Orthokeratology for Myopia Control: Understanding the True Optics & Biomechanical Properties (A Practitioner’s Clinical View)

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Outline (Slide 1)

I. GP lenses for myopia control, the past and present (Slide 2)
   A. Spherical GP lens
   B. Aspheric back optical zone GP lens
   C. Day wear reverse geometry lens
   D. Nightwear reverse geometry lens
      1. Traditional designs
      2. Multiple curve (8+) with aspheric back optical zone

II. Are we achieving myopia control effect with current applications of ortho-k designs? (Slide 3)
   A. LORIC Study: Cho et al, Vitreous Chamber Elongation, 2 years follow up.
      1. Vitreous chamber elongation by 0.20 mm in 2 years
   B. Chow 2010, Average Myopia Progression After 5 Years
      1. Significant axial elongation with low Rx (<-3.0D)
      2. Small changes in axial length >-4.0D
      3. Maintained axial length when reach -5.0D or above

III. How can we achieve the proper peripheral defocus without over correction? (Slide 4)
   A. Mid-peripheral thickening of tissues
   B. Small area of central treatment zone
   C. Application of asphericity at back optical zone for extra forces
   D. Application of double reverse zone to enhance effectiveness
   E. Basic goal of peripheral optical treatment strategy
      1. Development & progression of myopia linked with the NATURE & Quality of both central & peripheral retinal images (Earl Smith III: Peripheral Defocus Theory) (Slide 5)
      2. Myopia control through optical intervention (peripheral myopia defocus) (Slide 6): Creates potential source of blur from steep intermediate curve with central clear vision
      3. How hyperopic is the periphery at 30 degree?
      4. Do peripheral refraction & aberration profiles vary with the types of myopia? (Bakaraju et al, 2009) (Slide 7)
      5. The amount of peripheral plus power at 5.0 mm as compared to the amount of minus power corrected (Slide 8 & 9)
      6. Tear profiles of different corrective ortho-k lenses (Slide 10)

IV. The Optics of Ortho-k (Slide 11)
   A. Foveal treatment zone in ortho-k is approximately 1.5 to 2.5 mm in diameter
   B. Amount of peripheral plus power increases with pupil size
   C. Large optical zone diameter creates distorted central vision (Slides 12,13)
   D. Optimum size from 5.2 to 5.4 mm (Chow 2013) (Slide 14)
V. Understanding the true corneal profile following corneal reshaping (how can we account for the dramatic changes in refractive errors with a small amount of tissue to work with)
   A. Understanding the Munnerlyn Formula (Slide 15)
   B. Compare the amount of tissue displacement with -3.0 D correction for 1.0, 3.0 and 5.0 mm treatment zone
   C. Corneal profile presented over the pupil is the essential optical ingredients to correct both central & peripheral refractive errors for myopia control (Slides 16,17,18)

VI. Force acting in orthokeratology (Slide 19)
   A. Forces affecting the reverse geometry lens on the eye (tear film diagram) (Slide 20,21)
      1. Lid force (Compression): positive force, push-off of treatment zone (base curve flatter than K readings)
      2. Tension force (squeeze film force): negative, pull force
      3. Tear layer (fluid) force
      4. Surface tension force (small capillary force): pull-on of the alignment zone towards reverse zone, capillary attraction (Slide 22)

VII. Other forces applied for enhancement of results
   A. Aspheric back optical zone & the optical nature (Slide 23,24,25,26)
      1. Small central aperture for distant viewing (about 1.5 to 3.0 mm of OZD). Fulfils Myopia Control Theory
      2. Progressively flatten from central zone towards the edge of BOZ
      3. Progressively diminishing of minus power towards the periphery (increasing near add power for defocus theory)
      4. Optical nature of aspheric multifocal lens related to pupil size (creates high order of spherical aberration)
   B. Addition of 2nd reverse zone (relief/enhancement zone)
      1. Can be used to enhance the building up of the mid-peripheral corneal tissue (steeen) for more ortho-k effect (enhancement with surface tension force)
      2. Use to balance pressure between reverse curve 1 & alignment curve (Slide 27,28)

VIII. Understanding the nature of corneal biomechanical properties & force applied (Slides 29-35)
   A. Viscosity & damping: corneal hysteresis (CH) as the result of viscous damping in corneal tissue
   B. Elasticity: direct response to a force
   C. Corneal resistance factor (CRF): Mathematically similar to CH, provides more information about elastic properties
   D. Correlation of CH/CRF vs central corneal thickness (CCT)
   E. CH/CRF relationship to ortho-k response
   F. Influence of biomechanical properties in ortho-k for myopia control: age related
   G. Corneal biomechanical properties between races