



OCT en Neuro Ophtalmologie

Applications

Intérêt du SPECTRAL Domain



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Absence de conflit d'intérêt dans cette présentation

Introduction

- Développé en 1991, OCT utilisé en neuro ophtalmologie dans les affections du NO et en particulier dans la SEP
- Principale nouveauté Spectral Domain ou Fourier Domain
- Etat des publications (Time Domain) et exemples (Spectral Domain)

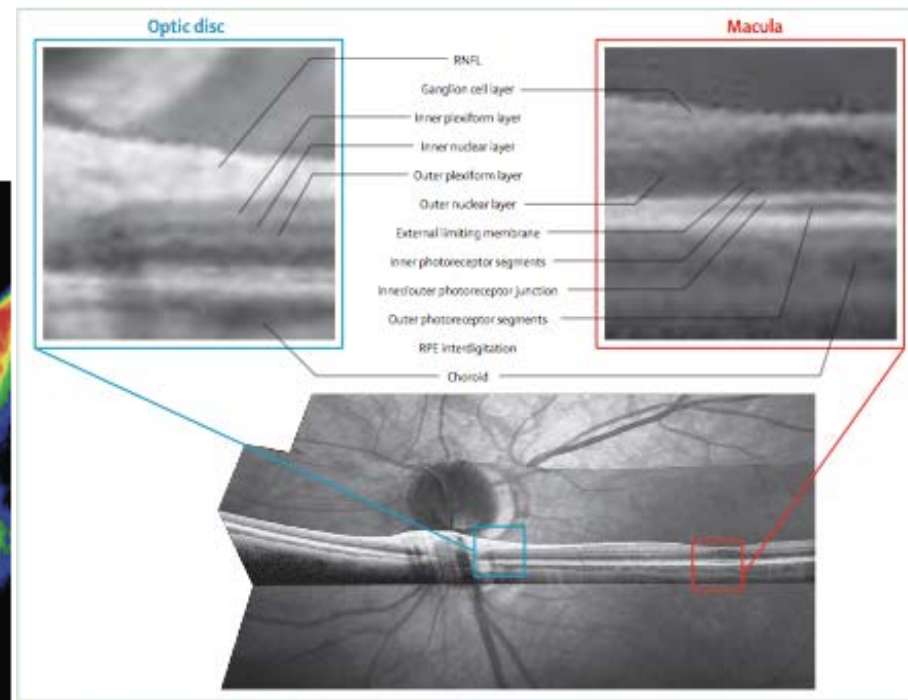
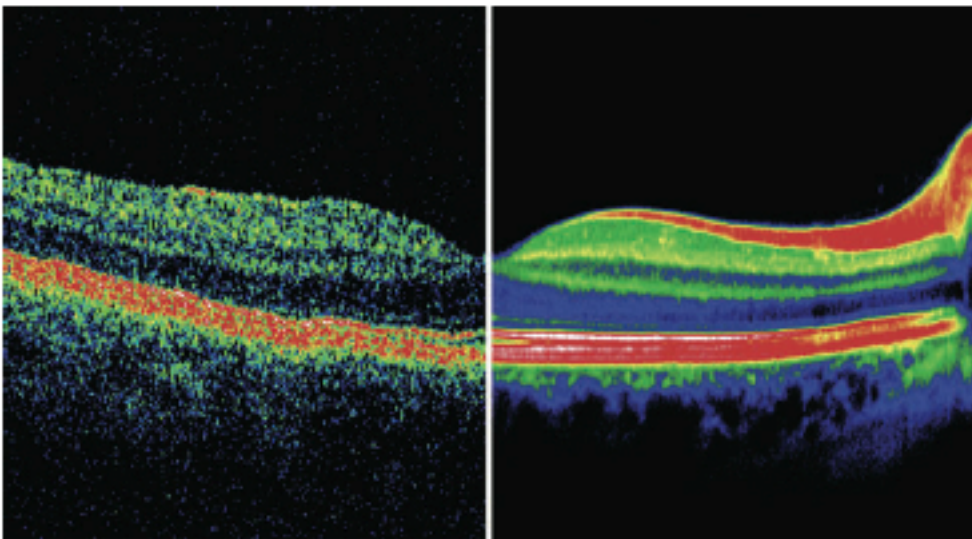
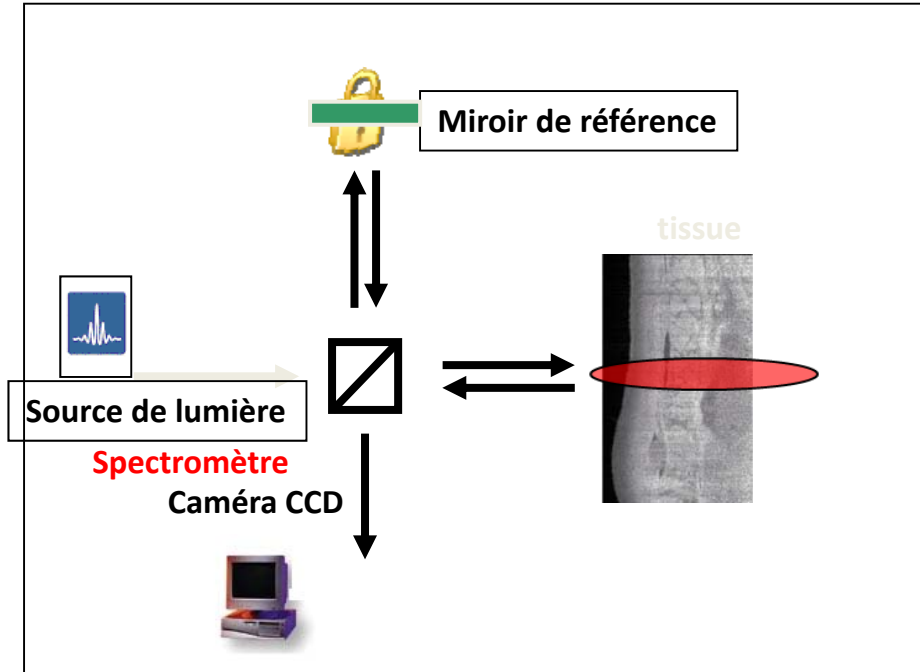
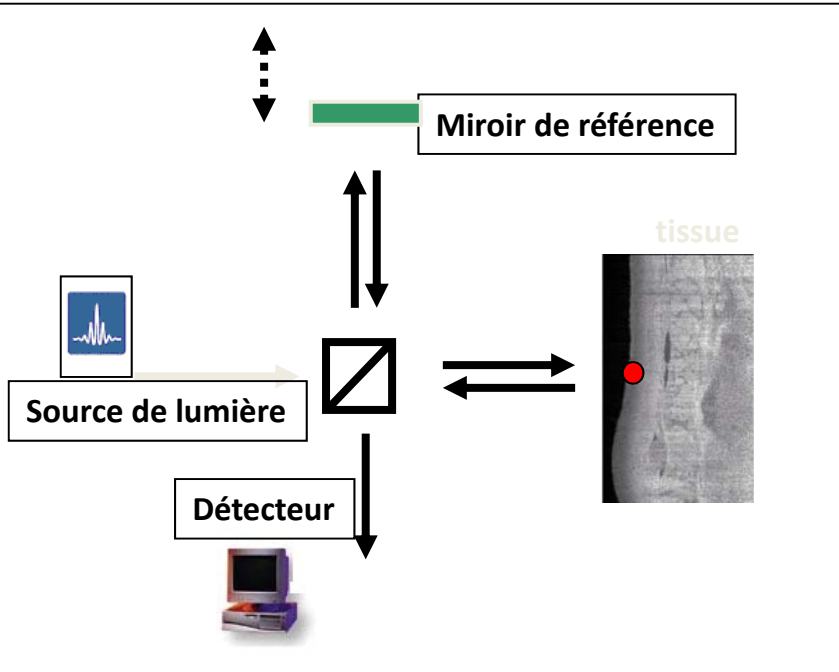


Figure 1: Spectral or Fourier domain OCT image of a normal eye showing retinal layers

La Différence

« TIME DOMAIN »

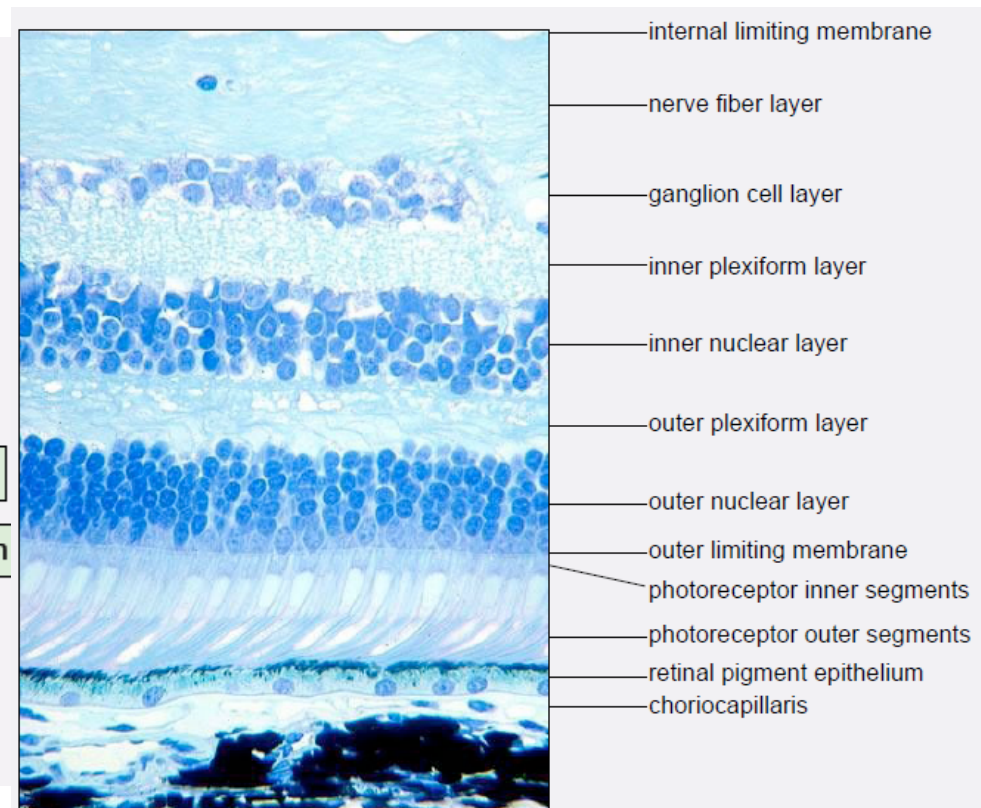
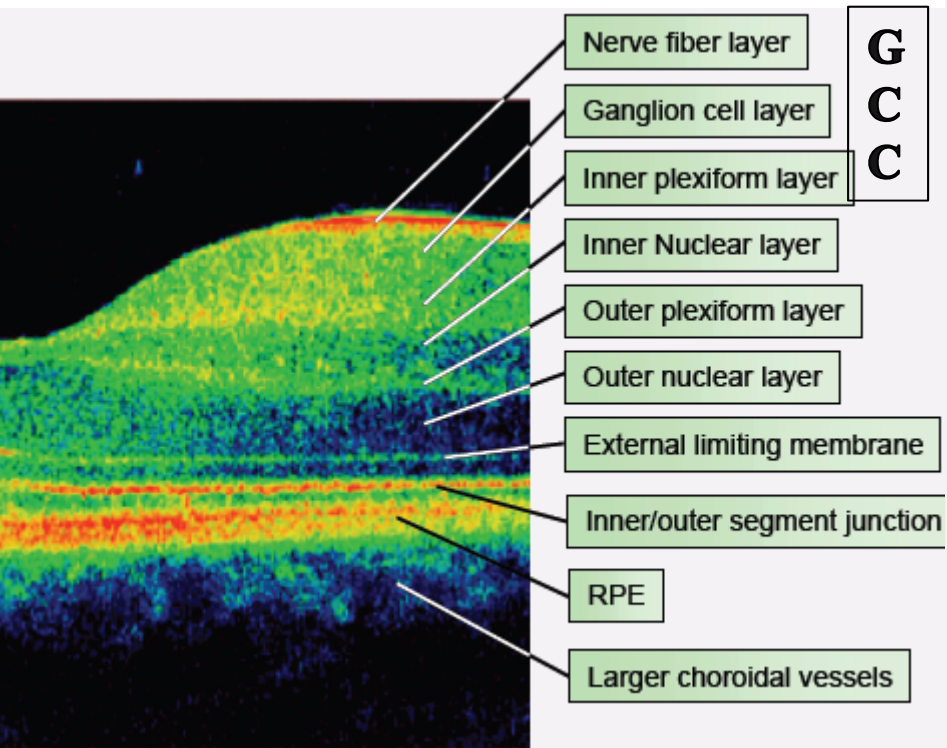
FOURIER DOMAIN



RNFL : 512 points sur une circonférence de 3,4mm autour du NO en 1.3 s

Fast RNFL : 3 passages de 256 points chacun sur un même diamètre en moins de 2 secondes et moyenne des 3

- 1) **Un miroir de référence fixe**
- 2) **Un spectromètre**



Les différents OCT Spectral Domain

Instrument	Manufacturer	Axial resolution (μm)	Transverse resolution (μm)	Scan speed	Additional features
RTVue OCT	OptoVue	5	15	26 000 A-scan/s	Segmentation of multiple retinal layers, anterior segment OCT module
Cirrus HD-OCT	Carl Zeiss Meditec	5	25	27 000 A-scan/s	Segmentation of the ILM and RPE
Spectralis OCT	Heidelberg Engineering	3.5	14	40 000 A-scan/s	Eye tracking, automatic rescan, infrared imaging
Spectralis OCT + HRA	Heidelberg Engineering	3.5	14	40 000 A-scan/s	Same as above + red-free imaging, autofluorescence, fluorescein, and ICG angiography
SOCT Compernicus HR	Optopol Technology SA	3	12–18	55 000 A-scan/s	Detect RAPD, Doppler analysis of retinal blood flow
Spectral OCT SLO	OPKO Instruments/OTI OPKO Health	5–6	15	27 000 A-scan/s	Registration with SLO, Microperimetry
3D OCT-1000	Topocon Medical Imaging Systems	6	20	18 000 A-scan/s	Combined OCT with fundus camera
Bioptigen SDOCT	Bioptigen	4.5	10	20 000 A-scan/s	Handheld

OCT et Neuro Ophtalmologie (1)

La SEP

Optical coherence tomography in multiple sclerosis: a systematic review and meta-analysis

Axel Petzold, Johannes F de Boer, Sven Schippling, Patrik Vermersch, Randy Kardon, Ari Green, Peter A Calabresi, Chris Polman

Lancet Neurol 2010; 9: 921-32

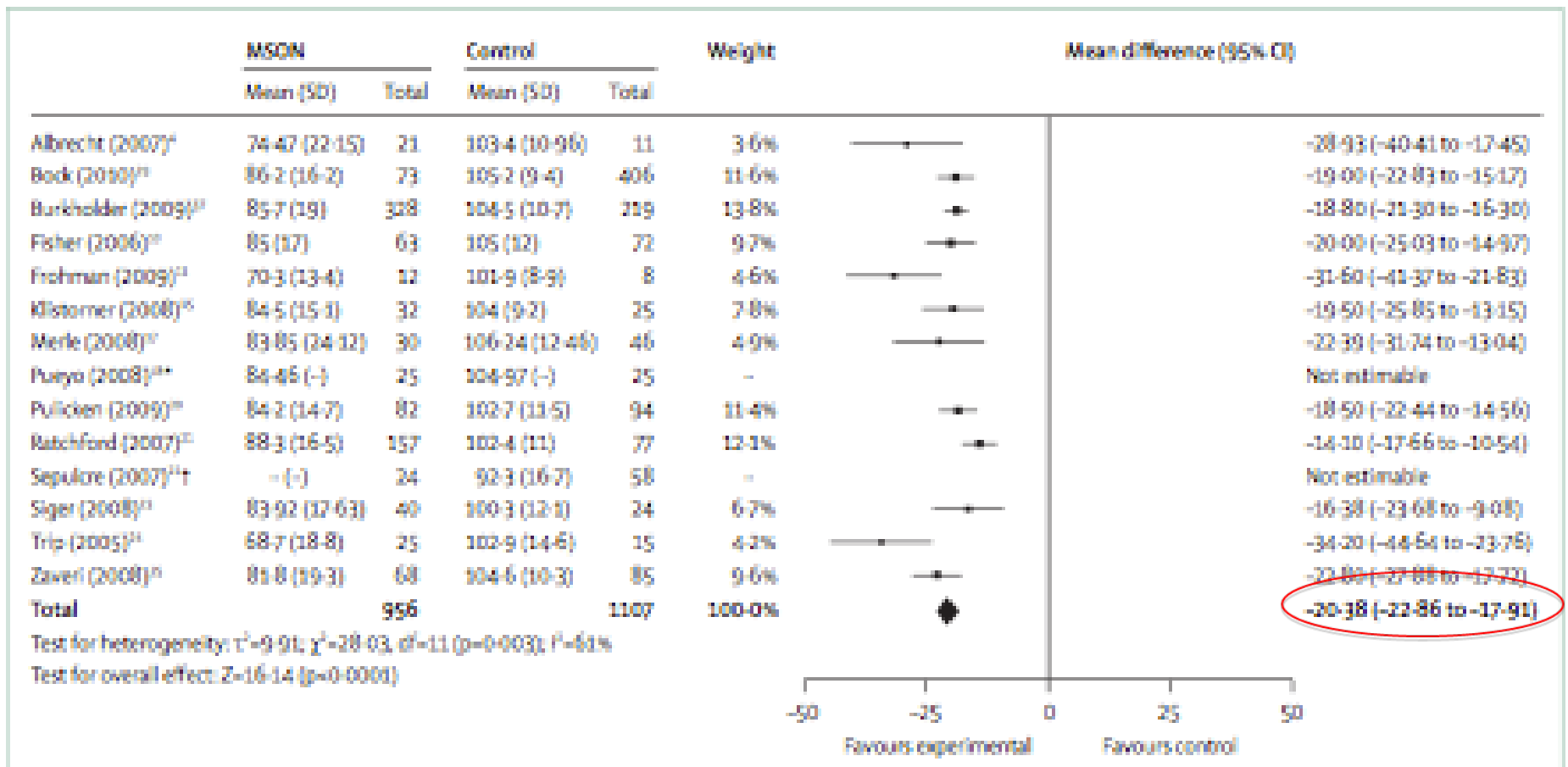
DOI: 10.1016/S1473-3099(10)70001-1

- Dans la SEP, perte axonale et démyélinisation. Handicap lié à la perte axonale.
- Intérêt en cas de névrite optique et surtout si pas de névrite optique car les axones sont non myélinisés
- 96 articles entre 1991 et mai 2010 dont 32 sont des séries

OCT et Neuro Ophtalmologie (1)

La SEP

- OCT post névrite optique chez patients SEP



Névrite optique et SEP

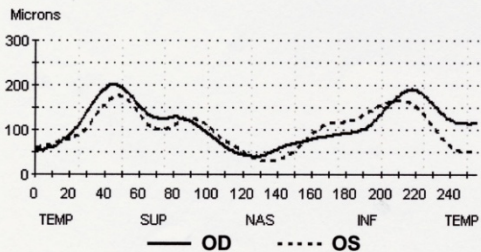
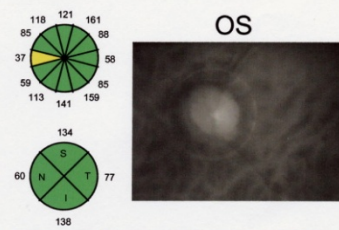
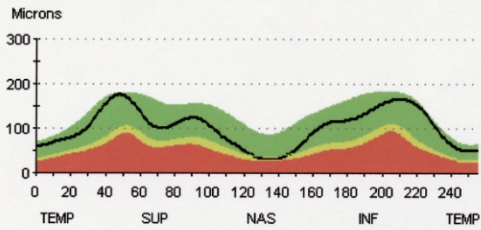
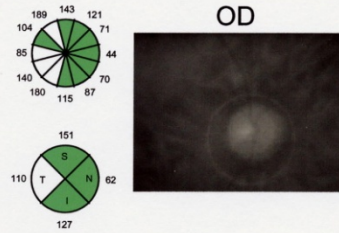
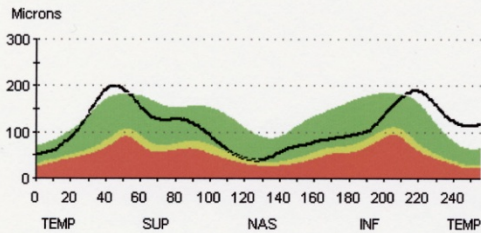
STRATUS OCT RNFL Thickness Average Analysis Report - Ver. 3.0

DOB: NA, Female

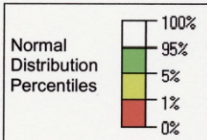
ScanType: Fast RNFL Thickness (3.4)

ScanDate: 03/26/2004

ScanLength: 10.87



	OD (N=3)	OS (N=3)	OD-OS
lmax/smax	0.95	0.94	0.01
smax/lmax	1.05	1.07	-0.02
smax/tavg	1.82	2.31	-0.49
lmax/tavg	1.73	2.16	-0.43
smax/navg	3.24	2.95	0.29
Max-Min	160.00	148.00	12.00
Smax	200.00	177.00	23.00
lmax	190.00	166.00	24.00
Savg	151.00	134.00	17.00
lavg	127.00	138.00	-11.00
Avg.Thick	112.45	102.05	10.40



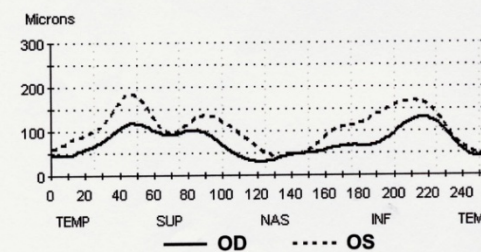
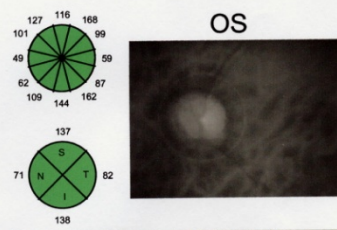
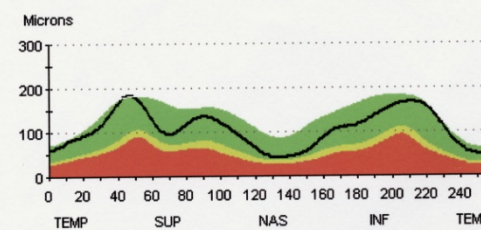
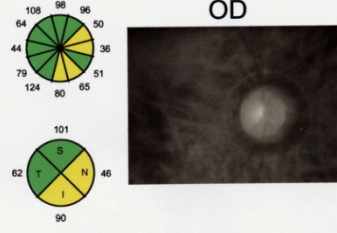
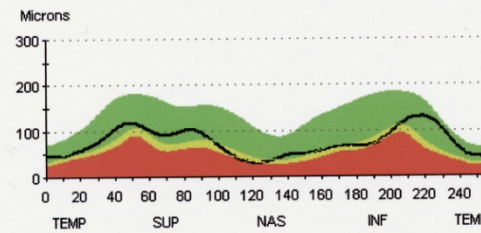
STRATUS OCT RNFL Thickness Average Analysis Report - Ver. 3.0

DOB: 04/12/1961, ID: NA, Female

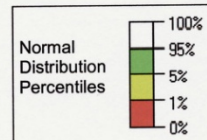
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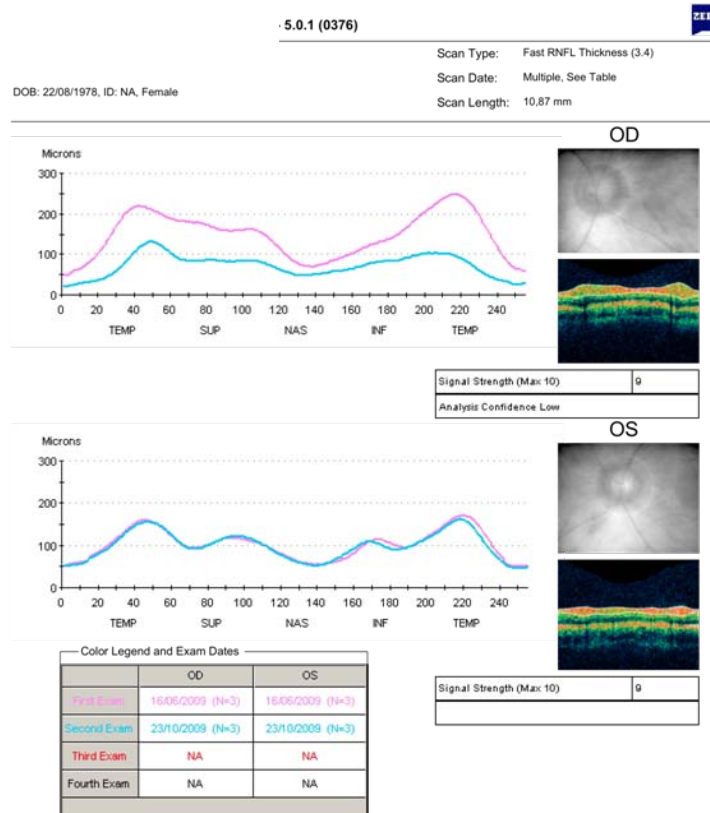
ScanLength: 10.87



	OD (N=3)	OS (N=3)	OD-OS
lmax/smax	1.11	0.92	0.20
smax/lmax	0.90	1.09	-0.19
smax/tavg	1.88	2.25	-0.36
lmax/tavg	2.10	2.06	0.04
smax/navg	2.56	2.60	-0.04
Max-Min	100.00	141.00	-41.00
Smax	117.00	184.00	-67.00
lmax	130.00	168.00	-38.00
Savg	101.00	137.00	-36.00
lavg	90.00	138.00	-48.00
Avg.Thick	74.64	106.97	-32.32



Névrite optique et SEP

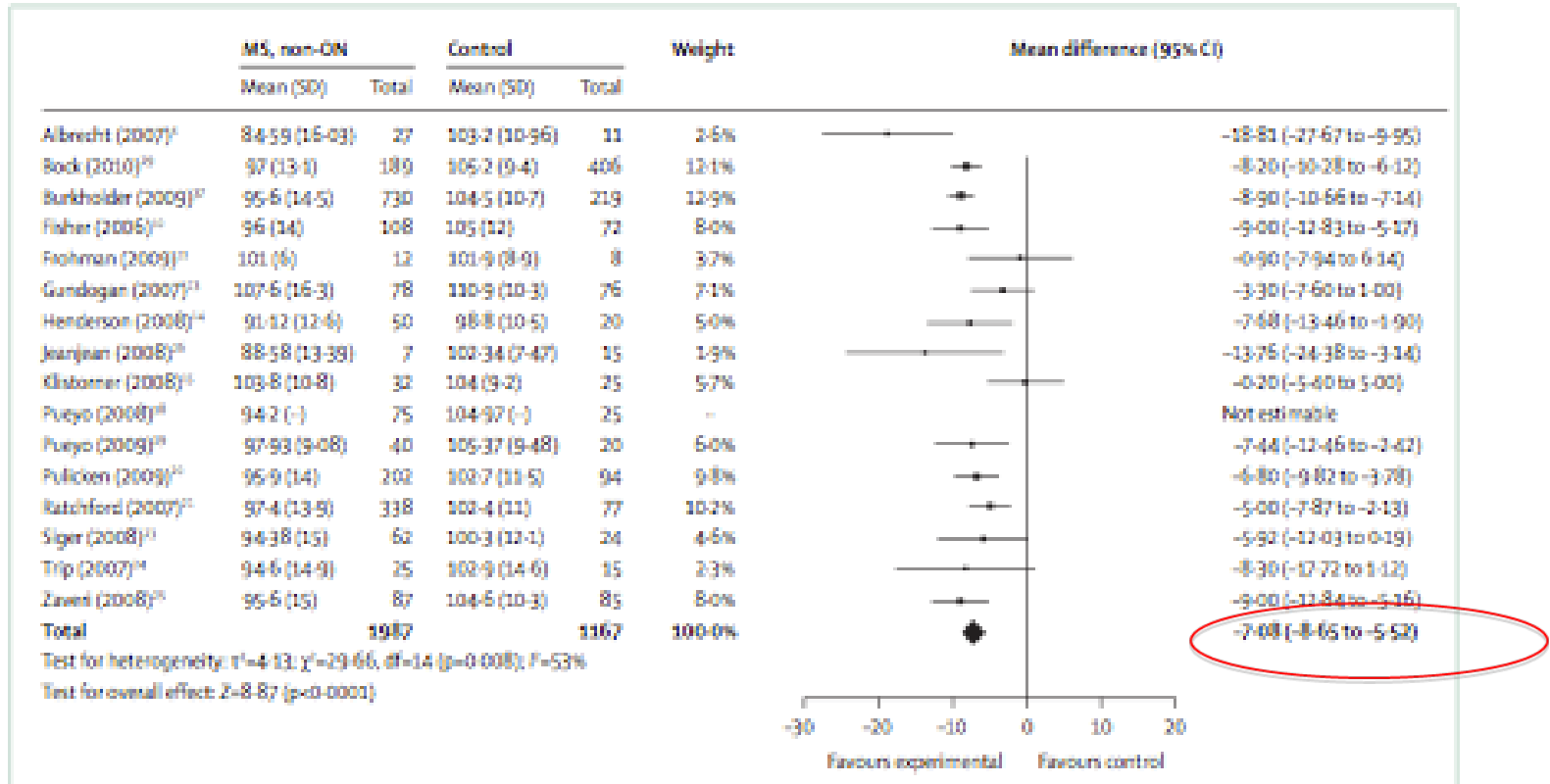


En dessous de 75 microns chances de récupérer une bonne fonction visuelle sont faibles

OCT et Neuro Ophtalmologie (1)

La SEP

- OCT chez patients SEP sans névrite optique

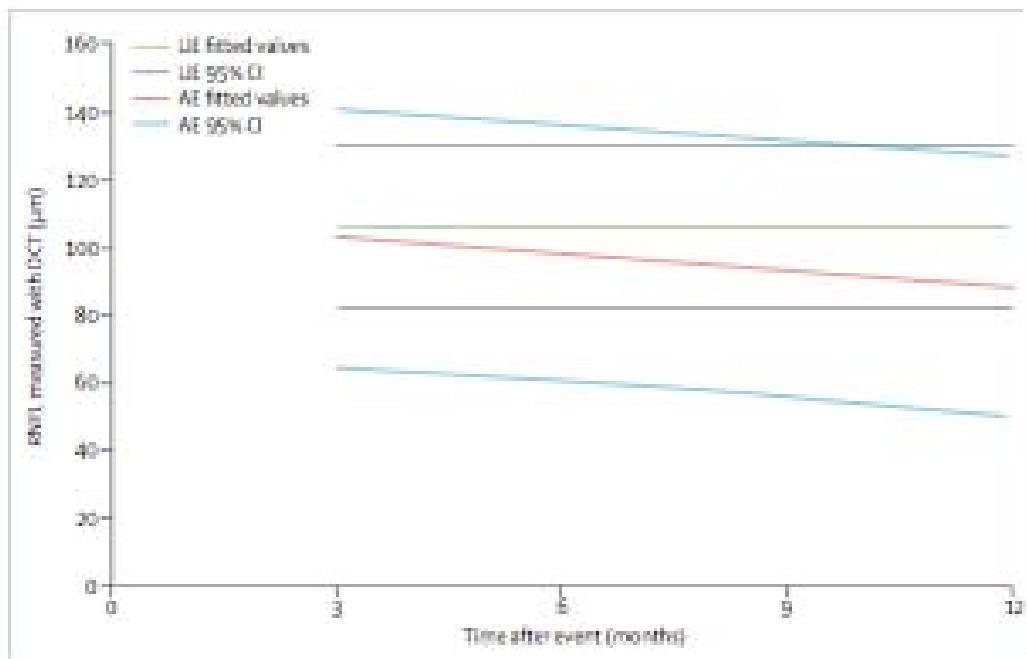


OCT et Neuro Ophtalmologie (1)

La SEP

- Post névrite optique, amincissement sensible à 3 mois
- En cas de SEP, perte d'environ 2 microns par année, ne semble pas influencée par les traitements

Costello F, Hodge W, Pan YL et al. Tracking retinal nerve fiber layer loss after optic neuritis : a prospective study using OCT Mult Scler 2008;14:893-905

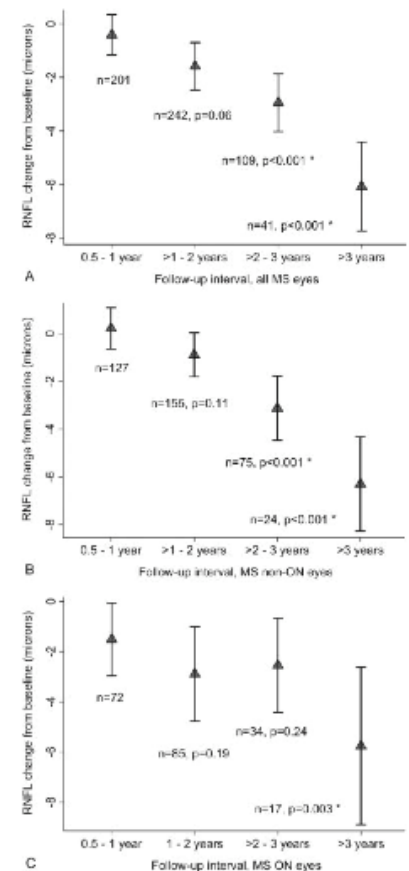


Longitudinal Study of Vision and Retinal Nerve Fiber Layer Thickness in Multiple Sclerosis

Lauren S. Talman, BA,¹ Esther R. Risker, MD,¹ David J. Sackel, BS,¹ David A. Long, Jr., BS,¹ Kristin M. Galetta, MS,¹ John N. Ratcliff, MD,² Deacon J. Lee, BA,¹ Sheena K. Farrell, BS,² Michael J. Loguidice, BA,¹ Gina Remington, BSN, RN,¹

ANN NEUROL 2010;67:749-760

Maureen G. Maguire, PhD,^{1,2} Steven L. Galetta, MD,^{1,2} Elliot M. Frohman, MD, PhD,¹ Peter A. Calabresi, MD,² and Laura J. Balcer, MD, MSc^{1,2}



OCT et Neuro Ophtalmologie (1)

La SEP

- Pas de valeur prédictive de l'OCT sur le déclenchement d'une SEP après névrite optique à 2 ans (Costello F, Hodge W, Pan YI, et al. Retinal nerve fiber layer and future risk of multiple sclerosis. CanJNeurolSci 2008;35:482 – 487)
- Dans les yeux sans ATCD de névrite optique la perte axonale est plus marquée en cas de SEP progressive que dans les SEP RR et les CIS (Costello F, Hodge W, Pan YI, et al. Differences in retinal nerve fiber layer atrophy between multiple sclerosis subtypes. J Neurol Sci 2009; 281:74 – 79 / Henderson AP, Trip SA, Schlottmann PG, et al. An investigation of the retinal □□nerve fibre layer in progressive multiple sclerosis using optical coherencetomography. Brain 2008; 131 (Pt 1):277–287)

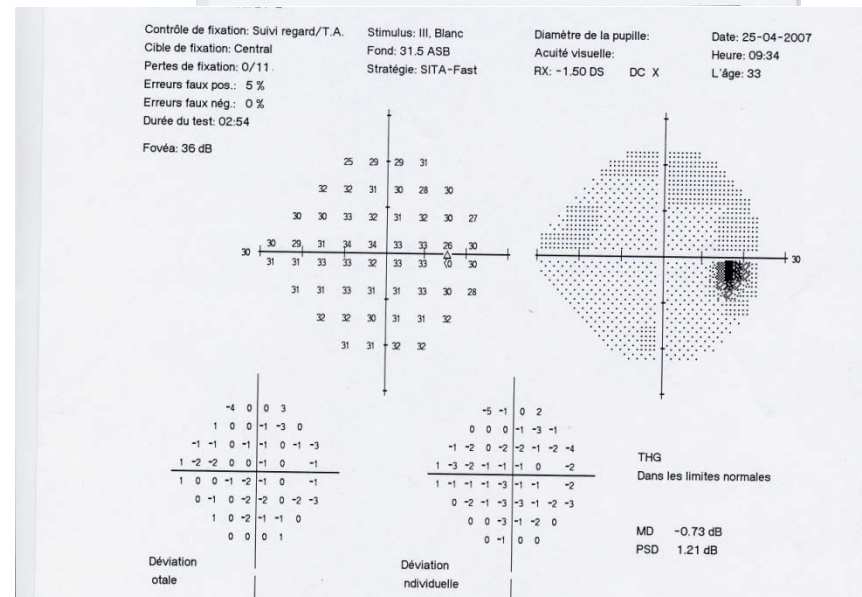
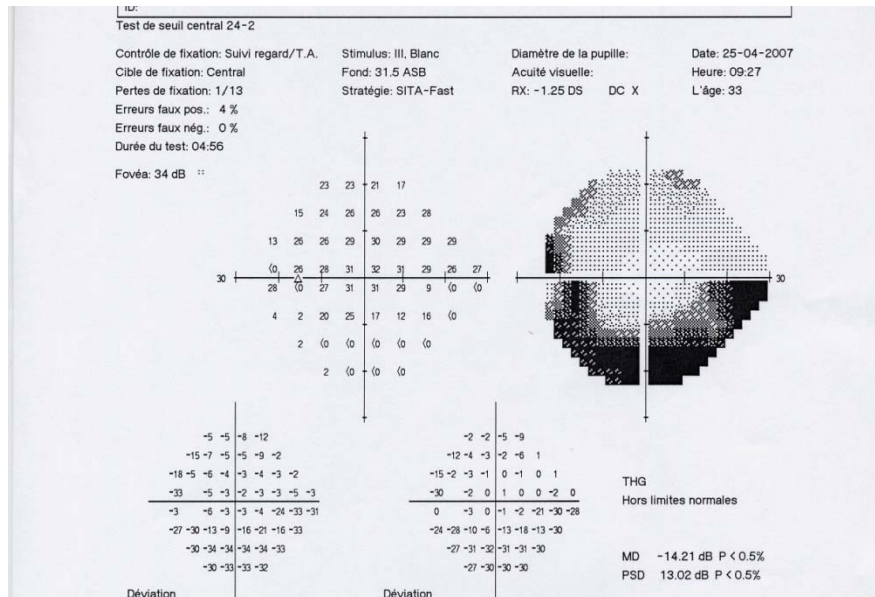
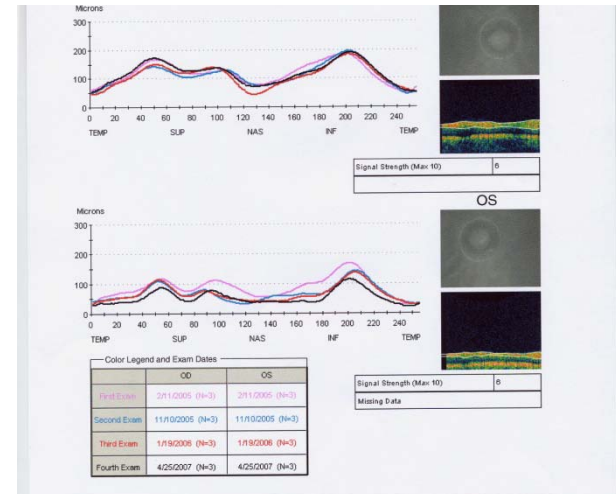
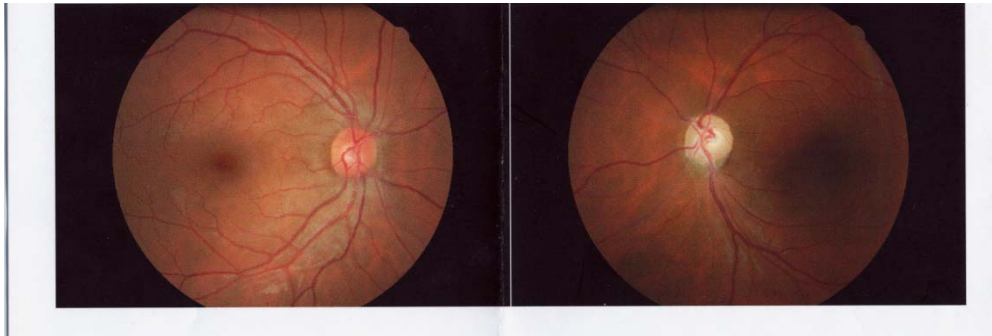
OCT et Neuro Ophtalmologie (1)

La SEP : OCT et handicap

- Sur le plan visuel assez bonne corrélation RNFL et AV mais surtout AV bas contraste et sensibilité aux contrastes
- Champ visuel : bonne corrélation entre RNFL et MD surtout si ATCD de névrite optique
- Corrélation avec le score EDSS surtout pour les yeux qui n'ont pas fait de névrite optique
- Toutes ces études sont faites avec OCT time Domain

Névrite optique chronique

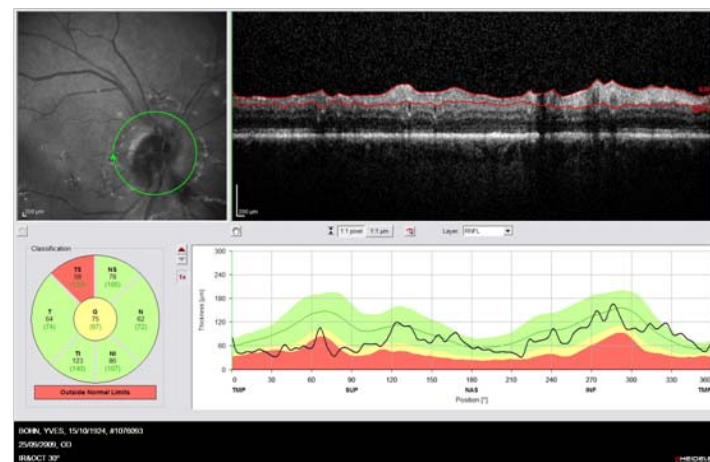
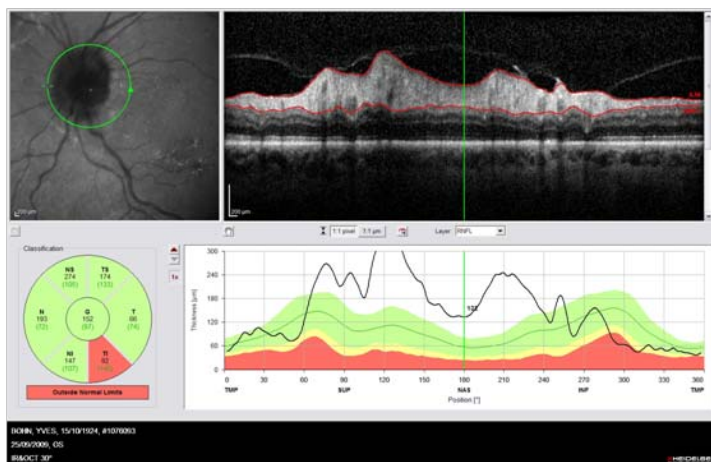
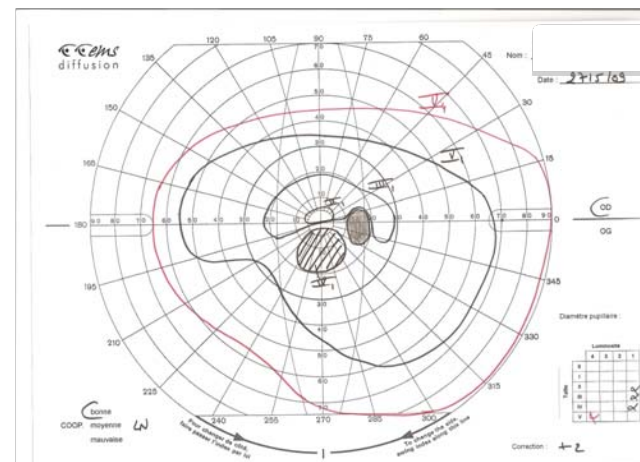
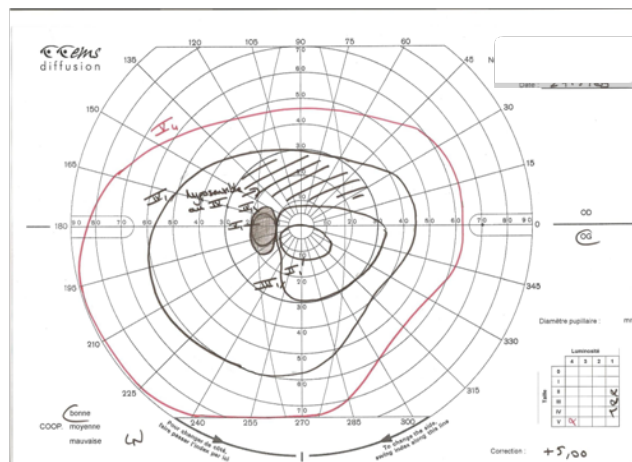
Permet un suivi des NO



OCT et Neuro Ophtalmologie (2)

La NOIA

- Permet un monitoring de l'OP dans les NOIA.
- Un article a comparé les morphologies de papilles avec NOIA NA (22 patients) et groupe témoin : papilles pleines mais pas plus petites (Chan CK, Cheng AC, Leung CK, et al. Quantitative assessment of optic nerve head morphology and retinal nerve fibre layer in nonarteritic anterior ischaemic optic neuropathy with optical coherence tomography and confocal scanning laser ophthalmoscopy. Br J Ophthalmol 2009; 93:731–735.)



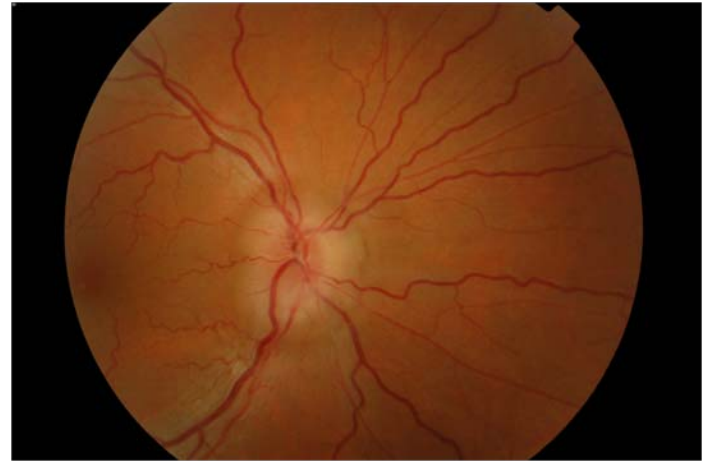
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24/05/2009, 05
RMOCT 30"

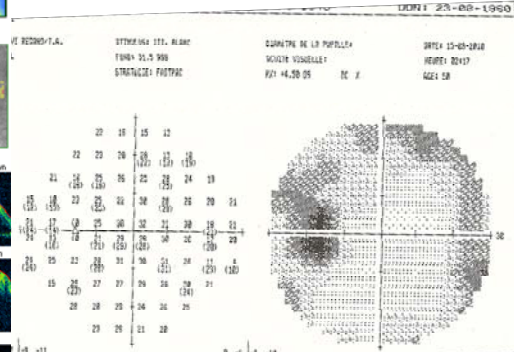
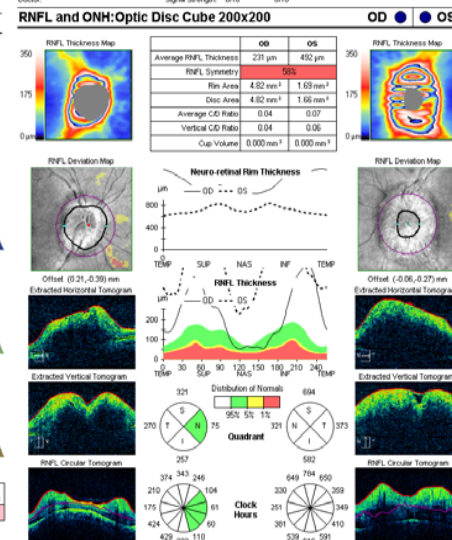
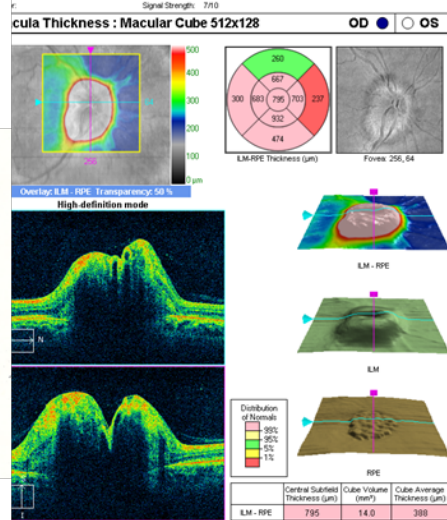
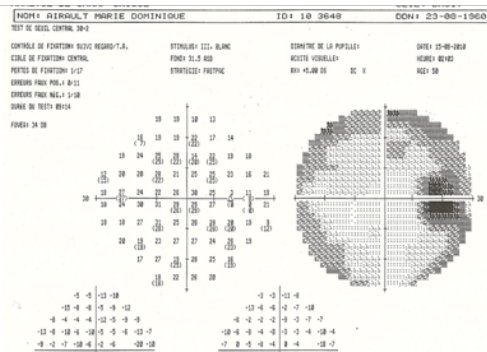
BOB, YVES, 15/10/2024, #1010003
24/05/2009, 03
RMOCT 30"

OCT et neuro ophtalmologie (3)

L'OP de stase

- Permet de suivre l'évolution de l'OP
- Mais ne distingue pas une résolution simple d'une atrophie optique +++++
- Utile surtout dans les OP d'importance moyenne





High Definition Images: HD 5 Line Raster

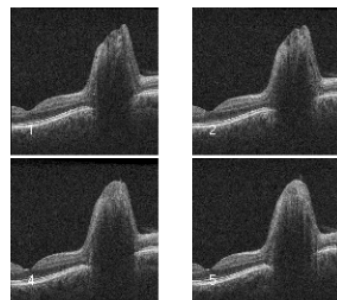
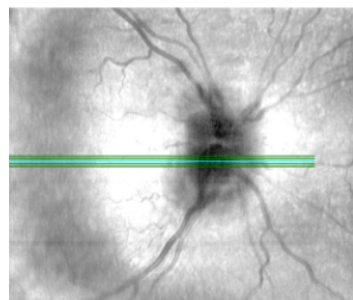
High Definition Images: HD 5 Line Raster

High Definition Images: HD 5 Line Raster

Scan Angle: 0°

Spacing: 0.075 mm

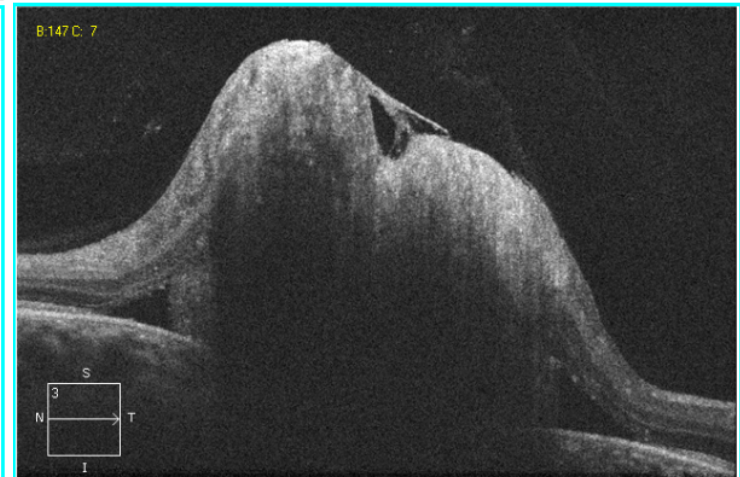
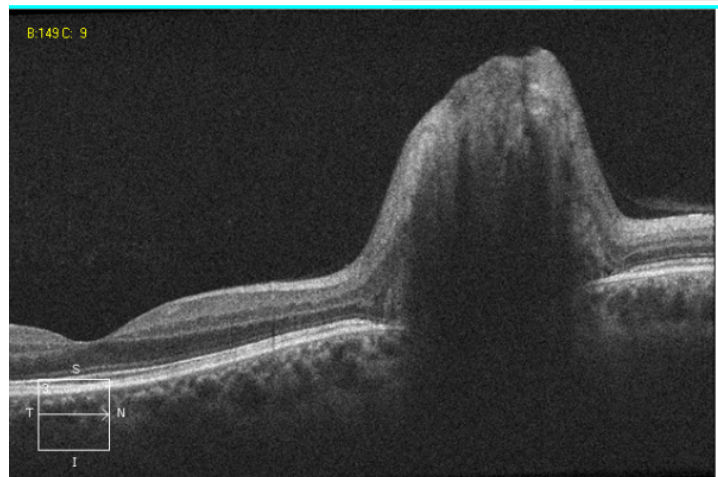
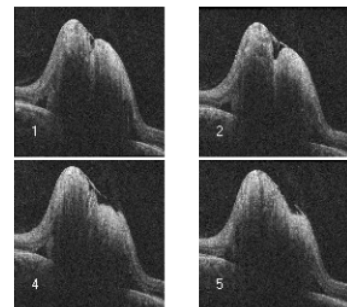
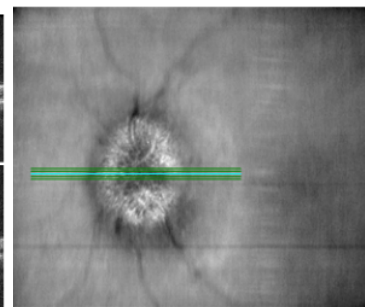
Length: 9 mm



Scan Angle: 0°

Spacing: 0.075 mm

Length: 6 mm



OCT et neuro ophtalmologie (3)

L'OP de stase

Follow-up of Mild Papilledema in Idiopathic Intracranial Hypertension with Optical Coherence Tomography

Gema Rebolledo and Francisco I. Muñoz-Neurete
(*Invest Ophthalmol Vis Sci.* 2009;50:5197-5200)

TABLE 3. Mean RNFL Thickness, MD, and PSD over Time

	Acute	3 Months	6 Months	1 Year	P*
Average RNFL	183.2 ± 73.9	124.8 ± 24.4	123.3 ± 32	107.8 ± 30.4	0.000
Superior RNFL	208.8 ± 82.9	144 ± 33.7	137.1 ± 39.3	117.04 ± 30.2	0.000
Inferior RNFL	226.2 ± 87.3	167.9 ± 3.2	160.3 ± 39.8	142.3 ± 38.2	0.000
Nasal RNFL	144.5 ± 72.2	95.1 ± 41.2	86.6 ± 20.5	82.7 ± 34.2	0.003
Temporal RNFL	153.1 ± 110.9	110 ± 52.5	100.7 ± 43.2	89 ± 45.3	0.040
MD	-6.2 ± 7.6	-5.1 ± 7.1	-4.9 ± 7.4	-4.5 ± 5.6	0.000
PSD	4.3 ± 2.4	3.7 ± 3	3.1 ± 2.8	2.4 ± 0.9	0.005

* Friedman test.

22 patients et 22 témoins

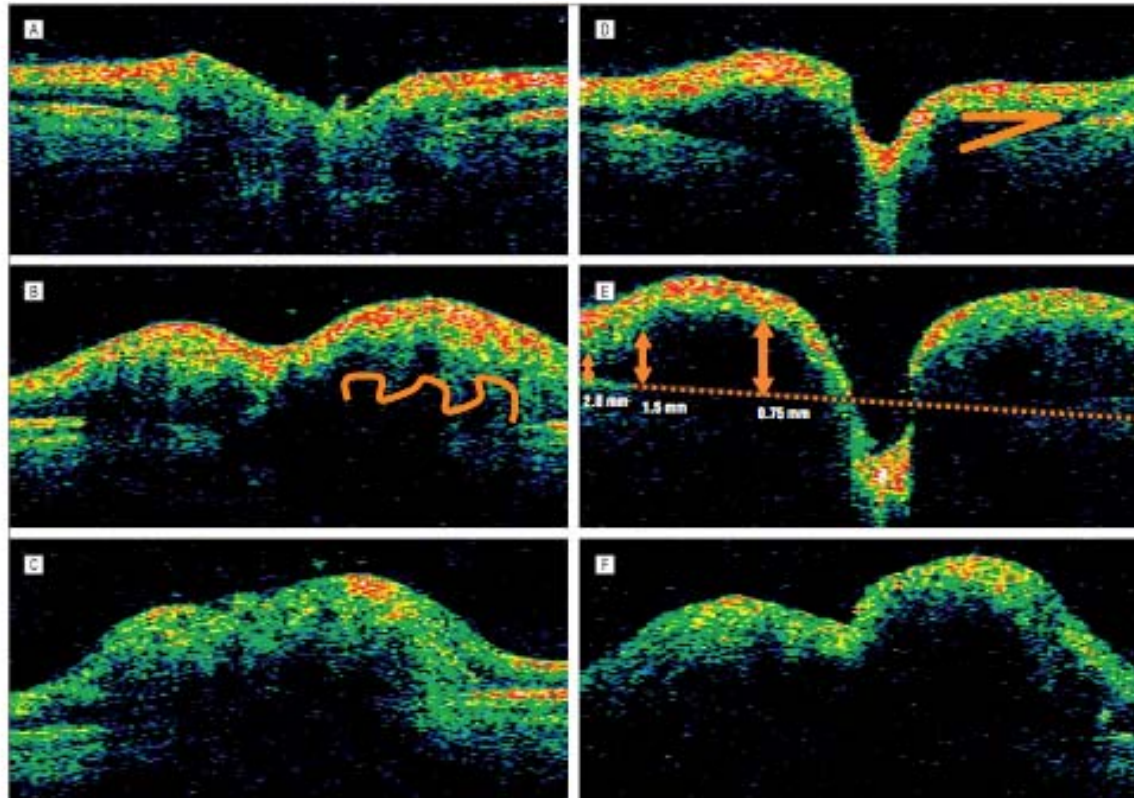
OCT et neuro ophtalmologie (4)

Anomalies papillaires : drusen

Differentiating Optic Disc Edema From Optic Nerve Head Drusen on Optical Coherence Tomography

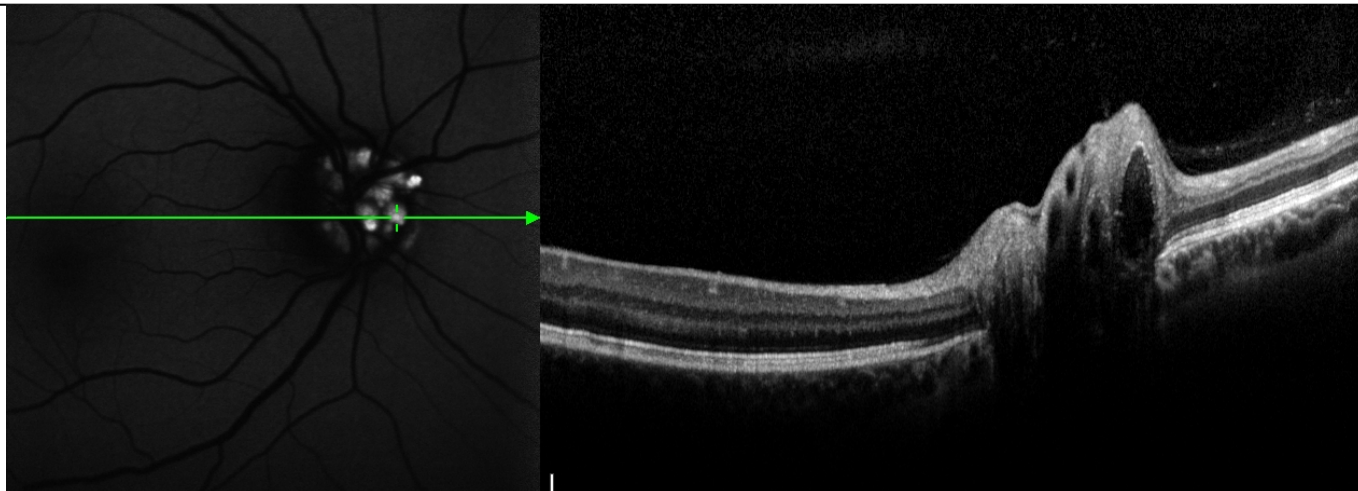
Lenworth N. Johnson, MD; Meredith L. Diehl, MD; Chuck W. Hamm, COT, CRA, OCT-C;
Drew N. Sommerville, MD; Gregory F. Petroski, PhD

Arch Ophthalmol. 2009;127(1):45-49



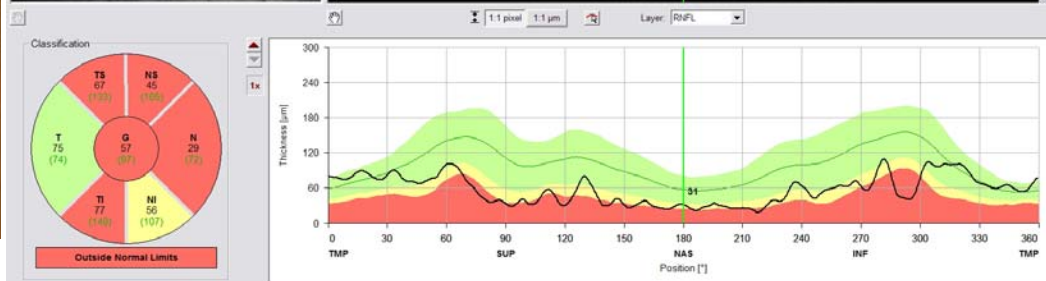
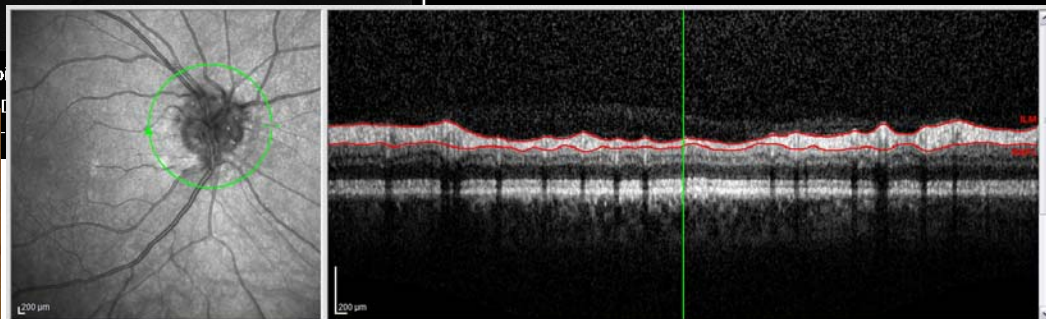
OCT et neuro ophtalmologie (4)

Drusen de la papille

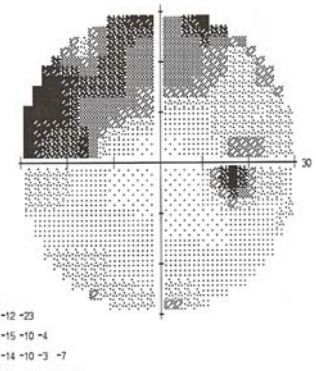


200 µm

gossart, jean p
03/11/2009, 01



RX: +1.00 DS DC X L'âge: 45

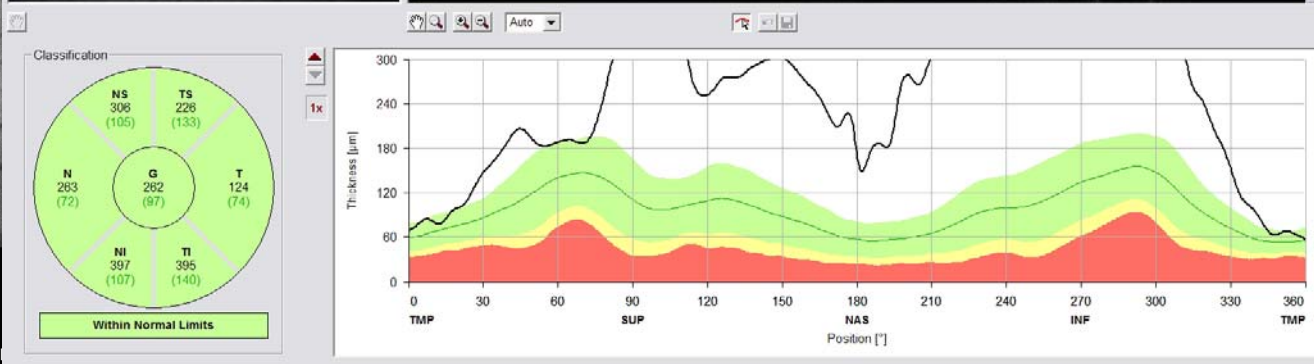
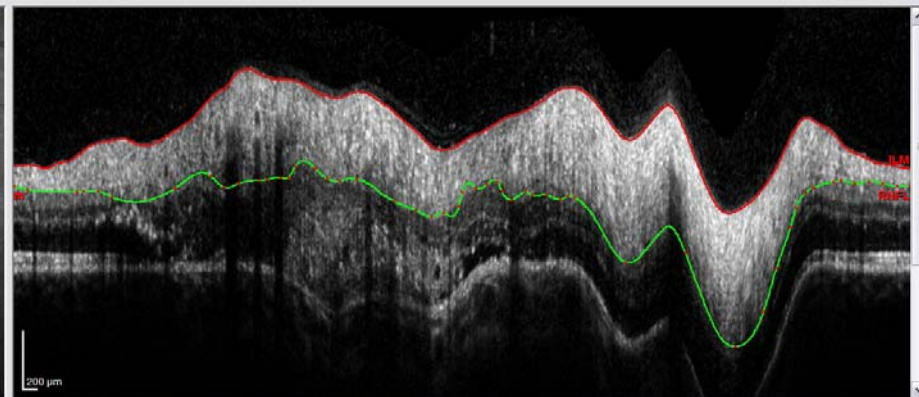
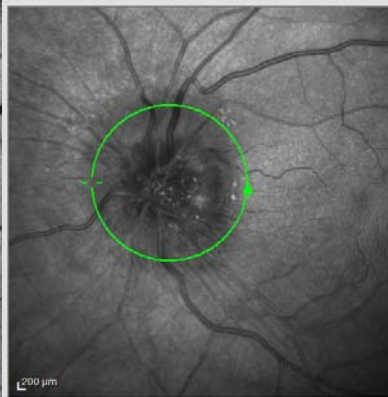


OCT et neuro ophtalmologie (4)

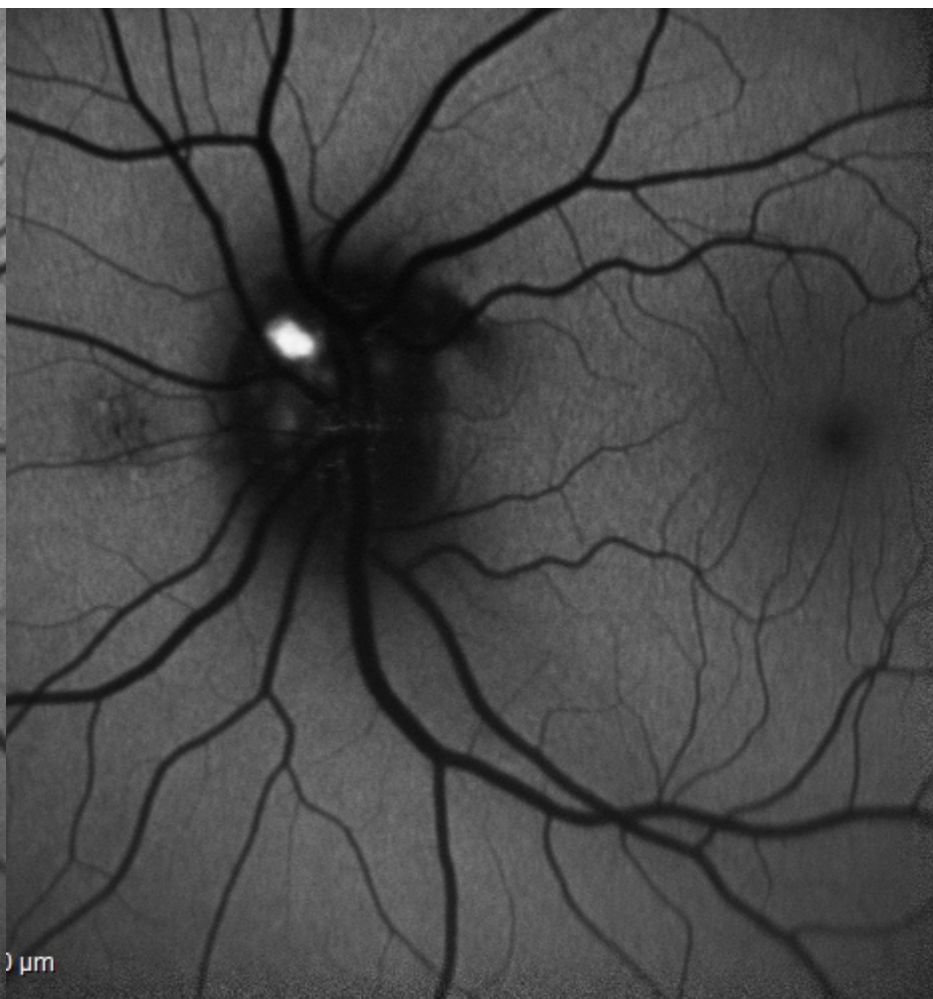
Drusen de la papille



gossart, jean pierre, 07/06/1964, #07061964
03/11/2009, OS
AutoFluo 30° ART



HEIDEL
ENGINEERING



03/09/2010, OD

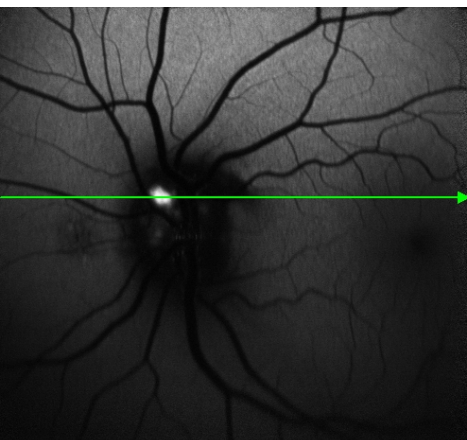
AF 30° ART(22) [HR]

09/2010, OS

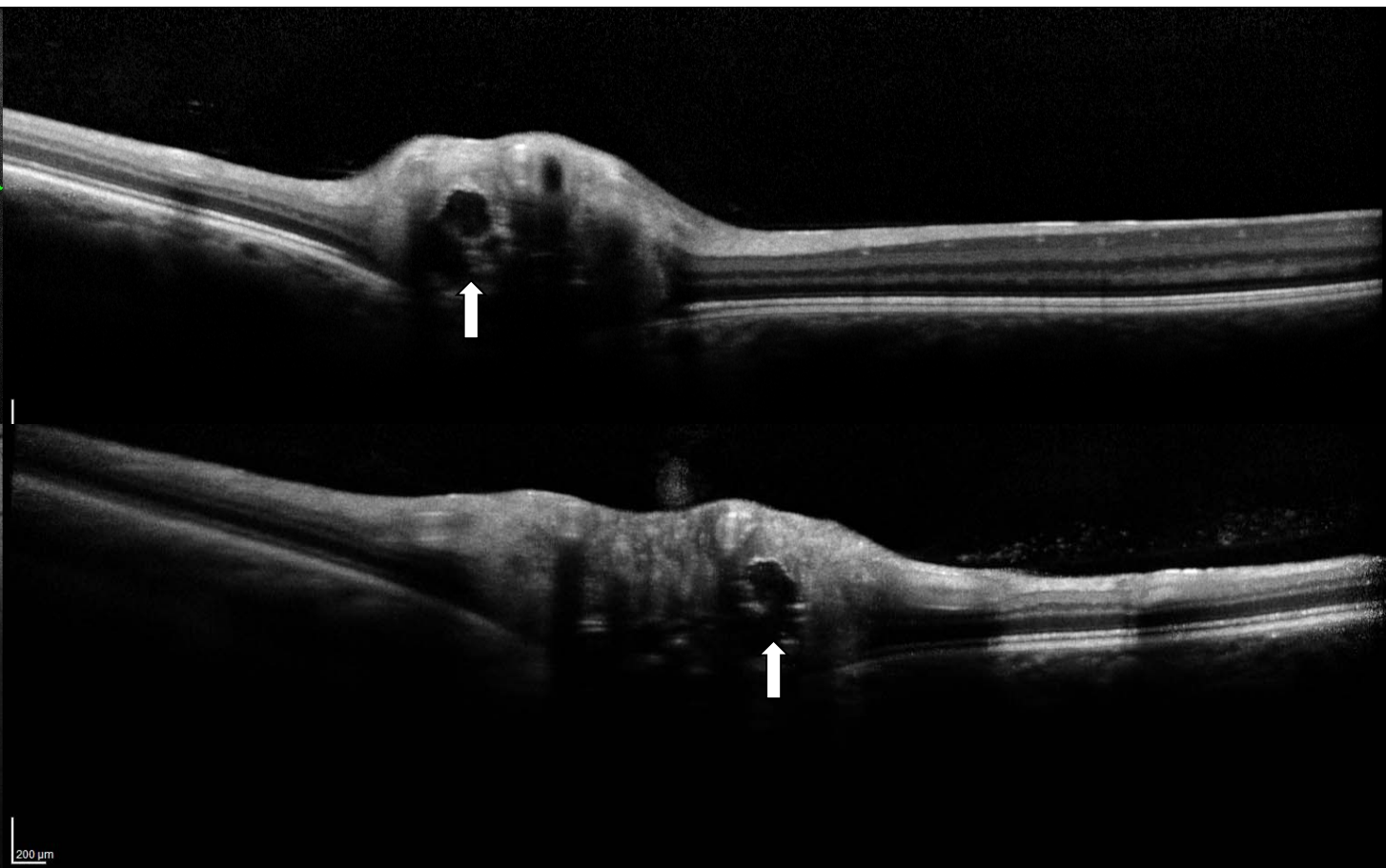
30° ART(26) [HR]

HEIDELBERG
ENGINEERING

HEIDELBERG
ENGINEERING



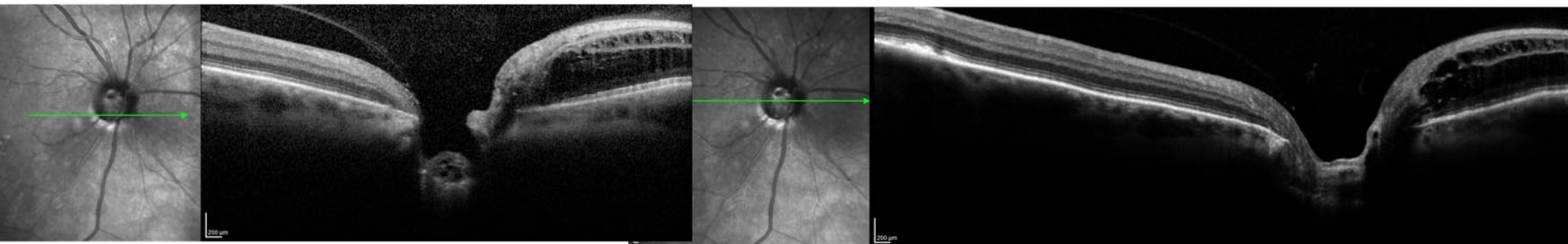
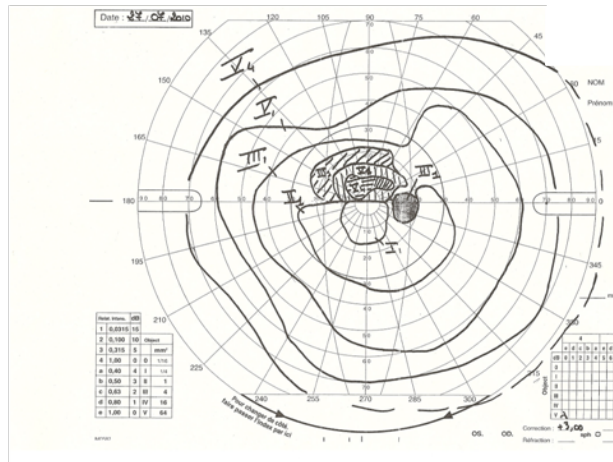
200 μm



200 μm

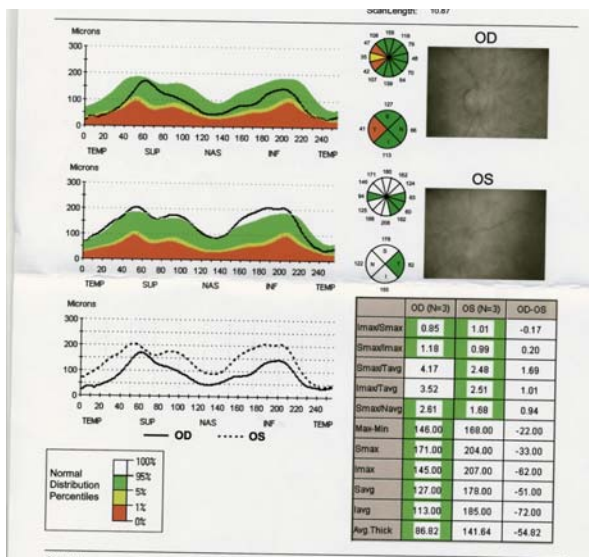
OCT et neuro ophtalmologie (4)

Anomalies papillaires : fossettes

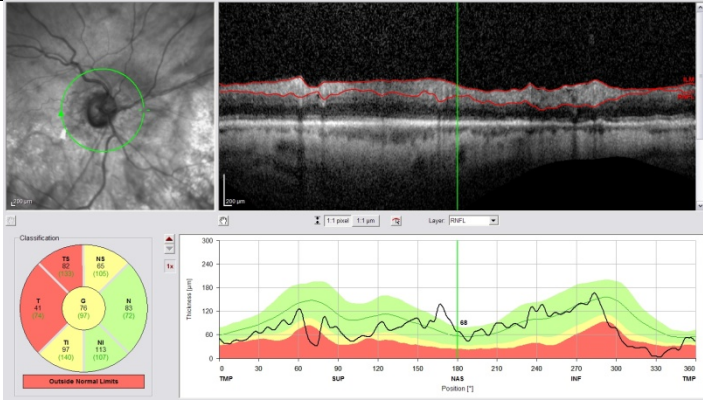


OCT et neuro ophtalmologie (5)

NO de Leber

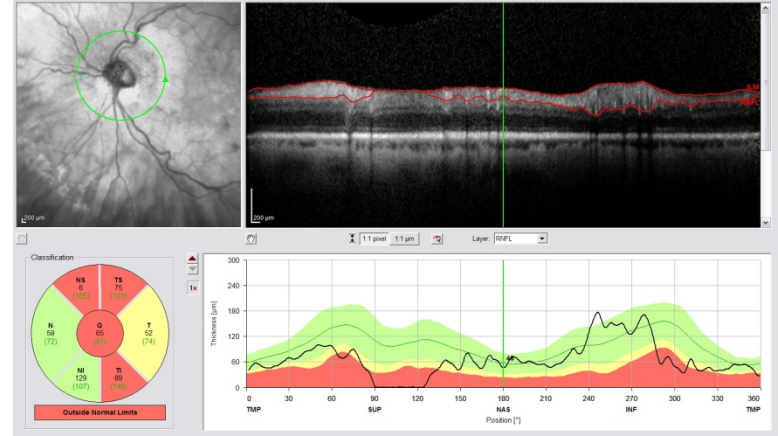


- Atteinte droite puis gauche
- Au stade aigu, vraie saillie avec augmentation du RNFL
- Mais faux OP



ATANGANA, BERNADETTE, 13/07/1538

21/08



ATANGANA, BERNADETTE, 21/08/2009, OS

EMOCT 30° AUT



OCT et neuro ophtalmologie (6)

NO compressive, syndrome chiasmatique

- Predicting Visual Outcome After Treatment of Pituitary Adenomas With Optical Coherence Tomography

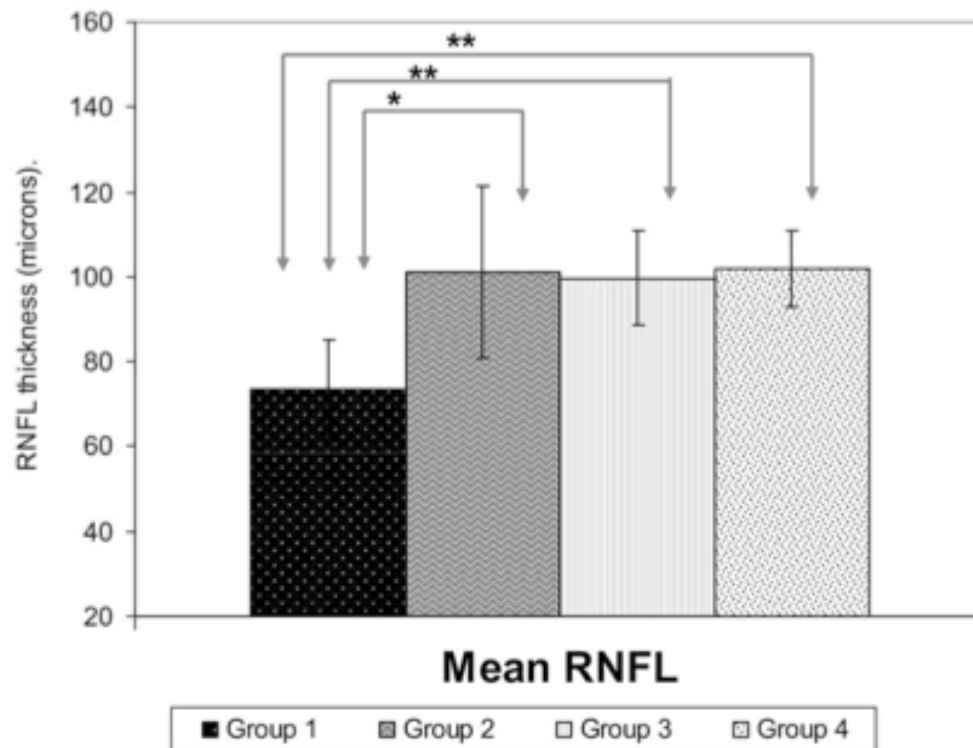
MAUD JACOB, GÉRALD RAVEROT, EMMANUEL JOUANNEAU, FRANÇOISE BORSON-CHAZOT,
GILLES PERRIN, MURIEL RABILLOUD, CAROLINE TILIKETE, MARTINE BERNARD, AND ALAIN VIGHETTO

Am J Ophthalmol 2009

- Evolution post opératoire de la fonction visuelle dans les adénomes
- Aucun facteur pronostique établi, notamment:
 - déficits CV
 - âge patient
 - pâleur papillaire
 - durée d'évolution des symptômes
 - caractéristiques endocriniennes de la tumeur
 - pattern ERG

- 19 patients, 37 yeux
- Groupe contrôle: 23 patients, 46 yeux
- Macro-adénome comprimant les voies visuelles antérieures (IRM), avec ou sans retentissement visuel
- Critères d'exclusion:
 - Traitement antérieur de l'adénome
 - Myopie > -6dp (valeurs normales de RNFL non établies)
- Examen ophtalmologique complet 1 mois avant TRT, puis à 2 semaines et 3 mois après TRT avec:
 - CV automatisé 30°, analyse MD
 - OCT 3, « Fast RNFL »

Diminution d'épaisseur moyenne RNFL avant chirurgie / contrôle: Groupe 1 = 28% groupe 2 =1%, groupe 3=2%



- 1: Déficit initial CV
3 mois après TRT :
amélioration incomplète ou
aggravation du CV
- 2: Déficit initial du CV
3 mois après TRT : résolution
complète du déficit
- 3: Pas de déficit du CV avant et
après TRT
- 4: Contrôle

OCT et Neuro Ophtalmologie (7)

Elimine les maculopathies occultes

Elimine ce qui n'est pas une NO

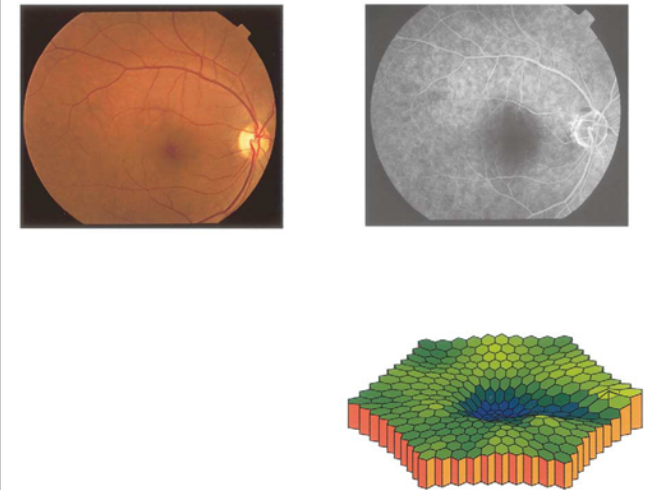
Foveal Thickness in Occult Macular Dystrophy

Mineo Kondo, MD, Yasuki Ito, MD,
Shinji Ueno, MD, Chang-Hua Piao, MD,
Hiroko Terasaki, MD, and Yoro Miyake, MD

726

AMERICAN JOURNAL OF OPHTHALMOLOGY

MAY 2003



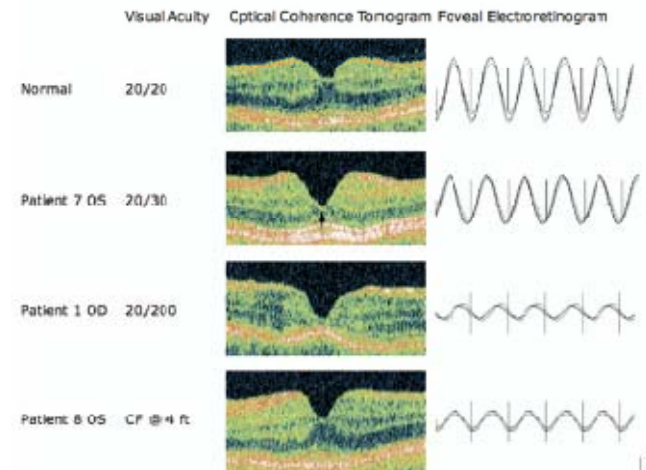
Optical Coherence Tomography Findings in Occult Macular Dystrophy

Robert J. Brockhurst, MD, and
Michael A. Sandberg, PhD

AMERICAN JOURNAL OF OPHTHALMOLOGY

MARCH 2007

Optical Coherence Tomograms and Foveal Electroretinograms in Patients with Occult Macular Dystrophy





Femme de 45 ans,
diagnostic de SEP et NO

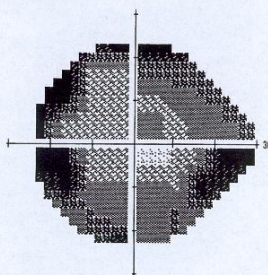
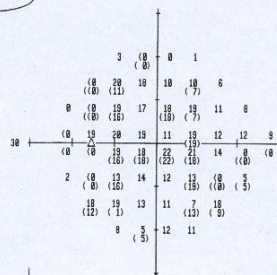


OEIL : GAUCHE
DDN : 19-12-1963

STIMULUS: III. BLANC
FOND: 31.5 ASB
STRATÉGIE: FASTPAC

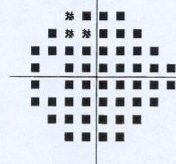
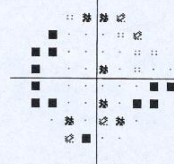
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ACUITÉ VISUELLE:
RX: DS DC

DATE: 13-02-2000
HEURE: 11:45
AGE: 44



PATIENT PEU FIABLE

MD	-19.45 DB	P < 0.5%
PSD	6.64 DB	P < 0.5%
SF	4.48 DB	P < 2%
CPSD	4.61 DB	P < 0.5%

DÉVIATION
TOTALEDÉVIATION
INDIVIDUELLE

:: < 5%
 < 2%
 < 1%
 < 0.5%

HOPITAL LARIBOISIERS
2, RUE AMERISE PARE
75010 PARIS
OPHTHALMO./ORTHOPTE
TEL. 49.95.64.87

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HFA II 740-1139-A12.3/A12.3

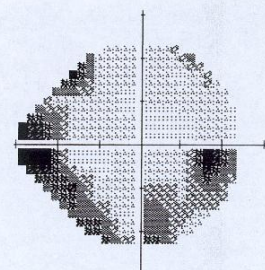
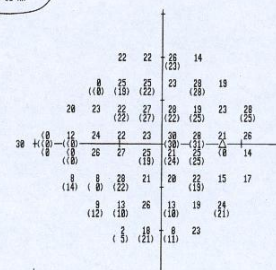
OEIL: DROIT
DDN: 19-12-1963

1531 WE SEUIL LEMIKEL 29-2

STIMULUS: III, BLANC
FOND: 31.5 ASB
STRATÉGIE: FASTPAC

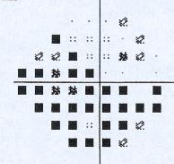
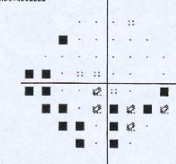
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ACUITÉ VISUELLE:
RX: -0.50 DS DC

DATE: 13-02-2008
HEURE: 11:30
AGE: 44



FOVER: 33 DB

	-5	-6	-3	-13	
	-30	-7	-6	-6	-1 -10
	-9	-7	-9	-4	-6 -8 -7 -3
-30	-24	-7	-10	-3	-2 -2 -4
-30	-32	-6	-5	-11	-10 -7 -16
	-18	-27	-7	-11	-12 -11 -16 -13
	-19	-19	-5	-19	-12 -8
	-25	-10	-20	-7	

DÉVIATION
TOTALE
$$\begin{array}{rrrrrrrr} & & -1 & -1 & & 2 & -9 & \\ & -26 & -3 & -2 & & 2 & 3 & -5 \\ & -4 & -3 & -5 & 0 & -2 & -4 & -2 & 2 \\ -25 & -20 & -3 & -6 & -5 & 2 & 3 & & 0 \\ \hline -25 & -20 & -1 & -1 & -6 & -6 & -2 & & -12 \\ & -14 & -23 & -3 & -7 & -7 & -7 & -11 & -9 \\ & & -15 & -15 & -1 & -15 & -8 & & -4 \\ & & & -21 & -6 & & -16 & -3 & \end{array}$$
DÉVIATION
INDIVIDUELLE

PATIENT PEU FIABLE

MD	-11.31	DB	P (0.5%)
PSD	0.44	DB	P (0.5%)
SF	3.03	DB	P (10%)
CPSD	7.79	DB	P (0.5%)

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75010 PARIS
OPHTALMO./ORTHOPTIE
TEL. 49.95.64.87

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HEA II 740-1139-012.3/012.3

DOB: 12/2/1953
Gender: Female
Physician:

Exam Date: 4/8/2008
Exam Time: 4:16 PM
Technician: Hopital Lariboisiere
Signal Strength: 6/10

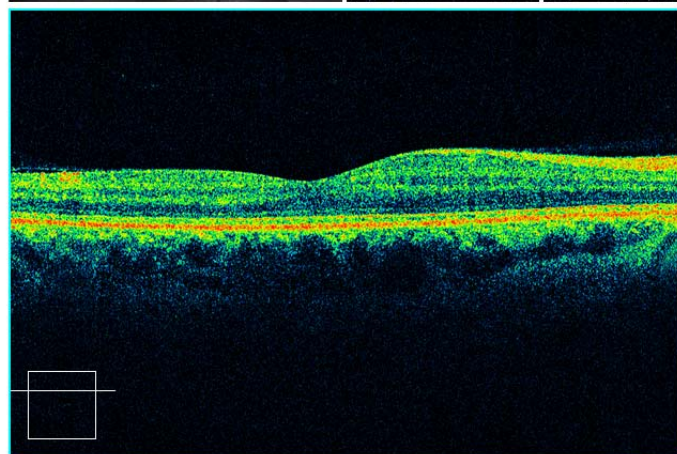
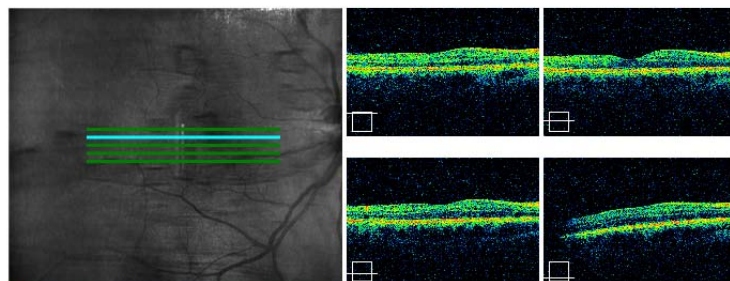
CZMI



HDIA: 5 Line Raster

OD ● ○ OS

Scan angle: 0° Spacing: 0.25 mm Length: 6 mm



Comments

Physician's Signature

SW Ver: 3.0.0.64
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Page 1 of 1

DOB: 12/2/1953
Gender: Female
Physician:

Exam Date: 4/8/2008
Exam Time: 4:22 PM
Technician: Hopital Lariboisiere
Signal Strength: 6/10

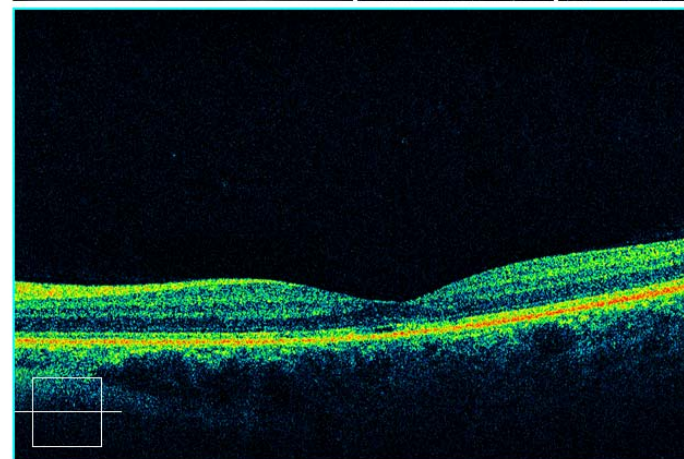
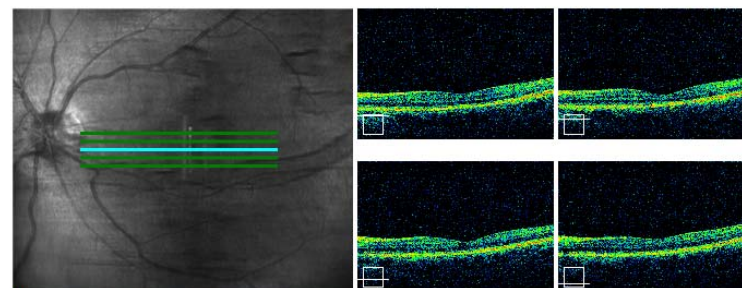
CZMI



HDIA: 5 Line Raster

OD ○ ● OS

Scan angle: 0° Spacing: 0.25 mm Length: 6 mm



Comments

Physician's Signature

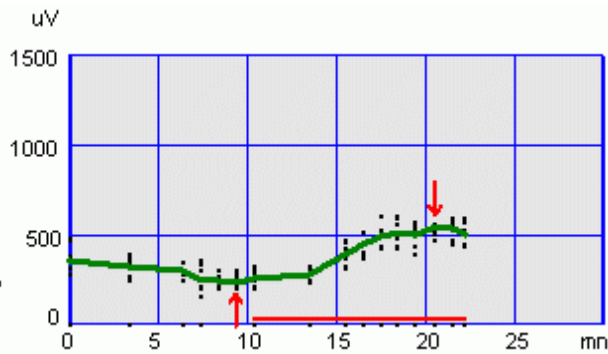
SW Ver: 3.0.0.64
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Page 1 of 1

OD

minimum = 236uV

maximum = 549uV

rapport de ARDEN = 233%

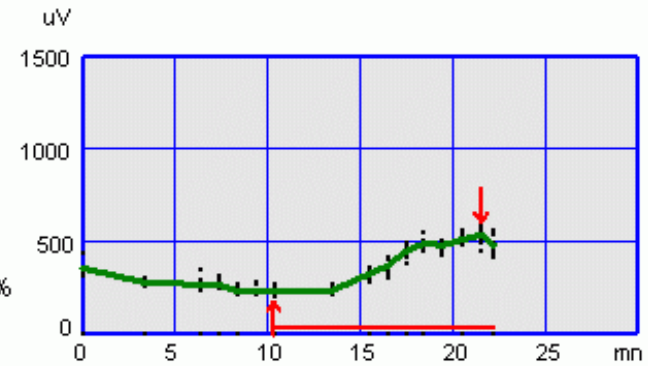


OG

minimum = 231uV

maximum = 528uV

rapport de ARDEN = 228%

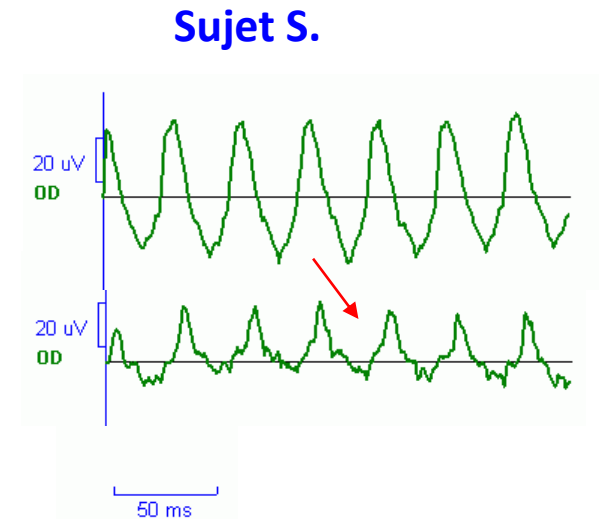
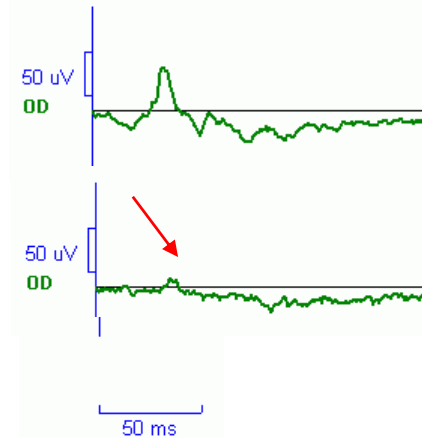
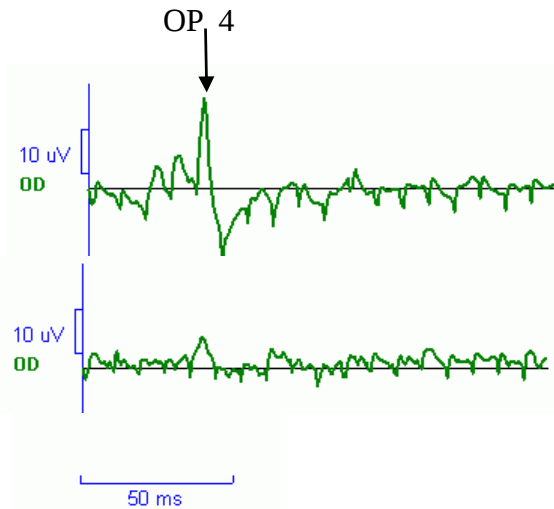


ERG flash standard : réponse globale

Phot-OPs

Cone-response

Flicker-response



Phot-OPS : **OD = OP4**
OG = 0

Cone-response OD : nl
OG = 0

Flicker-response : OD: nl
OG



date naissa. : 02/12/1963

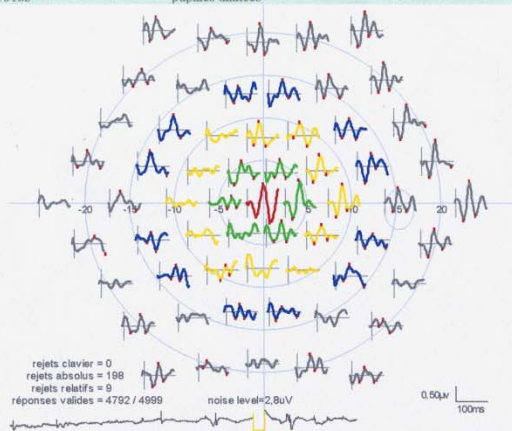
examen :

MERG61B OD

CARTE DES REPONSES LOCALES - K1

enreg 156183

pupilles dilatées

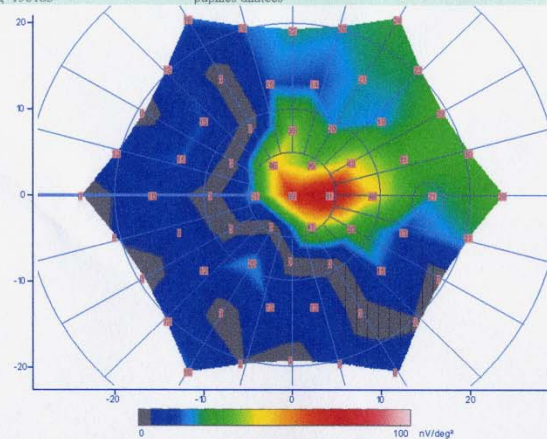


MERG61B OD

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pupilles dilatées

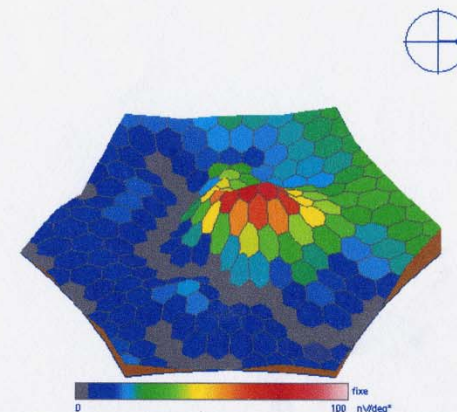


MERG61B OD

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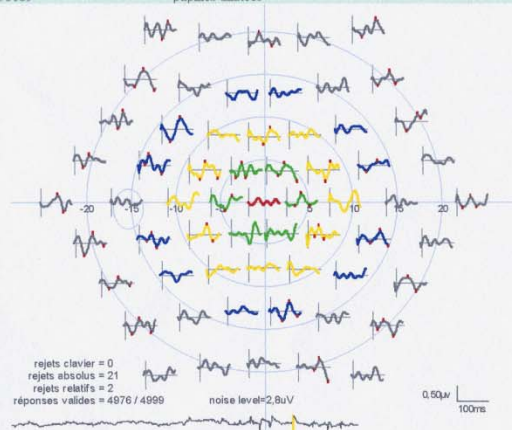


MERG61BF OG

CARTE DES REPONSES LOCALES - K1

enreg 156189

pupilles dilatées

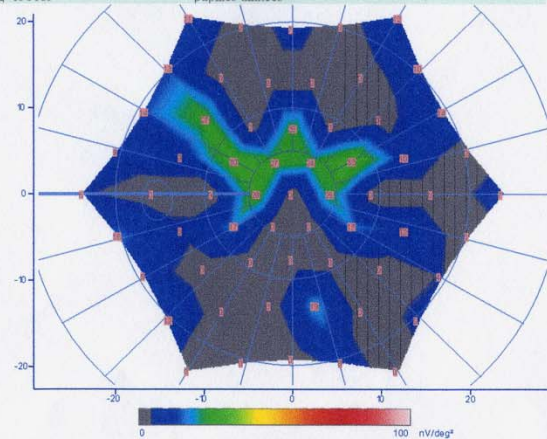


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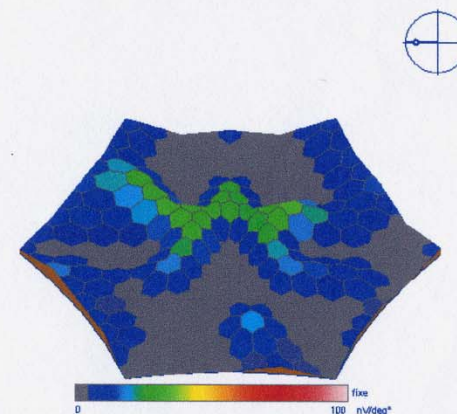


MERG61BF OG

CARTE DES REPONSES LOCALES - K1

enreg 156189

pupilles dilatées



ASSISTANCE
PUBLIQUE



HÔPITAUX
DE PARIS

Groupe Hospitalier LARIBOISIÈRE - FERNAND WIDAL

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Ophtalmologique
WIN8000D
Metrovision
4 rue des platanes

METROVISION



OCT et neuro ophtalmologie

- Outil très utile, support de la clinique +++
 - Communiquer et expliquer +++ car assez bonnes corrélations avec les paramètres visuels
 - Suivre les patients, en particulier NO *chroniques rétrobulbaires* (SEP, toxiques, *compressives*), moins utile si OP
 - Eliminer la fausse neuro-ophtalmologie (macula) ++
 - Evaluation thérapeutiques (SEP)

