REFRACTIVE SURGERY OVERVIEW 2007 – Lecture notes

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Importance of refractive surgery

Refractive surgery increasingly popular
Essentially healthy eyes with normal visual acuity
Up to 5% will have minor complications / side-effects
1% will have visually significant symptoms
Techniques increasingly complex and evolving
>100,000 procedures in UK >30,000 in Australia pa.

Radial keratotomy

Results similar to PRK up to -3.0 to -4.0D
Problems – progressive hyperopia, diurnal fluctuation, a dying "art"

Alternatives in low myopia:

intra-corneal ring (ICR) / segments
PMMA ring in peripheral stroma at 2/3rd depth
Flattens central corneal curvature
Effect proportional to ring thickness
Mainly used as "Intac" segments for keratoconus

LASERS and refractive errors

1995: PRK good enough for US Navy

30 Navy / marine personnel
-2.50D to –5.50D (Mean –3.35D)
All eyes 20/20 unaided at 1 year
No loss of BSCVA at 12 months

Development of scanning spot lasers vs Broad beam lasers

1997:PARK with scanning spot lasers University of Dundee; prospective study PRK/PARK, Correction of Spherical equivalent with significant myopia by surface based ablation

Mean astigmatism 1.63D 50 consecutive eyes 1996-97

Attempted Correction	**6/6**	**6/9**	**6/12**	**+/-0.50D**
≤-5.00D	**76%**	**97%**	**97%**	**76%**

ADVANTAGES of LASIK over PRK	**DISADVANTAGES of LASIK vs PRK**
Relatively painless Rapid visual recovery Treats greater refractive errors Minimal corneal healing Interface haze rare Easy to retreat/enhance	Expense of microkeratome Technically more complex Surgical flap complications Post-op flap displacement Interface debris Sterile interface keratitis (DLK) Rare possibility of late ectasia

LASIK vs PRK in high myopia

Early (1998) randomised prospective study (N=220) correcting myopia from –6.00 to –15.0D Summit Apex Excimer Laser mean correction of –9.30D. One of the best ever comparative studies – highlights very similar outcomes except loss of BSCVA in this very highly myopic group treated by PRK.

	Pre-Op	20/20	20/40	Regression	Loss of BSCVA
PRK N = 105	-9.23D +/- 1.76D	19.1%	66.2%	-0.89D	11.8%
LASIK N = 115	-9.30D +/- 1.70D	26.2%	55.7%	-0.55D	3.2%

Refractive surgical trends - ASCRS Surveys of refractive surgeons

1997 40% PRK, 18% LASIK

1999 25% PRK, 58% LASIK

2000 70% will perform PRK to -3.00D
92% will perform LASIK to -7.00D
58% will perform LASIK to -12.00D
Only 4% implant phakic IOLs

2005 94% of surgeons do PRK and LASIK
Only 31% consider LASIK for -10.0D
Trend towards phakic IOLs >-10.0D
Only 8% would do +5.00D LASIK
88% use wavefront analysis
Presbyopia correction 42% monovision and 33% multifocal IOL
Trend to thinner LASIK flaps with Intralase

So Doctor – would you have refractive surgery?

15% of refractive surgeons in USA have undergone refractive surgery !

Current issues in refractive surgery

LASEK/Epi-LASIK vs LASIK
Tracking and centration
Wavefront ablations
Complications of corneal refractive surgery
Intra-ocular surgical options

Is LASEK the new LASIK? LASEK: Laser assisted sub-epithelial keratectomy
Topical anaesthetic
8mm diameter 55 micron incision of epithelium, uncut margin
2-3 drops of 18% ethanol for 40 secs, copious BSS
Epithelial flap detached, gathered, folded
Standard PRK treatment
Irrigated and flap rolled into original position
Antibiotic and soft contact lens

Advantages of LASEK	**Disadvantages of LASEK**
In comparison to LASIK Eliminates microkeratome cut Rx thin corneas Rx eyes with narrow IPF Rx recurrent erosions/ BM dystrophies Rx lifestyles inappropriate for LASIK May be better option for Wavefront treatment **In comparison to PRK** None See 2006/2007 references in main handout	**In Comparison to LASIK** 4-7 days visual recovery vs 24 hours More painful Lower upper limit for Rx Delay between eyes? **In comparison to PRK** Slower procedure Slower to heal Equally or more painful in minority Rx same range of myopia/hyperopia

Prospective study of LASEK vs PRK

Prospective study, 25 subjects, 50 eyes, LASEK one eye, PRK contralateral eye
Mean approx -3.00+/-2.00D both groups
LASEK eyes had more discomfort at Day one - 72% vs 24% & Day three - 80% vs 4%
Re-epithelialised: PRK 3.3 vs LASEK 3.6 days
UAVA similar, no lost BSCVA or haze

■ **Is LASEK / Epi-LASEK simply PRK by another name?**

Trends towards LASEK in Europe & UK
Globally driven by
Patient safety concerns – Keratectasia / Thin corneas
Wavefront ablations
Estimated currently activity in UK
50-70% LASIK, 20-30% LASEK, 10% PRK

Broad beams and large zones vs the advent of small spot lasers
A greater need for tracking
Small-spot algorithm complexity

Conclusions: tracking
Non-tracker mean decentration generally < 0.5mm
Wide beam lasers less sensitive to decentration
Small spot lasers appear to benefit from trackers
Three Laser systems in region of 10 msec response
Essential for treatment of higher order aberrations
Tracking of torsional elements needs fully addressed

Photorefractive surgery - summary

193 nm excimer laser
0.25 microns of tissue removed per pulse
Small beam lasers with tracking
PRK – surface based up to -5.00 to -7.00D
LASEK – epithelial flap up to -5.00 to -7.00D
LASIK – under 160 mm flap up to -10.00D
Hyperopia – PRK <+2.0, LASEK/IK <+4.0D

Higher corrections or thin corneas
Consider intraocular surgery

Wavefront: Basics
Ideal optical system focuses incoming rays with a plane wavefront ……
Hartmann-Shack analysis

Contributions to refractive error
108 Healthy eyes , 20 to 30yrs old, 5.0mm pupil

2nd Order 90.8% - Sphere/cylinder
3rd order – 6.4%
4th order – 2.6%
5th order – 0.2%

Typical aberrations – 10 subjects
Autonomous Wavefront: "Ladarvision" coma and spherical error predominate after 2nd order

Contemporary LASIK: Comparing wavefront and standard ablation
Prospective comparative study (N=500)
University of Auckland & Eye Institute Auckland
Planoscan or Zyoptix using B&L 217z laser
-1.00D to –12.00D
More zyoptix eyes achived 6/5 unaided, however, 82% in both groups 6/6 or better

Wavefront driven ablations: summary
Reduce treatment induced aberrations rather than create perfect wavefront
Only have significant reduction in aberrations in highly aberrated eyes
LASIK flap creation induces aberration
Surface based ablation may be better for wavefront
See extended lecture notes for further details

Surgical correction of hyperopia

- Hexagonal keratotomy
- Radial thermokeratoplasty
- Holmium YAG LTK
- Hyperopic intacs
- Excimer H-PARK
- H-LASIK
- H-LASEK
- Prelex ©

Current options in the surgical correction of hypemetropia

+1.50 - +2.00D
- Laser Thermo keratoplasty LTK
- Conductive keratoplasty CK

+1.50 – +2.50D
- Hyperopic PRK

+1.50 - + 4.00D
- Hyperopic LASIK

Also consider
- Clear lens extraction >50 years
- Posterior chamber phakic IOL

Laser thermo-keratoplasty (LTK)
Holmium YAG laser
Thermal shrinkage of collagen steepens cornea
Contact and non-contact delivery systems
Only corrects 1.5D - 2.0D of hyperopia
Some decay of refractive effect over 1-2 years – little used

Conductive keratoplasty @ 1 year: 2004 FDA approved for presbyopia (CK)
Prospective, 355 eyes, subjects > 40yrs range of +0.75 to +3.00D
- >20/20 56%
- >20/25 75%
- >20/40 92%

Spherical Equiv
- +/- 0.50D 63%
- +/- 1.00D 89%
- no loss 2 lines BSCVA

Acufocus for presbyopia
- Studies commencing in New Zealand and Australia

Intra-ocular options in 2007
Clear lensectomy/Prelex
Ant Chamber phakic IOL
- Baikoff angle supported
- Artisan iris clip

Starr Intra-ocular contact lens

Clear lens extraction
Advantages
theoretically any refractive error
good optical results
Disadvantages
Intraocular
Loss of accommodation
Cystoid Macular oedema
Retinal detachment
Endophthalmitis

The VERISYSE Phakic Intraocular Lens
is an iris-fixated anterior chamber IOL for the surgical correction of moderate to high myopia.

Endothelial cell loss reduced ?
Enclavation improved ?
European multicentre trial:
N = 70 eyes
Myyopia (-8.90D), hyperopia (+3.25D)
88.6% 20/40 or better all eyes +/-1.00D
4.5% loss of endothelial cell count @ 6 months
No loss of BSCVA

Artisan (Worst) iris claw lens - Correction of hypermetropia (N=57):

29 primary (mean +6.06D)
28 secondary (mean +5.88D)
Residual refractive error: 0.55+/-1.49D
Surgically induced cyl: 1.85+/-1.19D
Post-op iridocyclitis in 14%
Endothelial cell loss of 9.4% @ 1 year

Summary – phakic intraocular lenses and clear lens exchange

Clear lens phaco increasingly popular
Risk of detachment in high myopes
Angle supported AC IOLs
Pupillary ovalisation
Endothelial cell loss
IOL rotations
Iris fixated IOLs
PC-PIOLs (ICL)

Early studies of Collagen polymer posterior chamber implantable contact lens (Staar ICL)

38 eyes of 22 subjects, Pre-op –15.10D (-7.8 to –29D), 3mm sutureless incision
Mean 13.6 month followup
Mean SphEq –2.00+/-2.48D
In eyes <18.0D: 96%+/-1.0D and 88% +/- 0.50D
BSCVA I line or better in 72%
Complications
6.3% lost one line BSCVA
Pupillary block glaucoma in 3 eyes (7.9%)
One eye developed cataract at 1.5 years (2.6%)
Lensectomy and low power IOL in 2 eyes

Early reports (2003) PC-Phakic IOLs: main complications - opacity of crystalline lens

14.7% Stable opacities
18.7% Progressive opacifications
Median time to opacification 27.1 months
10.7% opacity required cataract extraction
Designs have been modified

Staar Phakic IOL FDA studies

STAAR® Surgical Company began studies with the implantable contact lens (ICL) in 1993. This was launched in European markets in 1997 but did not receive FDA approval until 2005 when the Visian ICL (implantable Collamer Lens) was approved. There have been several model changes, including a Toric IOL. Although it is claimed that more than 50,000 ICLs have been implanted, to date there are limited published data on latest designs but presentations at conferences suggest the risk of cataract formation has reduced significantly to acceptable levels and predictability is superior to LASIK for high myopia.

Summary: Whats new in IOL design?

Artisan iris clip lens
Starr ICL
Multifocal IOLs
    ReStor
    ReZoom
Acrysof toric IOLs
True accommodative IOLS
    The Crystalens

2005 JCRS Questionnaire review of surgeons - Presbyopia

    42% prefer monovision
    33% prefer multifocal IOL

Trend to thinner flaps with Intralase

    Intralase - LASIK flap creation
    Femtosecond laser
    Highly focused
    Low energy
    Creates LASIK flap
    May be used in corneal transplantation

Outcome satisfaction

Complaints and complications in perspective