Very Rapid Alternate Occlusion as a Treatment for Suppression in Intermittent Exotropia

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The two case studies discussed in this article demonstrate a new application of the concept of rapid alternation between eyes to reduce suppression. A very rapid alternate occlusion can be achieved using electronically driven liquid crystal lenses. These cases showed that alternation rates between 4.5 and 8 Hz can facilitate transfer of binocular images and thereby help reduce suppression in intermittent exotropia. The 9-Hz alternation used with the lights of the TBI instrument may not always be optimal. Rapid alternate occlusion at patient-specific frequencies provides the simultaneous perception needed for stereoscope tasks and thereby reduces suppression quickly, concurrently increasing alignment stamina. Key Words: TBI, suppression, exotropia, rapid alternate occlusion

INTRODUCTION

Rapid alternate stimulation with lights has been known and used at least since the late 1960s. The TBI trainer, two small lights powered and controlled to flash alternately without being lit simultaneously, was used through closed lids at a set alternation rate of about 9 Hz. Other devices such as the Fusion Aider used the same principle of alternate stimulation/occlusion with mechanical means to break down suppression and even anomalous correspondence. Suggested use was a minimum of 30 minutes each day. The strong visual stimulus provided by the alternating lights (with the TBI) was theorized to override the neurological inhibitory activity assumed to be responsible for the suppression. Some reports of epileptic seizure from alternate stimulation were reported.

The physical form of the TBI (lights over closed lids) limited its use. The concept of alternate stimulation has now been updated with liquid crystal lenses and programmable electronics. When current is applied to the liquid crystals, they become essentially clear. Without current, they are essentially opaque. The change from opaque to clear occurs in a few milliseconds, making change-time inconsequential and creating very close to a square wave cycle. Because no integral light sources are involved and transparent phases are spaced by opaque phases, Very Rapid Alternate Occlusion may be an accurate description of the instrument's action. The instrument can be used with most therapy procedures, including stereoscopes and red/green anaglyphs because the portion of the unit in contact with...
the patient is a standard sports goggle with the liquid crystals behind the goggle plano lenses (Fig 1). If polarized vectographs are used with the device, polarizing lenses must be outside (in front of) the goggle lenses to maintain proper polarization.

**CASE REPORTS**

These two case reports introduce the instrument and illustrate some early results. The first prototype (Fig 2) was wholly variable in alternation rate, allowing trial and error use of procedures such as cheiroscopic drawing tasks to find an alternation frequency that most completely extinguished suppression during the task.

**Divergence Excess with Intermittent Central Suppression treated at 8 Hz:**

**Patient G.R.**

Patient G.R. was referred by her primary care optometrist to our office for orthoptic evaluation. He noted that she was an 8-year-old girl with no particular complaint about her eyes. G.R. was healthy and was taking no medication. She had previously had some vision therapy, but her mother noticed that the exotropia was still present “at times.” G.R. was an excellent student.

The referring doctor measured $28^\circ$ exotropia on a distance cover test; however, G.R. was $6^\circ$ exophoric at near. The referring doctor’s distance refraction finding of $+0.75 - 0.50 \times 115$ OD and $+0.75 - 0.50 \times 65$ OS produced 20/20 – with either eye. He noted near stereopsis at 60 seconds and full ocular motilities. The results of his dilated fundus examination of her eyes was within normal limits.

During my examination G.R. stated that her eyes hurt and were blurry during reading. G.R. could not detect diplopia on the cover test and, indeed, had no visual or kinesthetic feedback signaling her when her eye would drift out. A distance correction of OU $+0.50$ provided 20/25 on the projected vectographic chart (lower contrast letters). Near vergence ranges (break/recovery) were 24/6 (#16) and 24/−6 (#17). Repetition increased base in vergence (#17) to 36/6. Accommodative range (#20) was −2.00 blur-out/−1.00 recovery net from the $+0.50$ OU distance refraction.

Left-eye suppression was noted on near phorias (#15A and B) and the Borish near card fixation disparity target. The left eye also showed an Intermittent Central Suppression response on the Borish card split diamond target. The right eye’s near diamond target faded, but did not black out. At distance, the anisocoria balance and fixation disparity targets (AO adult vectographic slide) were suppressed, although G.R. could control which side was suppressed on the fixation disparity target.

Because G.R. lived 2 hours away, we started a variable schedule of in-office therapy that averaged one visit per week. Therapy centered around diplopia training and monocular fixation/binocular field (MPBF) stereoscope procedures to reduce suppression both
centrally and in the near periphery. Van Orden stars with fusion rings and occasionally cheiroscopic drawings were used. Home therapy included more diplopia training, accommodative rock with lens flippers, and simple 10Δ base out prism rock while watching TV.

Office fusion work included vectographs pushing base out ranges and moving back from the instrument to move into intermediate space. Stereoscope “distance” jumpuctions such as Van Orden no. 5 were done with 10Δ base out in the lens wells. The Macula Integrity Tester with added red and green overlays flashes on alternate sides when viewed with similar red/green/polaroid goggles. G.R. did this at intermediate distances with 6 base out or −1.00 D sphere OU to start building distance alignment while trying to control suppression.

Eighteen sessions into the therapy, G.R.’s suppressions were reduced dramatically, but her eye was still wandering when she was tired at the end of the day or when she was ill. Distance associated phoria (vectographic fixation disparity target) was now ortho with OU + 0.25 sphere distance refraction (20/20 acuity).

Throughout much of the therapy, cheiroscopic drawings were attempted and proved nearly impossible. G.R. could not achieve consistent enough simultaneous perception in the stereoscope to accomplish the drawings. Rapid electronic alternate occlusion became available for the last six therapy sessions (sessions 19 through 24). An 8-Hz alternation rate provided the consistent image transfer needed for the cheiroscopic tracing task. At the same time we accomplished this consistent binocularity during the cheiroscopic procedures, G.R.’s mother reported improvement in G.R.’s daily sustained eye alignment. At the final examination no suppression was found on either distance or near vectographic targets. Distance-associated phoria (fixation disparity) was 2 base out. Distance cover was now at 10 exophoria. Near phoria (13B) was 12 exo through + 0.50. Base out near vergences (16B) had increased to 30/6. Interestingly, although reading was not a primary complaint, G.R.’s mother said her reading had improved three to four grade levels during the 24 therapy sessions over nearly 7 months.

Patient G.R. was discharged to the care of her primary care optometrist. In the discharge report her doctor was urged to be very critical of her eye alignment. Because rapid alternate occlusion had such a profound effect on her ability to see with both eyes simultaneously, and therefore on her eye alignment, any regression might be easily managed by following similar procedures.

Exotropia with Intermittent Central Suppression Treated at 4.5 Hz: Patient H.H.

Patient H.H. was an 11-year-old girl referred to our office by her primary care optometrist for treatment of intermittent exotropia. She had had reading lenses prescribed which she had discontinued wearing after about 1 year. She complained that she could read only 15 to 20 minutes before developing a headache. During reading she would lose her place and re-read often, all the while holding her reading material “one inch from her face.” Patient H.H. was taking no medication, had no allergies, and her family, developmental, and personal health history were otherwise unremarkable.

Patient H.H. had 20/50 OD and 20/40 OS unaided distance acuities while displaying a 10Δ intermittent exotropia. Near acuities were 20/60 OD and 20/40 OS with a 10Δ intermittent exotropia at near. While she was in the office, the strabismus was manifest more than 50% of the time both at distance and near. Binocular rotations were very jerky. NPC was 16 inches with watering and loss of fixation. Pursuits did not indicate paresis in any field of motion. All health findings were within normal limits, including ophthalmoscopy, pupil reflexes, and visual fields.

Near phorias were testable at 20 exo (14A) and 15 exo (14B). Repeat near vergence responses were variable and questionable, but showed the expected exo tendency with 16B at 30/+6 and 17B at 40/12. Accommodative range (#20 net) was −3.00 blur-out/−1.00 recovery. Accommodative facility (Haynes/PUCO procedure) was reduced at plus phase 0 cycles; minus phase 11.5 cycles (55% of minus phase expected).

H.H.’s distance refraction of OU + 0.25 D sphere produced 20/25 acuity on the AO distance vectographic chart with either eye. The change in acuity from the 20/50 and 20/40 entrance acuities might be explained by Streff
Syndrome, variability from the visual confusion created by suppression, or by initial apprehension of the child. H.H. was not pushed to maximal performance on the entrance acu-

ties.

Oclusion of the right eye was necessary to record an acuity for the left eye on the vecto-

graphic chart. However, suppression was also noted on the right eye’s acuity letters, as well as an alternate suppression on distance fixation disparity (vectographic) targets. During the near evaluation for intermittent central suppression using the modified Borish near card, H.H. alternately suppressed the sides of the diamond target every 2 seconds, with only occasional binocularity displayed (letter visibility on both sides of the diamond). In addition, near associated phoria (fixation disparity) showed complete and constant suppression of the right eye, making the test impossible.

Vision therapy included antisuppression therapy with diplopia training and cheiro-

scopic therapy, along with accommodation and convergence training using lens flippers and various vectographic and anaglyph therapies. When appropriate, vestibular integration with balance boards was included in the therapy procedures. Later in therapy, tachisto-

scope procedures were added. Homework included anaglyph word searches, diplopia training, accommodative rock, Bernal's aperture rule, simple prism rocks while watching TV, and stereopsis training using an inexpensive foldable, disposable home stereoscope with depth disparity line drawings. The exotropia remained at 10 prism dipters at distance, but had reduced to somewhat less than 10^x exotropia at near.

Two months (25 sessions) into therapy H.H. started to show occasional binocular periods of 3 seconds or so on the near diamond target, commenting that the binocularity “bugs my eyes.” At this point we were able to start using rapid electronic alternate occlusion to aid us. A 4.5-Hz alternation rate overrode H.H.’s suppression on stereoscope chiero-

scopic tracings and drawings. At the next progress evaluation 12 sessions later, H.H. was phoric at distance and at near. At that point, we noted she didn’t appreciate gross stereopsis on the stereoscope tasks (eg, VO 2 stars with fusion circles). An 8-Hz alternation rate produced appreciation of depth. Interest-

ingly, that alternation rate seemed to be a fairly narrow band. Increasing or decreasing the flash rate 0.5 to 1 Hz flattened the picture again.

H.H. used rapid alternate occlusion for 23 of the total 53 vision therapy sessions. During those 23 sessions during the last 3 months of therapy, the number of vectographic test targets showing suppression decreased to one distance and one near vectographic test target. Before the introduction of rapid alternate occlusion, H.H. experienced only occasional periods of binocularity on the modified Borish Near Card diamond target and distance vecto-

graphic anisocoria balance target. At the close of therapy, the diamond target showed a variable alternation with suppression periods generally lasting 1 or 2 seconds and some suppressions lasting 5 seconds. However, suppression-free periods lasted up to 10 seconds. At distance, suppressions were only noted on the alternate letter (binocular letter-left eye only-

right eye only-etc.) vectographic line (referred to as the “malingering test” by AO).

In addition, as therapy ended stereopsis was appreciated on stereoscopic line drawings within 5 seconds. Patient H.H. became phoric (straight) more than 95% of the time. Her mother could not remember the last time she saw her daughter’s eye turn. On cover testing, H.H. measured 10^x exophoria at distance. Distance associated phoria (vectographic fixation disparity target) measured 2^x base out. Near cover test measured 8 exophoria. Near phorias (15A and 15B) measured 13 exophoria through +1.00 OU. Accommodative range was greater than 3.00 D (#20) and accommo-

dative facility was 100%.

Besides being phoric essentially constantly, patient H.H. and her mother reported that her headaches and watery eyes were gone. The mother also reported that H.H. enjoyed reading more, and her reading performance had improved. Patient H.H. has been discharged to the referring doctor for further care. Again, the final report to him stressed watching for any recurrence of the exotropia.

DISCUSSION AND CONCLUSIONS

These are preliminary results from a new vision therapy instrument. These units are now in routine use in the author’s practice on
Both strabismic and nonstrabismic patients, and seem to be speeding the elimination of suppression. Further research is planned and additional uses for the device will be evaluated. Because this instrument can be used with many standard vision therapy techniques and instruments, other uses of very rapid alternate occlusion in vision therapy need to be researched and standardized. Use of rapid alternate occlusion in nonstrabismics to treat intermittent central suppression also must be evaluated. My clinical impression is that more thorough treatment of intermittent central suppression is occurring in less time (perhaps in as much as one-third less time) since we have been using rapid alternate occlusion. In time, similar units may be considered for home therapy use.

When the first prototype instrument became available, the 9-Hz alternation rate suggested by the TBI literature seemed an appropriate starting place for stereoscope therapy procedures. However, unlike published frequencies for the TBI the most effective antisuppression treatment alternation rate with rapid alternate occlusion turned out to be somewhat individual. In more than 65 patients, the average alternation rate that has been used in vision therapy to date is 6 Hz. The range that has proven effective for suppression reduction so far is from 4 to 12 Hz, with most patients' suppressions responding to alternation frequencies between 4 and 9 Hz. Several patients have shown two frequencies that seem to be most effective, or are effective at different times and on different days. Also worth noting is that electronic rapid alternate occlusion has produced no convulsive responses in these patients.

Cheirosopic tracings in the stereoscope are used to determine the most effective alternation rate. While wearing the alternate occlusion glasses and doing the tracing in the stereoscope, the alternation frequency of the liquid crystals is altered and the patient is questioned about anything disappearing. Bracketing between higher and lower frequencies usually gives a range of about 1 Hz where the picture and pencil tip are the most visually stable, showing the least possible suppression response.

These two cases have demonstrated the value of liquid crystal lens electronic rapid alternate occlusion in intermittent exotropia. Substantial decreases in suppression and improvement in eye alignment as evidenced by reported phoric behavior during waking hours came shortly after use of the procedure began. Both these exotropes showed breakthroughs in their abilities for simultaneous perception on stereoscope tasks when specific frequencies of alternation were used. The possible implications for the practice of vision therapy are improved treatment of suppression, and thereby less time spent by the patient in vision therapy.

REFERENCES