Fitting Peripheral Prisms for Patients with Hemianopia

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Vision with Hemianopia

Typical Static Simulation

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 →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

Optical Blind Spot

Apical Scotoma


Apical Scotoma

Without Prism looking to the right

With Prism looking to the right

Apical Scotoma - Optical Blind Spot

With Right Hemianopia

With Right Hemianopia

With Right Hemianopia

With Binocular Sector Prism looking straight ahead

With Right Hemianopia

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

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

Magnitude of effects illustrated is incorrect


Visual Field – With Large Gaze Shift

Computed

With 20° Sector prisms

Gaze shifted 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


Most Saccades are Less than 15°

What happens if gaze shift is Less than 10°?
Visual Field – Unilateral Sector Prism

With 20Δ Sector prisms

Gaze shifted 5° into the Prism

Computed Expanded Field

Central Scotoma

View with gaze center

No effect of prism

View with 11° gaze left – No Prism

Prism is 2 mm left - 6° left

Note apical scotoma

View with 5° gaze left into prism (11° Gaze shift)

Expansion

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 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

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

No Escape from the Apical Scotoma

Properly designed apical scotoma prevents diplopia in primary gaze

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

View with 5° gaze left-peripheral prism

Expansion (confusion)

View with 20° gaze left-peripheral prism

Minimal Increased field peripherally.

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Total Internal Reflection

View with 5° gaze left-peripheral prism

Expansion (confusion)


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

- Number of patients
- Interprism separation (mm)
- 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

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

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
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

Observe head posture when walking

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

Clearance should be > 3mm

Verify sufficient clearance for structural integrity (3mm)

If needed shift template no more than 3mm temporally
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

Upper segment shifted temporally 5° = 1.75 mm
Upper segment shifted temporally 15° = 5 mm

 Apex Scotoma Shifted Centrally

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

Shifting Prism Nasally Increases Diplopia

Nasal prism shift →
Upper segment shifted Nasally 5° = 1.75 mm

Simulating the Monocular View with High Power Prisms

Scene field-of-view at primary gaze

Simulating the **Monocular** View with Different Configurations

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

Field of view through windshield

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

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?

Percent of patients complete crossover

Real Sham Neither

p < 0.001
26% chose sham

Emphasizes the importance of including a control condition

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 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

Percent Satisfactory

No Prism Sham Prism Real Prism

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

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 complete your session evaluation using EyeMAP™ online at
http://eyemap.cistems.net

Tweet about this session using the official meeting hashtag #aaoptom14

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