Fitting Peripheral Prisms for Patients with Hemianopia

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Disclosure of Financial Interest
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Vision with Hemianopia

Visual scene for simulations

Simulation with (left) Hemianopia
Simulation with (left) Hemianopia

Gaze Left

Outline

• Prior Approaches and their Limitations
• The Peripheral Prisms and Their Use
• Clinical Trials Evaluating the Use of P Prisms
• Fitting the Peripheral Prisms
• Training Patients in the Use of the Prism
• Oblique Prisms Fitting
• Fitting the Prisms - Hands-on Training

Prior Prism Approaches and their Limitations

Prisms for Hemianopia

Binocular Overall Prisms Yoked Prisms

Field shift only
No field gained

Why only $20 \Delta \approx 10^\circ$?
- Higher power $\rightarrow$ Larger effect
- Heavy and thick lenses
- Poor image quality
  - Unacceptable foveally
  - Even with ophthalmic prism
  - Worse with Fresnel

**Bilateral Sector Prisms**
- Prism on both lenses prism base to the field loss
- Prism on half of lenses
- Most positions of gaze - no effect at all
- On right gaze - only shift image
- Do not expand the field

*Right Hemianopia*

*Apical Scotoma with Bilateral Sector Prisms*

*Cohen, J.M. & Weiss, B., Visual Field Remediation, Chapter 1, Remediation and Management of Low Vision 1996*
With Binocular Sector Prism looking straight ahead

With Right Hemianopia

Without Prism looking to the right

With Right Hemianopia

With Prism looking to the right

Apical Scotoma - Optical Blind Spot

With Right Hemianopia

Unilateral Sector Prisms
Using Fresnel Press-on™ Prisms – 3M

- Prism on one lens only on side of the field loss
- Most positions of gaze — no effect at all
- On right gaze - ?

Right Hemianopia

Unilateral Sector Prism


Just Flipped for Left Hemianopia

Left Hemianopia

Unilateral Sector Prism – Left Gaze


Unilateral Sector Prism – Left Gaze


Visual Field – With Large Gaze Shift

Computed

With 20Δ Sector prisms

Gaze shifted 20° into the Prism

Visual Field – with Larger Gaze Shift

Measured

With 20Δ Sector prisms

Gaze shifted 20° into the Prism

View of a person with left Hemianopia with Unilateral Sector Prism

Gaze to the right

No effect of prism

View of a person with left Hemianopia with Unilateral Sector Prism

Large gaze shift to left (into the prism)

- Double vision (Confusion) expands the field
- Double vision (Diplopia) is disturbing

Most Saccades are Less than 15°

What happens if gaze shift is Less than 10°?

Limitations of Prior Approaches

- Most positions of gaze unaffected by prisms
  - Requires scanning to blind side
- Diplopia in central vision
  - Annoying and disturbing
- Apical scotoma in central field
  - Do no harm?
- Acuity limits prism power centrally
  - Expansion limited to 10°

Peripheral Prisms and Their Use

Hemianopia and Strabismus
Right Hemianopia with Right Exotropia
Field Expansion
Reported in Congenital Hemianopia
“Panoramic vision”

Hemianopia and Exotropia
• About 15 cases of teenagers with documented ARC reported
• Surgeons usually do not operate on exotropes with hemianopia

• Works also with esotropia of the other eye
  – One such teenage case reported
  – I have seen 2 more

Hemianopia and Esotropia
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Field Expansion Solution
• Make Hemianopes Strabismic
• Diplopia is a problem
• Double vision peripherally, easy to adapt
  • Physiological Diplopia

Horopecter – Zone of single binocular vision
• Physiological Diplopia

Turn Hemianopes to Exotropes?
• No surgery needed
• We know how to do it with a simple prism

• Problem - Exotropia causes double vision
  – Adults do not develop ARC

• Diplopia and Confusion are unacceptable in central vision
Peripheral Prisms

Peripheral Unilateral Prism
Left Hemianopia

Solution - Peripheral Prisms

• All positions of gaze affected by prisms
• Diplopia is limited to periphery
  – Maintain single central vision
  – Double vision peripherally, easy to adapt
• Apical scotoma limited to periphery
• High prism power possible in periphery (57Δ)
  – Expand upper and lower fields by up to 30°

View with the Peripheral Prisms
Gaze to left
Peripheral double vision (Confusion) expands field
Peripheral double vision (Diplopia) minimally disturbing

View with the Peripheral Prisms
Gaze to Right
Peripheral double vision (Confusion) expands field
Field expansion in all positions of gaze

Peripheral Prism Horizontal Design

Permanent prism segments on upper & lower parts of lens
Users always look through central, prism-free area; No central diplopia
Prisms on left lens Base left for left hemianopia

Visual field expansion measured by Goldman perimetry
Binocular visual fields - Left hemianopia
Without peripheral prisms
With 40Δ peripheral prisms
Upper & lower field expanded laterally by about 30°
No Escape from the Apical Scotoma
But the impact is minimal - Apex is peripheral
Other eye covers for the apical scotoma

57Δ ≈ 30°

Works at Any Position of Gaze

Gaze 15° left
Gaze 15° right

Improve Image Quality Safety & Cosmestis

Permanent Prism
Solid PMMA Fresnel

Improved Cosmetics and Safety

Clinical Studies and Clinical Trials

Evaluations of peripheral prisms

- Long-term benefit in obstacle avoidance for at least 50% of wearers in:
  - Case series report¹
  - Laboratory extended wear trial²
  - Multi-center clinical trial³
  - All with 40Δ prisms

Community-Based Multi-Center Study
• Long-term follow up to evaluate:
  – Fitting procedures
  – Patient acceptance
  – Functional utility
  – Preliminary evaluation of permanent prisms
• Main outcome measures
  – Minimum inter-prism separation
  – Long-term success rate (continue to wear)
  – Helpfulness for obstacle avoidance

Determine minimum inter-prism separation tolerated for walking
Tolerated = comfortable single central vision with no change in head posture between without and with prisms

Final prism fitting positions

An inter-prism separation of 12mm adopted for a simplified fitting protocol


Fitting the Peripheral Prisms

Basic Fitting Protocol
• Frame selection and fitting
  – Adjustable nose pads
  – Fitting well and does not slip
  – At least 36mm in the vertical B dimension
    • At least 18mm from pupil center to upper eye wire
      – Upper eye wire at about the level of eyebrow
    • At least 18mm from pupil center to lower eye wire
      – 23mm for bifocals

Evaluated in Second Multicenter Clinical Trial
Using a cling-on single piece template

Template has a fixed inter-prism separation of 12mm

Initial Fitting Position

- Mark pupil center on demo lens
  - Copy the center mark to back of the lens
- Center the Template on pupil position
  - Laterally and vertically
  - This is the initial fitting position
- Rub template well in the center to improve optical quality

Initial Fitting Position

1 deg is about 0.35 mm on carrier lens
1 mm ≈ 3 degrees

Prisms are placed
6 mm above and below pupil
About 16.5 degrees above and below

Adjusted Position

- Observe head posture while walking-no prism
- Place an occluder in front of the fellow eye
- Explain that black patches represent locations of prism segments in the real glasses
  - Can use prism in place of black patch
- Explain lack of Rx correction in demo lenses
- Place glasses on patient and take for a walk
  - Changes in head posture observed?
  - Interference of patches noted by patient?
- Adjust Template position up or down as needed

Determining minimum inter-prism separation tolerated for walking

Tolerated = comfortable single central vision with no change in head posture between without and with prisms

Observe head posture when walking without prism

Upper prism
Start 6mm above pupil center
Observe head posture when walking with prism
Determining minimum inter-prism separation tolerated for walking

Tolerated = comfortable single central vision with no change in head posture between without and with prisms

Observe head posture when walking

**Upper prism**
- Move down until causes problem
- Observe head posture when walking with lower prism position
  - Change in head posture?
  - Causing double vision?

Observe head posture when walking

**Lower prism**
- Start 6mm below pupil center
- Repeat procedures to find highest tolerated position

Clearance should be > 3mm
Not met here

If needed shift template no more than 3mm temporally

Verify sufficient clearance for structural integrity (3mm)

When satisfied secure template in position with a tape

Clearance now > 3mm
Measure template position - x and pupil center height - y
Can you increase
the field expansion by
shifting prism temporally
towards the field loss
No! Field expansion
determined by prism power

Shifting Prism Temporally is Not Helpful

Shifting Prism Nasally Increases Diplopia
Nasal prism shift ➔
Upper segment shifted Nasally 5° = 1.75 mm

Template position can be used to fit
Temporary Pre Cut Prisms
or Permanent Prisms
Pre Cuts speed up fitting and may be use
without template once experienced

Newer Design
Oblique Peripheral Prisms
Binocular Perimetry

Without Prisms

Left hemianopia

With Prisms

Field of view through windshield

Oblique Prisms


Oblique peripheral prism glasses

Visual field expansion

Binocular visual fields - Left hemianopia

Field expansion in area relevant to driving

We now have 57D peripheral prisms

High Power Oblique Prisms

40Δ providing 22° expansion

57Δ providing 30° expansion

57Δ Oblique Prisms tilted at 25°

Placebo-Controlled, Crossover Trial of Real and Sham Prism Glasses

Two treatment groups

• Real oblique and sham horizontal
• Real horizontal and sham oblique
• Order of real/sham counterbalanced

Real 57Δ oblique

Sham <5Δ horizontal

With horizontal prisms

With 40Δ Oblique prisms
Main Results

• 73 Enrolled

• 61 completed the cross-over
  – 37 (61%) clinical decision to continue wear
  • No difference between oblique and horizontal
  – 25 (41%) still wearing at 6 months

Comparison questionnaire
If you were only allowed to keep one pair of glasses, which would you choose?
  First pair?
  Second pair?
  Neither?

Comparison questionnaire
Which pair of glasses would you choose?

Emphasizes the importance of including a control condition

On-road driving with prisms study

• Three routes, each ~ 1 hour
  – Busy streets in Ghent, Belgium
  – Dual-control car

• Two evaluators:
  – Examiner of the Belgian Road Safety Institute
  – “Back seat” evaluator

Comparison questionnaire
Which pair of glasses would you choose?

Reasons for choosing real or sham

More helpful when walking

Vision more comfortable

On-road driving - Procedures

• One pre-fitting on-road test
  – without prisms

• Two post-fitting on-road tests
  – With “sham” prisms (oblique)
  – With “real” prisms (oblique)

Evaluator masked

Training Patients in Use of the Prism

**Satisfactory responses to unexpected hazards**

![Graph showing the percentage of satisfactory responses for No Prism, Sham Prism, and Real Prism interventions.](image)

- **Satisfactory** = Score of 4 or 5
- **Error bars** = 95% confidence

Interventions by driving instructors: brake, gas, steering

![Bar chart showing the number of interventions for No Prism, Sham Prism, and Real Prism.](image)

Fewer blind-side interventions with real prisms

- Fewer is better here

In-office training
- Demonstration of expansion effect
  - Binocular confrontation visual fields
- Head turning
  - Fixate objects detected via prism image through the clear carrier section
- Demonstration of undesirable central diplopia
- Reach-and-touch exercise
  - Familiarization with shifted directions of objects
- **Wear prism glasses as much as possible**
  - Except driving and extended reading

Home training instructions
- Wear prism glasses as much as possible
  - Except driving and extended reading
- Practice use first in familiar environments
- Gradually expand range & complexity
  - Always have a companion when expanding range first
  - Take other glasses with you in case of need to remove
- Practice reach and touch exercises
  - Use head movement when not exercising

Workshop Equipment & Supplies

All provided by Chadwick Optical

- What is in your personal kits is yours to keep
- Demo glasses, demo clip-ons, tools etc. are provided for the workshop use only
  - Please, do not take anything that is not in your kit
More Information

Find it all on our web site

www.eri.harvard.edu/faculty/peli/index.html

Also on Chadwick Optical web site

http://www.chadwickoptical.com

MA medicaid is paying $650 for a pair of these