



Femtosecond (FS) Laser Assisted Endothelial Keratoplasty

R.M.M.A. Nuijts, MD, PhD
 Y.Y.Y. Cheng, MD, E. Pels, PhD,
 and the DLCTS-Study Group



University Hospital Maastricht
 Cornea Bank Amsterdam, Netherlands
 The Netherlands

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History: Posterior Lamellar Keratoplasty

- Posterior Lamellar Keratoplasty (PLK)
 - 1955 Tilleit
 - 1998 Melles
- Deep Lamellar Endothelial Keratoplasty (DLEK)
 - 2003 Terry
- Descemetorhexis
 - 2004 Melles
- Descemet Stripping Automated Endothelial Keratoplasty (DSAEK)
 - 2005 Price, Gorovoy (Ophthalmology 2006; 113:1939-1942)
- Femtosecond laser assisted Descemet Stripping Endothelial Keratoplasty (FS-DSEK)
 - December 2005: First case of FS-DSEK.
 - Cheng et al. "Femtosecond laser assisted Descemet Stripping Endothelial Keratoplasty." J Cataract Refract Surg 2007;33(1):152-155.

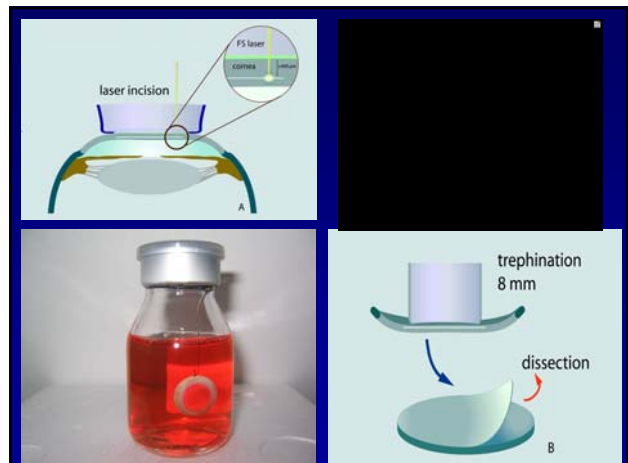
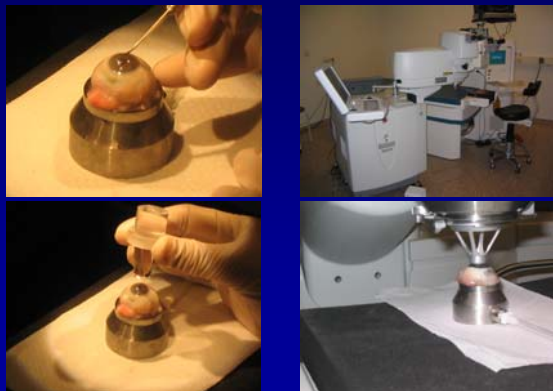
Purpose

- To evaluate the feasibility and safety of the Femtosecond laser for the preparation of posterior lamellar discs.
- To evaluate the preliminary results of the Femtosecond laser assisted Descemet Stripping Endothelial Keratoplasty (FS-DSEK) vs Penetrating Keratoplasty (PK).

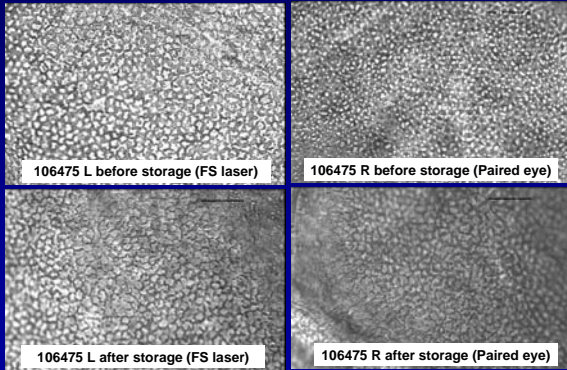
Methods

- Evaluation of endothelial cell viability after FS laser dissection:
 - Cornea Bank in Amsterdam (n=14)
 - before and after corneal storage
 - University Hospital Maastricht (n=9)
 - before or after dissection
- Evaluation of posterior lamella texture/surface
 - Scanning Electron Microscopy (SEM)
- Evaluation of the depth of the FS laser lamellar cut
 - Scanning Electron Microscopy (SEM)

30 kHz FS laser procedure



Endothelial Cell Viability before and after organ culture storage

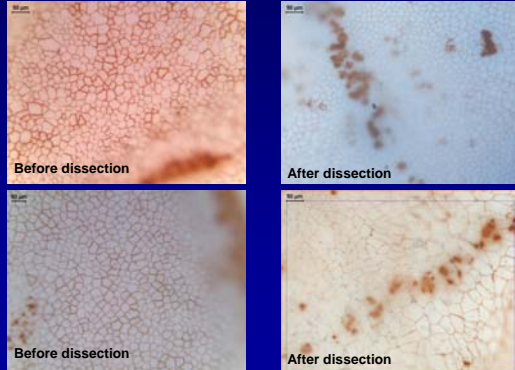


Endothelial Cell Viability before and after organ culture storage

	FS Cornea N = 14 mean [sd]	Paired cornea N = 14 mean [sd]	P - value
Time from death to excision (hrs)	67 [10]	21 [11]	<0.001
Storage time (hrs)	175 [128]	204 [75]	0.552
ECD before storage (cell/mm ²) *	2551 [231]	2438 [279]	0.140
ECD after storage (cell/mm ²) *	2671 [223]	2585 [296]	0.010
Endothelial cell loss (%)	4.9 [6.8]	3.2 [7.0]	0.415

ECD = endothelial cell density
* Cornea Bank Amsterdam

Endothelial Cell Viability before or after dissection of posterior lamellar disc

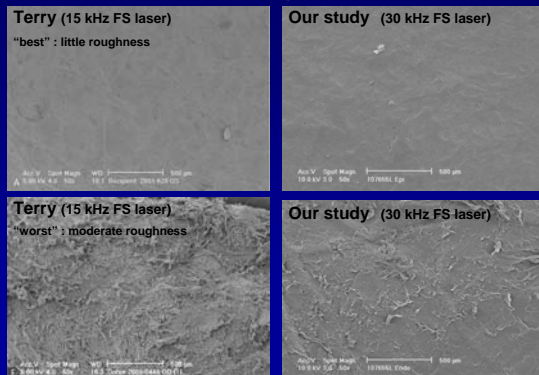


Endothelial Cell Viability before or after dissection of posterior lamellar disc

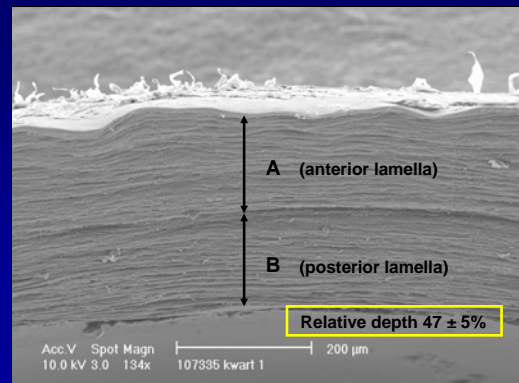
	Before dissection N = 4 Mean [±sd]	After dissection N = 5 Mean [±sd]	P - value
Storage time (hrs)	93 [4.6]	154 [153]	0.453
ECD (cells/mm ²) *	2136 [577]	2153 [608]	1.0
Damage (%)	3.4 [3.5]	6.5 [3.2]	0.142

ECD = endothelial cell density
* University Hospital Maastricht

Grading Surface Smoothness in comparison to Terry et al. Cornea 2005:24



Depth of the FS Lamellar Cut



Conclusions

- FS laser preparation of a posterior lamellar disc is technically feasible.
- No significant endothelial cell loss after FS laser posterior lamellar disc preparation and subsequent organ culture.
- Surface smoothness of 30 kHz FS laser dissection appears better than 15 kHz FS laser dissection.
- The achieved depth of the FS lamellar cut correlated well with the predicted depth.

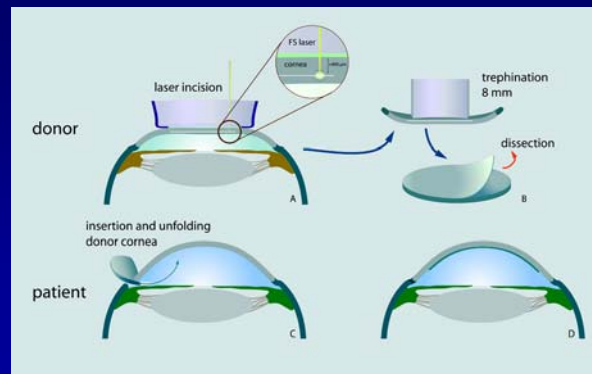
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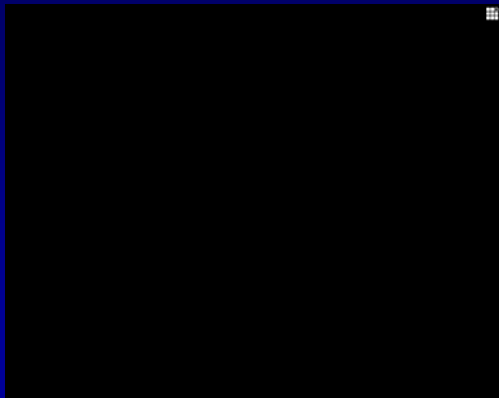
Purpose

- Prospective multicenter randomized study (Dutch Lamellar Corneal Transplantation Study).
- Evaluation of preliminary results of FS-DSEK vs PK.

FS-DSEK



FS-DSEK



Results FS-DSEK

Case	Age (yrs)	Follow up (wks)	Pre-op BSCVA (Snellen)	Post-op Refraction	Post-op BSCVA (Snellen)	Post-op astigmatism (D)
Case #1 D.	83	20	0.10	+1.0 -2.25 x105	0.40*	2.1
Case #2 E.	65	19	0.20	+2.75 -2.5 x 85	0.40	2.0
Case #3 L.	51	19	0.10	-3.5 -2.25 x170	0.20*	1.0
Case #4 W.	75	27	0.20	+1.75 -1.0 x 95	0.15*	2.0
Case #5 R.	75	35	1/60	+5.0 -3.0 x 110	0.20*	1.2
Case #6 B.	72	14	0.30	+3.25 -1.75 x 95	0.40	0.8
Case #7 C.	72	33	1/60	0.0 -0.75 x 95	0.16*	3.1
Case #8 E.	79	14	0.30	+4.0 -2.5 x 75	0.50	1.2
Case #9 L.	72	14	0.05	+2.25 -1.0 x 0	0.125*	1.7
Case #10 T.	72	26	0.10	+4.0 -4.0 x 100	0.20	3.4

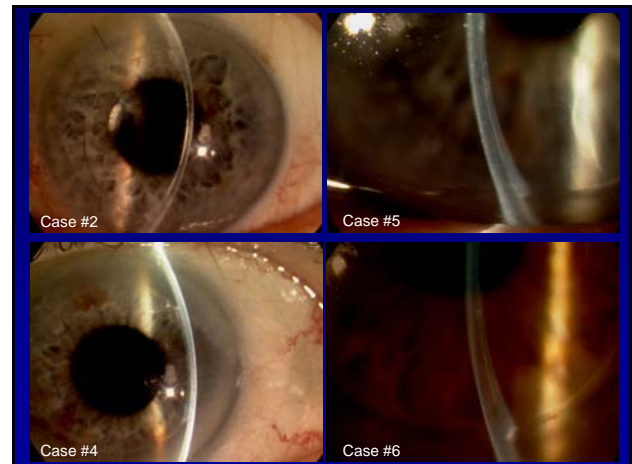
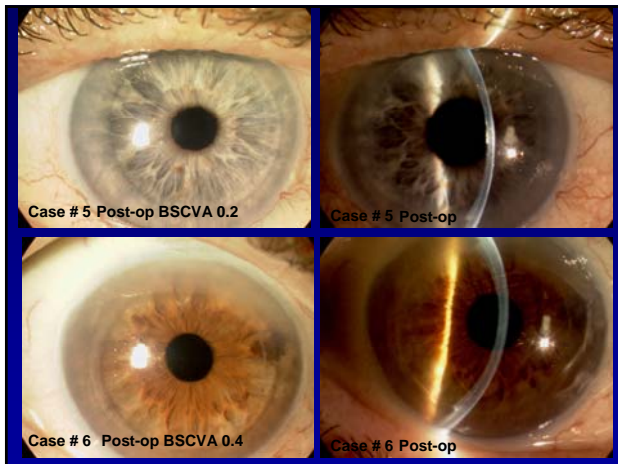
* Retinal/Macular disease

FS-DSEK vs PK Patients

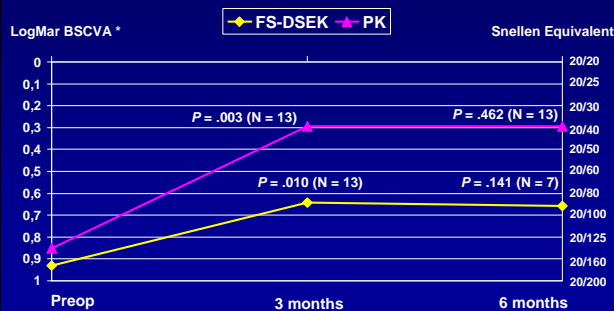
	FS-DSEK N = 13 eyes	PK N = 13 eyes
Age (yrs) [mean ± sd]	70.4 ± 9.0	76.0 ± 4.1
Follow-up (wks) [mean ± sd]	20.9 ± 7.9	25.9 ± 7.0
Fuchs Endothelial Keratopathy	3	5
Pseudophakic Bullous Keratopathy	10	8
Retinal/Macular disease	6	2

FS-DSEK vs PK Preoperative

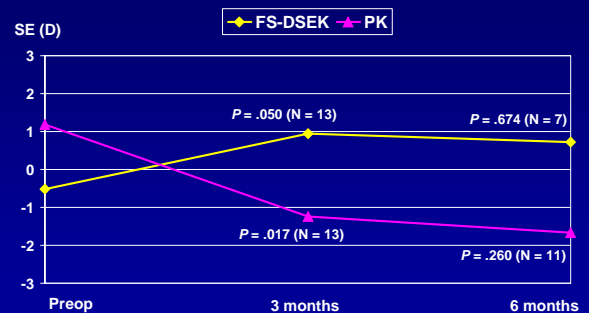
	FS-DSEK (N = 13) Mean ± SD	PK (N = 13) Mean ± SD	P - value
LogMAR BSCVA (Snellen)	0.93 ± 0.5 (0.17 ± 0.1)	0.85 ± 0.6 (0.22 ± 0.1)	0.375
Spherical Equivalent (D)	-0.52 ± 2.5	1.19 ± 1.5	0.050
Refractive Astigmatism (D)	-0.62 ± 0.7	-0.88 ± 0.8	0.370
Topographic Cylinder (D)	1.23 ± 0.4	1.73 ± 1.7	0.628



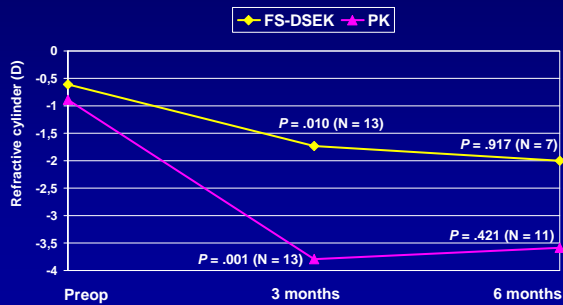
FS-DSEK vs PK LogMar BSCVA



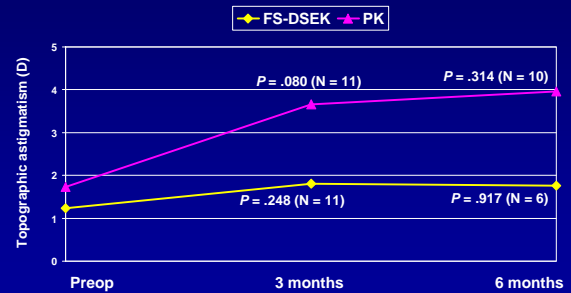
FS-DSEK vs PK Spherical Equivalent (SE)



FS-DSEK vs PK Refractive Cylinder (D)



FS-DSEK vs PK Topographic Astigmatism (D)



FS-DSEK vs PK 3 months postoperative

	FS-DSEK (N = 13) Mean ± SD	PK (N = 13) Mean ± SD	P - value
LogMAR BSCVA (Snellen)	0.64 ± 0.2 (0.25 ± 0.1)	0.30 ± 0.2 (0.55 ± 0.2)	0.001
Spherical Equivalent (D)	0.94 ± 2.0	-1.24 ± 2.5	0.044
Refractive Astigmatism (D)	-2.19 ± 1.7	-3.79 ± 3.5	0.029
Topographic Cylinder (D)	1.81 ± 0.9	3.67 ± 2.2	0.047

FS-DSEK vs PK 6 months postoperative

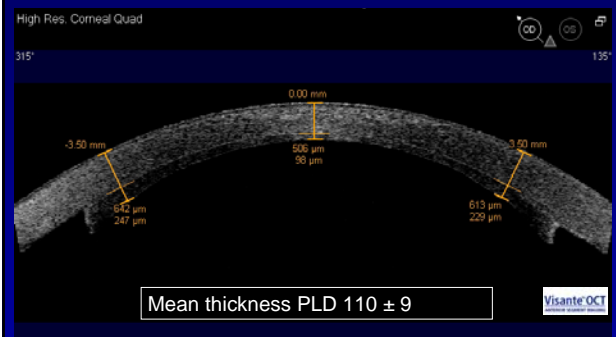
	FS-DSEK (N = 7) Mean ± SD	PK (N = 11) Mean ± SD	P - value
LogMAR BSCVA (Snellen)	0.66 ± 0.2 (0.24 ± 0.1)	0.29 ± 0.2 (0.56 ± 0.3)	0.004
Spherical Equivalent (D)	0.71 ± 2.6	-1.66 ± 2.8	0.085
Refractive Astigmatism (D)	-2.0 ± 1.3	-3.59 ± 1.6	0.044
Topographic Cylinder (D)	1.77 ± 0.9	3.96 ± 2.2	0.022

Complications FS-DSEK

case	Post-op (days)	Complications	Treatment
Case #1 D. (surgeon 1)	1	•fluid between recipient and donor	2 events: 1.air bubble in AC 2.corneal incision/draining fluid/ air bubble in AC
Case #3 L. (surgeon 1)	1	dislocation of the PLD	•reposition of the PLD/ air bubble in AC
Case #8 E. (surgeon 2)	1	•fluid between recipient and donor •IOP ↑	•IOP: medication •3 weeks post-op corneal incision/ draining fluid
Case #9 L. (surgeon3)	1	•fluid between recipient and donor •IOP ↑	•1 days post-op: removal of the air bubble •3 weeks post-op corneal incision/ draining fluid

PLD = Posterior Lamellar disc
AC = Anterior Chamber

Corneal Thickness



Corneal Thickness

Case	Post-op Central corneal thickness (µm) mean ± sd	Post-op Central Posterior lamellae (µm) mean ± sd	Post-op Peripheral Posterior Lamellae (µm) mean ± sd
Case #2 E.	541 ± 12	74 ± 10	198 ± 34
Case #3 L.	738 ± 11	178 ± 7	349 ± 38
Case #4 W.	604 ± 7	109 ± 12	234 ± 49
Case #5 R.	553 ± 8	109 ± 11	256 ± 61
Case #6 B.	597 ± 3	108 ± 11	262 ± 57
Case #7 C.	575 ± 12	82 ± 4	248 ± 33
Mean	601 ± 9	110 ± 9	258 ± 45

Conclusions (1)

- The results of the in vitro study show: FS-DSEK is technically feasible
- At 3 & 6 months postoperatively the FS-DSEK group demonstrated:
 - A lower refractive astigmatism ($P = 0.029$ & $P = 0.044$)
 - A lower topographic cylinder ($P = 0.047$ & $P = 0.022$)
- At 3 & 6 months postoperatively the FS-DSEK group demonstrated:
 - A lower Snellen BSCVA ($P = 0.001$ & $P = 0.004$)

Conclusions (2)

- BCVA of FS-DSEK is limited by:
 1. Macular retinal disease (6/13 pts)
 2. Interface wound healing problems:
 - Folds?
 - Haze?
- 3. Learning curve of different surgeons may bias the results



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rnu@soog.azm.nl
ych@soog.azm.nl

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- ZonMw, Raad van Bestuur AzM, RVB, LSBS



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