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symposium paper

Management of Binocular Anomalies: Efficacy of Vision Therapy, Exotropia

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ABSTRACT

This paper presents a survey of the literature on management of the various forms of exotropia. Criteria for success of treatment are examined. A table summarizing the results of 11 studies is given.

Key Words: exotropia, visual training, criteria for successful treatment

Exotropia is a condition where the visual axes are misaligned in a divergent pattern, either constantly or intermittently, and at distance and/or near. Exotropias fall into four categories: (1) convergence insufficiency; (2) divergence excess (true and pseudo); (3) basic exotropia; and (4) congenital exotropia.

This paper will deal with the efficacy of vision therapy in treating the clinical entity of exotropia. The literature is voluminous, but it is often difficult to compare studies because either not enough information is given or criteria for inclusion and/or success are tremendously disparate. In 1961, Ludlam[1] reviewed 15 articles to assess the efficacy of vision training as a treatment modality in the management of strabismus. At least one or more of the following faults was identified in each of the papers reviewed:

1. Orthoptics was viewed as a secondary method of cure to be used after surgery had not provided the desired results. Reports of orthoptic and surgical results were so intertwined that it was impossible to judge accurately the role played by vision training.
2. No satisfactory description of "cure" or results was given.
3. Vision training was administered by persons having a minimal education in this area.
4. Some of the data for rates of cure were based on the authors' recollections.
5. Too strict a selection process in reporting cases obscured the true value of vision training alone as a specific treatment for large numbers of strabismics.

This paper will only assess studies which consider visual training as a primary therapy mode and which avoid the faults cited by Ludlam.

Exotropia includes:

1. Convergence insufficiency (CI)—a clinical entity most commonly characterized by receded nearpoint of convergence (NPC), exodeviation at near vision, relatively little or no exodeviation at distance, reduced positive relative convergence, and often associated with reduced accommodative amplitude.[2]
2. Divergence excess (DE)—characterized by exophoria or tropia, greater at distance than at near, by at least 10 Δ, normal NPC, normal prism convergence at near, excessive prism divergence at distance, no appreciable amblyopia, and normal stereopsis on any near stereo test. A true divergence excess is one which is best described in terms of the above. However, a pseudo DE is one which is best described as a basic exotropia (see below) after short-term (about 45 min to 1 h) monocular patching.[3]
3. Basic exotropia is present when the angle of deviation at near is approximately equal to the angle of deviation at distance.[4]
4. Congenital exotropia is a constant large

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angle deviation which does not change at near or distance fixation; it occurs during the first year of life and is not associated with any other ocular or systemic abnormality.[5]

This discussion is directed toward assessing the efficacy of visual therapy as a treatment modality to resolve both the clinical entity and the symptoms. Therefore, let us examine the symptoms manifested in each of the conditions being discussed:

1. CI—discomfort after reading or nearwork, frontal headaches, "eye aches", diplopia, sleepiness, tearing, blurred vision, and loss of concentration are among the most commonly reported symptoms.[2]

2. DE—nearpoint asthenopia including near blur, frontal headaches, words running together, etc., cosmesis, visual confusion, closing one eye in bright light, and diplopia are among the most frequent symptoms.[3]

3. Basic exotropia—patients are generally asymptomatic unless the strabismus is of recent onset. If any symptom is manifest it is photophobia.[4]

Special mention should be made of the complaint of photophobia. According to von Noorden,[4] photophobia occurs frequently in association with intermittent exo deviations, but no one has tried to explain this phenomenon. It is assumed that when a person is outdoors and looking at infinity, there are no near cues to stimulate convergence. In addition, bright sunlight dazzles the retinae so that fusion is somehow disrupted, causing the deviation to become manifest. These explanations imply that one eye is closed to avoid diplopia. In describing this phenomenon, most investigators do not make a clear distinction between photophobia and avoidance of diplopia. von Noorden and Burian[4] questioned 25 patients with intermittent exotropia who habitually closed one eye in bright sunlight, and none had ever experienced diplopia during the manifest phase of strabismus. Eustace et al.[6] have shown that by increasing room illumination, exophoria turns to exotropia in intermittent exotropes and photochromatic lenses may be used to deal with photophobia in such patients. Wirtschafter and von Noorden[7] have demonstrated that bright light adversely affects amplitude of fusional convergence in patients who maintain a delicate balance between exophoria and intermittent exotropia. Orthophoric patients did not show the same phenomenon. Although these observations have been made, they do not explain the mechanism of the photophobia. However, von Noorden states that this is a very important clinical entity inasmuch as patients manifesting this symptom may be on the verge of converting from a phoria to a tropia.

Now that the phenomenon of exotropia has been defined in terms of signs and symptoms, it is necessary to define criteria for evaluating success of the treatment. Most studies define their own criteria for "success," and no two studies have exactly identical criteria (unless one investigator specifically uses another's criteria). However, to integrate different studies meaningfully for the purpose of this paper, I have informally generalized and "averaged out" the most often used criteria of many investigators. These may then be applied broadly to all the papers being discussed and most of those cited in the Additional References. Most authors divide criteria for evaluation into four categories: (1) excellent; (2) good; (3) fair; and (4) poor. Because of the strict criteria applied by most investigators, it is reasonable to consider that if a patient achieves a rating of "good," he/she may be classified as a successful visual therapy case. A list of criteria to be met for classification as good includes: (1) no strabismus (phorias for all viewing distances); (2) comfortable and without asthenopia; (3) NPC = 5 cm or closer; (4) normal vergence ability at distance and near; (5) good awareness of diplopia when dissociated; and (6) slight central suppression may be present.

In Appendix A,[8] a listing of criteria for the classifications of "excellent," "fair," and "poor" is given as well. However, anyone who meets the above listed criteria for good will be considered a successful visual therapy patient. Again, it seems reasonable to accept this as a definition of functional cure.

VISION THERAPY

Inactive Therapy

Inactive therapy modes include lens therapy, prism therapy, and occlusion therapy. An example of each of these therapy regimens is cited below, and advantages and disadvantages of each are given. It should be noted that the longest follow-up was done 1 year after therapy was discontinued.

Caltrider and Jampolsky[9] used overcorrecting minus lenses for the treatment of intermittent exotropia. Their rationale was based on the following four observations:

1. Intermittent exotropia in young children should not be treated surgically because it often produces small-angle esotropia. This produces a risk of amblyopia and decreases the opportunity for the development of stereopsis.

2. Prisms may be used to compensate partially for the exo deviation, but spectacle weight and image distortion from prism is a problem.

3. Weak cycloplegics, used in an attempt to

increase the AC/A ratio, are a problem because dose standardization is very difficult.

4. Orthoptic sessions can be used in an attempt to increase fusional convergence, but overcorrecting minus lenses produces a more continuous form of orthoptic treatment.

Their population consisted of 35 children with intermittent exotropia. All were treated with overcorrecting minus lenses and all had an exotropia present at least 25% of the time. They used from 2 to 4 D of minus over the patient's distance correction. They reported the following results:

1. Forty-six percent showed a "qualitative" change, i.e., a poorly controlled intermittent exotropia became a well controlled exophoria.

2. Twenty-six percent showed a "quantitative" change, i.e., a decrease of at least 15 P.D. on alternate cover testing and this deviation remained latent while wearing the overcorrection.

3. Twenty-eight percent showed "no change," i.e., the intermittent exotropia persisted with the overcorrection. (A patient was placed in this category even if before the overcorrecting minus lenses the exodeviation was manifested 80% of the time and after the lens therapy it had improved to being manifested only 20% of the time.)

Duration of the lens therapy ranged from 2 to 156 months, with an average of 35 months. Ten children were followed for at least 1 year after the lenses were removed. The improved status maintained itself in 70% of these. It should be noted that all children started with equal vision in each eye and maintained it throughout the study; minus was reduced gradually, and at the start of therapy more than one-half the children had myopia or myopic astigmatism.

Ravault et al.[10] discuss the use of prisms in the treatment of divergent strabismus on a sample consisting of 20 basic exotropes and exotropes secondary to esotropia surgery. They did not include divergent strabismus secondary to either sensory obstacles (e.g., amblyopia) or motor obstacles (e.g., vertical deviations). They prescribed prism to re-establish ortho posture by exact correction of the angle of deviation so the patient was constantly using normal binocular vision under conditions of habitual viewing. Their population was divided into two groups: (1) objective angle cannot be corrected by prism (anomalous retinal correspondence) and (2) objective angle can be corrected by prism (normal retinal correspondence). They examined each patient at least once a week. At each visit prism was decreased so that the patient was kept in ortho- or exo-phoria at distance and at near. Binocular measurements were then taken and if binocularity was maintained through the decreased prism, the new amount of prism was applied. If not, the previous amount of prism was maintained for another week. Decrease in prism power ranged from 2 to 5 Δ at each visit.

The authors feel that the major or essential effect that results from constantly wearing a prismatic correction that produces ortho- or exophoria is antisuppression treatment. Once suppression is overcome, binocular vision can develop and fusion will recover its normal amplitude. There are three inherent problems associated with using prism in this way: (1) when suppression is overcome, pathological diplopia is clearly recognized and surgery to resolve it may be necessary; (2) maximum prism that can be prescribed for each eye is about 15 Δ; and (3) as the age of the patient increases, the prognosis becomes poorer.

Although numbers are not given, the authors concluded that prismatic treatment is easy and effective.

Berard[11] feels that for exotropia, prisms are required at any age and that they should be tried before surgery. If prism can be decreased to a small amount, no surgery will be necessary. With exotropia, the clinician should start with full base-in prism to neutralize the exodeviation.

Flynn et al.[12] performed occlusion therapy on 31 intermittent exotropes. Within this population, 9 had had surgery before the study. Treatment was exclusively full-time occlusion therapy ranging in length from 6 to 12 weeks and maintained on either a 2:1 or 5:2 dominant to nondominant eye ratio. There was no control population, but the authors did make the observation that there was no noticeable "spontaneous" cure rate among exotropes not treated with occlusion. Sensory testing included red lens and synoptophore tests with fusion targets for suppression and fusional amplitudes. For a positive sensory change to have occurred, two of the three parameters measured would have had to change in a positive direction, i.e.: (1) red glass diplopia present where it was absent before; (2) significant increase in the range of fusional amplitude (50% increase over the pretherapy measurement); and (3) disappearance of scotoma as measured in the synoptophore.

A positive motor response occurred when a deviation that was always tropic at a given fixation distance became an intermittent tropia or phoria or a deviation present at both distance and near disappeared. Their results were as follows: (1) 67% of their population showed either a sensory or a motor response; (2) 23% showed a dramatic recovery of motor and sensory response, and (3) 29% showed an increase in fusional amplitude.

However, there was a very significant negative effect that the authors played down. There were no negative sensory changes such as a decrease in fusional amplitude or increase of suppression. However, 39% (12 patients) demonstrated a negative change in the size and/or character of the deviation and in 6 patients a phoria became an intermittent or full-time exotropia. The authors felt that patching was more beneficial than harmful and particularly useful with those who were borderline for surgery.

Active Therapy

There are many studies which examine the effectiveness of orthoptics or visual training as a treatment modality for an exodeviation. Each of the studies cited below was chosen for the reason that criteria used to evaluate success were comparable, and each is felt, by the author, to be a particularly good study. Other studies may be found in the Additional References.

Sanfilippo and Clahane[8] studied 31 exotropes treated solely with orthoptics. None of their sample had had any surgical intervention and all received long-term follow-up. The population consisted of CI's, DE's, and basic exotropes. Therapy was an intensive home-based orthoptics program where parents and/or patients were given written instructions. Most patients were seen in-office for progress checks 7 or 8 times with a range from 5 to 22 visits. Visual training stressed antisuppression work and motor fusion. Pre- and post-training motor and sensory data were collected and re-evaluations were done 4.5 to 6.5 years after training was stopped. Using the criteria listed in Appendix A, the following results were obtained:

1. Before therapy 25 (81%) were rated poor and 6 (19%) were rated fair. None met the criteria for good or excellent.
2. After therapy, 20 (64.5%) were rated excellent, 3 (9.7%) were good, 7 (22.6%) were fair, and 1 (3.2%) was poor, with 84% showing improvement.
3. In long-term follow-up, 51.7% were rated excellent, and 16.1% were good. In other words, between the time therapy stopped and the follow-up evaluation (4.5 to 6.5 years later), 67.8% remained without a strabismus.

Cooper and Leyman[13] carried out a retrospective study of 673 intermittent exotropic patients with a minimum follow-up of 1 year . There were four modalities of treatment: (1) occlusion only, N = 11; (2) operation only, N = 264; (3) operation and orthoptics, N = 216; and (4) orthoptics alone, N = 182 (55 had large-angle exotropia).

Patients were classified as to type of exotropia with 25% being basic exotropia, 12% CI, 7% true DE, and 56% simulated (pseudo-) DE. [The authors defined "simulated divergence excess" as a patient who presented initially as a DE, but who, on short-term patching (45 to 90 min) became a basic exotrope. This high percentage of simulated DE was a surprise to the authors.] Cooper and Leyman reported results of good based on criteria more stringent than those cited in Appendix A, as follows: (1) occlusion only—36% were good; (2) operation only—42% were good (the majority of these patients had angles greater than 25 Δ); (3) operation and orthoptics—52% were good (the majority of these patients had more than 25 Δ); and (4) orthoptics only—59% were good (the majority of these patients had less than 25 Δ).

If the "orthoptics alone" group was broken into subgroups, the subgroup having exotropia of greater than 25 Δ achieved a good rating in 35% of the patients, whereas the subgroup having exotropia of less than 25 Δ achieved a good rating in 68% of the patients. Note that if you compare the 55 patients in the fourth group (orthoptics only) with deviations greater than 25 Δ with the second group (operation only), a higher percentage of the combined good and fair results was obtained with orthoptics only than with operation only.

Altizer[14] compared 29 exotropes (16 intermittent and 13 constant) treated surgically to 23 exotropes (13 intermittent and 10 constant) treated by orthoptics alone. Orthoptics included: at first constant and total occlusion was used to break down suppression, and then convergence exercises, base-in Fresnel prisms to produce orthophoria, and finally "maintenance" orthoptics of part-time occlusion and convergence exercises. Altizer's success ratio is significantly lower than other researchers have reported, but the orthoptically treated group fared slightly better than the surgically treated group. She concluded that success is about equal for surgical and orthoptics groups based upon her data that 10/23 (43.5%) exotropes were "controlled" with orthoptics and 11/29 (38%) were controlled with surgery.

Chryssanthou[15] collected data on 27 intermittent exotropes from 5 to 33 years of age—13 (48%) were simulated DE's, 1 (3.7%) true DE, and 13 (48%) CI's and basic exotropes. Nine patients had appreciable hyperdeviation, 4 had anomalous retinal correspondence when the deviation was manifested, and none were amblyopic. The criteria for success were similar to those outlined in Appendix A. The therapy mode was home-based orthoptics. Training procedures included occlusion (to break down suppression when present), diplopia awareness, and then stereograms to increase absolute prism convergence at both distance and near. The results of this study are summarized in Table 1. This study demonstrates clearly the effective-

TABLE 1. Results of orthoptic training and long-term follow-up.

	Before Training	After Training	Long-term Follow-up (6 to 30 months later)
Excellent	0	18 (66.7%)	10 (37%)
Good	1 (3.7%)	3 (11.1%)	8 (29.6%)
Fair	3 (11.1%)	3 (11.1%)	6 (22.6%)
Poor	23 (85.2%)	3 (11.1%)	3 (11.1%)

ness of the orthoptic therapy at the time of training and in follow-up evaluations 0.5 to 2.5 years later.

Pantano[16] looked at the effectiveness of orthoptics to produce long-term results in CI. She studied 207 patients from 10 to 46 years of age who underwent orthoptics training for their CI and re-evaluated them 2 years later. Criteria for diagnosis as CI were asthenopia with nearwork such as blurring, headaches, fatigue, tearing, and/or diplopia, which was alleviated by closing one eye. On initial evaluation, all, except for four presbyopes, showed improvement in their clinical findings when −3.00 D lenses were applied binocularly. Many claimed the blur and/or the diplopia was resolved through the minus lenses. Patients were broken down into three groups: (1) N = 103 CI type exodeviation; (2) N = 60 basic exophoria; and (3) N = 44 heterophoria where the deviation was less than 10 Δ and essentially orthophoric.

Pantano compared divergence amplitude at distance and near, absolute and relative NPC, absolute convergence amplitude at distance, and relative fusional amplitude (clear and single) at distance in the three groups. She found that most patients could overcome at least 20 Δ base-out at near. The presence of good absolute convergence and the improvement in image clarity with −3.00 lenses indicated that these patients were relying on accommodative rather than fusional convergence. Training was done at home with stereograms. At the time treatment was discontinued, the 207 patients were re-evaluated and divided into the following three groups:

1. Group I—could fuse the stereograms with the use of a pen (i.e., voluntary convergence and maintain clarity)—109/207—for these 107 patients clinical findings improved including disappearance of symptoms. The improvement in clinical findings and absence of symptoms were all maintained for at least 2 years after treatment was discontinued.
2. Group II—88/207—this group could fuse the images and withdraw the pen, but could not regain fusion without the aid of the pen. They also reported blurred images while fusing beyond 14 cm. The majority remained asymptomatic for 6 months (79%), but only 11% remained asymptomatic after 2 years.
3. Group III—10/207—these patients were considered to be failures. They could fuse only briefly with the pen in place and reported significant blur. Asthenopia persisted.

Pantano concluded that only those patients who were able to achieve both voluntary and fusional convergence, and who had learned to relax accommodation adequately while converging so that they had altered their AC/A ratio could maintain their status over time.

Goldrich[17] reported on 28 cases of DE (19 females and 9 males). His criteria for categorization as a DE included the following: (1) exotropia present on distance cover test with a single letter target at 20 ft; (2) exophoria or tropia on near cover test with an accommodative target at 16 in; and (3) exotropia at distance exceeds that at near by more than 10 prism diopters.

Goldrich identified 44 patients with divergence excess but 5 were eliminated because of previous surgery and two because of the presence of amblyopia. Eleven patients withdrew from treatment before evaluation of their progress could be made. This brought the experimental sample to 28 with DE. Vision training consisted of weekly in-office sessions with required home training. Procedures used included: motility, monocular accommodative rock, binocular accommodative rock, near stereo fusion, distance stereo fusion, fusion-accommodation flexibility, Brock string, antisuppression training, and flat fusion. The criteria that were used were similar to those proposed above such that excellent and good signify that no tropia was present. He found the effects of vision training were: (1) 71.4% (N = 20) achieved a status of excellent in an average of 29.2 sessions; (2) 10.7% (N = 3) achieved a status of good in an average of 28.3 sessions; (3) 14.3% (N = 4) achieved a status of fair in an average of 39.8 sessions; and (4) 3.6% (N = 1) remained at a status of poor in 35 sessions.

Therefore vision training improved visual alignment from "strabismus" to "no strabismus—with comfort" in 82.1% of his population in an average of approximately 7 months.

Daum[18] did a retrospective study of 110 CI patients. Daum defined the entity of CI as a syndrome with exo deviation at near with little or no deviation at distance, relative deficit of positive relative convergence, and receded NPC. It is often associated with a deficit of the negative relative accommodation and/or reduced accommodative amplitudes. Symptoms associated with CI include: ocular fatigue, headaches, and asthenopia. He postulates that the treatment of choice is orthoptics. Daum states that despite varied approaches, success rates vary from 80 to 90% and only 2 to 10% of CI patients cannot achieve any relief from orthoptic training.

In analyzing his 110 CI patients, Daum found the prevalence of the most commonly reported symptoms to be as follows: (1) headaches (56%); (2) diplopia (47%); (3) blur (47%); (4) asthenopia (36%); (5) fatigue (19%); (6) reading problems (10%); (7) no symptoms (4%); and (8) photophobia (3%).

He also found that 86 (78%) had latent exodeviations, 22 (20%) had intermittent exotropias, and 2 (2%) had constant exotropias. The average duration of therapy was 4.3 weeks (SD ±4.1 weeks) and the range was from 1 to 34 weeks. In examining his results, Daum found a lower success ratio than other investigators and that is probably because he used more restrictive criteria for total success. Other investigators often relied on subjective criteria. In fact, a large percentage of the partially successful group were placed in that category because they had failed the objective criteria. He broke his population into three groups:

1. Total success—this group passed the objective criteria and experienced no symptoms. Thirty-three patients (41%) fell into this classification.
2. Partial success—either objective or subjective deficiencies were alleviated, but not both or some relief in both. Forty-five patients (56%)fell into this group.
3. No success—neither objective nor subjective relief was reported. Two patients fell into this group.

The most common vision training tasks done were those that would strengthen the positive vergence system, e.g., binocular push-up and variable vectograms. Accommodation was trained as necessary. Most of the training was done by the patient at home with follow-up visits every 1 to 2 weeks.

Cooper et al.[19] in a carefully controlled experimental design demonstrated unequivocally that CI with symptoms responded to vision training and that as vergence abilities increased there was a concurrent and marked reduction in symptoms. Within the experimental design a patient had to have two of the following three criteria to be classified as a CI: (1) NPC >7.5 cm with recovery >12.5 cm using an accommodative target; (2) near vision base-out ranges less than twice the demand (Donder's criterion); and (3) base-out ranges at near vision less than or equal to 2 SD's below the population mean of 21 Δ (SD 6 Δ).

Asthenopia was evaluated by use of a seven item questionnaire—each item was scored on a scale from 1 to 5 points (the higher the score, the less the asthenopia). The diagnosis of CI with accompanying asthenopia was made independently by two clinicians. Random dot stereograms (RDS's) were used with either increasing base-out vergence demand in the experimental condition or constant vergence demand in the control condition. Vectograms were used to measure base-out fusional ranges and forced vergence fixation disparity curves were plotted. The experiment was broken into four phases: (1) phase I: baseline vergence measurements and asthenopia survey; (2) phase II: control; (3) phase III: experimental condition; and (4) phase IV: orthoptics condition.

Random dot stereograms (RDS's) were used with either increasing base-out vergence demand in the experimental condition or constant vergence demand in the control condition. Vectograms were used to measure base-out fusional ranges and forced vergence fixation disparity curves were plotted. All the clinical tests, the fixation disparity tests, and the questionnaire were administered at each phase of the experiment. After the test phase, patients were divided into matched pairs. Each member of a pair was assigned randomly to either an experimental or control group. Patients in the experimental group received a vergence training procedure initially identical to that experienced during the test phase, whereas the control group was exposed to RDS's with no disparity. Training consisted of 100 trials at each weekly session with disparity increasing with each correct response and decreasing with each incorrect response. Vectograms were used at the end of each training session to measure positive relative convergence. The control group was given 100 trials at zero disparity. When a patient in the experimental group achieved a positive relative convergence of 25 Δ or greater in three consecutive sessions, the control and experimental members of a pair were reversed. Then the new experimental group received vergence training, while the new control group looked at zero disparity stimuli. After this was done, RDS baseline testing was performed again, and traditional visual training was done. The orthoptic training included accommodative, vergence, and stereoscopic procedures. After a minimum of eight sessions, a final RDS baseline evaluation and an asthenopia survey were taken, and fixation disparity curves were generated.

Cooper found that although the automated (RDS condition) fusional vergence training resulted in an increase in fusional convergence ranges and on the fixation disparity curves, traditional orthoptic therapy resulted in the greatest amount of improvement of fusional convergence ranges and the greatest reduction in asthenopia. Cooper's results support the conclusion that improvements during the experimental phase were the result of more than the mere exposure to fusional targets. The lack of change in symptoms after the control phase strongly suggests that symptoms were due to vergence anomalies rather than psychosomatic and neurotic factors.

One final therapy mode that should be mentioned for the treatment of exotropia is biofeedback. Goldrich,[20] working with 12 exotropes (XTs) (7 DE's, 3 basic XTs, 1 postsurgical constant XT, and 1 constant XT of neurological origin). Goldrich proposes that the advantages of oculomotor biofeedback therapy are: (1) shorter treatment time; (2) elimination of lengthy home visual training exercises; and (3) enhanced motivation. The target for the biofeedback therapy was a single J/2 letter at 33 cm. He found that the highest recovery rate after training occurred in the group of six intermittent XTs without amblyopia and no prior history of unsuccessful surgical or orthoptic therapy. His patients were treated as follows:

1. DE—hours of therapy = 8 to 18; results were 5/7 (71.4%) achieved excellent status, and 2/7 achieved a status of fair (i.e., straight at least 80% of the time).
2. Basic XTs—hours of therapy = 19 to 21; results were ⅓ achieved excellent status, ⅓ achieved fair status (straight about 85% of the time), and ⅓ somewhat improved.
3. Postsurgical XT—6 h of therapy—poor results.
4. Constant XT (neurological origin)—16 h of therapy produced cosmetic improvement.

The data cited above support the premise that visual training (orthoptics) is a viable therapy modality. Even using the most stringent of criteria, success rates are quite impressive. If we combine the samples of the studies the total number of patients is 615 (excluding Goldrich[20] and inactive therapy regimens). Three hundred and seventy-eight (more than 61%) of these achieved a status of good or better (see Table 2). Symptoms, when evaluated, were managed exceptionally well by orthoptic therapy. Particularly impressive is the "durability" of the orthoptics/vision training results. The Sanfilippo and Clahane[8] study followed patients for at least 4.5 years and up to 6.5 years from the cessation of therapy. Maintenance of status was evident in almost 70% of their subjects. Chryssanthou[15] followed patients for up to 2.5 years and found that 86% remained without a strabismus. Pantano[16] found that if patients were able to achieve voluntary and fusional convergence and could achieve flexibility between accommodation and convergence (i.e., relax accommodation while converging to the appropriate fixation distance), the improved status was maintained over time. It would, therefore, seem reasonable to conclude that visual therapy is effective in the treatment of exodeviations and associated symptoms. This is true even when the treatment is applied by medically oriented orthoptists. The body of literature is especially supportive of this therapy modality in the treatment of exotropia.

TABLE 2. Summary of results.

Investigator	Therapy Mode	N	"Good" or better
Inactive			
Caltrider and Jampolsky[9]	Over minus	35	25
Ravault et al.[10]	Prism neutralization	20	?
Flynn et al.[12]	Occlusion	31	21[a]
Active			
Sanfilippo and Clahane[8]	Orthoptics	31	23
Cooper and Leyman[13]	Orthoptics	182	107
Altizer[14]	Orthoptics	23	10[b]
Chryssanthou[15]	Orthoptics	27	21
Pantano[16]	Orthoptics	207	109
Goldrich[17]	Orthoptics	28	23
Daum[18]	Orthoptics	110	78
Cooper et al.[19]	Orthoptics	7	7
		615	378
Good or better = 378/615 = 61.41%			

[a] In 39% of the patients being occluded there was a negative change.

[b] Although this percentage is lower than other investigators, it was still better than Altizer's surgical results (11/29).

APPENDIX A

Criteria for Classification of Success[8]

Excellent

1. Phoria for distance and near in the primary position and reading position
2. Absolute convergence not <20 Δ for distance and near
2. Relative convergence not <15 Δ for distance and near
4. Unlimited nearpoint of convergence
5. No suppression
6. Excellent awareness of diplopia during testing situation
7. Comfortable without asthenopic symptoms

Good

1. Phoria for distance and near in the primary and reading position

2. Absolute convergence not <15 Δ for distance and near
3. Relative convergence not <10 Δ for distance and near
4. Nearpoint of convergence 5 cm or closer
5. Slight central suppression
6. Good awareness of diplopia when dissociated
7. Comfortable without asthenopic symptoms

Fair

1. Intermittent at one testing distance only; phoria in the other positions
2. Absolute convergence not <10 Δ for distance and near
3. Relative convergence not <5 Δ for distance and near
4. Nearpoint of convergence 7 cm or closer
5. Moderate peripheral and foveal suppression
6. Fair awareness of diplopia
7. Slight asthenopic symptoms; problems with diplopia

Poor

1. Tropia at any distance or intermittent at two of four testing distances
2. Absolute convergence <10 Δ for distance and near
3. Relative convergence <5 Δ for distance and near
4. Nearpoint of convergence poorer than 8 cm
5. Peripheral and foveal suppression
6. No awareness of diplopia

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