A PRELIMINARY STUDY TO COMPARE THE PREDICTION ERROR OF POSTOPERATIVE REFRACTION IN PAEDIATRIC CATARACT SURGERY BETWEEN 2 DIFFERENT INTRAOCULAR LENS POWER CALCULATION FORMULAS

By

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ABSTRAK

Pengenalan : Rawatan katarak di kalangan kanak-kanak telah berkembang pesat sejak 15 hingga 20 tahun yang lalu. Kini terdapat kecenderungan untuk memasukkan kanta intarokular pada bayi dan juga kanak-kanak kecil semasa mereka menjalani pembedahan katarak meskipun umum tahu mata kanak-kanak ini masih dalam proses pertumbuhan pesat and sentiasa mengalami perubahan status refraksi.

Objektif : Kajian ini bertujuan menilai ketepatan ramalan refraksi pada 3 bulan selepas pembedahan bagi kanak-kanak yang menjalani pembedahan katarak berserta implantasi kanta intraokular.

Tatacara : Kajian intervensi ini dijalankan secara rawak. Ia melibatkan 31 mata daripada 24 kanak-kanak yang berjaya menjalani pembedahan katarak berserta implantasi kanta intraokular. Semua kanak-kanak ini berusia 12 tahun ke bawah. Kuasa kanta intraokular ini dikira menggunakan formula 'SRK II' atau 'Modified Formula For Paediatric IOL Calculation'. Tiga bulan selepas pembedahan, refraksi dilakukan bagi mendapatkan nilai refraksi sebenar. Nilai refraksi ini kemudian ditukar kepada nilai 'spherical equivalent'. Beza di antara refraksi sebenar selepas pembedahan dengan refraksi ramalan sebelum pembedahan dikira sebagai ralat refraksi. Analisa data dilakukan bagi menilai ketepatan kedua-dua formula ini berdasarkan ralat refraksi tadi.

Keputusan : Min ralat refraksi bagi kumpulan SRK II ialah 1.03 (0.69) D manakala bagi kumpulan Modified Formula pula ialah 1.14 (1.19) D. Walau bagaimanapun nilai ini secara statistiknya adalah tidak signifikan ($p > 0.05$). Sebanyak 18.75% daripada pesakit dalam kumpulan SRK II telah berjaya mendapat refraksi sebenar diantara ± 0.5 D daripada nilai ramalan; dan bagi kumpulan Modified Formula pula, sebanyak 46.67%. Ralat ramalan dalam lingkungan ± 0.5 D dianggap tepat. Namun tidak terdapat perbezaan yang signifikan dari segi statistik bagi kedua-dua formula ini.

Kesimpulan : Kesimpulannya ralat refraksi selepas pembedahan katarak di kalangan kanak-kanak adalah setara bagi formula SRK II dan Modified Formula. Kewujudan Modified Formula ini telah memberi alternatif kepada pakar mata dalam pemilihan formula bagi pengiraan kuasa kanta intraokular bagi kanak-kanak.

ABSTRACT

Introduction : The treatment of paediatric cataracts has progressed tremendously in the past 15 to 20 years. There is a growing trend towards intraocular lens implantation in infants and younger children whose eyes are still undergoing rapid growth and refractive changes.

Objective : This study is intended to assess the predictability of desired refractive outcomes at 3 month postoperative period in paediatric patients undergoing cataract surgery with primary placement of an intraocular lens.

Methodology : This randomized interventional study of 31 eyes (24 patients) that successfully underwent cataract surgery and intraocular lens implantations. All patients were 12 years old and below. Intraocular lens power calculations were made using either SRK II or Modified Formula For Paediatric IOL Calculation. The postoperative refractive outcome was taken as the spherical equivalent of the refraction at 3 month postoperative follow-up. The prediction error was taken as the absolute difference between the predicted and the actual refraction. The data were analysed to compare the mean prediction error between SRK II and Modified Formula and evaluate the predictability.

Results : The mean prediction error in the SRK II group was 1.03 (0.69) D while in Modified Formula 1.14 (1.19) D. The SRK II group showed lower prediction error of 0.11 D compared to Modified Formula group, but this was not statistically significant

($p > 0.05$). 18.75% eyes in SRK II group achieved good predictability i.e. the refraction postoperatively was within ± 0.5 D from predicted refraction compared to 46.67% eyes in the Modified Formula group. However the difference of the predictability between the two formulas was also not statistically significant.

Conclusion : We would like to conclude that the predictability of postoperative refraction in paediatric cataract surgery is comparable between Modified Formula and SRK II formula. The existence of the Modified Formula provides an alternative to the ophthalmologist for intraocular lens calculation in paediatric patients.

Chapter

Introduction

1 INTRODUCTION

1.1 STUDY INTRODUCTION

In a healthy eye, light from an object is focused on to the retina resulting in a clear image. Most of the focusing power of the eye is provided by the cornea. However about 20% of the focusing power is supplied by the lens. Any clouding or alteration in the shape of the lens may interfere with its ability to focus light within the eye. There are many different causes of cataracts in children. Some children have a strong family history of cataracts that may be present at birth and increase with age. Other children may have an underlying metabolic problem that causes the natural lens to swell and become cloudy. In children, particularly those under 8 years old, it is critical that the eye sees a clear image. Otherwise the visual system may not develop normally and become amblyopic.

According to the most recent epidemiologic studies, the prevalence of visually significant cataracts diagnosed within the first year of life ranges from 2.03 to 3.00 per 10 000 births (Bhatti et al., 2003, Holmes et al., 2003). This is not a high incidence compared with other eye problems, but congenital cataracts are one of the leading causes of serious visual impairment in young children.

The treatment of congenital cataracts has progressed tremendously in the past 15 to 20 years. The management of a visually significant cataract usually requires surgical removal of the natural lens. In the past, most ophthalmologists recommended that the entire natural lens be removed surgically, and that the resulting loss in focusing power be compensated for by a hard or soft contact lens or by high power convex glasses. Intraocular lens implants have been used by ophthalmologist as an alternative to contact lenses and glasses. To date, lens implantation has proven to be safe and is rapidly becoming the standard of care in children with visually significant cataracts. There is a growing trend towards intraocular lens implantation in infants and younger children (Awner et al, 1996) whose eyes are still undergoing rapid growth and refractive changes (Gordon and Donzis, 1985, Inagaki, 1986).

Among the problems which arise regarding the use of intraocular lenses in the pediatric population is the question of the power of the implant that should be used, considering the expected growth of the child's eye. A number of intraocular lens power calculation formulas have been developed and their accuracy reported (Kora et al, 1990, Maya et al, 2007). There is no general consensus as to which approach or which particular formula is the most accurate.

The Sanders-Retzlaff-Kraff (SRK) power formula, originally derived and published in 1980-1981, has become the most widely used formula for implant power calculation throughout the world (Sander et al, 1988, Dang and Sunder, 1989). However, we must bear in our mind that this formula does not consider myopic shift, one of the important element in calculating intraocular lens power in paediatric age group.

A wise choice of desired post operative refraction for the individual patient is crucial in the calculation of intraocular lens power. It is fundamental that the calculation of intraocular lens power should be as accurate as possible in giving a predictable post operative refraction. We routinely use the SRK II formula to calculate intraocular lens power, even in paediatric age group. However, there is no evidence that this currently used formula has good predictive accuracy in paediatric, whose eyes are still undergoing rapid growth and refractive changes. The paediatric cataract surgeon therefore now requires an additional 'formula', one that will predict the final refraction for any selected lens on the basis of the patient's age.

This prospective study is designed to compare the predictive accuracy of the intraocular lens power calculation in children after primary intraocular lens implantation for paediatric cataracts using SRK II formula versus Modified Formula For Paediatric Intraocular Lens Calculation.

This Modified Formula For Paediatric Intraocular Lens Calculation comes with a program. This program calculates the predicted refraction of a child made pseudophakic, given biometric measurements and intraocular lens parameters. It allows the surgeon to see how closely the actual refractions match those predicted by the program. This formula taking into account the myopic shift expected in children, based on the logarithmic model of myopic shift; that not consider in SRK II Formula.

So far to our knowledge, there is no published study to see the accuracy of intraocular lens power calculation comparing these two methods (SRK II and Modified Formula For Paediatric Intraocular Lens Calculation). This study is the first of its kind to be done.

1.2 BACKGROUND

1.2.1 LENS AS A REFRACTING MEDIUM

In a healthy eye, light from an object is focused on to the retina resulting in a clear image. Most of the focusing power of the eye is provided by the cornea. However about 20% of the focusing power is supplied by the lens.

The lens is a transparent, biconvex structure in the eye that along with the cornea helps to refract light to be focused on the retina. Any clouding or alteration in the shape of the lens of the eye may interfere with its ability to focus light within the eye.

In children, particularly those under seven years old, it is critical that the eye sees a clear image. Otherwise the visual system may not develop normally and amblyopia will occur. This condition may accompany cataract in children.

1.2.1.1 ANATOMY OF THE LENS

The lens which is also known as 'aquula' (Latin; a little stream, dim of aqua, water) is a transparent, biconvex, crystalline structure which is situated in the posterior chamber of the eye. It is situated between the posterior surface of the iris and the vitreous body. Together with the iris, it forms an optical diaphragm that separates the anterior and posterior chambers of the eye. It is suspended in position by the zonules of Zinn, which consist of radially arranged delicate yet strong fibres that support and attach it to the ciliary body. The lens, which has considerable flexibility, is kept in position by these fibres.

The crystalline lens consist of five major structures; embryonic nucleus, foetal nucleus, cortex, lens epithelium, and lens capsule. Started to develop at about 28th day of gestation, the lens forms from a layer of surface ectoderm. At birth, the foetal nucleus and embryonic nucleus make up most of the lens volume. The cortex, the outer most layers is produced continually throughout life by the anterior lens epithelium. Because the size of the lens capsule remains relatively constant, the lens density increases. Thus infants and young children have a relatively soft lens which can easily be removed by simple aspiration.

The lens has no blood supply or innervation after foetal development. It depends entirely upon the aqueous humor to meet its metabolic requirements and to carry off its waste.

The lens grows continuously throughout life. The equatorial diameter of the lens is about 6.5 mm at birth, increases to 9 to 10 mm in the second decade of life and then remains almost constant. The thickness (anteroposterior diameter) varies with age between 3.5 mm at birth to 5 mm at extreme age.

The refractive index of the lens is 1.39 and its refractive power is about 16 to 17 D. This refractive power is roughly about one-fourth of the eye's total power. Its accommodative power varies with age, being 14 to 16 D at birth; 7 to 8 D at 25 years of age and 1 to 2 D at 50 years of age.

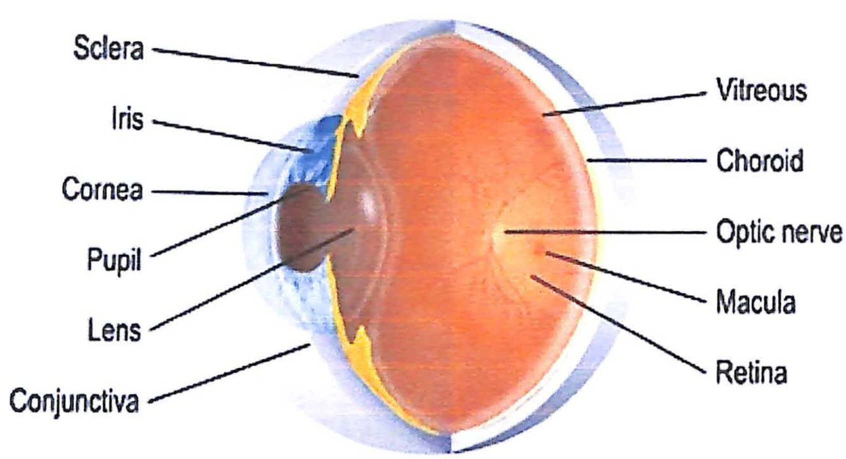

Figure 1.1 : Cross section of the human eye, showing the lens relationship to surrounding ocular structures

1.2.1.2 PHYSIOLOGY AND METABOLISM

Throughout life, lens epithelial cells at the equator continue to divide and develop into lens fibre, resulting in continual growth of the lens. As the lens is avascular, the aqueous humor serves as a source of nutrition and as a sink for lens waste products. It is nourished by diffusion from the aqueous humor. Many areas of the lens physiology, biochemistry and metabolism are complex and not clearly understood and are still the subject of active research.

The metabolism and growth of the lens cells are self-regulating. Metabolic activity is essential for the preservation of the integrity, transparency, and optical function of the lens. The epithelium of the lens helps to maintain the ion equilibrium and permit transportation of nutrients, minerals and water into the lens. This type of transportation which referred as 'pump-leak system', permits active transfer of sodium, potassium, calcium, and amino acids from the aqueous humor into the lens as well as passive diffusion through the posterior lens capsule. Maintaining this equilibrium is essential for the transparency of the lens and is closely related to the water balance. The water content of the lens is normally stable and in equilibrium with the surrounding aqueous humor.

1.2.1.3 FUNCTIONS OF THE LENS

The main functions of the lens are to maintain its own clarity, to refract light and to provide accommodation. The lens focuses light rays onto the retina by refracting them. The cornea does most of the refraction, and the crystalline lens fine-tunes the focus.

Although the lens provides only about 30% of the refracting power of the eye, it provides all of the focusing power. The lens is the structure that most responsible for adapting to the changing axial length of the eye and its subsequent influence on the refractive needs of the eye.

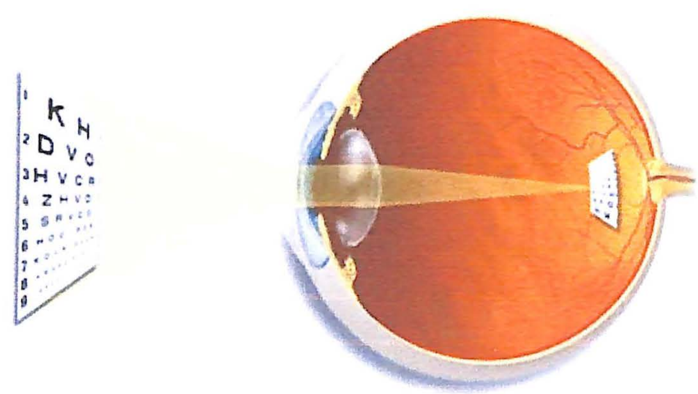

Figure 1.2 : Light rays passing through the lens that focus on the retina

1.2.1.4 DISORDERS OF THE LENS

Abnormalities of the crystalline lens constitute a significant source of visual impairment in children. They include changes in clarity (cataract), shape (lenticonus), size (microspherophakia), location (ectopia lentis), and development (persistent foetal vasculature). Paediatric lens abnormalities provide a special challenge to the ophthalmologist as early detection and prompt treatment are crucial to obtain good visual outcomes. There is not yet any medical treatment that can prevent the formation or progression of cataract in the lens of the otherwise healthy individual eye.