



## Pediatric photorefractive keratectomy for anisometropic amblyopia: a review

Somayeh Tafaghodi Yousefi (MD)\*, Mohammad Etezzad Razavi (MD), Alireza Eslampour (MD)

Eye Research Center, Khatam Eye Hospital, Mashhad University of Medical Sciences, Mashhad, Iran

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### ABSTRACT

Amblyopia is one of the most important reversible eye disorders in children and different treatments are suggested. Early diagnosis and effective treatment in amblyogenic age are important criteria. These critical periods correspond to the period when the child's developing visual system is sensitive to abnormal input caused by stimulus deprivation, strabismus or significant refractive errors. Traditional treatments such as glass wearing, contact lens used with patch therapy have limitations. Laser corneal refractive surgeries introduce an alternative for the treatment of anisometropic amblyopia. Current indications for refractive surgery include anisometropia, bilateral high myopia and accommodative esotropia. Several reports confirmed that with recent development in keratorefractive surgery, it could be a safe method to be used in children. The goal of the permanent surgical treatment is to reduce refractive errors, treat amblyopia and make better the binocular function. Corneal haze is certainly a major concern in children receiving surface ablation, especially in high myopic treatments. However, controversies still exist on whether it could be done in this population or not. This article reviews the available data about refractive surgery for treating anisometropic amblyopia.

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## Introduction

### Amblyopia

Amblyopia is a Greek word, which means "dullness of vision". In ophthalmology,

it defines as reduced visual acuity that could not be explained by the effect of any

**\*Corresponding author:** Somayeh Tafaghodi Yousefi.  
Eye Research Center, Khatam Eye Hospital, Mashhad  
University of Medical Sciences, Mashhad, Iran  
**E-mail:** Tafaghodis891@mums.ac.ir  
**Tel:** 09153171672

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abnormality in the eye (1). Amblyopia is the most common reason of unilateral visual impairment in children and juvenile (2-7), which is most often detected through routine vision screening programs (8). Vision screening is recommended between ages 3 to 5 years because successful treatment of amblyopia is not expected in children older than 6 years old (9-12).

There are 3 main causes of early visual impairment, which lead to amblyopia including strabismus, anisometropia or high bilateral refractive errors (isometropia) and visual deprivation (13).

### ***Anisometropia***

Anisometropia is the most common reason of amblyopia, which occurs due to uncorrected asymmetrical refractive error between the two eyes. Uncorrected anisometropia induces blurry image in one eye and unusual binocular interaction by producing different images on the fovea (7).

Normal appearance of anisometropic child and good visual performance of dominant eye delay the diagnosis of amblyopia. The level of anisometropia, which leads to amblyopia, has been studied in different literature. In conclusion, anisohyperopia of more than 1 diopter, anisomyopia of more than 2 diopters and anisoastigmatism of more than 1.5 diopter may produce amblyopia (14,15). The amount of anisometropia has a direct connection with the severity of amblyopia (16,17).

Successful visual outcome with traditional amblyopia therapy for anisometropia of more than 4 diopter has been reported (10).

### ***Search strategies***

MEDLINE, ISI Web of Science, CINAHL, AMED and Cochrane Library were searched for 2013 articles related to amblyopia, anisometropia, corneal refractive surgery and amblyopia therapy.

### ***Treatment of amblyopia***

The treatment of anisometropic amblyopia includes correction of the refractive errors by spectacles or contact lenses with patching of the dominant eye.

### ***Spectacles***

Even today, spectacles are the most common treatment for anisometropic amblyopia. However, it has limitations in full optical correction of high anisometropic refractive errors.

Anisokonia means dissimilar image size. Aniseikonia of more than 5% to 6% (Typically present with 3 or more diopters of anisometropia) cannot be well tolerated (18).

While performing the patching therapy, children can tolerate spectacles. However, once the patching is finished, the great aniseikonia occurs and the child cannot tolerate spectacle with full dioptric correction in their binocular state (19-24).

Furthermore, in eccentric gazes, thick lenses can induce prismatic effects (25,26). Both of these reasons create binocular image unfused and disrupt binocular fusion (27). Anisometropic glasses of more than 2 to 3 diopters are also cosmetically problematic when corrected by spectacle due to different magnification of the hyperopic lens or minification effect of the myopic lens (28,29).

### ***Contact lenses***

Alternate treatment for anisometropic amblyopia is the use of contact lenses. Contact lenses eliminate all disadvantages of spectacles with better quality of vision and contrast sensitivity.

In spite of these benefits, contact lenses have some disadvantages such as the difficulty of insertion and removing, being time-consuming for parents, risk of microbial keratitis and comparatively high expenses (30-33).

Because children are usually disregarded to hygiene, they are at higher risk of infections

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than adults who use contact lenses (34,35).

### ***Occlusion, penalization***

Even though it is a common need to correct the anisometropic amblyopia, but further amblyopia treatment is regularly necessary. This extra treatment contains occlusion therapy, optical or pharmacologic penalization with cycloplegic agents or the combination of these procedures are used in children in whom the correction of refractive error cannot improve visual acuity. Most of the time occlusion therapy does not associated with any complaint (36).

Atropine penalization has some disadvantages containing photosensitivity and anticholinergic effect (37). In comparison, optical penalization that utilizes a lens to blur visual acuity in the dominant eye is an accepted method (38,39).

Considerable psychosocial pressure connected to amblyopia therapy has been reported by these children and their parents during the treatment period (36).

Even in adults that have a history of amblyopia treatment in early years, psychosocial difficulties related to the previous amblyopia therapy were reported that have negatively affected behavior in places such as work, school and other social relations (40).

The other experimental method that treats amblyopia in adults and children is the use of medication for example levodopa, carbidopa and citicoline that can enhance dopaminergic neurotransmission in the brain (41-47).

These methods can improve visual acuity mildly but unfortunately, the improvement was not persistent after the discontinuing of the medication (42,44-49).

### ***Refractive surgery***

Refractive surgery is a reasonable option in the treatment of children with refractive anisometropic amblyopia, especially in patients who cannot tolerate spectacle or contact

lenses. Both laser in situ keratomileusis (LASIK) and photorefractive keratectomy (PRK) have been well established in adults for correction of refractive errors (50,51). Refractive surgery through excimer laser has been useful in children as well as in particular cases with amblyopia due to high myopic anisometropia (24,52).

Refractive methods that may be useful in children are PRK, LASIK and laser epithelial keratomileusis (LASEK). PRK and LASIK have been the most widely studied among the excimer laser procedures (53). Most of the ophthalmologists have suggested LASIK and PRK for children younger than two years old (54-56).

Both procedures can be performed under regional anesthesia with self-fixation in older and obliging children (21,57-59). Anxiolytic agents such as midazolam or diazepam have also been suggested (22,58). In young children, general anesthesia with intravenous sedation or laryngeal mask can be applied (59).

The procedure of photorefractive keratectomy includes the removal of the corneal epithelium, that can be done manually or by excimer laser as well. Following that, computer-guided ablation of the Bowman's membrane and anterior corneal stroma was done. Laser in situ keratomileusis contains creating a flap of the central corneal composed of epithelium, Bowman's membrane and the anterior part of stroma. Then, the ablation of the posterior corneal stroma laser was done by computer-guided excimer.

After the change in the corneal stroma to correct the refractive error, the flap is positioned again and is detained in place by primarily feeble, usual biomechanical bonds. After LASIK flap repositioning, handling of the eye must be avoided to decrease the risk of flap dislocation. Creation of a LASIK flap also reduces the degree of refractive correction that may be achieved

by laser ablation because an adequate bed of intact stroma must stay to ensure corneal integrity for a long time (60-62).

The surface-ablation techniques (PRK) and laser (LASEK) avoid these disadvantages because they do not require stromal flap creation (63,64). These procedures have been also utilized to correct refractive errors in a few numbers of children (65).

In comparison, the advantages of LASIK are more than PRK with less discomfort after surgery, sooner visual recovery and greater part of Bowman remains without any change (66). In addition, the advantages of PRK are less complication connected with LASIK including corneal flap loss, tear or striae and keratectasia (67-71). Corneal haze is an important risk factor for PRK reported in adult, which can be temporary or permanent (72,73).

The implications of permanent or temporary corneal haze in children are greatly different from adults because the visual system of the child is undeveloped and the risk of worsening the amblyopia being worsened by vision deprivations is higher. Luckily, corneal haze that can occur after refractive surgery has been typically mild in small children treated with PRK. Therefore, the suggested postoperative topical steroid was followed. Corneal haze is certainly a major concern in high myopic treatments (74,75).

### ***Refractive surgery for amblyopia therapy***

Astle et al. set up a study on 27 pediatric patients (1-6 years old) with anisometric amblyopia, mean preoperative spherical equivalent (SE) was 10.7 (range of -0.8 to -25.0 D). After a follow-up of 12 months, the average correction was 9.3 D with mean postoperative SE of -1.4 D. Mean best corrected visual acuity (BCVA) improved from 20/70 to 20/40. Sixty-four percent gained binocular vision or visual function. Three patients had mild degree of haze. The rate of myopic shift averaged

about 1.4 per year in this population. They reported that PRK was safe and could be helpful for amblyopia therapy (54).

Autrata et al. in 2004, reported that amblyopia due to high myopic anisometropia could be treated with PRK or LASEK when ophthalmologists faced with uncooperative child for occlusion therapy. They used PRK and LASEK to correct anisomyopia in 27 patients with a mean age of 5.4 years (range of 4 to 7 years). Mean preoperative SE of 21 patients was -8.3 D (range, -6.0 to -11.3 D). After a follow-up of 24 months, mean postoperative SE was -1.6 D. Mean BCVA improved from 20/95 to 20/26. Seventy eight percent gained binocular vision. Three patients had a mild degree of haze. The rate of myopic shift in this population averaged 1.1 D per year. In addition, they reported refractive surgery was safe and it had the same incidence of complications in pediatrics comparing adult (65).

In another study, Paysse EA et al. found that due to refractive surgery for amblyopia therapy, severe anisometric amblyopia has been resolved in long-term follow up and these methods were acceptable for amblyopia therapy (55).

When conventional treatments of amblyopia failed, refractive surgery for amblyopia therapy could be an alternative for ophthalmologists, which have been reported by Alio et al. in 1998 (22).

Some risk factors should be consider in successful refractive surgery for amblyopia therapy. First, the severity of the amblyopia and the second one is patient age (less than 7 years old is favorable), third one is corneal thickness, forth of them is general anesthesia protocol (76). These factors could influence on treatment results.

### **Conclusion**

Several researches have reported that visual acuity and binocular vision outcomes were considerably better in children who



received permanent surgical correction of anisometropia compared to those who were conventionally treated using spectacles and contact lenses (55,65). The refractive error reply in children was considered to be similar to that of adults with similar refractive errors. Visual acuity and stereopsis enhanced in spite of several children being outside the standard age of visual plasticity. Photorefractive keratectomy may play a role in the treatment of anisometropia in children (77).

Other reports have also recommended that the refractive surgery was effective in the treatment of high hyperopic anisometric amblyopia in children older than 6, but after this age the treatment of amblyopia has been less successful (78,79).

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### Conflict of Interest

The authors declare no conflict of interest.

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