Bag-in-the-lens intraocular lens implantation in pediatric cataract

Essay

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List of Abbreviations

AC	:	Anterior chamber
ACCC	:	Anterior continuous curvilinear capsulorhexis
AD	:	Autosomal dominant
AR	:	Autosomal recessive
BIL	:	Bag-in-the-lens
BSS	:	Balanced salt solution
CME	:	Cystoid macular edema
IOL	:	Intraocular lens
LECs	:	Lens epithelial cells
LIB	:	Lens-in-the-bag
MVR	:	Microvitreoretinal
OVD	:	Ophthalmic viscoelastic device
PAS	:	Periodic acid schiff
PCCC	:	Posterior continuous curvilinear capsulorhexis
PCO	:	Posterior capsular opacification
PFV	:	Persistent foetal vasculature
SCI	:	Sealed-capsule irrigation
VAO	:	Visual axis opacification

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ABSTRACT

Congenital cataract is the most common cause of treatable childhood blindness and remains a very important and difficult problem to manage. The timing of treatment is crucial to the visual development and successful rehabilitation of children before development of stimulus-deprivation amblyopia, strabismus and nystagmus.

The pediatric eyes are different in comparison with the adult eyes so they need special operative considerations while performing cataract surgery including suture closure of tunnel wounds and paracentesis openings, and replacing the classic ACCC by alternative methods like vitrectorhexis, radio frequency and Fugo plasma blade.

The BIL IOL has a special design in which a 5 mm optic is surrounded by a peripheral groove defined by the elliptical haptics, and the optic and the haptic are perpendicularly oriented to each other.

Bag in the lens IOL implantation has proven to be a safe and well-tolerated approach for treating pediatric cataract with a very low rate of visual axis reopacification and a low rate of secondary interventions for other postoperative complications.

Key words: Bag-in-the-lens, Tassignon and pediatric Cataract

Introduction

Congenital cataract is the most common cause of treatable childhood blindness, accounting for 5% to 20% of blindness in children worldwide. In developing countries, the prevalence of blindness from cataract is higher, about 1 to 4 per 10 000 children **(Foster et al., 1997).**

Cataract may be unilateral or bilateral and can vary widely in size, morphology and degree of opacification. Genetic mutation is likely the most common cause of bilateral congenital cataract not associated with a systemic disease and inheritance is most often autosomal dominant (AD); although it can be X-linked or autosomal recessive (AR). In contrast, most cases of unilateral cataract are neither inherited nor associated with a systemic disease. They are likely the result of local dysgenesis and may be associated with other types of ocular dysgenesis such as persistent foetal vasculature (PFV), posterior lenticonus or lentiglobus **(Francis et al., 2000).**

The timing of surgery and its relationship to the duration of deprivation is important. Unilateral congenital cataract surgery within 6 weeks of birth produces the best outcomes. The equivalent 'latent' period for bilateral visual deprivation may be longer at around 10 weeks **(Lambert et al., 2006).**

The conventional intraocular lens (IOL) implantation technique, also called the lens in the bag, consists of inserting the IOL in the capsular bag causing a large area of contact between the IOL biomaterial and capsular bag. The capsular bag response described as a foreign body reaction of lens epithelial cells (LECs) to the IOL biomaterial results in stimulation of LECs causing posterior capsular opacification (PCO), which is the most common complication of cataract surgery in children. It is a serious complication because it can lead to amblyopia **(Lambert et al., 2006).**

Many studies tried to find factors influencing the development of PCO. Interventions include modifications of surgical technique explicitly to inhibit PCO, modifications in IOL design (material and geometry) and implantation of additional devices **(Findle et al., 2010).**

Clinical trials have found that there were no significant differences in PCO formation between different IOL materials (e.g PMMA, silicone, hydrogel or acrylic) **(Findle et al., 2005).** However, there are significantly lower PCO rates in IOLs with sharp posterior optic edges than in IOLs with round optic edges **(Buel et al., 2005).**

In pediatric cataract, primary posterior capsulotomy/ capsulorhexis and anterior vitrectomy are now considered routine surgical steps **(Vasavada et al., 2001)**.

Pars plicata posterior capsulorhexis, sealed-capsule irrigation (SCI) and bag-in-the-lens IOL are newer surgical approaches to posterior capsule management **(Vasavada et al., 2001).** The bag-in-the-lens technique uses a new IOL design and a modified implantation technique ,the IOL consists of a 5mm optic surrounded by a peripheral groove defined by the elliptical haptics, perpendicularly oriented to each other. In the bag-in-the-lens technique, the anterior and posterior capsules are placed in the IOL's groove after a capsulorhexis of the same size is created in both capsules **(Tassignon et al., 2007)**. The idea is capturing the remaining LECs in a closed space preventing them from migrating onto the visual axis **(De Groot et al., 2006).**

Aim of the Work

The aim of this work is to review the literature for the current role of bag-in-the-lens IOL implantation technique in the treatment of pediatric cataract.

Anatomy of the lens

The lens of the eye is a transparent, biconvex, elliptical, semi solid, avascular body of crystalline appearance located between the iris and the vitreous. Laterally the equatorial zone of the lens projects into the posterior chamber and is attached by the zonules to the ciliary epithlium **(Assia et al., 1991)**.

The mean crystalline lens diameter is 6.00 mm at birth, 6.8 mm at 2 months, 7.1mm at 3 months, 7.66 mm at 6 to 9 months, 8.4 mm at 21 months, 8.5 mm at 2 to 5 years, and 9.3 mm at 16 years. While the age is a predictor of the crystalline lens size, corneal diameter and globe axial length are better predictors **(Bluestein et al., 1996).**

The crystalline lens grows throughout life by the deposition of new fibers. At birth the human lens weighs approximately 90 gm, and it increases in mass at a rate of 2 mg per year as new fibers form .The most rapid lens growth occurs from birth to 2 years of age **(Bluestein et al., 1996).**

Lens capsule

The capsule is a smooth, homogenous, acellular elastic membrane that completely envelops the lens and the cells of origin are completely contained in it. It is the basement membrane of the lens epithelium and is the thickest basement membrane of the body. It is divided into anterior capsule secreted by lens epithelium and considered as the basement membrane of anterior lens epithelium,and posterior capsule secreted by the superficial lens fibers and considered as the basement membrane of the lens cells that have their nuclei near the equator. By light microscopy it is a PAS positive transparent homogenous structure; by electron microscopy it has a lamellar structure and consists of 40 lamellae each is 40 nm thick and consists of type 4 collagen fibers embedded in glycosaminoglycans. The thickness of the capsule is not uniform **(Fig. 1)** and varies according to the age of the eye and the site of the capsule where measurements are taken. It is thinnest at the equator and poles, the anterior capsule is thickest in a circular area 3mm from the anterior pole, and the posterior capsule is thickest in an area 1mm from the posterior pole. Thickness increases anteriorly with age, but there is little change at the posterior pole **(Snell and Lemp, 1998).**

The local differences in capsular thickness are important surgically, particularly because of the danger of tear or rupture of the thin posterior capsule during cataract surgery **(Assia et al., 1991).**

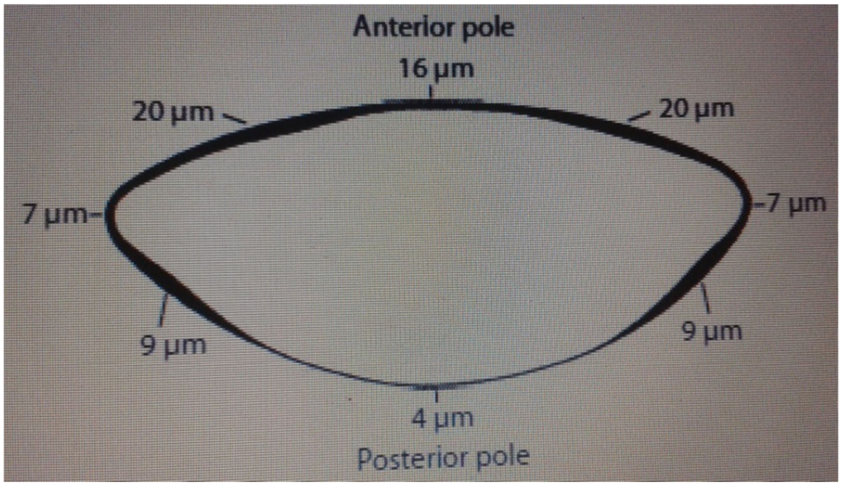

Figure (1): Schematic view of the lens capsule showing the relative thickness of various portions **(Schrehardt and Nauman, 2008).**

Lens epithelium:

The lens epithelium consists of a single sheet of cuboidal cells spread over the front of the lens **(Fig. 2)**, deep to the capsule and extending outwards to the equator. There is no corresponding posterior layer because the posterior epithelium of the embryogenic lens is involved in the formation of the primary lens fibers which occupy the center of the lens nucleus. There are 3 zones in the lens epithelium. The central zone represents a stable population of cells. The intermediate zone is peripheral to the central zone and its cells are smaller. The germinative zone is the most peripheral and is located just preequatorial **(Apple et al., 1992).**

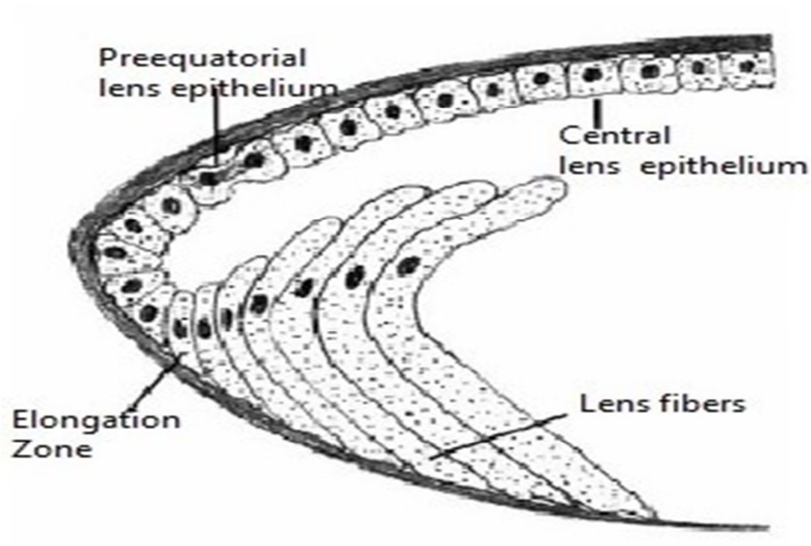

Figure (2): Schematic view of the (pre)equatorial lens epithelium differentiating into lens fibers **(Schrehardt and Nauman, 2008).**

The lens fibers:

The lens fibers are laid down in concentric layers, the outermost of which lie in the cortex of the lens and the innermost in the core of the nucleus **(Fig.3)** The lens fibers are strap like or spindle shaped cells which arch over the lens in concentric layers from the front to the back. The average width is 10-12 µm and the average thickness is 1.5-2 µm at the adult equator. The tips of the fibers meet those of other fibres to form sutures (**Kuszak and Brown 1991; Wright and Spiegel, 2013).**

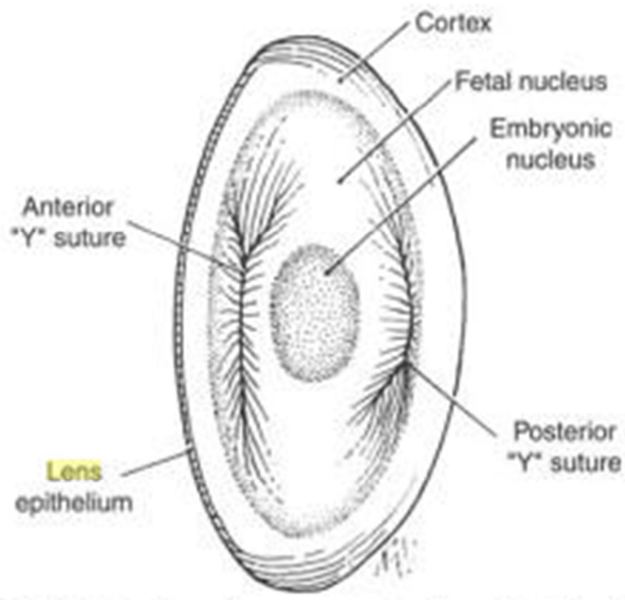

Figure (3): Drawing of a cross section through a juvenile lens **(Wright and Spiegel, 2013).**

Lens sutures:

The suture arrangements of the lens become increasingly complex with the growth of the lens. In the fetal nucleus there is an anterior erect Y and a posterior inverted Y suture **(Fig. 3)**. After birth more branch points are added to the succeeding suture lines, so that in the adult nucleus the sutures have a stellate structure **(kuszak and Brown 1991).**

Zonule:

The earliest fibres of the zonular apparatus are a continuation of the internal limiting membrane that