

# The Effect of Altitude on Vision in Military Personnel Following SMILE Refractive Surgery

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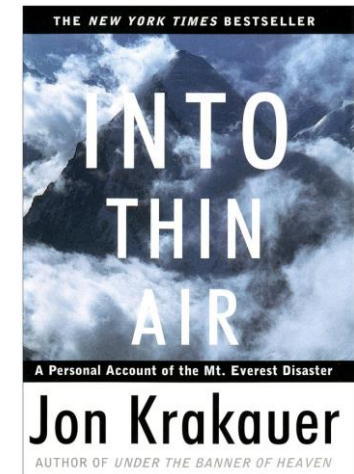
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# Corneal Refractive Surgery (CRS)- Changes at Altitude

Corneal flattening with associated hyperopic shift in post-RK patients exposed to high altitudes

- 1988 case report<sup>1</sup>
  - Proposed that decreased barometric pressure is the cause of worse vision in post-RK patients at altitude
- 1995 case series report<sup>2</sup>
  - Exposure to 12,000' in Bolivia → progressive hyperopic shift and corneal flattening in post-RK patients
  - Hypothesized that hypoxia causes increased stromal hydration with focal corneal expansion
- 1996 study<sup>3</sup>
  - Significant and progressive corneal changes after 24 hrs of exposure to 14,100' (Pike's Peak)
- 1996 case report<sup>4</sup>
  - Physician s/p bilateral RK suffered disabling RE changes at 27,000' (Mt Everest)
- 1998 prospective study<sup>5</sup>
  - Air-tight goggles → proved that corneal changes due to hypobaric hypoxia



# Corneal Refractive Surgery (CRS)- Changes at Altitude

Few case reports of myopic shift at altitude in post-LASIK eyes

- 2000 case report<sup>6</sup>
  - Post-LASIK patient experienced noticeable nearsightedness while mountain climbing (Peru)
- 2001 case report<sup>7</sup>
  - 2 physicians post-LASIK with moderate loss of UDVA with normal UNVA at 22,841' (Argentina)
- 2001 prospective study<sup>8</sup>
  - Air-tight goggle system → myopic shift
- Case reports of normal vision at altitude in post-LASIK patients<sup>9,10</sup>

No significant corneal changes reported in post-PRK eyes at altitude<sup>11,12</sup>

***Study Question:* Do post-SMILE corneas remain stable when exposed to a hypobaric hypoxic environment under operational conditions?**

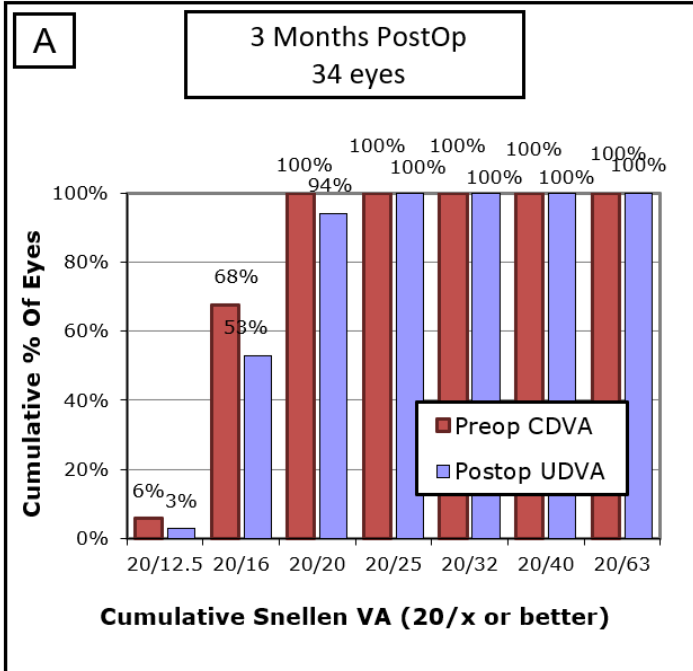
# “SMILE at Altitude” Study Design & Patient Demographics

Design: Non-randomized prospective study

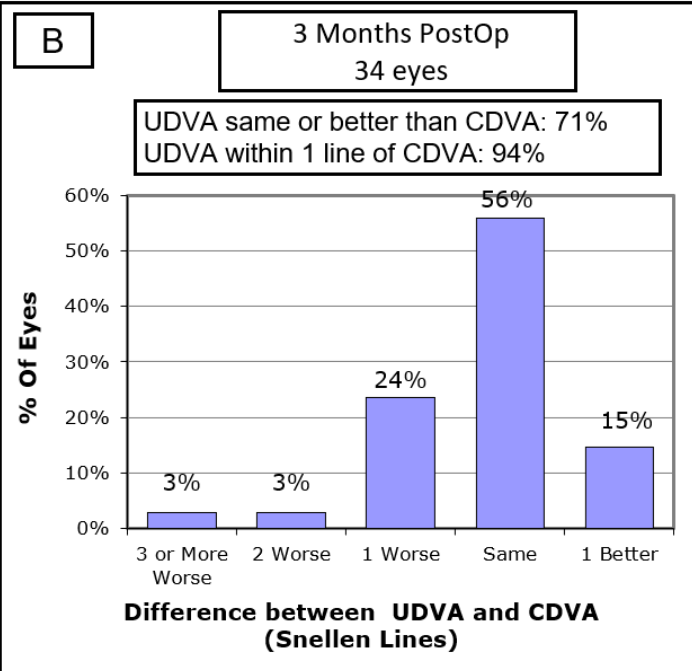
## Subjects:

- 17 active-duty personnel at least 1 month s/p SMILE OU (Zeiss VisuMAX femtosecond laser) performed at the Joint Warfighter Refractive Surgery Center (Lackland AFB)
  - 15 males, 2 females
  - Age: 21-39 (mean: 28.4)
  - Days from SMILE procedure: 31-387 (mean: 142 days)
  - Inclusion criteria
    - AD military age 21-54
    - Undergone bilateral standard of care SMILE refractive surgery for myopia correction, at least 30 days earlier
    - Cleared to participate by a flight surgeon
    - Attended the required Altitude Chamber Research Training (ACRT)
    - Agree to avoid hyperbaric and hypobaric environmental conditions for 72 hrs after chamber flight
  - Exclusion criteria
    - Pregnancy or planning to become pregnant
    - Pre-existing medical conditions found by flight surgeon that would DQ subject from altitude chamber participation

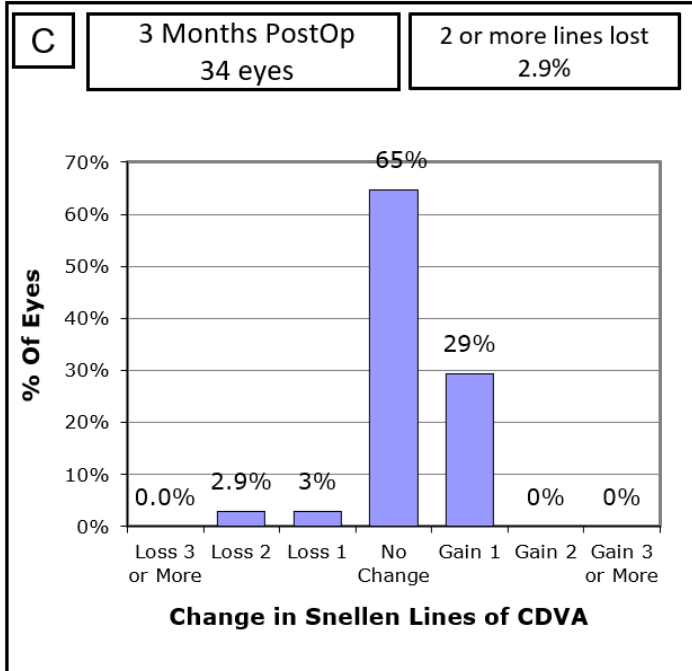
# POM3



**Uncorrected Distance Visual Acuity**



**Uncorrected Distance Visual Acuity vs. Corrected Distance Visual Acuity**



**Change in Corrected Distance Visual Acuity**

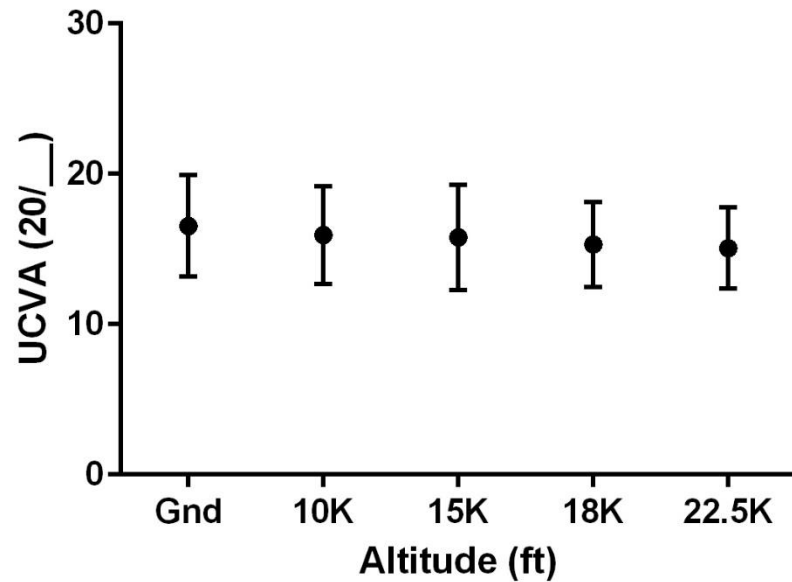
# “SMILE at Altitude” Study Methods

## Examinations

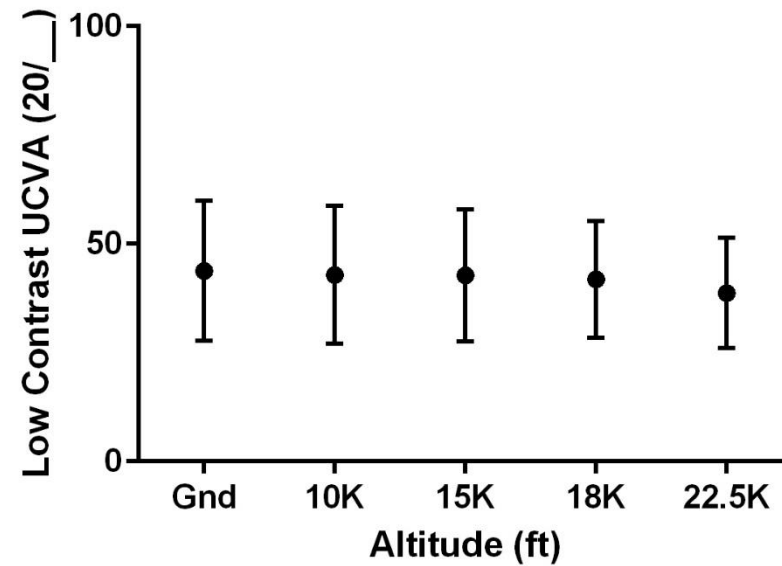
- KBR Hypobaric Chamber at Brooks City-Base (San Antonio, TX)
  - Ground-level (GL, approx. 675’), 10000’, 15000’, 18000’, and 22500’
    - Ascent/descent rate: 5000’/min
    - 10-30 mins at each altitude
  - Subjects and testers wear USAF approved aircrew oxygen masks with 100% oxygen
- Measured parameters
  - High- and low-contrast (5%) visual acuity
    - Rear-illuminated light box (Precision Vision) at 13 feet under dark room conditions
    - Sloan ETDRS High and 5% Low Contrast
  - Refractive error (NIDEK ARK-530A Auto Refractor)
  - Keratometry (OCULUS Pentacam HR)
  - Slit-lamp exam at ground level and at 22500’ (Kowa SL-15 portable slit lamp)



# “SMILE at Altitude” Study Data- UCVA & LCVA



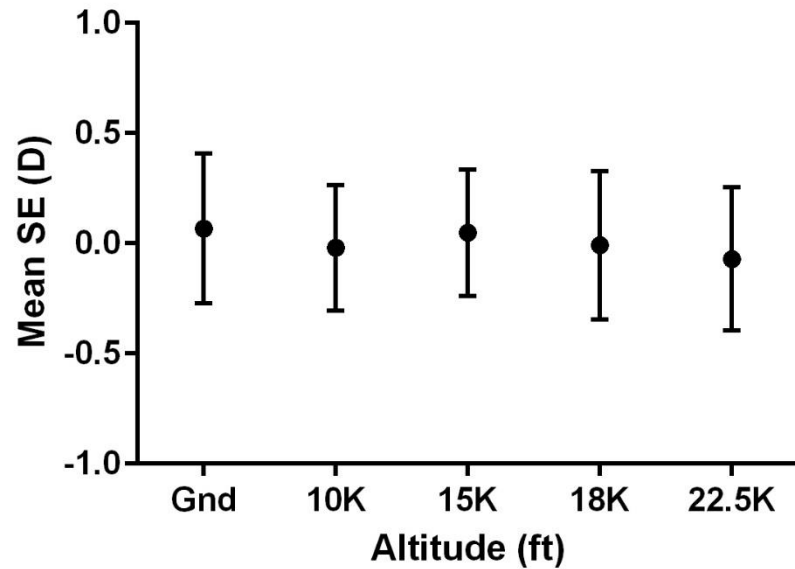
P-value: 0.0692



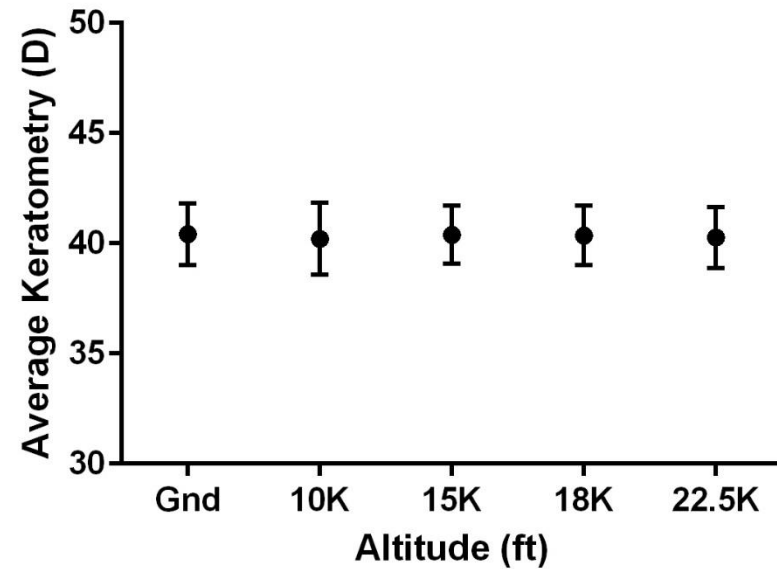
P-value: 0.0602



# “SMILE at Altitude” Study Data- Refractive Error & Keratometry

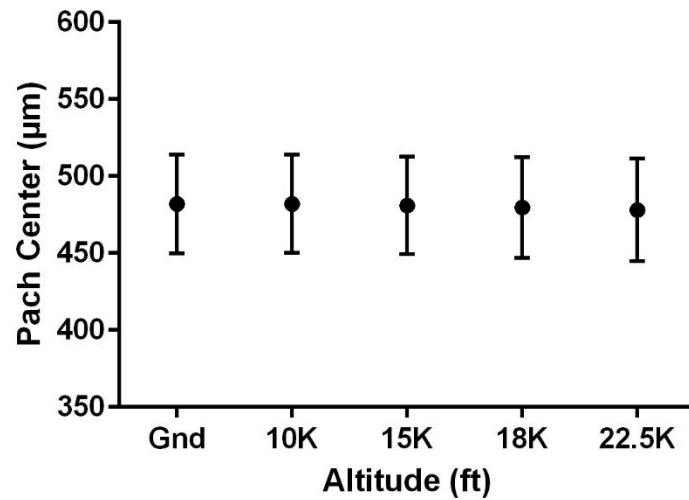


P-value: 0.0615

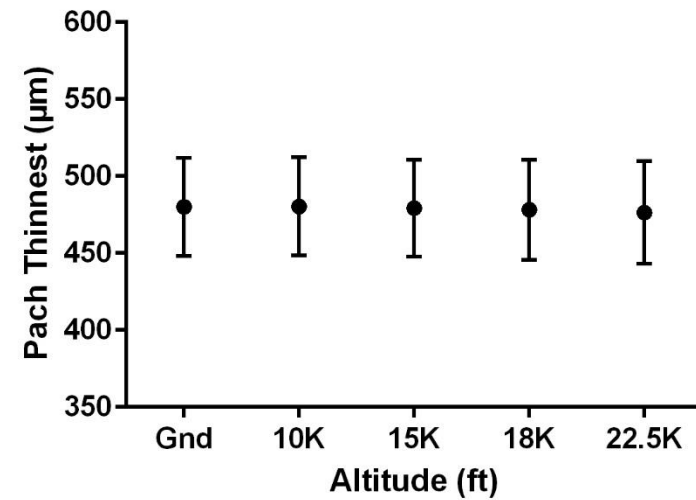


P-value: 0.1798

# “SMILE at Altitude” Study Data- Pachymetry



P-value: 0.0656



P-value: 0.0581

# Study Conclusions

- No significant change in high- and low-contrast uncorrected visual acuity, corneal thickness, or refraction up to 22,500' simulated altitude
- Post-SMILE corneas demonstrate stability in a hypobaric hypoxic environment over a 30 min – 1 hour time period
- Hypotheses
  - Corneal incision depth plays a role in corneal stability
  - Undiagnosed corneal endothelial dysfunction in case reports of swelling and refractive changes

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