Anisometropic Amblyopia: The Potential Role of Keratorefractive Surgery

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ABSTRACT

Introduction: Traditional therapy for anisometropic amblyopia often fails when severe anisometropia is present. Recent advances in refractive surgery for anisometropic amblyopia suggest that surgical treatment may be a viable alternative in certain situations.

Methods: The potential indications for refractive surgery for anisometropia, the different refractive procedures available, and the risks and benefits of each procedure are discussed.

Results: The most reasonable indication at present is severe anisometropia that is nonresponsive to conventional therapy. The risks, though rare, of PRK and LASEK are corneal haze and regression of refractive correction, and risks of LASIK are keratectasia, flap loss, flap tear, or buttonhole, and regression of refractive correction.

Conclusions: Surgical interventions now exist that have value in the treatment of anisometropic amblyopia. Randomized clinical trials are needed in order to optimally evaluate the long-term safety and efficacy of these treatments.

INTRODUCTION

Anisometropic amblyopia management has changed little in the past hundred years. Traditional therapy consists of correcting the refractive error with spectacles or contact lenses, followed by the addition of occlusion or penalization therapy of the sound eye if the amblyopia persists. This conventional therapy, as simple as it sounds, fails not infrequently. If the definition of failure is a final visual acuity of 20/40 or worse, conventional therapy fails in from 10% to over 50% of children published in the literature.1-4 Recent advances in refractive surgery for anisometropic am-
blyopia suggest that surgical treatment may be a viable alternative to conventional therapy for anisometropic amblyopia in certain situations.

The science of correcting refractive error has undergone an interesting evolution. Spectacle correction has been around since the thirteenth century and contact lenses since the 1880s. Refractive surgical procedures began in the 1970s with radial keratotomy followed by epikeratophakia and now excimer laser procedures. Most recently, clear lens extraction and phakic intraocular lenses have become accepted for treatment of selected refractive error problems in the adult population.

POTENTIAL INDICATIONS FOR SURGICAL INTERVENTION

Why should we consider surgical interventions for anisometropic amblyopia? There are several reasons: (1) Conventional therapy sometimes fails, and such patients currently have no other alternatives; (2) Patients who are “successfully” treated often have vision that is less than optimal; (3) Residual amblyopia is very common and could possibly be prevented if the refractive error were normalized at an earlier age; (4) With severe anisometropia, correcting the refractive error often causes aniseikonia, reduced stereopsis/binocularity, and image distortion; (5) Lastly, it is incumbent upon all physicians to continue to responsibly explore potential new treatment options that may offer better outcomes and/or simplify treatment regimens.

We know that the success rate of conventional therapy declines with increasing anisometropia, and the severity of the amblyopia increases with increasing anisometropia. What then are the potential indications for surgical intervention of anisometropic amblyopia? An obvious potential indication would be failure with conventional therapy. Another possible indication could be a certain level of severe anisometropia known to be associated with a poor visual outcome. As we become more comfortable with these procedures and the results, this second potential indication may become reality.

Amblyopiogenic levels of anisometropia are well known. Two diopters of anisomyopia, 1 D of anisohyperopia, and 1.5 D of anisoastigmatism are known to lead to amblyopia if left uncorrected. Is this entry level of anisometropia, however, enough to offer refractive surgery? It probably is not, because the success rate for this entry level of anisometropia is exceedingly high with conventional therapy. Kivlin5 found that there was a distribution of treatment success that directly related to the amount of anisometropia, with decreasing success associated with increasing anisometropia. When more than 6 D of anisomyopia was present, only 25% of children had a successful outcome with conventional therapy. When 3 to 6 D of anisomyopia or anisohyperopia was present, only 67% were successfully treated with conventional therapy. Less severe levels of anisometropia typically achieved good success rates. From this data, it is probably reasonable to consider refractive surgery for anisometropic amblyopia when at least 3 to 4 D of anisomyopia or anisohyperopia is present.

POTENTIAL REFRACTIVE SURGICAL PROCEDURES FOR ANISOMETROPIA

The specific refractive procedures that may be applicable for children are photorefractive keratectomy (PRK), laser in situ keratomileusis (LASIK), laser assisted subepithelial keratectomy (LASEK), clear lens extraction, phakic intraocular lenses, and intrastromal corneal rings (Intacs). The only refractive procedures that have undergone any significant investigation in children are PRK, LASIK, and LASEK.
RISKS AND BENEFITS OF VARIOUS REFRACTIVE SURGICAL PROCEDURES

As with any medical or surgical intervention, there are pros and cons associated with each of these excimer laser procedures. The advantages of PRK include achieving a stable refractive correction with a less invasive procedure than LASIK as it is a surface ablation. The disadvantages of PRK when compared to LASIK are the risk of postoperative corneal haze that may require four to six months of topical corticosteroid use, longer recovery time (approximately three days for the epithelium to heal), and more discomfort. When compared to PRK, LASIK enjoys the same advantages of stable correction, but it offers the benefits of faster recovery and limited pain. The potential disadvantages/complications of LASIK, however, are significant, potentially vision threatening, and include flap dislocation, tear (or hole) keratectasia, epithelial ingrowth, and possible long-term corneal endothelial cell loss. LASEK essentially has the same risk profile as PRK, though it may be associated with less discomfort.

Published studies to date have involved approximately 220 children who have undergone an excimer laser refractive procedure. All studies\textsuperscript{6–19} have shown consistent, predictable refractive correction, mild to excellent visual acuity improvement, and minimal or no complications. In studies that evaluated stereopsis, more than 50% of patients tested improved regardless of age at time of refractive procedure (Table). Sample size, however, has been small in all studies to date, and only two\textsuperscript{6, 16} have included a control group treated with con-

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Age (yrs)</th>
<th># pts</th>
<th>Pre Mean SE (D)</th>
<th>Mean Post SE (D)</th>
<th>Mean Pre BCVA</th>
<th>Mean Post BCVA</th>
<th>Mean FU (Mo)</th>
<th>Corneal Haze</th>
<th>Complic</th>
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</thead>
<tbody>
<tr>
<td>Paysse PRK</td>
<td>2–11</td>
<td>8</td>
<td>-13.75</td>
<td>-3.30</td>
<td>20/270</td>
<td>20/87</td>
<td>36</td>
<td>Min</td>
<td>None</td>
</tr>
<tr>
<td>Tychsen PRK/LASEK</td>
<td>4–16</td>
<td>35</td>
<td>-11.5</td>
<td>-1.26</td>
<td>20/87</td>
<td>20/47</td>
<td>29</td>
<td>Min</td>
<td>None</td>
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<tr>
<td>Autrata PRK/LASEK</td>
<td>4–7</td>
<td>27</td>
<td>-8.25</td>
<td>-1.61</td>
<td>20/95</td>
<td>20/26</td>
<td>24</td>
<td>Min</td>
<td>None</td>
</tr>
<tr>
<td>Astle PRK</td>
<td>6.3*</td>
<td>27</td>
<td>-10.68</td>
<td>-1.37</td>
<td>20/70</td>
<td>20/40</td>
<td>12</td>
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<td>None</td>
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<td>O’Keefe LASIK</td>
<td>2–12</td>
<td>6</td>
<td>-10.20</td>
<td>-3.00</td>
<td>20/142</td>
<td>20/63</td>
<td>24</td>
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<td>None</td>
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<tr>
<td>Hittner LASIK</td>
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<td>5</td>
<td>-9.05</td>
<td>NR</td>
<td>20/30</td>
<td>20/30</td>
<td>18</td>
<td>None</td>
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<tr>
<td>Nassaralla LASIK</td>
<td>8–15</td>
<td>9</td>
<td>-7.22</td>
<td>-0.22</td>
<td>NR</td>
<td>NR</td>
<td>12</td>
<td>None</td>
<td>None</td>
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<tr>
<td>Rybintseva LASIK</td>
<td>9–15</td>
<td>38</td>
<td>-6.00</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>18</td>
<td>None</td>
<td>None</td>
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<td>Nucci PRK/LASIK</td>
<td>9–14</td>
<td>14</td>
<td>-7.96</td>
<td>-0.67</td>
<td>20/125</td>
<td>20/121</td>
<td>20</td>
<td>NR</td>
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<td>Singh PRK</td>
<td>10–15</td>
<td>9</td>
<td>-12.13</td>
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<td>20/82</td>
<td>20/44</td>
<td>10</td>
<td>1 severe</td>
<td>None</td>
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<tr>
<td>Nano PRK</td>
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<td>-7.9</td>
<td>-1.55</td>
<td>20/400</td>
<td>20/72</td>
<td>12</td>
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<td>Agarwal LASIK</td>
<td>5–11</td>
<td>16</td>
<td>-14.88</td>
<td>-1.44</td>
<td>20/37</td>
<td>20/37</td>
<td>36</td>
<td>2 mod 2 free</td>
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<tr>
<td>Rashad LASIK</td>
<td>7–12</td>
<td>14</td>
<td>-7.87</td>
<td>-0.55</td>
<td>20/50</td>
<td>20/25</td>
<td>12</td>
<td>None</td>
<td>None</td>
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<tr>
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<td>-9.58</td>
<td>-2.42</td>
<td>20/114</td>
<td>20/35</td>
<td>24</td>
<td>1 severe</td>
<td>None</td>
</tr>
</tbody>
</table>

* Mean age, range not given.

ventional therapy. Randomized clinical trials are now needed to optimally evaluate these surgical alternatives for anisometropic amblyopia.

Other potential surgical treatments for refractive correction that may ultimately be considered for children include clear lens extraction, phakic intraocular lenses, and intrastromal corneal rings. Each has had little or no investigation in children. Good results have also been reported for adults with high refractive error undergoing clear lens extraction.\textsuperscript{20-24} Ali et al. recently reported excellent visual and refractive results from refractive myopic lensectomy for high anisometropia in children.\textsuperscript{25} Increased risk of retinal detachment after clear lens extraction, however, is significant, especially for children with axial myopia. As with all of these procedures, the risk/benefit profile must be carefully considered.

Very limited research on phakic intraocular lenses in children has been published. Several case reports and case series\textsuperscript{26, 27} involving children have shown good results. The risks of phakic intraocular lenses, however, are serious and can be vision threatening, including cataract and corneal endothelial cell loss with the secondary corneal decompensation.

Intrastromal corneal rings are a very effective and reversible surgical method to reduce mild to moderate myopic refractive error up to approximately 4 D. They may become a viable alternative for children in the future if, through technological advances, greater degrees of myopia become amenable to this treatment.

CONCLUSION

In summary, surgical interventions now exist that have value in the treatment of anisometropic amblyopia. Most studies in children have involved excimer laser refractive procedures, though some research is beginning to appear involving clear lens extraction and phakic intraocular lenses. Though one or more of these procedures appear to offer a great deal of hope for selected patients, routine use of refractive surgery in children is not yet reasonable. Randomized clinical trials are needed in order to optimally evaluate the long-term safety and efficacy of these treatments.

REFERENCES

13. Astle WF, Huang PT, Ingram AD, Farran RP:


Key words: anisometropic amblyopia, LASIK, LASEK, PRK, surgery, clear lens extraction