The Benefits, Risks, and Efficacy of Strabismus Surgery in Adults

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ABSTRACT
Strabismus surgery in adults achieves satisfactory alignment with one operation in approximately 80% of patients, depending on the specific nature of the problem. Risks of adult strabismus surgery are relatively low, and serious complications are anecdotal and rare. Even if the strabismus has been long-standing, most adults will experience some improvement in binocular function after strabismus surgery. Consequently, adult strabismus surgery should not be considered merely cosmetic in most cases. In esotropic patients, this improvement typically takes the form of an expansion of binocular visual fields; however, some patients may also regain stereopsis. There are many psychosocial benefits to adult strabismus surgery. This is reflected in the finding that the majority of adults surveyed with strabismus would trade a portion of their life expectancy to be rid of their strabismus. (Optom Vis Sci 2014;91:e102–e109)

Key Words: strabismus, ophthalmology, diplopia, visual fields, depth perception

It has been estimated that 4% of adults in the United States have strabismus. The development of strabismus after visual maturity (aged ~9 years) is usually accompanied by diplopia. Paralytic or restrictive strabismus secondary to head injury or neurologic disease, Graves orbitopathy, orbital fracture, or orbital tumor are all common causes of strabismus that may have an onset after visual maturity. Alternatively, late-manifesting strabismus can be idiopathic or caused by decompensation of a previously mild and asymptomatic latent eye muscle imbalance. Because most of these aforementioned patients have the troubling symptom of diplopia, they tend to seek treatment from appropriate eye care professionals via optical management with prisms, eye exercises, or strabismus surgery.

Strabismus that either was untreated in childhood or recurred in adulthood after previous successful treatment during childhood is typically characterized by suppression of one eye and is usually not associated with diplopia. As such, adults may be less persistent in seeking treatment for their ocular misalignment. If they are not advised that their strabismus may be effectively treated, they may be under the misconception that corrective treatment is not possible. To investigate the prereferral experience and perceptions of adults with untreated or recurrent childhood strabismus, I conducted a retrospective review of the last 200 consecutive such patients I operated on. Patients were identified from my clinical database from the Pediatric Eye and Adult Strabismus Clinic of the University of Wisconsin Hospital and Clinic, Madison, Wis. Inclusion criteria included (1) having strabismus that had an onset before the age of 9 years; (2) the strabismus was either not corrected in childhood or corrected and recurred later; (3) underwent surgery by the author and was followed for at least 6 weeks after surgery; and (4) the record clearly indicated what prompted the referral for surgery at that particular point in time and what, if anything, may have led to a delay in referral (it is my practice to routinely ask new patients about these issues). Exclusion criteria included patients who had been under my continuous care since childhood. The review was compliant with the Health Insurance Portability and Accountability Act and was approved by the institutional review board of the University of Wisconsin.

The results of the review are summarized in Table 1. They indicate that a substantial percentage of these patients were under the misconception that nothing could be done to treat their strabismus or that treatment was ill advised. The data also indicate that the vast majority were successfully treated with strabismus surgery as determined during their last postoperative examination, all of which were at least 6 weeks after surgery. For the 65 patients (33% of the total) who were told or thought for years that their strabismus could not be treated, four misconceptions were identified as reasons they had delayed seeking treatment for years.

Often, these mistaken ideas had been initiated or reinforced by health care providers—comprehensive ophthalmologists, optometrists, and primary care physicians. These misconceptions included (1) Nothing can be done for an adult with strabismus; (2)
Strabismus surgery is not effective in adults; (3) Surgery is just “cosmetic” and does not improve binocular function; (4) There is a high risk associated with strabismus surgery in adults including a substantial risk of intractable postoperative diplopia. There are, of course, limitations to a retrospective review like this, the most important being that patients are reporting what they think they had been told in the past—sometimes many years earlier. What patients remember having been told and what they were in fact told may often not be the same. In addition, although it has been my practice to routinely inquire about patients’ prior understanding of what options were available to them, this information was not collected with the rigor used for a prospective study and may not have been accurately recorded in cases. Nevertheless, it appears that as much as one-third of this patient population does not have an accurate understanding of what can be accomplished with strabismus surgery.

Although the optometric literature contains a great deal of information about results from vision training to treat strabismus, there has been very little published therein to present the risks and benefits of strabismus surgery. Mills and coauthors\(^3\) reported on a literature review of articles on strabismus surgery in adults and identified 49 articles. Of these, only one was Cochrane level I (prospective randomized clinical trial) and the majority were Cochrane level III (case series). These studies varied in definition of success, length of follow-up, and inclusion criteria. Some consisted predominantly of patients with routine horizontal strabismus, but others included or were limited to more complex forms of strabismus. This is important because studies have shown that the patient mixture will affect the success rate.\(^1\)\(^,\)\(^4\)\(^,\)\(^5\) Although all these studies reportedly were limited to strabismus surgery in adults, the minimum age for inclusion varied. Some had a minimum age of 18 years for inclusion. Others defined “adult” as being after visual maturity and thus included some patients between 9 and 18 years of age because the authors felt that these patients have similar outcomes as older patients. Studies that focused primarily on aesthetic improvement in motor alignment used a final motor alignment of 10 prism diopters (PD) or less of horizontal tropia because that is the range of misalignment that would permit development of some binocularity in the form of the monofixation syndrome and some studies used multiple motor outcome criteria for evaluating cosmesis alone versus cosmesis plus sensory results.\(^1\) Many of the studies included a small number of patients but three had more than 250 patients (all Cochrane level III).\(^1\)\(^,\)\(^4\)\(^,\)\(^5\) All of these varying factors make a meta-analysis from the 49 studies reviewed by Mills et al. difficult to interpret. However, individual large studies can shed important light on the risks and benefits of strabismus surgery in adults, albeit subject to some limitations. Certainly, prospective randomized clinical trials would be preferable (Cochrane level I). However, as clinicians, we must make our treatment judgments based on the best information available to us. This holds for essentially all decisions for treating manifest strabismus (surgery, optical management, vision training) for which there are essentially no large prospective randomized clinical trials that one can rely on.

This review is not intended to debate the relative merits of strabismus surgery and vision training. Each reader must form his or her own opinion as to which patients to refer for which treatment modality. The purpose of the review is to address the aforementioned misconceptions about adult strabismus surgery and to review its success rates and risks in this population.

### HOW SUCCESSFUL IS ADULT STRABISMUS SURGERY IN IMPROVING ALIGNMENT?

Obviously, adults with strabismus represent a heterogeneous population with respect to etiology. The variable and complex nature of adult strabismus encompasses some of the most challenging strabismus conditions, including paralytic strabismus, strabismus associated with Graves orbitopathy, strabismus after prior childhood strabismus surgery, and strabismus after orbital fracture or tumor. Consequently, any success rate taken from a large heterogeneous series may not be applicable to any specific patient with a unique problem. Nevertheless, a review of large series of strabismus surgery in adults can give an overview of success rates. Several

### TABLE 1.

Referral history of 200 adult patients operated on for childhood-onset strabismus

| Thought or were told for years nothing could be done for their strabismus | 65/200 (33) |
| Had been under regular medical care by a PCP* | 56/65 (86)* |
| Had been receiving regular eye care* | 38/65 (58)* |
| Had specifically asked an eye care provider if their strabismus could be corrected and were either told “no” or it was inadvisable* | 32/65 (49)* |
| Had been told that, even if surgery successfully aligned their eyes, it would be “cosmetic only” and would not result in any improvement in binocularity | At least 47/200 (23.5)* |
| Strabismus surgery was successful‡ | 174/200 (87) |

*A subset of the 65 patients who thought or were told nothing could be done for their strabismus.

† Information was volunteered and documented in the chart but was not specifically asked about on a questionnaire, thus the actual number may be higher.

‡ Success defined as an alignment that was within 10 prism diopters of straight with no subjective symptoms of diplopia or visual confusion after one strabismus surgical procedure.

PCP, primary care provider.
such series of strabismus surgery in adults suggest that approximately 80% of patients will achieve satisfactory alignment with one surgical procedure.1-4,5 The one Cochrane level I study in the review by Mills et al.3 was a study by Carruthers et al.6 It included 12 patients older than 18 years who underwent strabismus surgery; a 13th patient was younger than 18 years. Ten (83%) of the 12 had a final alignment of 10 PD or less of horizontal tropia at least 6 months after surgery. The results of the three studies (Cochrane level III) that consisted of more than 250 patients are presented in Table 2.1-4,5 Although the study by Keech et al.4 had an overall success rate with respect to motor alignment and elimination of diplopia of 72%, it included a large number of patients with complex forms of strabismus that tend to be harder to correct. Of the 125 patients with exotropia, 50 (40%) were reoperations (had undergone prior surgery); of the 61 esotropic patients, 28 (46%) had prior surgery. Forty-four patients had surgery for vertical strabismus, of which nine (20%) had undergone prior surgery. One hundred three (30% of the total) had surgery for more complex forms of strabismus, including Duane syndrome, Graves orbitopathy, restrictive strabismus, and strabismus after prior scleral buckle. As expected, the subset of patients undergoing their first operation for primary esotropia or exotropia had a higher success rate than those undergoing reoperation or surgery for one of the more complex forms of strabismus. In the study by Keech et al., almost one-third of the patients had one or more of the aforementioned complex forms of strabismus.

Scott1 reported a series of 892 patients he operated on and separately analyzed the 492 whose strabismus began before visual maturation ([BVM] for which he used an age cutoff of 9 years), 312 whose onset was after visual maturation (AVM), and 119 with complex forms of strabismus, for example, paralytic strabismus, Brown syndrome, Duane syndrome, and dissociated vertical deviation. Scott’s outcome criteria for success were different in the three groups. Patients in the BVM group were primarily undergoing surgery for the purpose of improving cosmetics; for this group, he had two outcome criteria for success. One was 15 PD or less of tropia, which Scott took to represent a satisfactory cosmetic outcome, and also 8 PD or less of tropia, which would permit development of the monofixation syndrome. The success rates for the 492 patients in the BVM group are presented in Table 2.

WILL AN ADULT WITH STRABISMUS EXPERIENCE AN IMPROVEMENT IN BINOCULARITY AFTER STRABISMUS SURGERY?

Binocularity should not be viewed as an all-or-nothing phenomenon; it has different grades or depths. The highest level of binocularity is associated with high-grade stereopsis (40 to 60 seconds of arc). A minimum requirement for any meaningful degree of binocularity is a residual tropia that is less than 10 PD.7-9 High-grade stereopsis requires not only near orthotropia (no manifest deviation) but also good vision in each eye. Studies suggest that the single most important factor in determining if a patient with infantile esotropia or partly accommodative esotropia will regain stereopsis after strabismus surgery is the number of months of constant ocular misalignment; the longer the duration of the misalignment, the lower the chance of developing stereopsis.10-12 It is rare to see high levels of stereopsis in children who develop infantile esotropia before the age of 6 months, unless their eyes

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TABLE 2.

Reports of motor alignment

<table>
<thead>
<tr>
<th>Author</th>
<th>N</th>
<th>Age range/mean, y</th>
<th>Definition of motor success</th>
<th>Overall percent success</th>
<th>Follow-up range/mean, mo</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scott et al.</td>
<td>462</td>
<td>9-89</td>
<td>≤8 PD and ≤15 PD</td>
<td>≤8 PD = 60%* and ≤15 PD = 77%</td>
<td>Last visit (at least 6 wk)/34</td>
<td>Only includes BVM†</td>
</tr>
<tr>
<td>Keech et al.</td>
<td>333</td>
<td>11-70/Mean</td>
<td>≤10 PD horizontally and ≤5 PD vertically if no fusion</td>
<td>Elimination of diplopia if fusing</td>
<td>72% including reoperations</td>
<td>64% with one operation</td>
</tr>
<tr>
<td>Hertle</td>
<td>255</td>
<td>14-72/37</td>
<td>&lt;12 PD horizontal and &lt;5 PD vertical</td>
<td>Overall = 85% BVM* = 86% AVM* = 84%</td>
<td>6 mo–5 y minimum</td>
<td>1.8 y average</td>
</tr>
</tbody>
</table>

*Analysis does not include patients with sensory exotropia (n = 43) or sensory esotropia (n = 20) in the stricter outcome criteria analysis of ≤8 PD because the only concern was cosmetic.
†BVM, before visual maturity (9 years old), AVM, after visual maturity (after 9 years old).
are well aligned by age 1 year.\textsuperscript{13–15} Thus, one might assume that an adult with a long-standing history of infantile esotropia will have a negligible chance of developing stereopsis. However, adults may think that their strabismus began in infancy, yet they may in fact have had several years of proper ocular alignment in early childhood before the development of strabismus. Without accurate medical records of eye alignment from infancy, one cannot be certain. Many such patients will develop stereopsis if their eyes are aligned years later.\textsuperscript{16} One of the patients included in the study summarized in Table 1 demonstrated 50 seconds of stereopsis immediately postoperatively—when her eyes had been misaligned for at least 50 years previously.

The analysis of sensory results in adults undergoing strabismus surgery should separate patients who have the onset of strabismus BVM from AVM. The former typically do not have diplopia or binocularity preoperatively on usual sensory tests, for example, stereopsis, Worth 4-dot, and Bagolini lens. The development of binocularity preoperatively on usual sensory tests, for example, BVM from AVM. The former typically do not have diplopia or surgery should separate patients who have the onset of strabismus for at least 50 years previously.

Elimination of diplopia would be a useful way of assessing the sensory success resulting from surgery in the AVM-onset subset. In the series of Scott\textsuperscript{1} of 892 patients undergoing strabismus surgery, 462 had an onset BVM, and of them, 111 had congenital esotropia. Twenty-nine percent of the congenital esotropes showed improvement in their response to the Worth 4-dot test in that they no longer showed suppression, and 23% developed some stereopsis (range, 50 to 3000 seconds of arc) after surgery. Of the 127 patients with acquired esotropia, 63% had a similar improvement in their Worth 4-dot test response, and 46% showed improved stereopsis (range, 40 to 3000 seconds of arc). One hundred sixty-one patients were exotropic. Seventy percent of them similarly improved on the Worth 4-dot test, and 70% showed improved stereopsis after surgery (range, 40 to 3000 seconds of arc). The other two large studies did not report sensory outcome in the BVM-onset group in any detail.\textsuperscript{4,5}

Adult strabismus patients with normal binocularity and even some degree of binocularity (peripheral fusion) have the highest degree of stability after successful strabismus surgery.\textsuperscript{17} Even though adult strabismic patients with minimal or no binocularity accompanied by suppression after surgery may have less stability over time than those who do develop higher levels of fusion, many of these patients do show stability in their postoperative ocular alignment over time. In one study, just more than half of the patients who showed postoperative suppression with the Bagolini lens test maintained alignment within 10 PD of straight 5 years postoperatively and about one-third at 10 years after surgery.\textsuperscript{17} This study, being retrospective, was compromised with respect to long-term stability assessment because of many patients being lost to follow-up. However, it is also important to note that the majority of adults do in fact develop some degree of improvement in their binocularity, and for them, the data on stability are better. Of the patients who were aligned within 10 PD of straight with surgery and did not suppress with the Bagolini lens test postoperatively, 84% were still aligned within 10 PD of straight 5 years after surgery and 82% were at 10 years postsurgery.\textsuperscript{17}

Regrettably, many adults in my 200-patient retrospective review (at least 23.5%) were told that they would not “use their eyes together” after strabismus surgery even if their alignment were to be good—that surgery would be “only cosmetic” (Table 1). This statement is inaccurate and represents a reductionist approach to binocularity. As with other aspects of binocular function, “seeing with both eyes together” is not all or nothing. In one series,\textsuperscript{17} for example, 86% of adults undergoing strabismus surgery showed some improvement in binocularity postoperatively when tested for peripheral simultaneous perception using the Bagolini lens test,\textsuperscript{2,18,19} regardless of the nature of the strabismus or the presence of amblyopia. In my opinion, this test is highly indicative of what a patient actually experiences in daily life as it closely mimics everyday seeing circumstances.\textsuperscript{20} It provides more useful information than more dissociating tests that often involve the use of red-green lenses or dissociating apparatus. The patients in the aforementioned study went from suppression preoperatively to some form of simultaneous perception postoperatively. If they had a manifest tropia after surgery, this response would be indicative of anomalous retinal correspondence. Von Noorden and Campos stated that anomalous retinal correspondence is an adaptation to “restore some semblance of binocular cooperation.”\textsuperscript{20} Consequently, although they did not develop normal binocularity, the patients did show a change toward this semblance of binocular cooperation Von Noorden and Campos described. The Bagolini lens test is also useful because it has been shown that developing a peripheral simultaneous perception response with it after strabismus surgery was predictive of long-term postoperative stability in eye alignment.\textsuperscript{17}

**HOW SUCCESSFUL IS ADULT STRABISMUS SURGERY IN ELIMINATING EXISTING DIPLOPIA?**

Surgery to eliminate diplopia is primarily done in patients with an AVM onset of strabismus. In this group of patients, failure to eliminate diplopia usually means that surgery did not result in optimum alignment. In most cases, prisms, fusional exercises, or further surgery should be expected to eliminate the postoperative diplopia.

In the series of Scott\textsuperscript{1} of 892 patients undergoing strabismus surgery, 417 had diplopia before strabismus surgery and the elimination of diplopia was the main reason for undergoing surgery. Of them, all but eight patients (2%) were diplopia-free at least in primary gaze after surgery. In that study, Scott did not indicate what percentage of the 417 diplopic patients had an AVM onset; however, he did state that diplopia was a main indication for surgery in his 312 patients with an AVM onset. In the series of Hertle\textsuperscript{5} of 255 patients, 96 had an AVM onset, of whom 67 (70%) had diplopia in the primary gaze position at distance or near fixation before surgery. After surgery, only three patients (3%) were diplopia-free in the primary position at distance or near fixation and 25 (26%) were diplopia-free in all gaze fields.\textsuperscript{5}

**WHAT EFFECT DOES STRABISMUS SURGERY HAVE ON THE SIZE OF THE BINOCULAR FIELD?**

An improvement in stereopsis or fusion, however, should not be considered the only hallmark of a functional improvement in
binocularity in a person with strabismus. Typically, people who are esotropic and suppress the deviating eye will have a narrowed binocular visual field by about 25 degrees on the side of the suppressed eye when both eyes are open. Successful strabismus surgery in this setting will typically result in an immediate expansion of the peripheral visual field (Figs. 1 and 2). In one study of a consecutive series of 35 esotropic adults undergoing strabismus surgery, 34 (97%) showed an expansion of approximately 25 degrees in their binocular visual field. This occurred regardless of their visual acuity, the presence of amblyopia, or the duration of the strabismus. Expansion of binocular field may be an important benefit. Reports indicate that visual field constriction is highly correlated with an increase in motor vehicle accidents.

In addition, dynamic visual fields typically improve after successful strabismus surgery, which is important for activities like driving a motor vehicle or navigating stairs. Interestingly, some patients with constant exotropia have a “panoramic” vision or wider binocular field, which may reduce to normal after the exotropia is corrected.

WHAT IS THE SAFETY AND RELATIVE RISKS OF STRABISMUS SURGERY?

Surgical Risk

With respect to morbidity and mortality, strabismus surgery carries a very low risk. The procedure is often performed under general anesthesia. This has an estimated mortality risk in adults that ranges from less than 1 in 200,000 to 1 in 300,000. Endophthalmitis or clinically significant scleral perforations, both of which can have serious vision-threatening complications, have been reported anecdotally but are exceedingly rare.

Repeat Surgery

Probably the biggest downside with adult strabismus surgery, which is more a limitation than a risk, is the fact that not all patients achieve satisfactory alignment with one operation. This fact should rarely dissuade patients from having surgery if it is candidly explained in advance of the procedure during the discussion that leads to informed consent, in my opinion. As previously stated, approximately 20% of adults will need more than one surgical procedure to attain ocular alignment within 10 PD of straight, depending on the nature of their strabismus.

Risk of Creating Intractable Diplopia

The occurrence of diplopia after strabismus surgery when it was not present preoperatively should be analyzed separately from the persistence of preexisting diplopia. The latter is a failure of surgery to achieve satisfactory alignment. The former may also be the

FIGURE 1.
(A) This 62-year-old man has an 85 prism diopter right esotropia that has been present since early childhood. His right eye is amblyopic with a best corrected visual acuity of 20/200. (B) The same patient depicted in A shown 3 months after undergoing successful strabismus surgery.

FIGURE 2.
(A) Binocular visual field of the patient depicted in Fig. 1A. The visual field is approximately 30 degrees narrower to the right than to the left. (B) Binocular visual field of the patient in Fig. 1B performed 3 months after strabismus surgery shows an expansion of approximately 30 degrees to the right as compared with the preoperative visual field seen in Fig. 2A.
result of suboptimal postoperative alignment or it could occur despite perfect alignment. For example, exotropic patients with BVM onset typically have temporal hemiretinal suppression or a hemiretinal trigger for suppression. They will predictably be diplopic after surgery if they are overcorrected and have even a miniscule amount of esotropia. Similarly, if a patient with preoperative diplopia, no suppression, and normal retinal correspondence is not satisfactorily aligned with surgery, diplopia will likely persist. These examples, however, do not represent intractable diplopia. These patients need further management in the form of prisms, fusional exercises, or further surgery to achieve a more desirable alignment. Diplopia would be considered intractable if it develops despite optimum alignment (usually orthophoria to a small undercorrection for esotropia, esotropia, or hypertropia). In Scott’s study, there were 367 patients who did not have diplopia preoperatively, of whom 336 (92%) did not have diplopia after surgery. Of the 31 patients (8%) who had diplopia, the majority had suboptimal alignment and were diplopia-free with prisms or an abnormal head posture. Only five patients (1%) had intractable diplopia that was present as of their last examination. In another series of 424 adults undergoing strabismus surgery, only three patients (0.7%) had intractable diplopia postoperatively. The review summarized in Table 1 revealed considerable misunderstanding about the risk of intractable postoperative diplopia in adults undergoing surgery to correct a long-standing strabismus. Intractable diplopia can be a vexing problem, so fortunately, it is quite rare and is not necessarily permanent. Preoperative testing with prisms can help differentiate the patients who are at negligible risk for intractable diplopia from those who may have a somewhat greater risk. In one study, 424 adults undergoing strabismus surgery underwent preoperative prism testing for diplopia. The author recommended that prism testing for postoperative diplopia be performed in the following manner. While the patient is wearing proper optical correction, his or her deviation should be offset with prisms in the examination room with normal room illumination. If the patient does not report diplopia, he or she is to be considered at negligible risk for postoperative double vision if surgery achieves good alignment. The author has reported testing hundreds of patients in this manner and never had a patient develop intractable postoperative diplopia if he or she reported single vision when the deviation was offset with prisms preoperatively. If patients did report diplopia with prism testing, the risk of intractable postoperative diplopia was found to still be quite low, but possible. If the patient had concern about double vision but still wished to consider surgery, it was been recommended that he or she wears a Fresnel prism that offsets his or her angle of strabismus for 1 to 2 weeks. In many patients, the diplopia reportedly subsided after wearing the prism. Similarly, the author reported never having seen intractable postoperative diplopia in a patient who underwent the Fresnel prism trial and in whom the diplopia subsided preoperatively. Interestingly, if the diplopia persisted with the Fresnel prism, there was still only a rather small risk of intractable postoperative diplopia. Patients were reported who were still experiencing diplopia with a Fresnel prism in place just before surgery, yet they were diplopia-free the moment they awakened from strabismus surgery. Thus, in the study of 424 adult patients undergoing strabismus surgery after the aforementioned preoperative prism testing, the test had a negative predictive value of 100% for determining who would not see double after surgery but had a relatively low positive predictive value. Why the preoperative use of prisms does not always exactly mimic the surgical experience is not clear. Regardless, intractable postoperative diplopia was quite rare. In that series, only three patients (0.7%) developed persistent intractable double vision after surgery. Furthermore, all three were known to be at risk for this rare complication based on preoperative prism testing, yet they elected to have surgery anyway. In almost all patients in whom this rare complication occurs, the symptoms subside with time or can be ameliorated with optical management or further surgery.

ARE THERE PSYCHOSOCIAL BENEFITS TO ADULT STRABISMUS SURGERY?

Strabismus has serious and lasting effects of a psychosocial nature according to numerous reports. The majority of adults with strabismus feel that their ocular misalignment has substantial adverse effects on their quality of life, self-image, interpersonal relationships, ability to secure employment, social anxiety, and visual functioning. Adults with strabismus also showed higher levels of distress than age- and sex-matched controls. Although these subjective impressions on the part of strabismic adults, they have been confirmed objectively. Studies show that adults with strabismus are viewed with a significant negative social prejudice, are considered less intelligent, are less likely to be hired for a job, and are less likely to be promoted in the military. Visible strabismus negatively influences the ability to find a partner according to dating agencies. These findings are not trivial as reflected in the finding that a majority of adults with strabismus would trade a portion of their life expectancy in return for being rid of strabismus and its associated effects. A recent study by Berberat et al. provided neurophysiologic basis for this bias. In this study, 31 volunteers underwent functional magnetic resonance imaging while viewing images of strabismic and normal subjects. In 30 of 31 volunteers, viewing strabismic images led to significant activation in the amygdala, hippocampus, and fusiform gyri as compared with viewing images of normal subjects, indicating a negative emotional response. The authors concluded that “treatment of strabismus therefore changes the interpersonal dynamic for patients with strabismus on a demonstrable organic basis.” Interestingly, the only one of the 31 volunteers who did not show activation in the aforementioned areas of the brain was an ophthalmologist who was involved in designing the study. Studies show that adult strabismus surgery has a positive impact on health-related quality of life. Although these psychosocial issues do stem from having an abnormal appearance and abnormal eye contact, they are certainly real and go beyond being simply a cosmetic issue. Inability to get a job, or work in certain professions, is as much a physical handicap as having an orthopedic or cardiovascular problem that prevents certain activities.

NONSURGICAL THERAPIES FOR TREATING STRABISMUS

Many adults with strabismus can be managed with nonsurgical modalities. These include proper correction of refractive errors,
HOW COST-EFFECTIVE IS ADULT STRABISMUS TREATMENT?

Studies of adult strabismus surgery show it to be highly cost-effective and was found to be more so than adult cataract surgery.44,52,53

SUMMARY

Although there is a need for Cochrane level I clinical trials, the best available data suggest that adult strabismus surgery carries a very low risk of serious complications and is extremely cost-effective. It typically improves motor alignment and provides some level of improvement in binocularity ranging from subnormal to normal, depending on the age of onset or the strabismus. It can have a positive effect on visual functioning, psychosocial metrics, and even ability to obtain employment. Patients value the results quite highly. Many adults with strabismus are under the misconception that treatment is not possible, carries a low degree of success, or is risky. These misconceptions are often enhanced by practitioners who are not fully aware of the improvements that can result with surgery for adult strabismus. If an adult patient has strabismus, consideration should be given to referral to an ophthalmologist who has specific expertise in treating adult strabismus.

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