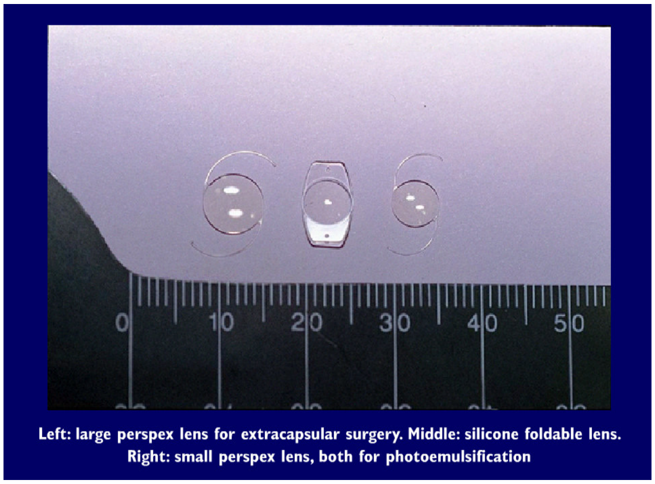


Figure 3-2. Different types of intraocular lenses. ***Left***: PMMA lens for extracapsular surgery. ***Middle***: silicone foldable lens for phacoemulsification. ***Right***: small acrylic lens for phacoemulsification (Khaw 2004).

IOL insertion

Prior to IOL insertion, the anterior chamber is usually filled with balanced salt solution, air or viscoelastic. Viscoelastic provide the most reliable anterior chamber maintenance along with protection of the corneal endothelium.

A posterior chamber IOL (Fig.3-2) may be inserted in the sulcus or in the capsular bag. If the surgeon wishes to insert the IOL into the capsular bag, viscoelastic is usually injected in to the bag; with care being taken to fully separate the anterior capsular flap from the posterior capsule. Direct visualization of haptic insertion is critical.

3.3 Phacoemulsification

Phacoemulsification (Fig.3-3) is an extracapsular technique that differs from conventional ECCE with nuclear expression by the incision required and the method of nucleus removal. This technique uses an ultrasonically driven tip to fragment the nucleus of the cataract and aspirates the lens. It results in a lower incidence of wound-related complications, faster healing, and more rapid visual rehabilitation than procedures that require larger incisions. This technique also creates a relatively closed system during both phacoemulsification and aspiration, thereby controlling anterior chamber depth and providing safeguards against positive vitreous pressure and choroidal hemorrhage.

Procedure (Fig. 3-5)

Patient preparation

As with conventional ECCE, pupillary dilation with cycloplegic / mydriatic drops is recommended. Some surgeons also use non steroidal inflammatory drops preoperatively to help maintain dilation during surgery. Pupil-stretching techniques or special iris retractor can be used to open miotic pupil unresponsive to pharmacological dilatation.(Liesegang 2001)

Figure 3-3 Ophthalmology surgeon performing phacoemulsification. (Khaw 2004)

Exposure of the globe

The eyelids are usually held apart during surgery with a lid speculum, although some surgeons prefer sterile adhesive strips or sutures to keep the lids apart. In selecting an eyelid speculum, the surgeon must take into account the size and location of the hand piece as it moves within the surgical field.

Incisions

Scleral tunnel incision. The scleral tunnel incision with an internal corneal lip has become the most frequently used incision among cataract surgeons. This incision gives the phaco surgeon an excellent degree of control during the procedure, and it also allows for conversion to conventional ECCE if necessary. It entails a two-planed incision that begins in the sclera to prevent induced postoperative astigmatism and ends in the clear peripheral cornea, to prevent iris prolapse. (Fig.3-6a).

Injecting viscoelastic through the paracentesis at this stage helps to maintain the IOP and anterior chamber depth, thereby making the subsequent keratome entry into the anterior chamber easier and safer.

After removing the cataract and inserting the IOL, the surgeon removes the visoelastic with the irrigation and aspiration handpiece and re-forms the anterior chamber with sterile balanced salt solution through the paracentesis.

Clear corneal incision. Many surgeons now prefer to perform phacoemulsification and insert foldable IOL through a clear corneal incision at the temporal limbus, often with the use of topical anesthesia. Advocates of this approach cite the speed of the operation and the rapid visual rehabilitation.

Anterior capsulotomy. Can-opener capsulotomy would result in radial tears in the anterior capsule extending from one or more of the initial puncture sites out to the periphery of the capsule. These radial tears could enlarge during hydrodissection. Continuous-tear capsulorrhexis provides a more stable smooth edge to the anterior capsular opening that resists radial tears and is therefore the technique used in phacoemulsification. The majority of cataract surgeons prefer a 5-6 mm opening. (Liesegang 2001)

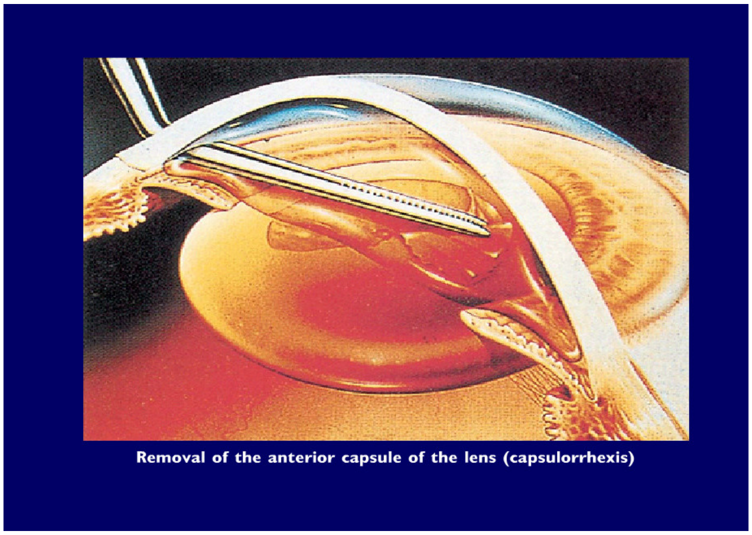
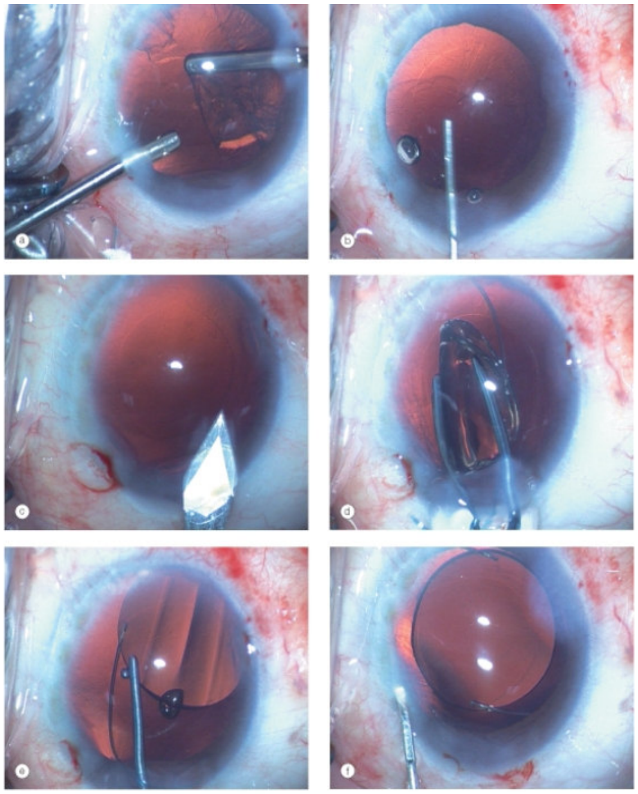


Figure 3-4: Capsulorrhexis. (Khaw 2004)

The surgeon begins with a central linear cut in the anterior capsule, using a cystotome needle. At the end of the linear cut, the needle is either pushed or pulled in the direction of the desired tear, allowing the anterior capsule to fold over upon itself. The surgeon then engages the free edge of the anterior capsule with either forceps (Fig.3-6b) or the capsulotomy needle, and the flap is carried around in a circular manner as the surgeon directs the tension toward the center of the lens. For maximum control, frequent re-grasping of the flap near the tear is helpful. If a radial tear extends toward the equator during capsulorrhexis, the surgeon may need to convert to a can-opener capsulotomy technique. (Kanski 2006)

Radial extension of the capsulotomy may occur in the setting of forward displacement of the lens with shallowing of the anterior chamber or anterior traction on the capsular flap.



© 2007 Elsevier Ltd. Kanski: Clinical Ophthalmology 6e

Figure 3-5 Completion of phacoemulsification (a) Cortical lens matter is pulled centrally and aspirated (b) viscoelastic is injected into the capsular bag (c) incision is enlarged (d) IOL is inserted (f) sideports are hydrated.(Kanski 2006)

If the capsulorrhexis tear starts to extend too far peripherally, the flap can sometimes be salvaged and the tear brought more centrally. First, the surgeon should check for positive vitreous pressure associated with forward displacement of the lens. This may be caused by the capsulotomy instrument, the surgeon's fingers, or the lid speculum pressing against the globe; and it can be corrected. Refilling the anterior chamber with viscoelastic, and inserting a second instrument through the paracentesis to press posteriorly on the lens may help reduce forward displacement of the lens and allow for redirection of the capsular tear. Using the bent cystotome needle to redirect the tear centrally may also be helpful, as this instrument causes minimal wound distortion when inserted in the eye, and it can create sharp changes in the direction of the tear over very short distances.

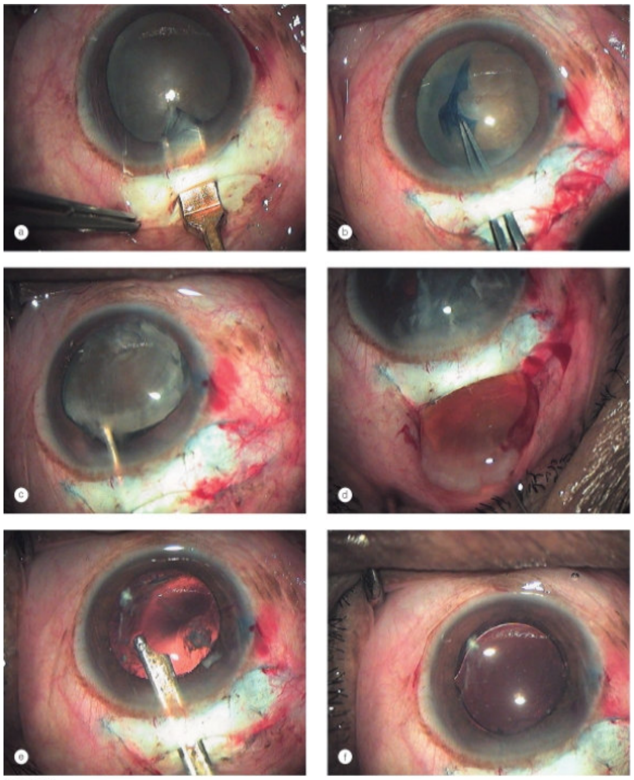


Figure 3-6 Small incision manual cataract surgery. (a) Anterior chamber is entered ; (b) capsulorrhexis; (c) prolaps of nucleus into anterior chamber; (d) expression of nucleus; (e) cortical cleanup (f) IOL in place

© 2007 Elsevier Ltd. Kanski: Clinical Ophthalmology 6e

Hydrodissection

Gentle injection of irrigation fluid is performed to separate the peripheral cortex from the underlying capsule. In addition to loosening the lens nucleus/cortex complex, this procedure facilitates nuclear rotation during phacoemulsification and hydrates the peripheral cortex, making it easier to aspirate after nucleus removal. The surgeon place a bent, blunt-tipped 25- to 30 –gauge needle attached to a 3 cc syringe under the anterior capsular flap. While the capsular flap is gently lifted, balanced salt solution is injected to hydrodissect the posterior cortical lamellae from the capsule. Gentle irrigation should continue until the surgeon sees a wave of fluid moving across the red reflex zone. Gentle posterior pressure centrally on the nucleus will express the posterior fluid and complete the hydrossection. If the nucleus is displaced into the anterior chamber, it can be deposited in the capsular bag with viscoelastic and posterior pressure. Hydrodisection is riskier after a can-opener capsulotomy and may result in significant radial tears that can extend posteriorly and threaten the posterior capsular integrity.

Location of phacoemulsification

The nucleus may be emulsified at various locations within the eye, including the anterior chamber, iris plane and posterior chamber. The location chosen for emulsification will determine which techniques for nucleus management are employed. (Fig.3-6)

Anterior chamber

When the technique of phacoemulsification was first developed, the anterior chamber was the preferred location for phacoemulsification. It has the advantage of less risk of rupturing the posterior capsule.

However, it has two significant disadvantages: it causes more corneal endothelial cell loss than posterior chamber phacoemulsification, and many surgeons find it difficult to prolapse the nucleus into the anterior chamber. This technique is now used less frequently unless the posterior capsule has ruptured and the surgeon must prevent the nucleus from subluxating into the vitreous or the patient is highly myopic with a very deep anterior chamber.

Iris plane

A later development was to perform the phacoemulsificationat at the iris plane. In this location, the superior pole of the nucleus was prolapsed anteriorly and emulsification occurred halfway between the corneal endothelium and the posterior capsule, thereby reducing the risk of damage to either structure. Once prolapsed, the nucleus could be manipulated with less stress on the posterior capsule and zonular fibers.

The iris plane location is often desirable for the beginning phacoemulsification surgeon and in case of small pupils or compromised capsular or zonular integrity. The disadvantages of this technique include the difficulty in prolapsing the nucleus and the potential damage to the corneal endothelium if the superior pole of the nucleus is emulsified too close to the cornea.

The posterior chamber

The posterior chamber is now considered the preferred location for phacoemulsification. Nucleus manipulation in this location requires capsulorrhexis, hydrodisssection, and one of several techniques of nuclear splitting. The advantages of posterior chamber phacoemulsification are the reduced risk of corneal endothelial trauma and the ability to minimize the size of the capsulorrhexis opening which is useful the suboptimal dilatation. The disadvantages include the need to emulsify close to posterior capsule and zonular fibers when the nucleus is being manipulated, the technical difficulty in small pupil cases, and the need to employ more sophisticated methods of nuclear splitting.

Supracapsular

A more recent innovation is the supracapsular phacoemulsification. The essence of this technique is prolapsing the nucleus through the capsulorrhexis during hydrodissection, and than replacing the nucleus into the posterior chamber on top of the capsular bag.

This approach the theoretically reduces the stress on the zonules during nucleus manipulation, can be used in small-pupil cases, and keeps the phacoemulsification tip and energy away form the corneal endothelium above and the posterior capsule below.

Endolenticular

An endolenticular approach has been developed that uses a very small opening (3 mm) in the anterior capsule through which the entire emulsification process occurs.

The advantages include maximum endothelial protection and the future possibility of injecting synthetic lens material into an almost intact capsular bag. In addition to the overall technical difficulty, however, include the disadvantages include the increased risk of posterior capsular rupture during both hydrodissection and emulsification and the need to enlarge the capsulorrhexis prior to IOL implantation. (Liesegang 2001)

Whole nucleus removal

The nucleus can be emulsified as a whole in either the iris plane or posterior chamber. If an iris plane approach is desired, a can-opener capsulotomy, pear-shaped capsulorrhexis, or generous circular capsulotomy is preferred. Following central nuclear sculpting and creation of a circular or D-shaped nuclear bowl, a two-handed technique is used to prolapse the superior pole of the nucleus into the iris plane. The second instrument (e.g., iris spatula or lens manipulator) inserted through the paracentesis is used to pushed inferiorly on the nuclear bowl, while the phaco handpiece (Fig.3-7) is used to spear the exposed superior pole of the nucleus. Irrigation through the phaco handpiece now creates a fluid wave that helps separate the posterior cortex from the underlying capsule. Using this classic two-handed technique, the surgeon then lifts and exposes the superior pole of the nucleus and emulsifies the rim from the 11 o'clock to the t o'clock positions. The nucleus is then rotated; continually exposing another segment of the posterior capsule emulsification. The remaining nuclear plate is then carefully elevated off the posterior capsule and emulsified.

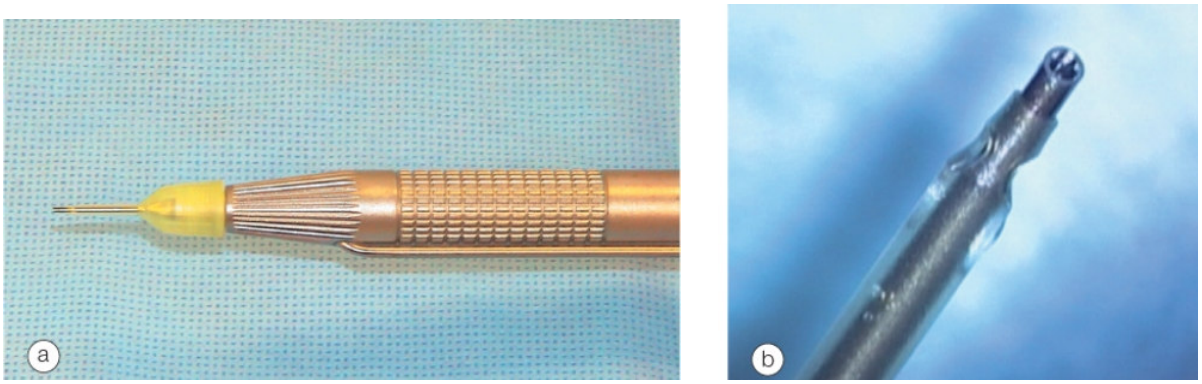


Figure 3-7 (a) Phaco handpiece with tip (b) phaco tip with sleeve.(Kanski 2006)

If the lens is soft, whole nucleus emulsification can be performed in the capsular bag after adequate hydrodissection. The surgeon sculpts the central and peripheral areas of the nucleus while rotating the lens (Fig.3-8), creating a thin cortical rim and posterior plate. The thin peripheral cortical rim is engaged inferiorly by the phaco tip, and while aspiration is maintained, the rim is pulled centrally and emulsified. The lens is rotated, and a new section of cortical rim is engaged, pulled centrally, and emulsified. This maneuver is repeated until the entire rim is removed. Finally, the residual posterior plate is elevated or subluxed above the edge of the anterior capsule and emulsified.(Kanski 2006)

Nuclear- splitting techniques

In some of the more recently developed techniques, phacoemulsification occurs within the capsular bag. These new techniques allow for removal of the hard endonucleus first, within the capsular bag, using the epinucleus and cortex as a cushion to protect the underlying posterior capsule.

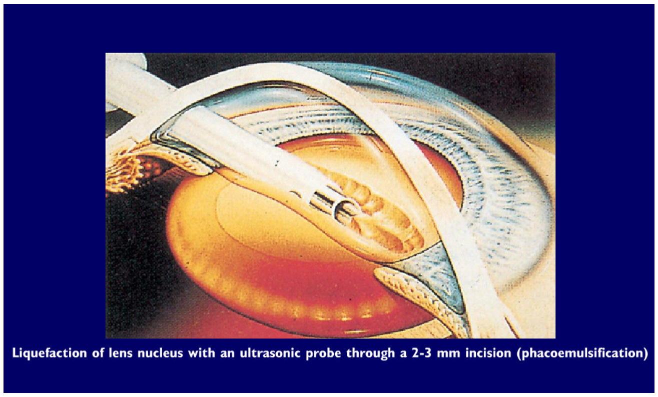
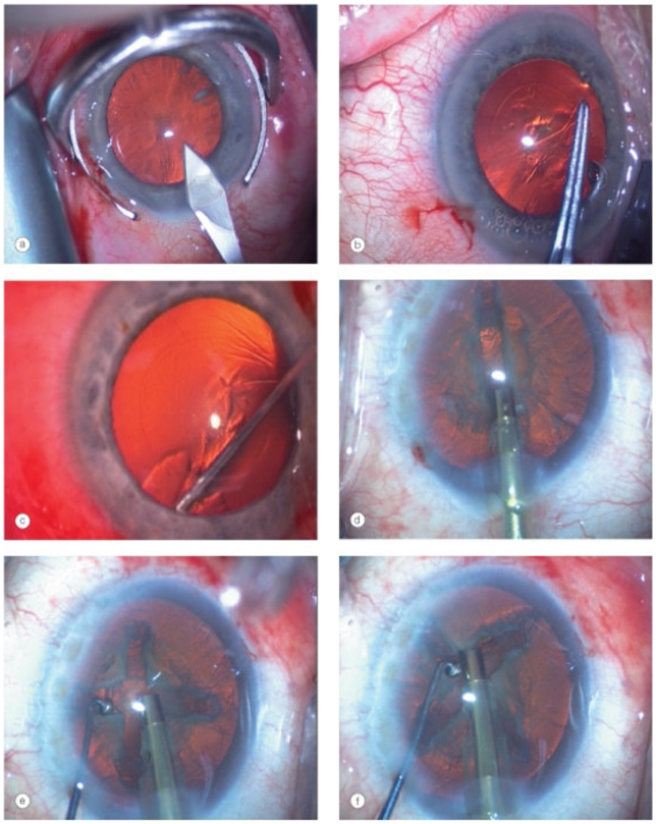


Figure 3-8 Liquefaction of nucleus with an ultrasonic probe phacoemulsification). (Khaw 2004)

The hard endonucleus is divided into several small pieces, which allows for more controlled removal using less phaco power and less phaco time. These techniques require a continuous curvilinear capsulorrhexis to provide an intact and very resistant capsular opening. Because the nucleus is divided into pieces before removal from the capsular bag, the capsular opening can be smaller than with whole nucleus removal. Effective hydrodissection and hydrodelineation are critical to the success of these techniques (Fig.3-9).(Gimbel 1991)

Other techniques for phacoemulsification have also been described, which are the following;

- Clip and Flip technique
- Crater divide and conquer technique
- Phaco fracture technique
- Crack and flip technique
- Chopping techniques
- Nuclear flip techniques



© 2007 Elsevier Ltd. Kanski: Clinical Ophthalmology 6e

Figure 3-9: (a)Corneal incision (b) capsulorrhexis (c) hydrodissection (d) nucleus is grooved (e) nucleus is cracked (f) each nuclear quadrant is emulsified and aspirated(Kanski 2006)

.

Instruments settings for phacoemulsification

Most methods of nucleus removal consist of several distinct steps including sculpting, cracking, grasping and emulsifying.

With actually phacoemulsification machines, all of the phacoemulsificaton parameters- power, aspiration flow rate, and vacuum- can be adjusted for each step of the procedure.

After the nucleus has been sculpted and cracked, the nuclear fragments are grasped and emulsified by occlusion of the phaco tip (Fig.3.4). Vacuum is essential at this point in the procedure to grasp the nuclear fragments, pull them to the center of the lens capsule and emulsify them. Full occlusion of the phaco tip allows the vacuum to build up to its maximum present level. Full vacuum draws nuclear material up into the tip and allows it to be deformed as it enters. The ultrasound power than emulsifies the material into smaller pieces. Flow functions to drive the emulsified nuclear material farther into the tip and it also helps to feed the additional nuclear material into the tip.

The repulsive action of the ultrasound tip oscillating against the nuclear material is counterbalanced by the vacuum and the following pulling the material inward.(Liesegang 2001)

The vacuum is set to a level appropriate for the hardness of the nucleus; harder cataracts require higher vacuum. If vacuum is set too low, lens chatter can occur with large and small nuclear fragments bouncing around the anterior chamber. The trend today is to use higher vacuum both to improve the purchase of the phaco tip on the nuclear material and to reduce phaco power and phaco time.

Irrigation and aspiration

The instruments and techniques for irrigation and aspiration for phacoemulsification are the same as for ECCE with manual expression (Fig.3-10). Occasionally, a small rim of nuclear or epinuclear material remains after phacoemulsification, and the surgeon may remove this soft material by pulling it into the aspiration port with a second instrument, while applying maximum vacuum suction. Alternatively this epinuclear material may be removed with the phacoemulsification tip, utilizing aspiration and occasional bursts of phaco power as needed

.

Intraocular Lens Implantation - IOL

The wound size must be large enough to accommodate the IOL.

1. Posterior chamber IOL implantation
2. Anterior chamber IOL implantation

Anterior chamber IOLs are inserted when a complication appears, due to which capsular support is insufficient. IOLs are supported by the chamber angle and are generally flexible. Earlier rigid types of anterior chamber IOLs required precise sizing to avoid lens movement and erosion of adjacent tissues. In the normal eye the chamber angle is circular while the limbus is oval.

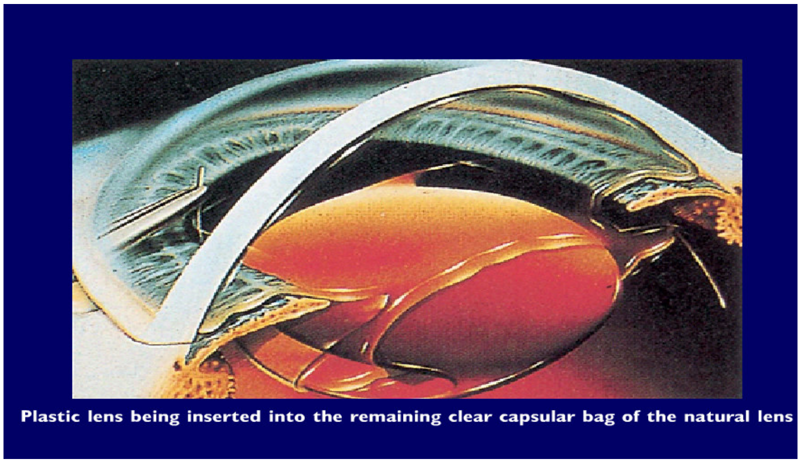
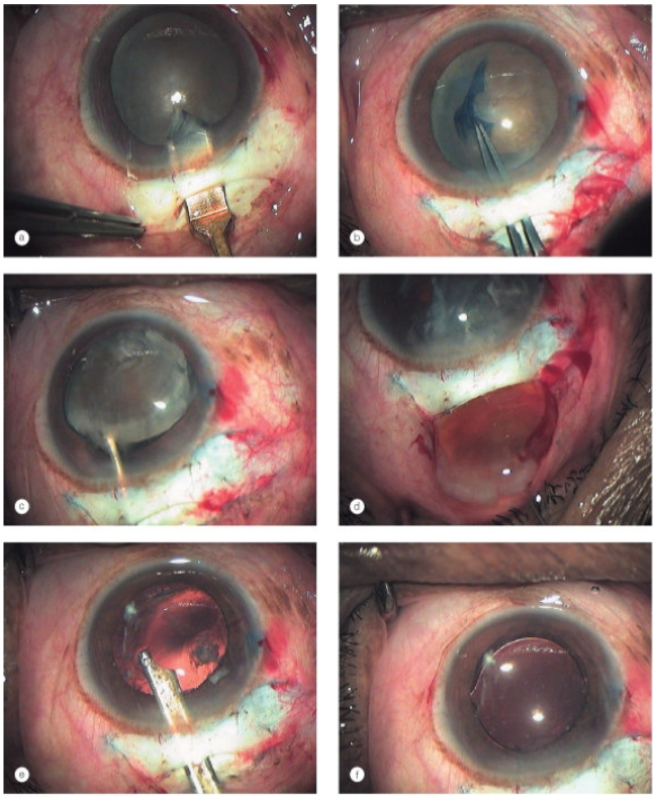


Figure 3-11- Lens being inserted into the remaining clear capsular bag of the natural lens (Khaw 2004)

Posterior chamber IOL implantation may be secured within the capsular bag or in front of the capsule within the ciliary sulcus (Fig.3-11). The IOL is advanced through the wound, with the inferior loop placed into position first. The IOL optic is then brought into the pupil, and the superior loop is fixed and placed into position. If the capsulorexis has been made, implantation can be performed with direct visualization of the anterior capsule opening. With other types of capsule opening, such as a can-opener capsulotomy, visualizing the anterior capsule for precise placement of superior loop may be more difficult. (Kanski 2006)



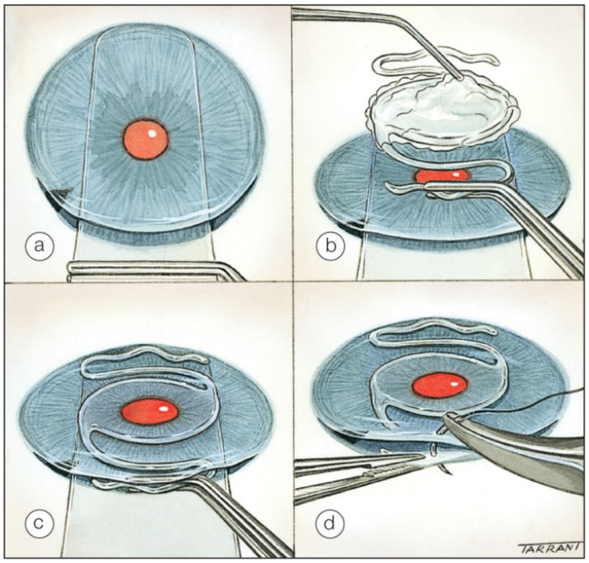
© 2007 Elsevier Ltd. Kanski: Clinical Ophthalmology 6e

Figure 3-10: Small incision manual cataract surgery. (a) Anterior chamber is entered;(b) capsulorrhexis; (c) prolaps of nucleus into anterior chamber; (d) expression of nucleus; (e) cortical cleanup (f) IOL in place (Kanski 2006)

The pupil is generally constricted pharmacologically prior to IOL implantation.

The anterior chamber depth is stabilized and the corneal endothelium is protected with viscoelastic or air. A lens glide may be inserted across the anterior chamber into the inferior angle to protect the pupil from the advancing inferior IOL haptic. As the IOL is held against the inferior angle, the glide is withdrawn while the intraocular lens is stabilized with forceps, and the superposterior lip of the wound is gently retracted to allow placement of the superior haptic in the angle (Fig. 3-12). Visual inspection should confirm the proper insertion of the superior haptic. The surgeon can adjust IOL position by using a hook to flex the optic toward either angle for repositioning (Liesegang 2001).

Alternatively, a second type of anterior chamber IOL exists, called "iris claw lens" or ARTISAN lens, which is attached on the front surface of the iris.



© 2007 Elsevier Ltd. Kanski: Clinical Ophthalmology 6e

Figure 3-12: Anterior chamber IOL implantation. (a) Glide is inserted (b) IOL is coated with viscoelastic (c) IOL is inserted (d) incision is sutured (Kanski 2006)

3.4 Complications of cataract surgery

Although cataract surgery is a successful procedure, complications may occur intraoperatively or during the immediate or late postoperative period. It is thus necessary to examine the postoperative cataract patient at periodic intervals. Complications of cataract surgery are summarized in the following table (Liesegang 2001)

The main intraoperative and postoperative complications are explained further in detail.(Liesegang 2001)

Complications of Cataract Surgery

I.Intraoperative

(In order of frequency)

Capsule Rupture	
Shallow or Flat Anterior Chamber	• Wound leak • Choroidal detachment • Pupillary block • Ciliary block • Suprachoroid hemorrhage
Hemorrhage	• Retrobulbar Hemorrhage • Suprachoroidal Hemorrhage or Effusion • Expulsive Choroidal hemorrhage • Delayed Choroidal Hemorrhage • Hyphema
Posterior Dislocation of Lens Fragments	
Posterior Infusion Syndrome	

II.Postoperative

Corneal Edema and Pseudophakic Bullous Keratopathy
Brown-McLeanSyndrome
Elevated IOP
Cystoid Macular Edema
Retinal Detachment
Endophthalmitis

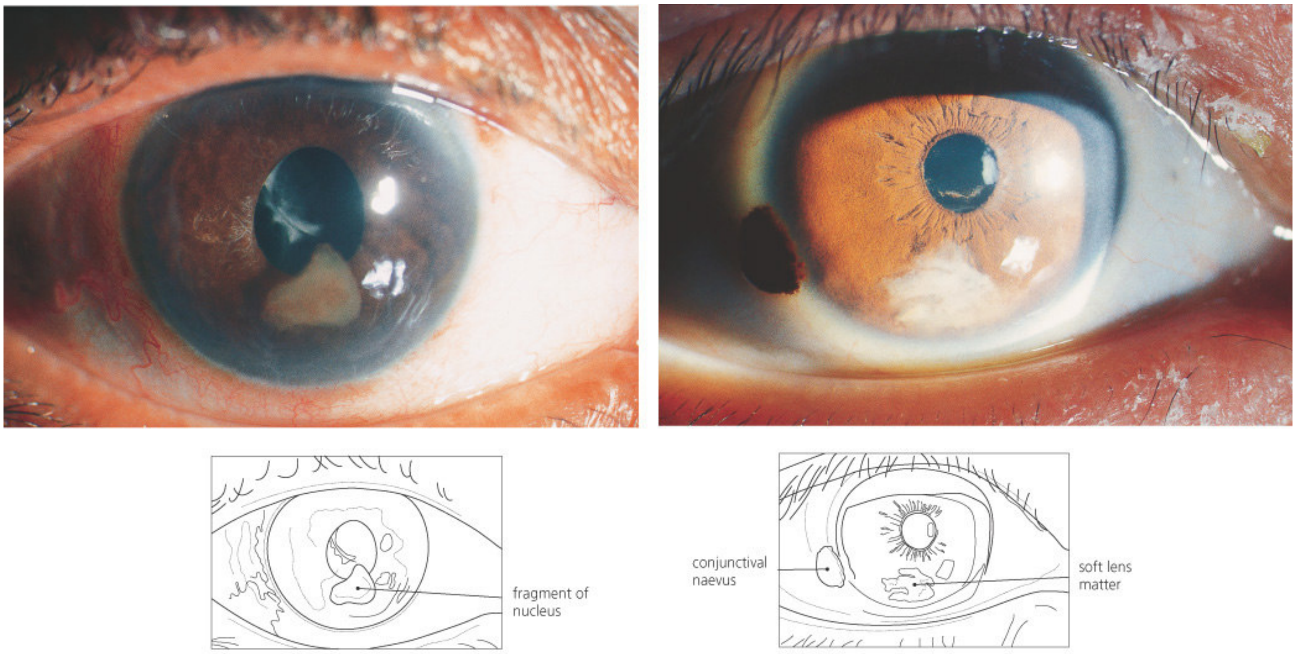
Chronic Uveitis
Corneal Melting with Ocular surface Disease
Wound Leak or Filtering Bleb
Iridodialysis
Cyclodialysis
Ciliary Block Glaucoma
Vitreus disruption or Incarceration in Wound
Induced Astigmatism
Pupillary Capture
Capsular Opacification and Contraction
Decentration and Dislocation of IOL
Uveitis-Gaucoma-Hyphema Syndrome
Wrong Power IOL
Pupillary Capture
Capsular Opacification and Contraction

I. Intraoperative complications

Retained lens fragments with intact posterior capsule

Patients with retained lens fragments present with varying degrees of inflammation depending on the size of the lens fragment, the type of lens material, amount of time elapsed since surgery, and the patient's individual response The clinical signs of retained lens material may include uveitis, glaucoma, corneal edema, and vitreous opacities causing profound visual loss.

Retained lens material does not necessarily require surgical intervention. In general, cortical material is better tolerated and more likely to resorb over time than is nuclear material, which persists longer and is more likely to incite a significant inflammatory reaction and elevated IOP, even in small amounts. In addition, smaller fragments of lens material are better tolerated than larger pieces, for the same reasons.



© 2005 Elsevier Ltd. Spalton et al: Atlas of Clinical Ophthalmology 3e

Figure 3-13: Dislocation of the lens fragments in the anterior chamber (Spalton 2005)

Observation is warranted for patients with small amounts of retained lens material in hopes that the lens material will be resorbed. Inflammation should be controlled with corticosteroid and nonsteroidal anti-inflammatory drops and cycloplegics. IOP can be controlled with topical agents and systemic carbonic anhydrase inhibitors. Surgical intervention maybe necessary to remove residual lens material in the following situations:

- Presence of a very large and visually significant amount of lens material
- Increased inflammation not readily controlled with topical medications

- Medically unresponsive elevated IOP resulting from the inflammation
- Associated retinal detachment or retinal tears
- Associated endophthalmitis

If the posterior capsule is intact, simple aspiration of residual cortex through an anterior incision may be carried out using an irrigation/aspiration instrument.

Capsular Rupture

If capsular rupture occurs during phacoemulsification, nuclear material may enter the posterior segment, and the high-fluid-flow state in the anterior chamber exacerbates this risk. A small rupture in the posterior capsule during emulsification of the nucleus can be managed by altering the surgical technique. To extract the remaining nuclear fragments mechanically, the surgeon should enlarge the incision and remove the nucleus with a lens loop or spoon in a manner that minimizes vitreous traction or further damage to the capsule. If the majority of the nucleus remains and the capsular tear is large, further attempts at phacoemulsification should be abandoned. Again, the incision should be enlarged and the nucleus removed with a lens loop or spoon (Fishkind 1999).

If only a small portion of the nucleus remains to be aspirated, the surgeon, by lowering the infusion bottle, may be able to remove the remaining nuclear material with the phacoemulsification tip (using full occlusion of the aspiration port and minimal phacoemulsification power). Insertion of a second instrument or lens glide behind the nuclear remnant may help prevent its dislocation into the vitreous. Alternatively, viscoelastic can be introduced posterior to the fragment in an effort to float it anteriorly. If the nuclear material drops posteriorly, the surgeon should perform an anterior vitrectomy and remove the peripheral cortical material. Retrieval of the nuclear fragment from the deep vitreous is not recommended. An IOL of choice may be inserted with consideration. The wound should then be sutured closed. The posteriorly dislocated nuclear material should be approached using a pars plana vitrectomy technique, either immediately or within a surgeon who is experienced with these techniques. Following are some guidelines on managing posteriorly dislocated lens fragments for the anterior segment surgeon:

- Attempt retrieval only if fragments are easily accessible.
- Perform anterior vitrectomy to avoid vitreous prolapse.
- Insert IOL when safe and indicated, preferably by capsular fixation, but into the anterior chamber as necessary.
- Perform standard wound closure and viscoelastic removal.
- Prescribe frequent postoperative topical NSAIDs and IOP-lowering agents.
- Provide referral for prompt vitreoretinal consultation.

When a small rent appears in the posterior capsule during aspiration of cortex without rupture of the vitreous face, the surgeon should attempt to remove the residual cortex without expanding the tear. With viscoelastic to stabilize the anterior chamber, some surgeons use a forceps to convert the tear into a round capsulorrhexis that will not spread equatorially. Residual cortex can then be removed from the peripheral lens capsule using low irrigation and aspiration flow to avoid disruption of the hyaloid face. Some surgeons prefer a manual technique, using a cannula attached to a handheld syringe to remove residual cortex after capsular rupture and there by avoiding any pressure from irrigation.

When larger posterior capsule tears occur, or when the anterior hyaloid face is broken, a vitrectomy is recommended to facilitate the removal of the residual cortex and the subsequent placement of an IOL. A vitrectomy can also prevent the development of vitreomacular traction from the IOL or the wound (Kim, Flynn et al. 1994)

Posterior dislocation of crystalline lens or fragments

Phacoemulsification of the cataractous lens has gained popularity in the recent years, as it enables small incision surgery and leads to more rapid visual rehabilitation. However, it is not free of complications, both intraoperative and postoperative, some of which can compromise the visual outcome.

Dislocation of crystalline lens fragments into the vitreous cavity is one of the most serious complications of phacoemulsification. Its incidence has been estimated between 0.2% and 1.5% (Lai, Kwok et al. 2005). It can induce marked intraocular inflammation, resulting in corneal edema, cystoid macular edema, vitreous opacification, vitreous hemorrhage, acute or chronic glaucoma, and retinal detachment (Kim, Flynn et al. 1994),(Borne, Tasman et al. 1996), (Margherio, Margherio et al. 1997), (Yeo, Charteris et al. 1999), (Kageyama, Ayaki et al. 2001),(Stewart 2007).

During lens removal, lens fragments may migrate into the vitreous cavity if zonular dehiscence or posterior capsular rupture occurs. This complication is thought to occur more commonly with phacoemulsification than with ECCE.

If there is a defect in the posterior capsule, pars plana vitrectomy and removal of lens material are more appropriate. When such major intervention is necessary, retained lens material should be removed from the vitreous by a surgeon skilled in pars plana vitrectomy techniques. Recent studies have reported that the vitreoretinal surgeon can delay intervention up to 7-14 days following the initial cataract surgery without jeopardizing the successful outcome. Chronic glaucoma and cystoid macular edema may be more likely when intervention is delayed more than 3 weeks after the cataract surgery.(Liesegang 2001) (Smiddy, Flynn et al. 1996)

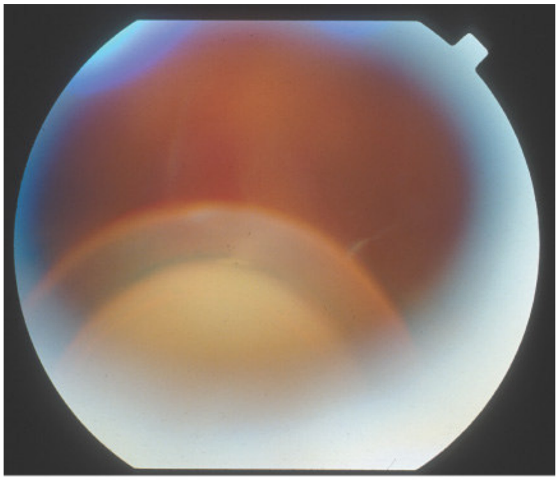


Figure 3-13 Rupture of the posterior capsule during phacoemulsification can lead to the loss of nuclear fragments into the vitreous cavity (Spalton 2005).

The preferred approach for removal includes pars plana vitrectomy with or without ultrasonic emulsification (with the fragmatome) to remove harder pieces of lens nucleus. In the setting of concurrent retinal detachment, the perfluorocarbon liquids may be useful to float the lens material anterior while stabilizing the retinal detachment. After the vitreous is removed, the fragmatome can be used at the low power setting in order to maintain the contact between the fragmentation probe and the nuclear fragment. The vitreous surgeon should be prepared for secondary IOL insertion if no IOL was inserted at the original cataract surgery. The retinal periphery should be examined for the presence of the retinal tears or retinal detachment in these patients.(Borne, Tasman et al. 1996) (Gilliland, Hutton et al. 1992)

Reported series with long–term follow-up have found that retinal detachment occurs in about 15% eyes with retained lens fragments. If the lens fragments are in the posterior vitreous, aggressive attempts to retrieve them from a limbal approach are sometimes complicated by retinal detachment with giant retinal tear. Giant retinal tear is more common in the inferior quadrants when a superior limbal approach was used for cataract surgery and attempts to retrieve the lens fragments through limbal vitrectomy.(Lewis, Blumenkranz et al. 1992)

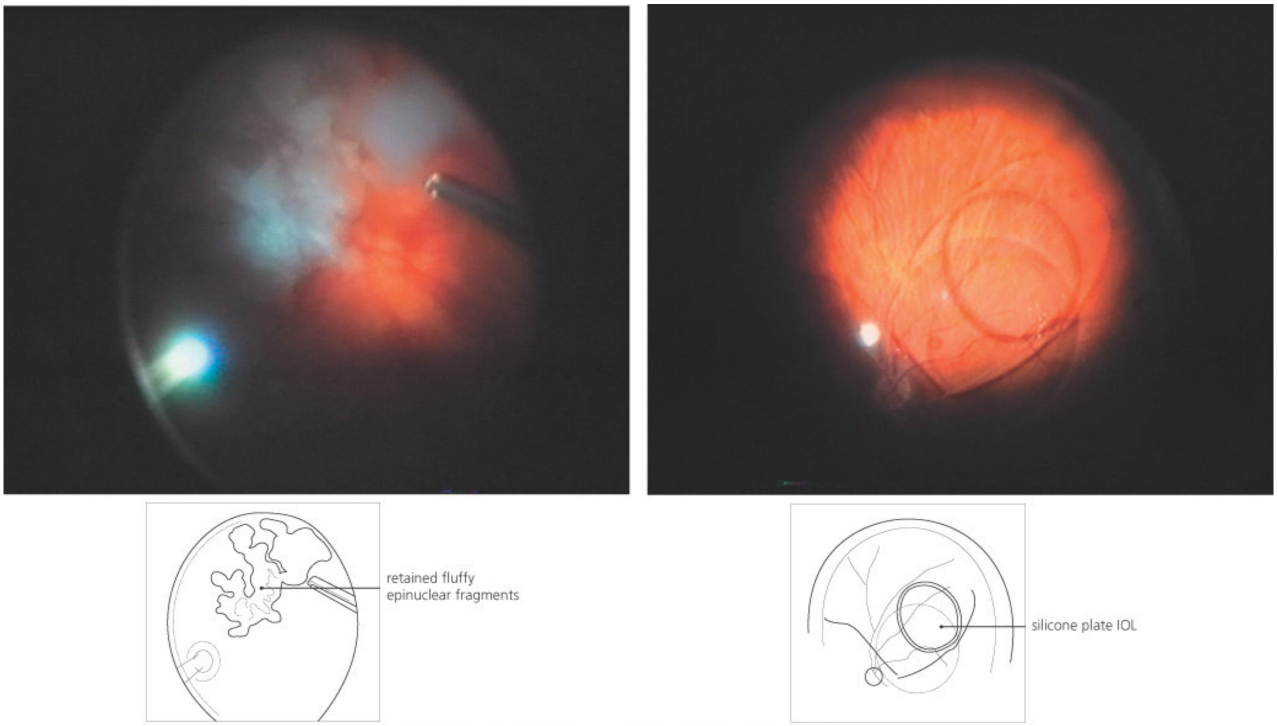


Figure 3-14: ***Left:*** Extensive dislocated lens fragments lying at the posterior pole at the time of their surgical removal. ***Right:*** Dislocated silicone plate IOL in the inferior retina following laser capsulotomy. (Spalton 2005)

Visual acuity outcomes in eyes with retained lens fragments are dependent on multiple factors. (Liesegang 2001)

- Preexisting posterior segment diseases
- Complications during the original cataract surgery
- Complications during the pars plana vitrectomy
- Postoperative complications during follow-up

Shallow or Flat Anterior Chamber may occur during ECCE or phacoemulsification because of inadequate infusion of balanced salt solution into the anterior chamber, leakage through an oversized wound, external pressure on the globe, or positive vitreous pressure.

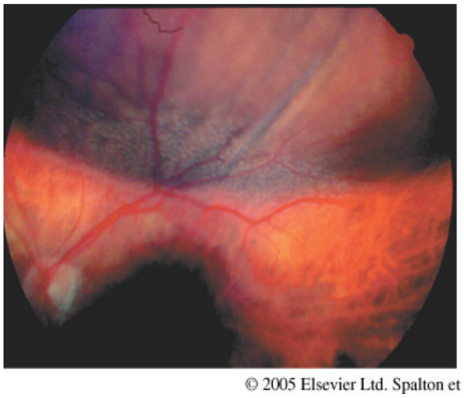
If the reason for the loss of anterior chamber depth is still unknown, the surgeon should check the red reflex to evaluate the possibility of suprachoroidal hemorrhage or effusion. Often it is necessary to examine the fundus with an indirect ophthalmoscope to confirm the diagnosis of a suprachoroidal hemorrhage or effusion.

Posterior infusion syndrome

In rare cases, the fluid infused into the anterior chamber may be misdirected into the vitreous cavity, causing an increase in the vitreous volume with subsequent forward displacement of the lens and shallowing of the anterior chamber. The fluid may accumulate in retrolenticular space or dissect posteriorly along the posterior wall of the vitreous cavity. The complication is most likely to occur during hydrodissection, when fluid is forcely injected into the capsular bag. A shallow anterior chamber resulting from posterior infusion syndrome may indicate loss of integrity of the capsular bag, damaged zonular fibers or misplacement of the irrigation tip. If gentle posterior pressure on the lens does not alleviate the situation, infusing intravenous manitol may allow the anterior chamber deepen.

Expulsive Choroidal Hemorrhage

Expulsive choroidal hemorrhage, a rare but serious problem, generally occurs intraoperatively .It require immediate action. It presents sudden increase in IOP accompanied by darkening of the red reflex, wound gape, iris prolapse, and expulsion of the lens, vitreous and bright red blood. The wound must be closed with sutures or digital pressure in the instant this condition is recognized.



© 2005 Elsevier Ltd. Spalton et

Figure 3-15 Choroidal hemorrhage (Spalton 2005).

II. Postoperative complications

Complications due to vitreous incarceration

Incarceration of vitreous in the wound during cataract surgery can lead to many postoperative complications:

- It contributes to faulty wound closure, possibly permitting entry of microorganisms into the eye and subsequent endophthalmitis.
- An insecure wound may allow epithelial or fibrous in growth, with the incarcerated vitreous serving as scaffold for the proliferating cells, especially in the presence of other complicating factors such as inflammation and hemorrhage.
- A wound leak may lead to hypotony, partial or complete collapse of the anterior chamber, peripheral anterior synechiae, and/or secondary glaucoma.

Incarcerated vitreous in the wound and iridovitreal adhesions may cause chronic ocular discomfort with inflammation, cystoid macular edema, and disc edema (Irvine-Gass syndrome). These complications have reportedly been reduced by sectioning the anterior vitreous bands with the Nd: YAG laser or by vitrectomy. Retinal detachment is another complication caused by contraction of the incarcerated vitreous. Such detachment may be rhegmatogenous or a combination on tractional and rhegmatogenous types and may require vitrectomy techniques in addition to sclera buckling.

The risk of complications of vitreous loss can be greatly reduced, first by meticulous closure of the wound at the time of cataract surgery and later be careful anterior vitrectomy if necessary (Fung 1985; Harbour, Smiddy et al. 1995)

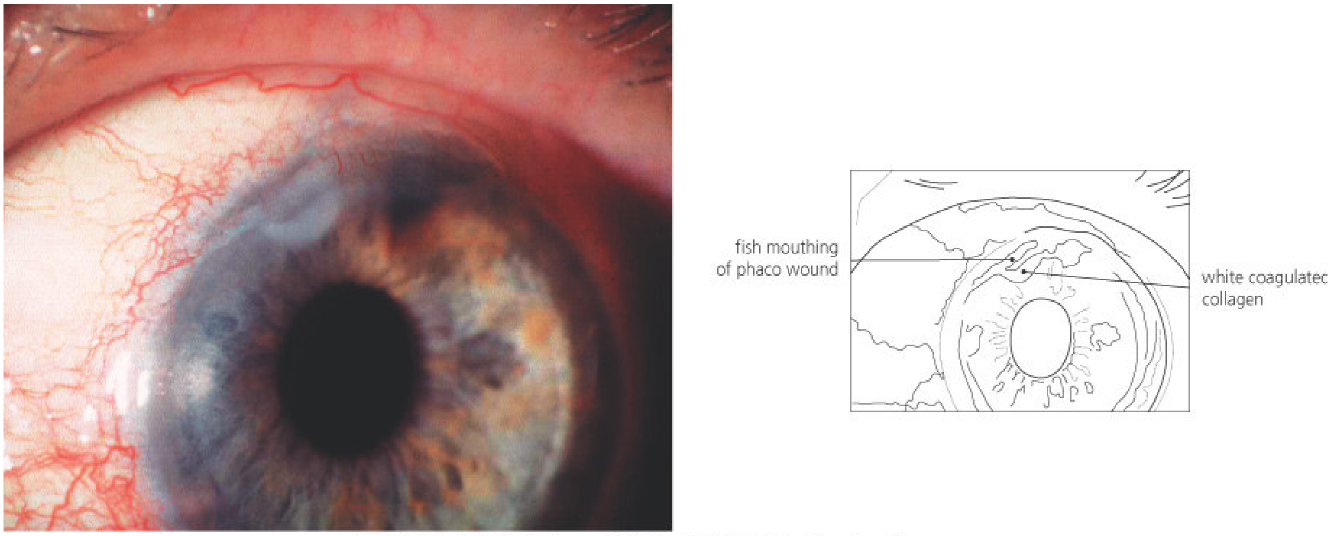
Flat or shallow anterior chamber

Flat or shallow anterior chambers can be classified according to etiology and level of IOP. Classification includes the following:

- Wound leak
- Choroidal detachment
- Pupillary block
- Ciliary block
- Suprachoroidal hemorrhage

Cases associated with ocular hypotension are usually secondary to leakage of aqueous at the wound site or choroidal detachment. Many patients develop an associated choroidal detachment that resolves spontaneously after wound closure.

Cases of flat or shallow anterior chamber with normal or high IOP are usually the result of pupillary block, ciliary block or suprachoroidal hemorrhage.



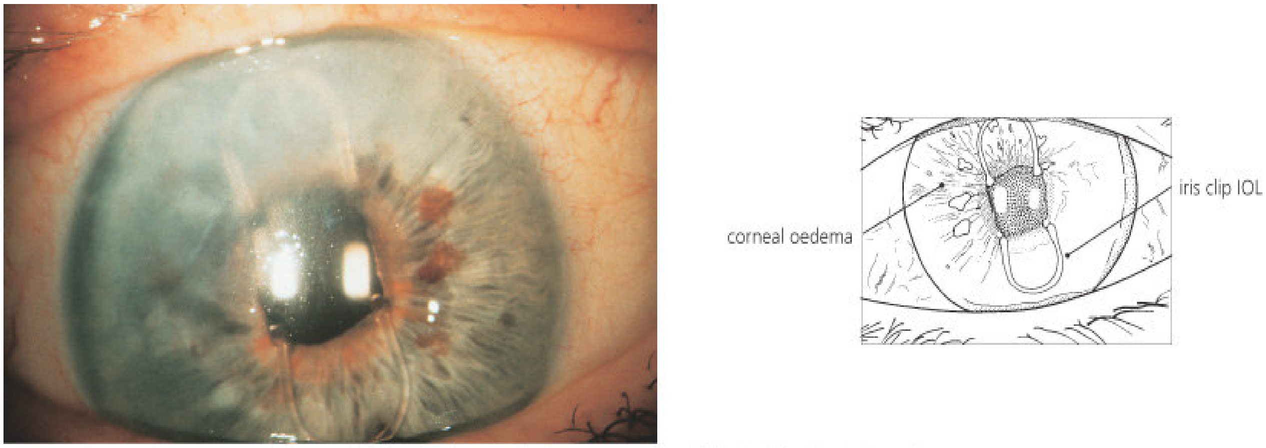
© 2005 Elsevier Ltd. Spalton et al: Atlas of Clinical Ophthalmology 3e

Figure 3-16: Fish mouthing of phaco wound. (Spalton 2005)

The flat anterior chamber during the postoperative period may cause permanent damage to ocular structures. Prolonged apposition of the iris to angle structures can cause permanent peripheral anterior synechiae and chronic angle-closure glaucoma. Corneal contact with either vitreous or an IOL can result in endothelial cell loss and chronic corneal edema.

Corneal Edema

They can occur in the immediate postoperative period. The incidence is higher in eyes with preexisting corneal endothelial dysfunction, and often caused by a combination of mechanical trauma, pronged intraocular irrigation, inflammation, and elevated IOP resulting in acute endothelial decompensation with an increase in corneal thickness. It generally resolves completely within 4-6 weeks following surgery. (Brown and McLean 1969)



© 2005 Elsevier Ltd. Spalton et al: Atlas of Clinical Ophthalmology 3e

Figure 3-17: Corneal oedema with the endothelium irritation as result of excessive phaco power or endothelial touch during surgery, or long term endothelial touch from an anterior chamber lens (Spalton 2005)

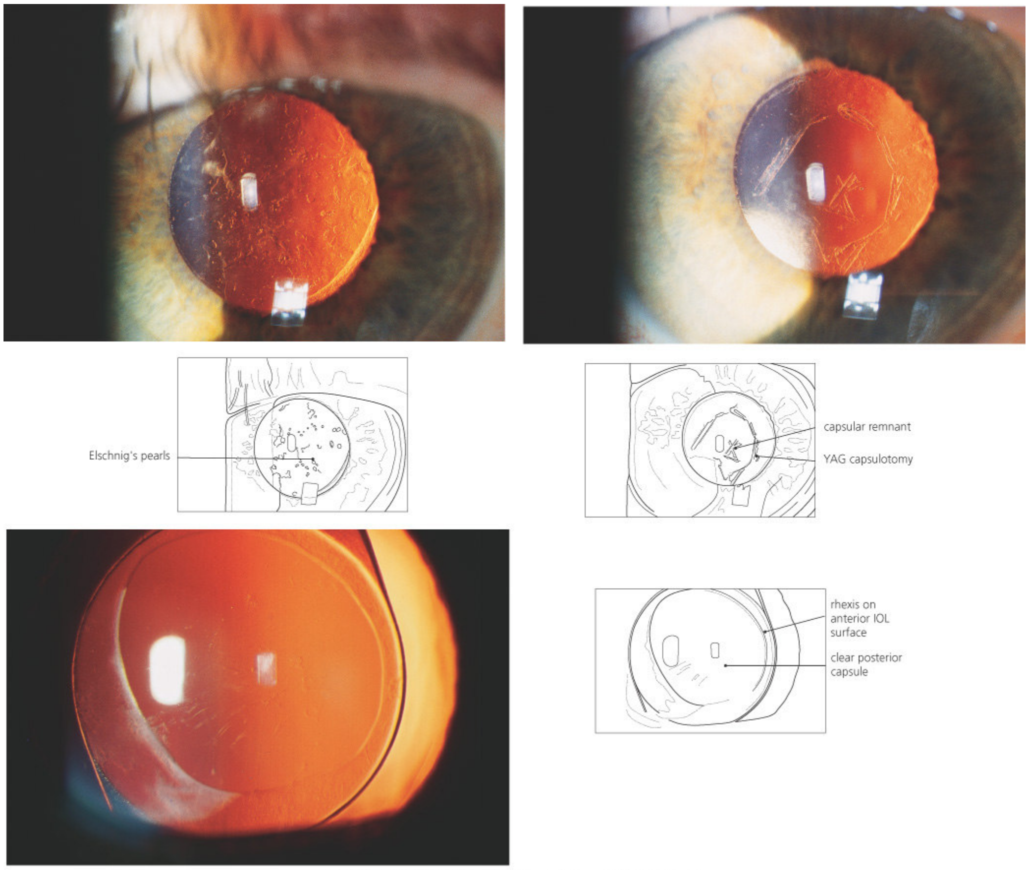
Hyphema

Hyphema is in the immediate postoperative period usually originates from the incision or the iris; it is commonly mild and resolves spontaneously. The two major complications from prolonged hyphema are elevated IOP and corneal blood staining. IOP should be monitored closely and treated in the usual medical fashion, although in may be difficult to control if the blood is mixed with the viscoelastic used during the procedure.

Posterior Capsule Opacification

The most common complication of cataract surgery by means of ECCE or phacoemulsification is opacification of the intact posterior capsule.

Capsular opacification stems from the continued viability of lens epithelial cells remaining after removal of the nucleus end cortex. These cells proliferate in several patterns. Where the edges of the anterior capsule adhere to the posterior capsule, a closed space will be reestablished consisting of nucleated bladder cells (Wedl cells) resulting in a Soemmering's ring. If the epithelial cells migrate outward Elschnig's pearls (large, globular, malformed lens cells) are formed.



© 2005 Elsevier Ltd. Spalton et al: Atlas of Clinical Ophthalmology 3e

Figure 3-18: ***Upper left:*** Elschnig's pearls on posterior capsule. ***Upper right:*** Posterior capsule after YAG laser capsulotomy. ***Down:*** Clear posterior capsule after cataract surgery. (Spalton 2005)

Additionally the introduction of continuous curvilinear capsulorrhexis has been accompanied in some cases by anterior capsule contraction and fibrosis.

Fortunately posterior capsule opacification is amenable to treatment by means of Nd:YAG posterior capsulotomy. (Liesegang 2001)

Retinal Detachment

Retinal Detachment occurs in 2%- 3% in eyes following ICCE, and in 0.5-2.0% eyes following ECCE. It is related to preoperative or intraoperative factors:

- Preoperative

- Lattice degeneration or retinal breaks should be treated prophylactically prior to cataract surgery or laser capsulotomy if fundus view permits, or as soon as possible thereafter.

- High myopia

- Intraoperative

- Disruption of the posterior capsule

- Vitreous loss, particularly if managed inappropriately, is associated with an approximate 7% risk of retinal detachment; myopia of over 6D increases to 15%.

Cystoid Macular edema

Is a common cause after complicated and uncomplicated cataract surgery (also known as Irvine Gass syndrome). It may be demonstrated angiographically in eyes with good vision. Fortunately in most cases it is transient. It occurs more often after complicated surgery involving rupture of the posterior capsule and vitreous prolepses, sometimes with incarceration in the incision.

It usually presents 1-6 months after surgery.

Associated factors include inflammation with release of prostaglandins, vitreomacular traction, and transient or prolonged hypotony.

If the diagnosis of cystoid macular edema is based on visual loss the incidence is 2%- 10% following intracapsular surgery and 1- 2% following ECCE with an intact posterior capsule.

Most studies find spontaneous resolution in patients who have undergone ICCE, with less than 3% incidence of permanent visual loss. Rarely, may develop many years after ICCE, especially in association with delayed postoperative rupture of the anterior hyaloid face. (Liesegang 2001)

Endophthalmitis

Endophthalmitis prevalence is 0.07%-0.32% in cataract surgery. Bacteria predominantly cultured in postoperative endophthalmitis are gram-positive, especially Staphylococcus epidermidis. Most of the bacteria come from the patient. Bacterial adhesion to intraocular lenses (IOLs) takes place during their implantation, a prominent etiological factor. Polypropylene was the first biomaterial that proved this relation of cause and effect between bacterial adhesion and endophthalmitis. The benefit of antibiotic prophylaxis during cataract surgery has yet not been proven, since the low prevalence of endophthalmitis makes controlled studies with a large cohort difficult (Kodjikian, Roques et al. 2005). However, a recent study showed that use of intracameral cefuroxime at the end of surgery reduces the occurrence of postoperative endophthalmitis (E.S.G. 2007)

Conclusions from the Endophthalmitis Vitrectomy Study (EVS) remain a foundation for management of postcataract surgery endophthalmitis, notably prompt intravitreal antibiotic administration after vitreous sampling, with consideration for pars plana vitrectomy in severe cases (Lemley and Han 2007)

Late onset endophthalmitis develops following cataract surgery when an organism of low virulence trapped within the capsular bag. It has an onset ranging from 4 weeks to years (mean 9 months) postoperatively and typically follows uneventful surgery. It may rarely be precipitated by YAG-laser capsulotomy, which releases the sequestrated organism from the posterior capsule into the vitreous. The infection is caused most frequently by *Propiobacterium acnes* and occasionally *Staphylococcus epidermidis*, *Corinebacterium spp.* or *Candida parapsilosis*.(Singh and Stewart 2006)

Because the sequestered organisms are isolated from host defenses and antibiotics, antibiotic treatment alone is unlikely to be successful. Removal of the capsular bag, residual cortex and IOL is recommended and requires pars plana vitrectomy. Secondary IOL implant may be considered at a later date. Intravitreal vancomycine (1mg in 1 ml) is the antibiotic of the choice although *P.acnes* is also sensitive to methicillin, cefazolin and clyndamycin. (Kim, Flynn et al. 1996)

4. PARS PLANA VITRECTOMY

The vast majority of the cases of posteriorly dislocated fragments after cataract surgery need to be treated by pars plana vitrectomy with or without intravitreous phacoemulsification. This technique has improved familiarity and confidence. (Ruiz-Moreno, Barile et al. 2006)

4.1 History

Modern instrumentation for intravitreal surgery was not developed until the latter half of the 20th century. Important milestones are the following:

- **1922**: Koeppe introduces biomicroscopy of the posterior segment, which makes it possible to examine details in the vitreous and retina.
- **1962**: Kasner intentionally excises vitreous gel through the corneal wound in an eye with a severe anterior segment laceration.

- **1970**: The first surgical technique called "Pars Plana Vitrectomy" is presented to the American Academy of Ophthalmology. Machemer develops the first clinically effective vitrectomy instrumentation and also the basic surgical principles.
- **1971**: First publication ever on Pars Plana Vitrectomy (Machemer 1971).
- **1972**: Coleman develops a knife with a diamond blade having an edge thickness of only 30 nm.
- **1974** O'Malley describes tree-port system with separate 20-Gauge (0.89 mm) instruments for the vitreous cutter, infusion, and endoillumination.
- **2002**: Fujii introduces the first commercially available sutureless transconjunctival 25-Gauge (0.5 mm) Pars Plana Vitrectomy, which improves outcomes in vitreoretinal surgery.
- **2005** Eckardt describes 23-Gauge (0.72 mm) transconjunctival sutureless system.
- **June 2008** PubMed search for 23- and 25-Gauge vitrectomy gives 143 publications.

4.2 Instrumentation

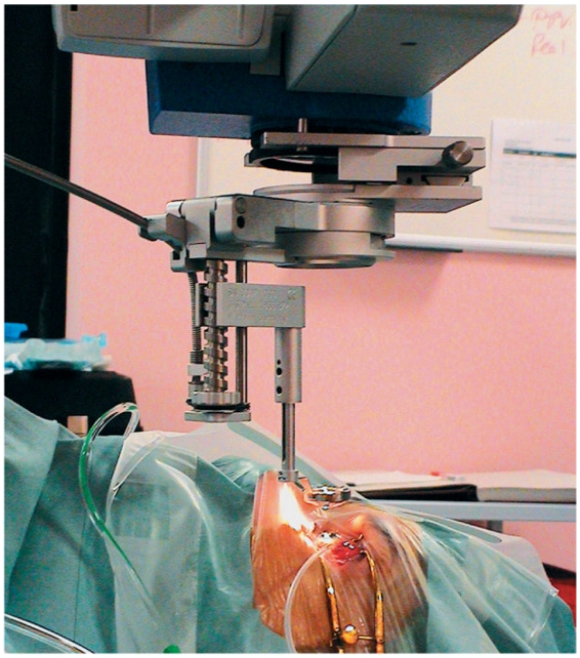
The following instruments have been developed throughout the evolution of Pars Plana Vitrectomy:

Operating Microscope

Motorized functions were necessary because of the need for frequent changes in focus, magnification and microscope position (Fig. 4-1).

- Basic vitrectomy instrumentation

Vitreous surgery requires specialized instruments with small diameter tips that are capable of excising intraocular tissue a bite at a time. In some instruments the functions are divided among two or more probes and cannulas (who permit more effective use of accessory instrumentation and specialized techniques)



© 2007 Elsevier Ltd. Kanski: Clinical Ophthalmology 6e

Figure 4-1: Wide-angle viewing system consists of an indirect lens beneath the operative microscope and a series of prisms to re-invert the image. The field of view is almost out to the ora serrata, and higher magnification lenses are also available for macular surgery.

- Full function vitrectomy probes

Full function vitrectomy probes usually combine cutting, aspiration, and infusion features in the housing of the instrument tip, and fiber optic illumination can be added as a sleeve around the tip.VISC (Vitreous-Infusion-Suction-Cutter) are most commonly used instruments.(Michels 1990)

- Divided system instrumentation-

The four instrument functions are divided among different probes and cannulas. They have several advantages compared with full-function probes. The small instruments are safely introduced to the temporal and nasal quadrants, and they are easier to handle.

1. **The cutter** has an inner guillotine blade which oscillates up to 1500 times/minute, cutting the vitreous gel into tiny pieces and simultaneously removing it by suction into a collecting cassette.(Fig.4-2) Newer high speed cutters (over 2500 oscillations per minute) are increasingly being used allowing less traction on the vitreoretinal interface during surgery.

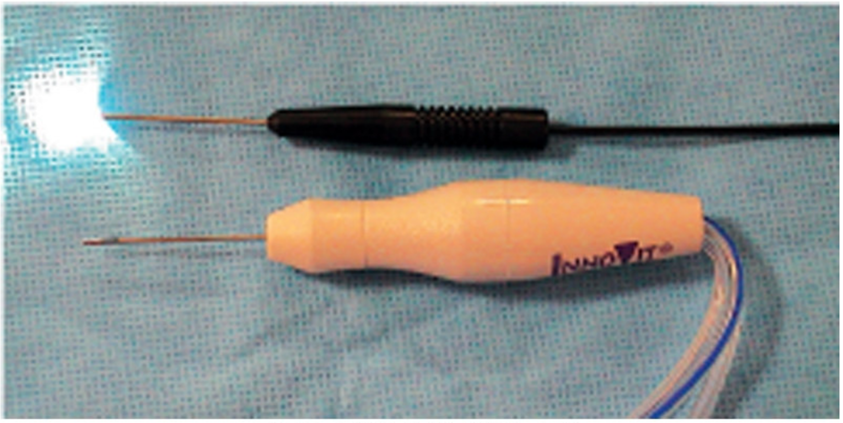


Figure 4-2-The cutter (Kanski 2006)

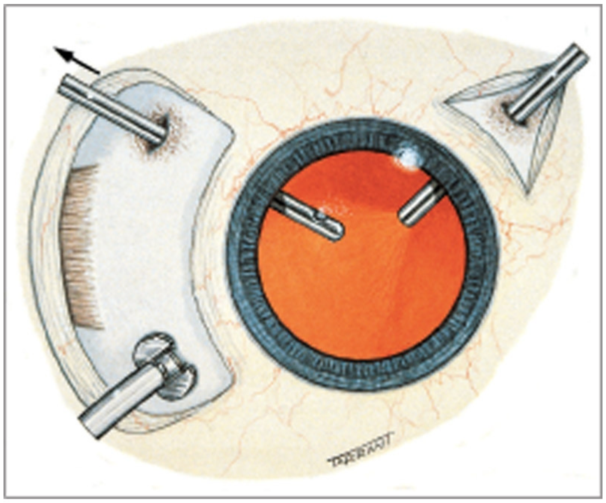
2. The intraocular **illuminate source** is through a fibreoptic probe which delivers light from an 80-150 watt bulb. Brighter, high intensity halogen type light sources are also becoming available and can be inserted via a self-retaining cannula into a fourth port. These have the advantage of allowing the surgeon to carry out true bimanual surgery, which can be particularly useful in challenging cases such as advanced tractional diabetic retinal detachment.

3. The **infusion cannula** usually has an intraocular length of 4mm, although in special circumstances (such as choroidal detachment or eyes with opaque media) a 6mm canula may be required.

4. **Accessory instruments** include scissors, forceps, and flute, needle, endodiathermy and endolaser delivery systems.Vitreoretinal scissors- useful to section tissue near inner retinal surface while causing only minimal traction on adjacent vitreoretinal attachment. (Kanski 2006)

Accessory instrumentation was also developed to deal with special intraocular problems such as active bleeding or a firm cataract lens.

Other accessory instruments were designed to assist in dissecting, sectioning and removing pathological intraocular tissue, removing intraocular foreign bodies, applying photocoagulation, and injecting gas into the vitreous cavity



© 2007 Elsevier Ltd. Kanski: Clinical Ophthalmology 6e

Figure 4-3: A standard three-post pars plana vitrectomy instrumentations set up, including the infusion tube (a), the cutter/aspiration probe (b), and the illumination source through a fibreoptic probe (c) (Kanski 2006)

5. **Wide – angle viewing system** consist of an indirect lens beneath the operative microscope and a series of prisms to re-invert the image. The field of view is almost out to the ora serrata, and higher magnification lenses are also available for macular surgery.

- Corneal contact lenses - are used to permit visualization deep within the vitreous cavity or at the peripheral retina.

- Ultrasonic phacofragmenter- Removal of cataractous lens during vitreous surgery is accomplished through a pars plana incision using an ultrasonic needle to emulsify and remove lens material of firm consistency. In divided system instrumentation a second infusion system attached to the ultrasonic needle is unnecessary. An ultrasonic needle with the same diameter as a small vitrectomy probe is used, and the emulsified lens material is removed through the lumen of the needle. The emulsified lens material is than lavaged out of the eye along the needle shaft and through the larger sclerotomy.
- Intraocular diathermy- two surgical instruments present in the eye serve as electrodes (current is mainly confined to elliptical field between electrodes of the bipolar system).
- Intraocular cryotherapy and instruments - permit precise and effective treatment of posterior retinal breaks located near the macula or optic nervehead and limits the amount of adjacent tissue damage. It is important adjunct to vitreous surgery. The activated laser beam and photocoagulation spot are readily visible, and the probe tip can be redirected after each application.
- Magnets – intraocular magnetic probes for metallic foreign body that could be introduced directly into the vitreous cavity. The tip can be positioned near the foreign body.
- Air pumps- fluid gas exchange in treating many eyes requiring vitreous surgery for retinal detachment. (Michels 1990)

4.3 Procedure

Despite the variations introduced by different indications and instrumentations, and the individual features of each case, the basic principles of vitreous surgery are well established. The operation is performed through watertight incisions, so that the intraocular pressure is maintained in a suitable range throughout the procedure, while not restricting movement of the instruments.

Minimum levels of the suction force are used throughout the operation to avoid causing the excessive traction on the retina.

The intravitreal surgical objectives are usually to be achieved in the following sequence:

- Removal of axial opacities

Release of any anteroposterior viteoretinal traction by excising the posterior vitreous surface , which is often partially separated from the retina in eyes with proliferative retinopathies and extends between and / or areas of posterior vitreoretinal detachment (Michels 1990)

- Release of transverse or tangential viteoretinal traction by excision of remaining portions of the posterior cortical vitreous and / or elevated tissue membranes that bridge between one area of retina and another
- Translumination can be used to aid the pars plana incision.

- Following limbal peritomy, an infusion cannula is secured to the sclera 3.5 mm behind the limbus in pseudophakic or aphakic eyes (4mm in phakic eyes) in the inferotemporal quadrant of the eye, at the level of the inferior border of the lateral rectus muscle.
- Two further scleroctomies are made at the 10 and 2 o'clock positions .These can standard stab incisions made with an MVR blade or self-sealing sclerotomies.
- The cutter and fiberoptic light pipe enter through the upper two sclerotomies.

- The central vitreous gel and posterior hyaloids face are excised.
- Introduction of the light and stripper with the central vitrectomy. Ablation of the multiples pieces of the cortex and the nucleus which are in the other part of the vitreous. If there is the adherences we releases mechanically, than we breaks them in small pieces between the stripper and light sonde. It is important to make separation of the posterior vitreous from the papilla to make the conclusion that there is not retinal detachment, and no suspect lesions in the periphery retina. Distinguish of the pars plana and infiltrated vitreous.
- Gas or silicone oil infusion to tamponade the retina in case of detachment of giant tear. Gases used are most often SF6 16% or C3F8 20%.
- Closing of the radiate incisions of the conjunctiva.
- Mephamesone subconjuctival at the end of the operation

The above basic steps apply to all vitrectomies, although transconjunctival small Gauge systems (25-Gauge and 23-Gauge) do not require a peritomy or posterior suturing. The great advantage of small Gauge vitrectomy systems involves making transconjuctival sutureless self-sealing angled sclerotomies. In that way, we decrease the possibility of vitreous incarceration in the sclerotomies, therefore reducing the risk of postoperative retinal detachment.

25-Gauge transconjunctival sutureless vitrectomy

25-Gauge pars plana vitrectomy was introduced in 2002 in an attempt to minimize surgical trauma and time. This method has evolved significantly since its introduction, with newer instruments and novel techniques expanding the scope and improving outcomes in vitreoretinal surgery. Proper case selection is imperative, as the smaller scale of the instruments and decreased fluidics work most efficiently when extensive manipulation of intraocular tissue or significant membrane dissection is not required. Unique complications of 25-gauge surgery such as hypotony and a possible increased rate of endophthalmitis may be related to unsutured sclerotomies, and revisions in surgical approach may help to decrease these potentially devastating complications. (Chen 2007)

The suggested advantages of 25-Gauge vitrectomy are shorter surgical time, less postoperative inflammation, faster visual recovery and improved patient comfort compared to 20-Gauge surgery. (Williams 2008)

23-Gauge transconjunctival sutureless vitrectomy

In the clinical practice, 25-Gauge instruments were sometimes too flexible to perform manipulation on the extreme periphery. Therefore, a 23-Gauge vitrectomy system was developed. 23-Gauge instruments are larger and thought to have improved rigidity over 25-Gauge instruments thus allowing greater rotation of the eye and the ability to perform more complete peripheral vitrectomy.

23-Gauge transconjunctival sutureless vitrectomy is an effective surgical technique in the management of vitreoretinal diseases for a variety of vitreoretinal surgical indications. The safety profile compared favorably with published rates for 25-Gauge systems.(Fine, Iranmanesh et al. 2007).

Complications are rare and compare favorably with previously reported and published literature on 20-Gauge and 25-Gauge surgery. (Tewari, Shah et al. 2008)

25- and 23-Gauge vitrectomy techniques may shorten operating time, improve patient comfort, and speed visual recovery. However, larger and better designed evidence-based studies are required to better understand relative values of 25-, 23-, and 20-Gauge vitrectomy. (Williams 2008)

It has not been evaluated which of the above systems are most appropriate for the treatment of posteriorly dislocated lens fragments. In our study, all the cases were operated with 20-Gauge instruments available from the beginning to the end of the study (January 1997 – December 2006). At present, 23-Gauge vitrectomy is the method of choice also in our clinic.

4.4 Main indications of pars plana vitrectomy

- Rhegmatogenus retinal detachment
- Tractional retinal detachment
- Proliferative vitreoretinopathy (PVR)
- Proliferative diabetic retinopathy
- Nonclearing vitreous hemorrhage
- Vitreoretinal interface disorder
    1. Vitreomacular traction syndrome
    2. Epiretinal memebrane
    3. Macular hole
- Crystalline lens dislocation
- Intraocular lens dislocation
- Intravitreal foreing body
- Posterior uveitis with vitreous opacification
- Endophtalmitis
- Synchysis scintillans (rare)
- Diagnostic vitrectomy

4.5 Complications of pars plana vitrectomy

Complications more commonly associated wit pars plana vtrectomy

- Intraoperative or postoperative retinal break
- Intraoperative or postoperative retinal detachment
- Intraoperative or postoperative cataract
- Postoperative vitreous hemorrhage
- Postoperative massive fibrin accumulation
- Postoperative anterior segment neovascularization

Complications associated with silicone oil

- Glaucoma
- Band keratopathy

Complications in intraocular surgery in general

- Endophtalmitis
- Sympathetic ophthalmia
- Recurrent corneal erosion (Liesegang 2001)

Pars plana vitrectomy has become the treatment of choice for posterior dislocation of lens fragments, helping to remove retained lens material and restore vision in many cases.(Kim, Flynn et al. 1994; Smiddy, Guererro et al. 2003; Ruiz-Moreno, Barile et al. 2006). Thanks to improved wide-viewing systems and instruments, this technique enables good visualization of the peripheral retina, the elimination of capsular and vitreous opacities, the release of vitreoretinal tractions, and the detection of retinal breaks.

Most studies performed in the past agree that pars plana vitrectomy may offer favorable results in such cases. However, the optimal timing of vitreoretinal surgery has not been established. Controversial reports exist favoring either early or late vitrectomy. Moreover, only 77% of posterior dislocation cases are referred to vitreoretinal surgeons, whereas 23% of pars plana vitrectomies are performed by the cataract surgeon himself (Margherio, Margherio et al. 1997), either in the same sitting or on a later date. Inexperience of the cataract surgeon to perform vitrectomy in such cases might be a factor influencing the final result, a question that has not been addressed.

SECOND PART

PURPOSE OF THE STUDY

The purpose of the present study is to compare the outcome and complications of pars plana vitrectomy for the treatment of posterior dislocation of lens fragments during phacoemulsification between anterior segment surgeons and confirmed vitreoretinal surgeons. An additional purpose is to investigate whether an optimal timing of vitreoretinal surgery exists based on the available data.

PATIENTS AND METHODS

We reviewed the medical records of all eyes that received pars plana vitrectomy for posterior dislocation of crystalline lens fragments during phacoemulsification at the Department of Ophthalmology of Geneva University Hospital during a period of 10 years, from January 1997 to December 2006. Patients with follow-up less than one month were excluded from the study.

The following parameters were recorded: the age and sex of the patients, any preexisting eye co-morbidity, the details of cataract surgery, the details of pars plana vitrectomy, the preoperative and final postoperative visual acuity, and the intra- and postoperative complications. Furthermore, special interest was focused on whether the pars plana vitrectomy was performed the cataract surgeon himself (C-surgeon) or a confirmed vitreoretinal surgeon (VR-surgeon), as well as on the interval between cataract surgery and the pars plana vitrectomy. Cataract surgeons were actually starting to learn the technique of vitrectomy, so a learning curve was present. Regarding the interval between cataract surgery and pars plana vitrectomy, three different groups were studied: patients receiving vitrectomy on day zero or one (0-1 d), patients operated within the first week after phacoemulsification (2-7 d), and patients operated later than the first week after phacoemulsification (>7 d).

In every case, a standard three-port pars plana vitrectomy was performed to remove the retained lens material. In brief, after the fixation of the perfusion tube and the introduction of the cutter and of the endo-illumination fiber optic probe, removal of the central vitreous was performed first. Any opacified capsular remnant or lens cortex was removed with the cutter. Then, posterior detachment of the vitreous was provoked, if not already present. Vitreoretinal tractions at the level of the crystalline fragments were released, and the fragments were removed either by aspiration with the cutter or using a lens loop. In some cases where the fragments were large or very hard, a fragmentome was used, with or without perfluorocarbon liquid to hold back the retina. Then, scleral indentation was done to eliminate the vitreous base, to dissect anterior vitreoretinal tractions and to detect retinal breaks. Cryotherapy or endolaser was applied on the latter. Finally, secondary intraocular lens (IOL) implantation or IOL scleral fixation was done, if this was possible and if it had not been done at the time of cataract surgery.

Visual acuity was expressed in decimal units, while calculations and comparisons of means were done after transformation to logMAR units. Three different levels of visual acuity were defined: poor vision (worse than 0.1), moderate vision (between 0.1 and 0.5), and good vision (better than 0.5). The influence of several parameters, including the type of surgeon, timing, and patient's age, on final postoperative visual acuity was evaluated.

Statistics were performed using the SPSS software (version 15.0 for Windows). Differences at a level of $p<0.05$ were considered statistically significant.

RESULTS

The study included 41 eyes of 41 consecutive patients operated by pars plana vitrectomy for posterior dislocation of lens fragments during phacoemulsification. Mean age was 78 years (range, 40 to 95 years). There were 18 (44%) male and 23 (56%) female subjects. The right eye was involved in 15 cases (37%), whereas the left eye was affected in 26 cases (63%).

Preexisting eye pathology likely to predispose to complications during cataract surgery included pseudoexfoliation in 13 cases (32%), glaucoma in 7 cases (17%), previous pars plana vitrectomy for vitreous hemorrhage in 2 cases (5%), and previous trabeculectomy in one case (2%).

During phacoemulsification, posterior capsular rupture had occurred at capsulorrhexis in one case (2%), hydrodissection in 2 cases (5%), probe introduction in one case (2%), ultrasound use in 27 cases (66%), and lens aspiration in 10 cases (24%). Dislocation of lens fragments into the vitreous had occurred at probe introduction in one case (2%), lens turning attempt in 4 cases (%), ultrasound use in 21 cases (51%), lens aspiration in 14 cases (34%), and anterior vitrectomy in one case (2%).

Among the 41 patients, 32 (78%) were operated by a confirmed vitreoretinal surgeon, whereas in 9 patients (22%) pars plana vitrectomy was performed by the cataract surgeon himself. Moreover, regarding the interval between cataract surgery and the pars plana vitrectomy, 14 patients (34%) were vitrectomized in the same sitting of phacoemulsification or in the next day (day zero or one), 13 patients (32%) were submitted to pars plana vitrectomy within the first week after phacoemulsification (day two to seven), and 14 patients (34%) were vitrectomized later than seven days after the phacoemulsification. The distribution of the patients into different types of surgeon and different intervals are summarized in Table 1.

Table 1. Distribution of patients into different types of surgeon that performed the pars plana vitrectomy (PPV) and into different intervals between phacoemulsification (phaco) and PPV.

Interval between phaco and PPV (days)	**C-surgeon**	**VR-surgeon**	Total
0-1	2	12	14
2-7	5	8	13
>7	2	12	14
Total	**9**	**32**	**41**

C-surgeon = cataract surgeon

VR-surgeon = vitreoretinal surgeon

The mean follow-up was 10 months (range, 1 to 48 months). At the end of the follow-up, final postoperative visual acuity was poor (lower than 0.1) in 13 cases (32%), moderate (between 0.1 and 0.5) in 16 cases (39%), and good (better than 0.5) in 12 cases (29%). The distribution of the patients into different levels of preoperative and final postoperative visual acuity is shown in Table 2. A shift of higher percentages of cases towards good visual acuity level (>0.5) at the end of the follow-up was observed. Thus, 29% of the patients after pars plana vitrectomy versus only 7% before vitrectomy had good visual acuity.

Table 2. Visual acuity (VA) before and after pars plana vitrectomy (preoperative and final postoperative VA, respectively). VA was better at the end of the follow-up period (P<0.001, chi-square goodness of fit test).

VA (decimal)	Preop. VA	Final postop. VA
<0.1	15 (37%)	13 (32%)
0.1-0.5	23 (56%)	16 (39%)
>0.5	3 (7%)	12 (29%)
Total	**41**	**41**

Preop. VA = preoperative visual acuity

Final postop. VA = final postoperative visual acuity

Visual acuity change after pars plana vitrectomy is shown in Table 3. A the end of the follow-up, in 14 patients (34%) visual acuity had deteriorated, in 4 patients (10%) it had remained stable, and in 23 patients (56%) improvement of visual acuity was observed. Of importance, in 15 patients (37%), visual acuity increase of 3 lines or more (decimal units) was observed.

Table 3. Visual acuity change after pars plana vitrectomy, at the end of the follow-up.

Visual acuity change	Preop. VA
Decrease	14 (34%)
Stable	4 (10%)
Increase	23 (56%)

Total	**41**

The causes of poor or moderate final visual acuity after pars plana vitrectomy are presented in Tables 4 and 5, respectively.

Table 4. Causes of poor final visual acuity (<0.1) after pars plana vitrectomy.

Cause (complication)	**No. of cases**
Retinal detachment	6
Persistent corneal edema	4
Cystoid macular edema	1
Epiretinal membrane	1
Glaucoma	1
Total	**13**

Table 5. Causes of moderate final visual acuity (0.1 to 0.5) after pars plana vitrectomy.

Cause (complication)	**No. of cases**
Persistent corneal edema	4
Cystoid macular edema	3
Glaucoma	3
Chorioretinal atrophy	3
Retinal detachment	2
Epiretinal membrane	1
Total	**16**

Intraoperative complications of pars plana vitrectomy included vitreous hemorrhage in 2 cases, iatrogenic retinal break in one case, and posterior pole petechias in one case. Postoperative complications of pars plana vitrectomy appeared in 27 patients (66%); they are given in detail in Table 6.

Table 6. Postoperative complications of pars plana vitrectomy in the present study (some patients presented more than one complication).

Complication	No. of cases
Persistent corneal edema	9 (22.0%)
Retinal detachment	8 (19.5%)
Cystoid macular edema	5 (12.2%)
Glaucoma	3 (7.3%)
Epiretinal membrane	3 (7.3%)
Hyphema	2 (4.9%)
Choroidal effusion	2 (4.9%)
Uveitis	2 (4.9%)
Chorioretinal atrophy	2 (4.9%)
Vitreous hemorrhage	1 (2.4%)

The characteristics regarding the 8 patients that presented retinal detachment have been further analyzed and are presented in Table 7. In all these cases, preoperative and final postoperative visual acuity was very low. Two cases needed two additional operations including silicone oil application because of recurrent retinal detachment. In both cases retinal detachment was due to proliferative vitreoretinopathy (PVR).

Table 7. Visual acuity and evolution of the cases that developed retinal detachment following pars plana vitrectomy. Visual acuity decreased in 7 cases and remained stable but very low in one case.

Case No.	Preoperative VA	Final post-op VA	No. of operations	Anatomical result
1	0.4	0.05	1	Attached retina
2	0.3	counting fingers	1	Attached retina
3	counting fingers	0.1	1	Attached retina
4	0.05	hand movement	2(+silic.oil)	Attached retina
5	0.25	counting fingers	1	Attached retina
6	0.2	0.1	2(+silic.oil)	Attached retina
7	0.25	hand movement	1	Attached retina
8	light perception	light perception	1	Attached retina

No correlation was found between the interval from phacoemulsification to pars plana vitrectomy and the final postoperative visual acuity (Table 8). Numbers regarding these parameters were almost equally distributed within the 3 defined groups, that is 0-1 day, 2-7 days, and >7 days from phacoemulsification. A slight tendency for visual acuity <0.1 was noted for the patients operated on day zero or one, but it did not reach statistical significance.

Table 8. Correlation of interval between phacoemulsification (phaco) and pars plana vitrectomy (PPV) with the final postoperative visual acuity (VA) (n=41). No correlation was found between this interval and the final postoperative VA (P>0.1, chi-square goodness of fit test).

	Final postoperative VA (decimal)			
Interval between phaco and PPV (days)	**<0.1**	**0.1 to 0.5**	**>0.5**	Total
0-1	6	4	4	14
2-7	3	5	5	13
>7	4	7	3	14
Total	**13**	**16**	**12**	**41**

In addition, no correlation was found between the interval from phacoemulsification to pars plana vitrectomy and the postoperative visual acuity change (Table 9).

Table 9. Correlation of interval between phacoemulsification (phaco) and pars plana vitrectomy (PPV) with the postoperative visual acuity change (n=41). No statistically significant correlation was found (P>0.1, chi-square goodness of fit test).

	Visual acuity change			
Interval between phaco and PPV (days)	**Decrease**	**Stable**	**Increase**	Total
0-1	4	3	7	14
2-7	6	0	7	13
>7	4	1	9	14
Total	**13**	**16**	**12**	**41**

Moreover, no correlation was found between the interval from phacoemulsification to pars plana vitrectomy and the number of postoperative complications (Table 10).

Table 10. Correlation of interval between phacoemulsification and pars plana vitrectomy with postoperative complications (n=41). This correlation was not statistically significant (P>0.1, chi-square goodness of fit test).

	Complication ?		***Main complications***			
Interval (days)	**No**	**Yes**	**Persist. corneal edema**	**RD**	**CME**	Total
0-1	5	9	2	3	2	14
2-7	2	11	4	3	2	13
>7	7	7	3	2	1	14
Total	**14**	**27**	**9**	**8**	**5**	**41**

Persist. = persistent

RD = retinal detachment

CME = cystoid macular edema

The selection of the surgeon seems to have played a role in the final result. According to Table 11, most cases operated by the cataract surgeon himself had poor final visual acuity (<0.1), whereas most cases operated by a confirmed vitreoretinal surgeon gained moderate visual acuity (between 0.1 and 0.5).

Table 11. Correlation of final postoperative visual acuity (VA) with regard to the pars plana vitrectomy (PPV) performed by cataract or vitreoretinal surgeon (n=41). Final postoperative VA was better in the case of vitreoretinal surgeon ($P<0.05$, chi-square goodness of fit test).

Final VA (decimal)	**PPV by C-surgeon**	**PPV by VR-surgeon**	Total
<0.1	4	9	13
0.1-0.5	2	14	16
>0.5	3	9	12
Total	**9**	**32**	**41**

C-surgeon = cataract surgeon / VR-surgeon = vitreoretinal surgeon

In addition, according to Table 12, far more cases operated by vitreoretinal surgeons had an increase of final postoperative visual acuity.

Table 12. Correlation of visual acuity (VA) change with regard to the pars plana vitrectomy (PPV) performed by cataract or vitreoretinal surgeon (n=41). Statistically more patients operated by a vitreoretinal surgeon had an increase of VA postoperatively ($P<0.001$, chi-square goodness of fit test).

VA change	**PPV by C-surgeon**	**PPV by VR-surgeon**	Total
Decrease	4	10	14

Stable	1	3	4
Increase	4 *(44%)*	19 *(59%)*	23
Total	**9**	**32**	**41**

C-surgeon = cataract surgeon / VR-surgeon = vitreoretinal surgeon

The postoperative complications were more frequent in the case of anterior segment surgeons performing the vitrectomy, 78% versus 63% (Table 13). This is particularly the case regarding retinal detachment, which was 3 times more frequent in the case of anterior segment surgeons performing the vitrectomy, 44% versus 13% (Table 13).

Table 13. Correlation of number of complications with regard to the pars plana vitrectomy (PPV) performed by cataract or vitreoretinal surgeon (n=41). Statistically more complications were observed when PPV was performed by the cataract surgeon ($P<0.05$, chi-square goodness of fit test).

	Complication ?		***Main complications***			
Surgeon	**No**	**Yes**	**Persist. corneal edema**	**RD**	**CME**	n
C-surg	2	7 *(78%)*	2	4 *(44%)*	2	9
VR-surg	12	20 *(63%)*	7	4 *(13%)*	3	32
Total	**14**	**27**	**9**	**8**	**5**	**41**

C-surg = cataract surgeon / VR-surg = vitreoretinal surgeon

Persist. = persistent

RD = retinal detachment

CME = cystoid macular edema

Regarding the effect of age on visual outcome, no correlation was found between the patients' age and their final visual acuity (Table 14).

Table 14. Correlation of patients' age with their final visual acuity (VA) (n=41). This correlation was not statistically significant (P>0.1, chi-square goodness of fit test).

	Final postoperative VA (decimal)			
Age	**<0.1**	**0.1 to 0.5**	**>0.5**	n
40-78	5	9	8	22
79-95	8	7	4	19
Total	**13**	**16**	**12**	**41**

Concerning the age and some major complications, younger persons presented retinal detachment more frequently. On the other hand, the group with older patients presented more frequently persistent corneal edema (Table 15).

Table 15. Correlation of patient's age with postoperative complications (n=41). A statistically significant correlation of age with persistent corneal edema and with retinal detachment was found (P<0.05, chi-square goodness of fit test).

	Complication ?		***Main complications***			
Age	**No**	**Yes**	**Persist. corneal edema**	**RD**	**CME**	n

40-78	7	15	3	6	3	22
79-95	7	12	6	2	2	19
Total	**14**	**27**	**9**	**8**	**5**	**41**

Persist. = persistent

RD = retinal detachment

CME = cystoid macular edema

DISCUSSION

In the present study, pars plana vitrectomy to manage posterior dislocation of crystalline lens fragments which had occurred during phacoemulsification showed favorable visual results, as it led to an increase of visual acuity in more than half of the patients (56%) at their last postoperative visit. Of importance, in more than one third of the patients (37%), visual acuity increased by 3 lines or more, and nearly one third of the patients (29%) achieved final vision defined as “good” (>0.5). These results come to agreement with most previous studies (Kim, Flynn et al. 1994; Tommila and Immonen 1995; Margherio, Margherio et al. 1997; Rossetti and Doro 2002) which have established pars plana vitrectomy as the treatment of choice for posterior dislocation of crystalline lens fragments during cataract surgery.

According to the present study, poor final visual acuity (<0.1) was mainly the result of retinal detachment, persistent corneal edema, and cystoid macular edema (Table 4), while moderate final visual acuity (0.1 to 0.5) was mainly due to persistent corneal edema, cystoid macular edema, and glaucoma (Table 5). These observations are consistent with the existing literature.

Interval between cataract surgery and pars plana vitrectomy

The optimal timing of vitreous surgery and lens fragment removal after complicated cataract surgery remains uncertain. According to some previous studies, visual outcome appears to be better if pars plana vitrectomy is done within the first week after cataract surgery(Tommila and Immonen 1995) or even at the time of cataract surgery (Kageyama, Ayaki et al. 2001), whereas other studies have found no correlation between visual outcome and the timing of vitrectomy(Blodi, Flynn et al. 1992; Gilliland, Hutton et al. 1992; Kim, Flynn et al. 1994; Borne, Tasman et al. 1996; Margherio, Margherio et al. 1997; Kwok, Li et al. 2002; Ho and Zaman 2007)

In our study, no correlation was found between the interval from phacoemulsification to pars plana vitrectomy and the final postoperative visual acuity (Table 8), the visual acuity change (Table 9), and the number of postoperative complications (Table 10). Numbers regarding these parameters were almost equally distributed within the 3 defined groups, that is 0-1 day, 2-7 days, and >7 days from phacoemulsification. A slight tendency for visual acuity <0.1 was noted for the patients operated on day zero or one (Table 8), but it did not reach statistical significance.

The absence of macrophages from intraocular fluid specimens obtained during the first three days after cataract surgery (Wilkinson and Green 2001) and the assessment of significantly less inflammatory cell activity in eyes which had retained lens fragments removed early (during the first week) (Yeo, Charteris et al. 1999) support the notion that early vitrectomy may prevent late complications (Stewart 2007). On the other hand, studies that show no correlation of timing can be biased by a tendency to operate early on eyes with greater volumes of retained lens fragments or a more marked early inflammatory response (Yeo, Charteris et al. 1999) Prospective controlled studies with subgroup analysis are needed to define the ideal interval between phacoemulsification and pars plana vitrectomy, if there is one. Due to the low incidence of this complication and due to ethical factors and factors regarding the patient-doctor relationship, such studies are difficult to perform. Unless they are done, however, the issue of the optimal timing of vitrectomy will remain open.

Selection of surgeon for pars plana vitrectomy and final result

The question whether the cases operated by the cataract surgeon himself and not referred to a confirmed vitreoretinal surgeon influence the final result has not been previously evaluated. In our study, the selection of the surgeon seems to have played a role in the final result. According to Table 11, most cases operated by the cataract surgeon himself had poor final visual acuity (<0.1), whereas most cases operated by a confirmed vitreoretinal surgeon gained moderate visual acuity (between 0.1 and 0.5). In addition, according to Table 12, far more cases operated by vitreoretinal surgeons had an increase of final postoperative visual acuity. As for the postoperative complications, they were more frequent in the case of anterior segment surgeons performing the vitrectomy, especially retinal detachment, which was 3 times more frequent (Table 13).

The threat of retinal breaks and of subsequent retinal detachment after pars plana vitrectomy in cases of posterior dislocation of lens fragments comes from the peripheral vitreous and its ability to transmit traction from the force of lens fragment movements to the retina (Singh and Stewart 2006). Meticulous removal of the peripheral vitreous gel before lensectomy addresses concerns about traction on the retina, so that the dropped fragments are effectively isolated, leaving no attachments to the periphery. Modern vitreoretinal approaches are therefore mandatory, for those cases.

Other associations

The analysis of preexisting eye pathology before cataract surgery confirmed that pseudoexfoliation remains a leading factor to predispose to complications during cataract surgery. It was present in one third of the patients included in the present study.

Main postoperative complications in the present study included persistent corneal edema, retinal detachment, cystoid macular edema, and glaucoma (Table 6), in agreement with data from the literature.

An interesting result of the present study was also the fact that the left eye was involved twice as much as the right eye in posterior dislocation of lens fragments during phacoemulsification. Apart from the possibility that this finding was due to normal variation, one might assume that some cataract surgeons are more prone to complications during cataract surgery when they operate on the left eye.

In our study, the age of the patients also played a role in the final result. Older patients more often had poor final visual acuity, whereas younger patients more often had good final visual acuity (Table 15). In addition, older patients presented twice as higher rate of persistent corneal edema, probably due to the gradual decrease of corneal endothelial cells with age. On the other hand, younger patients presented three times as higher rate of retinal detachment, probably because of a lower prevalence of complete posterior vitreous detachment in these ages, a fact that predisposes to vitreoretinal traction and breaks when lens fragments enter the vitreous.

CLINICAL IMPORTANCE OF THE PRESENT STUDY

In the present study:

1. We confirmed the results of previous studies about the efficacy of pars plana vitrectomy for posterior dislocation of lens fragments.
2. We described the anatomical and functional results of pars plana vitrectomy in these cases.
3. We gave important information regarding the appropriate timing of pars plana vitrectomy and the selection of the surgeon to perform it in these cases.

CONCLUSIONS

1. Dislocation of lens fragments into the vitreous body can be a serious complication of phacoemulsification.
2. Pars plana vitrectomy helps to preserve retinal anatomy, but the visual acuity is not restored in all the cases, especially in the presence of retinal detachment.
3. Due to the complications observed in our study, we consider that these cases should be undertaken by modern vitreoretinal techniques.

REFERENCES

Apple, D. J., Rabb, M.F (1985). Ocular Pathology. St.Louis, MO, The C. V. Mosby Company.

Blodi, B. A., H. W. Flynn, Jr., et al. (1992). "Retained nuclei after cataract surgery." Ophthalmology **99**(1): 41-4.

Borne, M. J., W. Tasman, et al. (1996). "Outcomes of vitrectomy for retained lens fragments." Ophthalmology **103**(6): 971-6.

Brown, S. I. and J. M. McLean (1969). "Peripheral corneal edema after cataract extraction. A new clinical entity." Trans Am Acad Ophthalmol Otolaryngol **73**(3): 465-70.

Buddecke, E. and J. Wollensak (1966). "[On the biochemistry of Zinn's membrane of the bovine eye]." Z Naturforsch B **21**(4): 337-41.

Chen, E. (2007). "25-Gauge transconjunctival sutureless vitrectomy." Curr Opin Ophthalmol **18**(3): 188-93.

Davson, H. (1990). Physiology of the eye. London, UK, Macmillan Press.

E.S.G., E. S. C. R. S. (2007). "Prophylaxis of postoperative endophthalmitis following cataract surgery: results of the ESCRS multicenter study and identification of risk factors." J Cataract Refract Surg **33**(6): 978-88.

Fine, H. F., R. Iranmanesh, et al. (2007). "Outcomes of 77 consecutive cases of 23-gauge transconjunctival vitrectomy surgery for posterior segment disease." Ophthalmology **114**(6): 1197-200.

Fishkind, W. J. (1999). The torn posterior capsule: prevention, recognition, and management. Focal Points: Clinical Modules for Ophthalmologists. A. A. o. Ophthalmology. San Francisco, CA, LEO. **17**.

Fung, W. E. (1985). "Vitrectomy for chronic aphakic cystoid macular edema. Results of a national, collaborative, prospective, randomized investigation." Ophthalmology **92**(8): 1102-11.

Gilliland, G. D., W. L. Hutton, et al. (1992). "Retained intravitreal lens fragments after cataract surgery." Ophthalmology **99**(8): 1263-7; discussion 1268-9.

Gimbel, H. V. (1991). "Divide and conquer nucleofractis phacoemulsification: development and variations." J Cataract Refract Surg **17**(3): 281-91.

Gray, H. (2000). Anatomy of Human Body. Philadelphia, PL, LEA & FEBIGER.

Harbour, J. W., W. E. Smiddy, et al. (1995). "Pars plana vitrectomy for chronic pseudophakic cystoid macular edema." Am J Ophthalmol **120**(3): 302-7.

Ho, S. F. and A. Zaman (2007). "Clinical features and outcomes of pars plana vitrectomy in patients with retained lens fragments after phacoemulsification." J Cataract Refract Surg **33**(12): 2106-10.

Hogan, M. (1971). Histology of the human eye. London, UK, WB Saunders.

Kageyama, T., M. Ayaki, et al. (2001). "Results of vitrectomy performed at the time of phacoemulsification complicated by intravitreal lens fragments." Br J Ophthalmol **85**(9): 1038-40.

Kanski, J. J. (2006). Clinical Ophthalmology. Edinburg, UK, Butterworth,Heinemann.

Khaw, P. T., Shah, P., Elkington, A.R. (2004). ABC of eyes. London, UK, BMJ Books.

Kim, J. E., H. W. Flynn, Jr., et al. (1996). "Endophthalmitis in patients with retained lens fragments after phacoemulsification." Ophthalmology **103**(4): 575-8.

Kim, J. E., H. W. Flynn, Jr., et al. (1994). "Retained lens fragments after phacoemulsification." Ophthalmology **101**(11): 1827-32.

Kodjikian, L., C. Roques, et al. (2005). "[Endophthalmitis: pathogenesis and antibiotic prophylaxis]." J Fr Ophtalmol **28**(10): 1122-30.

Kuzak, J. R., Deutsch,T.A., Brown,H.G (1999). Principles and Practice of Ophtathalmology Principles and Practice of Ophtalmology. D. M. Albert, Jacobiec, F.A. Philadelphia, PL, Saunders**:** 564-575.

Kwok, A. K., K. K. Li, et al. (2002). "Pars plana vitrectomy in the management of retained intravitreal lens fragments after cataract surgery." Clin Experiment Ophthalmol **30**(6): 399-403.

Lai, T. Y., A. K. Kwok, et al. (2005). "Immediate pars plana vitrectomy for dislocated intravitreal lens fragments during cataract surgery." Eye **19**(11): 1157-62.

Lemley, C. A. and D. P. Han (2007). "Endophthalmitis: a review of current evaluation and management." Retina **27**(6): 662-80.

Lewis, H., M. S. Blumenkranz, et al. (1992). "Treatment of dislocated crystalline lens and retinal detachment with perfluorocarbon liquids." Retina **12**(4): 299-304.

Liesegang, T. J., Deutsch, T.A., Grand, M.G. (2001). Biochemistry. Basic&Clinical Science Course. A. Academy of Ophthalmology. San Francisco, CA, LEO. **Lens and Cataract:** 10-16.

Liesegang, T. J., Deutsch, T.A., Grand, M.G. (2001). Complications of cataract surgery. Basic & Clinical Science Course. A. Academy of Ophthalmology. San Francisco, CA, Leo. **11 Lens and Cataract:** 160-186.

Liesegang, T. J., Deutsch, T.A., Grand, M.G. (2001). Diseases of the vitreous. Basic and Clinical Science. A. Academy. San Francisco, Leo. **XII:Retina and Vitreous**
256-263.

Liesegang, T. J., Deutsch, T.A., Grand, M.G. (2001). Embryology. Basic and Clinical Science Course. A. Academy of Ophthalmology. San Francisco, CA, LEO. **11, Lens and Cataract:** 21-39.

Liesegang, T. J., Deutsch, T.A., Grand, M.G. (2001). Epidemiology of Cataracts. Basic and Clinical Science Course. A. Academy of Ophthalmology. San Francisco, Ca, LEO. **11, Lens and Cataract:** 66-68.

Liesegang, T. J., Deutsch, T.A., Grand, M.G. (2001). Pathology. Basic and Clinical Science A. A. o. Ophtahalmology. San Francisco,CA, Leo. **V;Lens and Cataract** 40-65.

Liesegang, T. J., Deutsch, T.A., Grand, M.G. (2001). Surgery for Cataract. Basic and Clinical Science Course. A. A. o. Ophthalmology. San Francisco, CA, LEO. **11: Lens and Cataract:** 81-159.

Liesegang, T. J., Deutsch, T.A., Grand, M.G. (2001). Vitrectomy. Basic and Clinical Science Course. A. Academy of Ophthalmology. San Francisco, CA, Leo. **12: Retina and Vitreous:** 291-310.

Liesegang, T. J., Deutsch, T.A., Grand, M.G. (2001-2002). Anathomy. Basic&Clinical Science Course. A. Academy of Ophthalmology. San Francisco, CA, Leo. **11; Lens and Cataract:** 5-10.

Margherio, R. R., A. R. Margherio, et al. (1997). "Vitrectomy for retained lens fragments after phacoemulsification." Ophthalmology **104**(9): 1426-32.

McCulloch, C. (1954). "The zonule of Zinn: its origin, course, and insertion, and its relation to neighboring structures." Trans Am Ophthalmol Soc **52**: 525-85.

Michels, R. G. W., C.P,Rice,T.A (1990). Retinal Detachment. St.Louis, MO, The C.V.Mosby Company.

Nelson, L. B. and I. H. Maumenee (1982). "Ectopia lentis." Surv Ophthalmol **27**(3): 143-60.

Rossetti, A. and D. Doro (2002). "Retained intravitreal lens fragments after phacoemulsification: complications and visual outcome in vitrectomized and nonvitrectomized eyes." J Cataract Refract Surg **28**(2): 310-5.

Ruiz-Moreno, J. M., S. Barile, et al. (2006). "Phacoemulsification in the vitreous cavity for retained nuclear lens fragments." Eur J Ophthalmol **16**(1): 40-5.

Singh, A. and J. M. Stewart (2006). "Use of triamcinolone acetonide in retained lens surgery." J Cataract Refract Surg **32**(11): 1901.

Smiddy, W. E., H. W. Flynn, Jr., et al. (1996). "Retinal detachment in patients with retained lens fragments or dislocated posterior chamber intraocular lenses." Ophthalmic Surg Lasers **27**(10): 856-61.

Smiddy, W. E., J. L. Guererro, et al. (2003). "Retinal detachment rate after vitrectomy for retained lens material after phacoemulsification." Am J Ophthalmol **135**(2): 183-7.

Snell, R. S., Lemp, M.A. (1998). Clinical Anatomy of the Eye. Malden, MA, Blackwell Science, Inc.

Spalton, D. J., Hitchings,R.A.,Hunter,P.A. (2005). Atlas of clinical ophthalmology. Philadelphia, PL, Elsevier Mosby.

Stewart, M. W. (2007). "Management of retained lens fragments: can we improve?" Am J Ophthalmol **144**(3): 445-6.

Tewari, A., G. K. Shah, et al. (2008). "Visual outcomes with 23-gauge transconjunctival sutureless vitrectomy." Retina **28**(2): 258-62.

Tommila, P. and I. Immonen (1995). "Dislocated nuclear fragments after cataract surgery." Eye **9 (Pt 4)**: 437-41.

Wilkinson, C. P. and W. R. Green (2001). "Vitrectomy for retained lens material after cataract extraction: the relationship between histopathologic findings and the time of vitreous surgery." Ophthalmology **108**(9): 1633-7.

Williams, G. A. (2008). "25-, 23-, or 20-gauge instrumentation for vitreous surgery?" Eye.

Wolff, E. (1940). The anatomy of the eye and orbit. London, UK, H.K.LEWIA & CO.LTD.

Yeo, L. M., D. G. Charteris, et al. (1999). "Retained intravitreal lens fragments after phacoemulsification: a clinicopathological correlation." Br J Ophthalmol **83**(10): 1135-8.