Fitting Peripheral Prisms for Patients with Hemianopia
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Disclosure Statement:
Patents, Consulting, Funding of Research
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Vision with Hemianopia

Visual scene with normal field
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

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

Apical Scotoma with Bilateral Sector Prisms

Cohen, J.M. & Waiss, B.,
Visual Field Remediation, Chapter 1, Remediation and Management of Low Vision 1996

Optical Blind Spot - Apical Scotoma

With Right Hemianopia

Without Prism looking to the right

With Prism looking to the right

Apical Scotoma - Optical Blind Spot
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

Just Flipped for Left Hemianopia

Left Hemianopia

Unilateral Sector Prism – Left Gaze

OS only
Field Expansion
Prism Eye

Diplopia

Central Disturbing Annoying

Magnitude of effects illustrated is incorrect

OD only OS view Blocked by Apical Scotoma.
Immaterial seen without and with prism

Visual Field – With Large Gaze Shift

Computed

With 20Δ Sector prisms

Gaze shifted 20° into the Prism

Expanded Field

View with gaze center
With unilateral sector prism 20Δ

No effect of prism

View of scene with gaze right

No effect of prism

View with gaze center

No effect of prism

View with 20° gaze left – No Prism

View with 20° gaze left into prism

Diplopia

Expansion

Magnitude of Gaze Shift

What happens if gaze shift is Less than 10°?

Most Saccades are Less than 15°

PP = 10°

OD only

Diplopia

Gaze Shift

Gaze Shift

Fusion

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

Hemianopia with Exotropia

Right Hemianopia with Right Exotropia

Field Expansion

Reported in Congenital Hemianopia

“Panoramic vision”

Hemianopia and Exotropia

• About 24 cases of teenagers many 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 with Esotropia

Right Hemianopia with LEFT Esotropia

Field Expansion with Small peripheral loss

with Diplopia Except if ARC

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

Field Expansion Solution

• Make Hemianopes Strabismic

• Diplopia is a problem

• Double vision peripherally, easy to adapt
  • Physiological Diplopia
Horopter – Zone of single binocular vision

Peripheral Prisms
Peripheral Unilateral Prism
Left Hemianopia

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 20°

Properties of Peripheral Prisms
• High prism power possible in periphery (57Δ)
  – Expand upper and lower fields by up to 30° (even more)
• Double vision is limited to periphery
  – Maintain single central vision
  – Double vision (confusion) peripherally, easy to adapt
• Apical scotoma limited to periphery
  – Apical scotoma reduces diplopia
• All positions of gaze affected by prisms
  – Only with Press-On with inside lens configuration

With 57Δ gets 30° expansion
Calculated
Measured

**Properties of Peripheral Prisms**

- High prism power possible in periphery (57Δ)
  - Expand upper and lower fields by up to 30° (even more)
- Double vision is limited to periphery
  - Maintain single central vision
  - Double vision peripherally, easy to adapt
- Apical scotoma limited to periphery
  - Apical scotoma reduces diplopia
- All positions of gaze affected by prisms
  - Not really
  - Only with eyeward prism serration (EPS) configuration

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**No Escape from the Apical Scotoma**

Properly designed apical scotoma prevents diplopia in primary gaze

57Δ ≈ 30°

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**Works at Any Position of Gaze**

- Gaze 15° left
  - True only for EPS configuration
- Gaze 15° right
  - Works but effect is small

**View with gaze center-peripheral prism**

- Expansion (confusion)

**View with 5° gaze left-peripheral prism**

- Increased field & some distortion

**View with 20° gaze left-peripheral prism**

- Minimal
- Increased field peripherally.
- It is limited by TIR
- Total Internal Reflection

**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 report
  - Laboratory extended wear trial
  - Multi-center clinical trial
  - Independent clinical study
  - 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

Community-Based Multi-Center Study

- 60 patients screened in 18 clinics
  - Complete hemianopia, no neglect
  - 5 excluded, 12 withdrew pre-fitting
  - 43 fitted with prisms

- Of the 43 that were fitted
  - 32 (74%) continued wear after week 6 follow up
  - 21 (49%) continued long term wear (median 12 months)
  - Success rates varied between clinics
    - More patients ⇒ higher success rate

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

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**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

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**Degrees and mm**

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

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**Using a cling-on single piece template**

Template has a fixed inter-prism separation of 12mm

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**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***

Observe head posture when walking ***with lower prism position***
Change in head posture?
Causing double vision?
If using prism instead of template

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
Move up to find ***lowest*** tolerated position

Observe head posture when walking ***with lower prism position***

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

Clearance should be > 3mm
Not met here

Verify sufficient clearance for structural integrity (3mm)

If needed shift template no more than 3mm temporally
Can you increase the field expansion by shifting prism temporally towards the field loss **No!** Field expansion determined by prism power

With 57Δ OPS
Shifting Prism Temporally Increases Possibility of Spurious Reflection

Simulating the Monocular View with High Power Prisms

Scene field-of-view at primary gaze

Shifting Prism Temporally is Not Helpful

\[ \text{Upper segment shifted temporally 5°} = 1.75 \text{ mm} \]

\[ \text{Upper segment shifted temporally 15°} = 5 \text{ mm} \]

Shifting Prism Nasally Increases Diplopia

Nasal prism shift →

\[ \text{Upper segment shifted Nasally 5°} = 1.75 \text{ mm} \]

When satisfied secure template in position with a tape

Clearance now \( > 3 \text{ mm} \)

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

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When satisfied secure template in position with a tape

Clearance now \( > 3 \text{ mm} \)

Measure template position - \( x \) and pupil center height - \( y \)
Simulating the Monocular View with Different Configurations

Jung JH, Peli E (2014) Impact of high power and angle of incidence on prism corrections for visual field loss, Optical Engineering

Template position can be used to fit Temporary Pre Cut Prisms or Permanent Prisms

Pre Cuts speed up fitting and may be used 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

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

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?

<table>
<thead>
<tr>
<th></th>
<th>Real</th>
<th>Sham</th>
<th>Neither</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent of patients complete crossover</td>
<td>0%</td>
<td>26%</td>
<td>74%</td>
</tr>
</tbody>
</table>

26% chose sham

Emphasizes the importance of including a control condition

Comparison questionnaire

Reasons for choosing real or sham

<table>
<thead>
<tr>
<th></th>
<th>Chose real</th>
<th>Chose sham</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent &quot;yes&quot; responses</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>More helpful when walking</td>
<td>40</td>
<td>0</td>
</tr>
<tr>
<td>Vision more comfortable</td>
<td>0</td>
<td>60</td>
</tr>
</tbody>
</table>

p < 0.005

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

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)
  - Evaluators masked


Satisfactory responses to unexpected hazards

<table>
<thead>
<tr>
<th></th>
<th>No Prism</th>
<th>Sham Prism</th>
<th>Real Prism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent Satisfactory</td>
<td></td>
<td>0</td>
<td>100</td>
</tr>
</tbody>
</table>

p < 0.01

Satisfactory = Score of 4 or 5

Error bars = 95% confidence
Interventions by driving instructors: brake, gas, steering

Fewer blind-side interventions with real prisms
Fewer is better here

Recent driving simulator study

Horizontal field of view 225°

Pedestrian on a Collision Course

Slow Motion

Pedestrian on a Collision Course

Normal Motion

Blind side pedestrian detection rates in the driving simulator

Better with prisms
Better without prisms

Detection Rate Before Training
Training Patients in Use of the Prism

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
And on
http://www.hemianopia.org

MA Medicaid is paying $650 for a pair of these

Thank You!

Training help from colleagues experienced in fitting the peripheral prisms

Please remember to complete your session evaluations online.

Tweet about this session using the official meeting hashtag #aaoptom15