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Pediatric photorefractive keratectomy for anisometropic amblyopia: a review

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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

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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

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 anisometropic 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 anisometropic 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 anisometropic 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.

References

1. Revell MJ, Association BO. Strabismus: A History Orthoptic Techniques: Barrie & Jenkins; 1971.
2. Duane TD, Tasman W, Jaeger EA. Duane's Clinical Ophthalmology: J. B. Lippincott Co.1994.
3. Mittelman D. Amblyopia. Pediatr Clin North Am. 2003;50:189-196.
4. LaRoche GR. Amblyopia: detection, prevention, and rehabilitation. Curr Opin Ophthalmol. 2001;12:363-367.
5. Holmes JM, Kraker RT, Beck RW, et al. A randomized trial of prescribed patching regimens for treatment of severe amblyopia in children. Ophthalmology. 2003;110:2075-2087.
6. Repka MX, Beck RW, Holmes JM, et al. A randomized trial of patching regimens for treatment of moderate amblyopia in children. Arch Ophthalmol. 2003;121:603-611.
7. de Vries J. Anisometropia in children: analysis of a hospital population. Br J Ophthalmol. 1985;69:504-507.
8. Committee on Practice and Ambulatory Medicine and Section on Ophthalmology; American Academy of Pediatrics. Use of photoscreening for children's vision screening. Pediatrics. 2002;109:524-525.
9. Lithander J, Sjostrand J. Anisometropic and strabismic amblyopia in the age group 2 years and above: a prospective study of the results of treatment. Br J Ophthalmol. 1991;75:111-116.
10. Flynn JT, Schiffman J, Feuer W, et al. The therapy of amblyopia: an analysis of the results of amblyopia therapy utilizing the pooled data of published studies. Trans Am Ophthalmol Soc. 1998;96:431-450.
11. Oliver M, Neumann R, Chaimovitch Y, et al. Compliance and results of treatment for amblyopia in children more than 8 years old. Am J Ophthalmol. 1986;102:340-345.
12. Flynn JT, Cassady JC. Current trends in amblyopia therapy. Ophthalmology. 1978;85:428-450.
13. Yanoff M, Duker JS, Augsburger JJ. Ophthalmology: Mosby Elsevier; 2009.
14. Weakley DR. The association between anisometropia, amblyopia, and binocularity in the absence of strabismus. Trans Am Ophthalmol Soc. 1999;97:987-921.
15. Weakley DR Jr. The association between nonstrabismic anisometropia, amblyopia, and subnormal binocularity. Ophthalmology. 2001;108:163-171.
16. Kivlin JD, Flynn JT. Therapy of anisometropic amblyopia. J Pediatr Ophthalmol Strabismus. 1981;18:47-56.
17. Cobb CJ, Russell K, Cox A, et al. Factors influencing visual outcome in anisometropic amblyopes. Br J Ophthalmol. 2002;86:1278-1281.
18. Wu C, Hunter DG. Amblyopia: diagnostic and therapeutic options. Am J Ophthalmol. 2006;141:175-184.
19. Haw WW, Alcorn DM, Manche EE. Excimer laser refractive surgery in the pediatric population. J Pediatr Ophthalmol Strabismus. 1999;36:173-177.
20. Singh D. Photorefractive keratectomy in pediatric patients. J Cataract Refract Surg. 1995;21:630-632.
21. Nano HD Jr, Muzzin S, Irigaray F. Excimer laser photorefractive keratectomy in pediatric patients. J Cataract Refract Surg. 1997;23:736-739.
22. Alio JL, Artola A, Claramonte P, et al. Photorefractive keratectomy for pediatric myopic anisometropia. J Cataract Refract Surg. 1998;24:327-330.
23. Rashad KM. Laser in situ keratomileusis for myopic anisometropia in children. J Refract Surg. 1999;15:429-435.

24. Agarwal A, Agarwal T, Siraj AA, et al. Results of pediatric laser in situ keratomileusis. J Cataract Refract Surg. 2000;26:684-689.
25. Kowal L, Battu R, Kushner B. Refractive surgery and strabismus. Clin Experiment Ophthalmol. 2005;33:90-96.
26. Rubin ML. Optics for Clinicians. Gainesville:: Triad Publishing Company; 1993.
27. Kaufman PL, Alm A, Adler FH. Adler's physiology of the eye: clinical application: Mosby; 2003.
28. Nordlow W. Anisometropia, amblyopia, induced aniseikonia and estimated correction with iseikonic lenses in 4 year-olds. Acta Ophthalmol (Copenh). 1970;48:959-970.
29. van der Torren K. Treatment of amblyopia in strongly anisometropic eyes. Doc Ophthalmol. 1985;59:99-104.
30. Suchecki JK, Donshik P, Ehlers WH. Contact lens complications. Ophthalmol Clin North Am. 2003;16:471-484.
31. Wilhelmus KR, Robinson NM, Font RA, et al. Fungal keratitis in contact lens wearers. Am J Ophthalmol. 1988;106:708-714.
32. Wilhelmus KR. Review of clinical experience with microbial keratitis associated with contact lenses. CLAO J. 1987;13:211-214.
33. Dart JK. Predisposing factors in microbial keratitis: the significance of contact lens wear. Br J Ophthalmol. 1988;72:926-930.
34. Clinch TE, Palmon FE, Robinson MJ, et al. Microbial keratitis in children. Am J Ophthalmol. 1994;117:65-71.
35. Cruz OA, Sabir SM, Capo H, et al. Microbial keratitis in childhood. Ophthalmology. 1993;100:192-196.
36. Holmes JM, Beck RW, Kraker RT, et al. Impact of patching and atropine treatment on the child and family in the amblyopia treatment study. Arch Ophthalmol. 2003;121:1625-1632.
37. von Noorden GK. Amblyopia caused by unilateral atropinization. Ophthalmology. 1981;88:131-133.
38. Simons K, Gotzler KC, Vitale S. Penalization versus part-time occlusion and binocular outcome in treatment of strabismic amblyopia. Ophthalmology. 1997;104:2156-2160.
39. Simons K, Stein L, Sener EC, et al. Full-time atropine, intermittent atropine, and optical penalization and binocular outcome in treatment of strabismic amblyopia. Ophthalmology. 1997;104:2143-2155.
40. Packwood EA, Cruz OA, Rychwalski PJ, et al. The psychosocial effects of amblyopia study. J AAPOS. 1999;3:15-17.
41. Bhartiya P, Sharma P, Biswas NR, et al. Levodopa-carbidopa with occlusion in older children with amblyopia. J AAPOS. 2002;6:368-372.
42. Campos EC, Schiavi C, Benedetti P, et al. Effect of citicoline on visual acuity in amblyopia: preliminary results. Graefes Arch Clin Exp Ophthalmol. 1995;233:307-312.
43. Leguire LE, Walson PD, Rogers GL, et al. Levodopa/carbidopa treatment for amblyopia in older children. J Pediatr Ophthalmol Strabismus. 1995;32:143-151.
44. Leguire LE, Walson PD, Rogers GL, et al. Longitudinal study of levodopa/carbidopa for childhood amblyopia. J Pediatr Ophthalmol Strabismus. 1993;30:354-360.
45. Leguire LE, Rogers GL, Bremer DL, et al. Levodopa and childhood amblyopia. J Pediatr Ophthalmol Strabismus. 1992;29:290-298.
46. Pandey PK, Chaudhuri Z, Kumar M, et al. Effect of levodopa and carbidopa in human amblyopia. J Pediatr Ophthalmol Strabismus. 2002;39:81-89.
47. Gottlob I, Wizov SS, Reinecke RD. Visual acuities and scotomas after 3 weeks' levodopa administration in adult amblyopia. Graefes Arch Clin Exp Ophthalmol. 1995;233:407-413.
48. Leguire LE, Komaromy KL, Nairus TM, et al. Long-term follow-up of L-dopa treatment in children with amblyopia. J Pediatr Ophthalmol Strabismus. 2002;39:326-330.
49. Mohan K, Dhankar V, Sharma A. Visual acuities after levodopa administration in amblyopia. J Pediatr Ophthalmol Strabismus. 2001;38:62-67.
50. Schein OD, Vitale S, Cassard SD, et al. Patient outcomes of refractive surgery. The refractive status and vision profile. J Cataract Refract Surg. 2001;27:665-673.
51. Miller AE, McCulley JP, Bowman RW, et al. Patient satisfaction after LASIK for myopia. CLAO J. 2001;27:84-88.
52. Yin ZQ, Wang H, Yu T, et al. Facilitation of amblyopia management by laser in situ keratomileusis in high anisometropic hyperopic and myopic children. J AAPOS. 2007;11:571-576.
53. Nagy ZZ, Fekete O, Suveges I. Photorefractive keratectomy for myopia with the Meditec MEL 70G-Scan flying spot laser. J Refract Surg. 2001;17:319-326.
54. Astle WF, Huang PT, Ells AL, et al. Photorefractive keratectomy in children. J Cataract Refract Surg. 2002;28:932-941.
55. Paysse EA, Coats DK, Hussein MA, et al. Long-term outcomes of photorefractive keratectomy for anisometropic amblyopia in children. Ophthalmology. 2006;113:169-176.
56. Tychsen L, Packwood E, Berdy G. Correction of large amblyopiogenic refractive errors in children using the excimer laser. J AAPOS. 2005;9:224-233.
57. Nucci P, Drack AV. Refractive surgery for unilateral high myopia in children. J AAPOS. 2001;5:348-351.
58. Nassaralla BR, Nassaralla JJ, Jr. Laser in situ

keratomileusis in children 8 to 15 years old. J Refract Surg. 2001;17:519-524.
59. Paysse EA, Hamill MB, Koch DD, et al. Epithelial healing and ocular discomfort after photorefractive keratectomy in children. J Cataract Refract Surg. 2003;29:478-481.
60. Melki SA, Talamo JH, Demetriades AM, et al. Late traumatic dislocation of laser in situ keratomileusis corneal flaps. Ophthalmology. 2000;107:2136-2139.
61. Patel CK, Hanson R, McDonald B, et al. Case reports and small case series: late dislocation of a LASIK flap caused by a fingernail. Arch Ophthalmol. 2001;119:447-449.
62. Heickell AG, Vesaluoma MH, Tervo TM, et al. Late traumatic dislocation of laser in situ keratomileusis flaps. J Cataract Refract Surg. 2004;30:253-256.
63. Lee JB, Seong GJ, Lee JH, et al. Comparison of laser epithelial keratomileusis and photorefractive keratectomy for low to moderate myopia. J Cataract Refract Surg. 2001;27:565-570.
64. Claringbold TV, 2nd. Laser-assisted subepithelial keratectomy for the correction of myopia. J Cataract Refract Surg. 2002;28:18-22.
65. Autrata R, Rehurek J. Laser-assisted subepithelial keratectomy and photorefractive keratectomy versus conventional treatment of myopic anisometropic amblyopia in children. J Cataract Refract Surg. 2004;30:74-84.
66. Gimbel HV, Levy SG. Indications, results, and complications of LASIK. Curr Opin Ophthalmol. 1998;9:3-8.
67. Davis EA, Hardten DR, Lindstrom RL. LASIK complications. Int Ophthalmol Clin. 2000;40:67-75.
68. Knorz MC. Flap and interface complications in LASIK. Curr Opin Ophthalmol. 2002;13:242-245.
69. Schwartz GS, Park DH, Schloff S, et al. Traumatic flap displacement and subsequent diffuse lamellar keratitis after laser in situ keratomileusis. J Cataract Refract Surg. 2001;27:781-783.
70. Tabbara KF, El-Sheikh HF, Vera-Cristo CL. Complications of laser in situ keratomileusis (LASIK). Eur J Ophthalmol. 2003;13:139-146.
71. Piccoli PM, Gomes AA, Piccoli FV. Corneal ectasia detected 32 months after LASIK for correction of myopia and asymmetric astigmatism. J Cataract Refract Surg. 2003;29:1222-1225.
72. Moller-Pedersen T, Cavanagh HD, Petroll WM, et al. Stromal wound healing explains refractive instability and haze development after photorefractive keratectomy: a 1-year confocal microscopic study. Ophthalmology. 2000;107:1235-1245.
73. van de Pol C, Soya K, Hwang DG. Objective assessment of transient corneal haze and its relation to visual performance after photorefractive keratectomy. Am J Ophthalmol. 2001;132:204-210.
74. Lesueur LC, Arne JL. Phakic intraocular lens to correct high myopic amblyopia in children. J Refract Surg. 2002;18:519-523.
75. Chipont EM, Garcia-Hermosa P, Alio JL. Reversal of myopic anisometropic amblyopia with phakic intraocular lens implantation. J Refract Surg. 2001;17:460-462.
76. Paysse EA. Photorefractive keratectomy for anisometropic amblyopia in children. Trans Am Ophthalmol Soc. 2004;102:341-371.
77. Paysse EA, Hamill MB, Hussein MA, et al. Photorefractive keratectomy for pediatric anisometropia: safety and impact on refractive error, visual acuity, and stereopsis. Am J Ophthalmol. 2004;138:70-78.
78. Davidorf JM. Pediatric refractive surgery. J Cataract Refract Surg. 2000;26:1567-1568.
79. Medvedeva NI, Sheludchenko VM. Choice of a surgical correction method in hypermetropic anisotropia in children. Vestn Oftalmol. 2003;119:14-18.