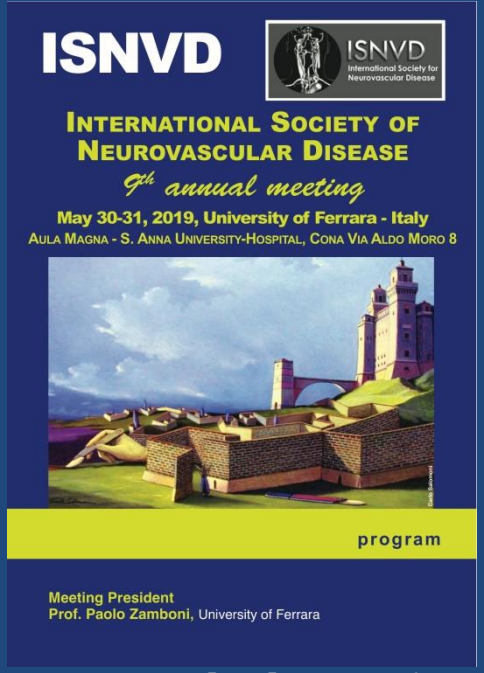


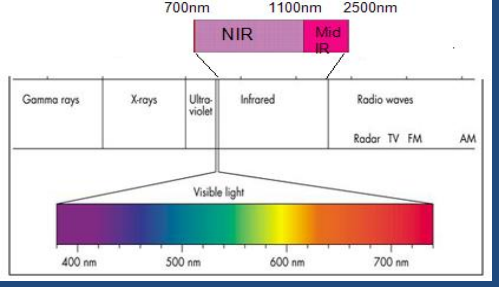
Cerebral protection and perfusion monitoring in vascular and endovascular surgery

Monitoring the intracerebral flow during CEA under general anesthesia

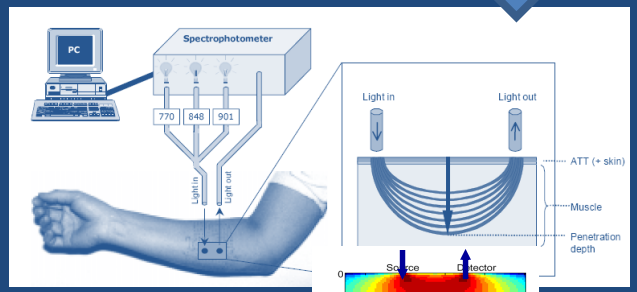
NEAR- INFRARED SPECTROSCOPY - NIRS

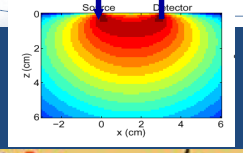
Fabio Manfredini, MD
University of Ferrara
Dept. of Rehabilitation Medicine, Univ. Hospital Ferrara

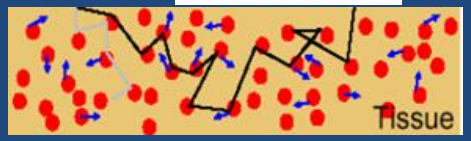
Technical notions



Light in NIR range can penetrate biological tissues

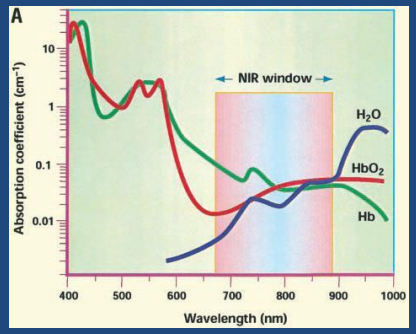




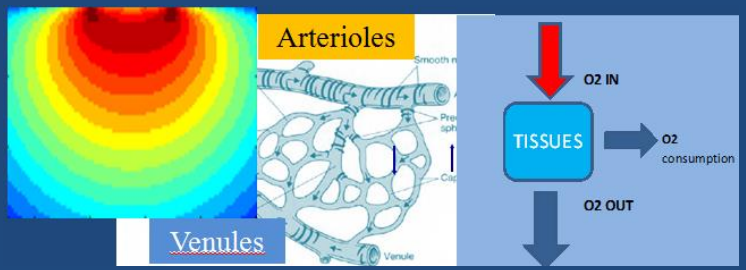


SCATTERED
partly ABSORBED
partly REFLECTED

Measured by a detector



Oxygen Exchange In Tissues



Quantified as
oxygenated and deoxygenated Hb
According to the spectrum (830-780 nm)

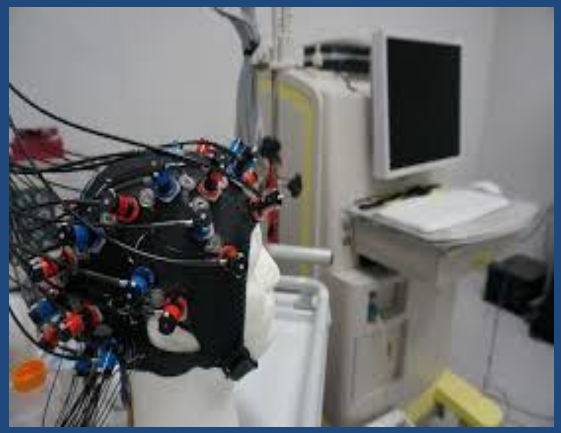
Cortical activation

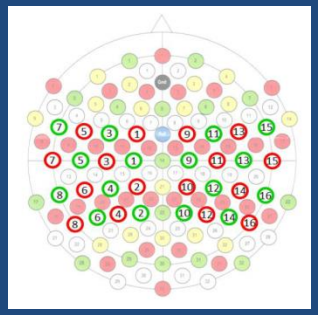
(and continuous recording)

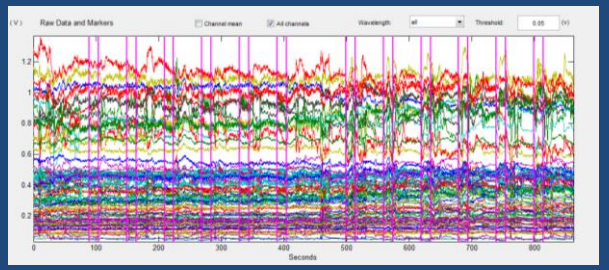
NIRS

Different oxymeters

Different applications

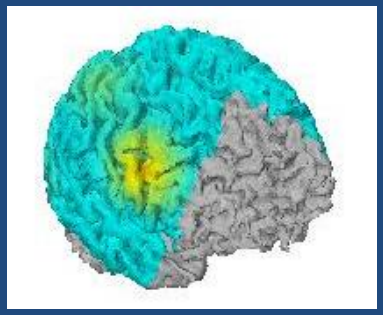






Brain activity, brain perfusion, plasticity
interhemisphere coherence

Several optodes on the scalp
Result: many traces (one for each channel) or a map



not suitable for monitoring during surgery

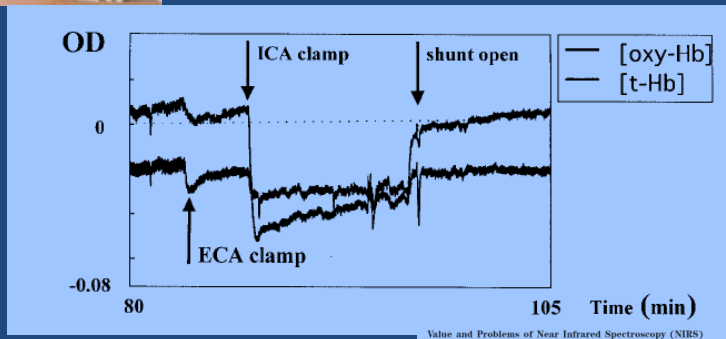
suitable for monitoring during surgery

NIRS

Different oxymeters

Different applications

Oxygenation monitoring (Continuous recording)



Value and Problems of Near Infrared Spectroscopy (NIRS) Monitoring for Carotid Clamp During Neurosurgical Intervention: From 9 Years Experience

Tohru Kobayashi, M.D., Satoshi Kuroda, M.D., Kiyohiro Houkin, M.D., Yoshinobu Iwasaki, M.D., and Hiroshi Abe, M.D.

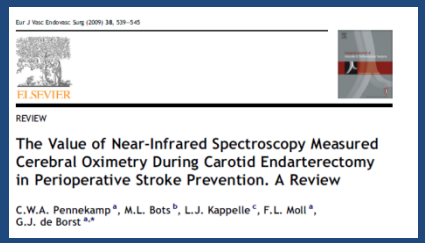
Department of Neurosurgery, University of Hokkaido, Graduate School of Medicine, Sapporo, Japan

Oxymeter sensors applied on the forehead

Parameters (depending on NIRS instruments):
regional cerebral oxygen saturation (rSO_2),
changes in intracerebral saturation (CsO_2),
tissue oxygen index (TOI)

Result: a trace or a number (index)

Cerebral Oxygenation monitoring during CEA

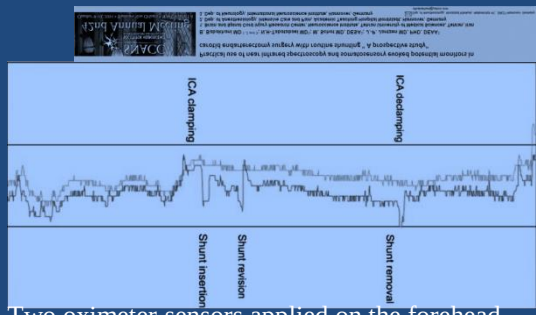

Eur J Vasc Endovasc Surg (2009) 38, 539–545

ELSEVIER

REVIEW

The Value of Near-Infrared Spectroscopy Measured Cerebral Oximetry During Carotid Endarterectomy in Perioperative Stroke Prevention. A Review

C.W.A. Pennekamp [a], M.L. Bots [b], L.J. Kappelle [c], F.L. Moll [a], G.J. de Borst [a,*]



Two oximeter sensors applied on the forehead

Transcranial Doppler

EEG monitoring

Stump pressure

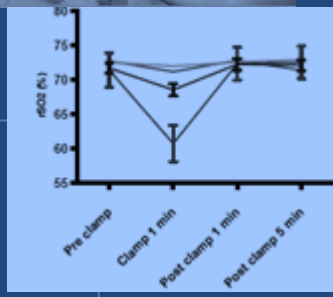
LIMITATIONS

Not applicable in 10% of the patients
(no temporal bone window)
Expensive
Dependent on the skills of the technicians

Time consuming
Interpretation
Influenced by certain anaesthetics

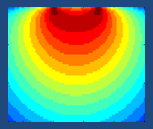
Not continuous

NIRS
as a possible alternative to traditional techniques



Somatosensory evoked potential (SSEP)

NIRS monitoring



Hemodynamics monitoring in deep tissues

Noninvasive

Suitable for continuous –bedside- measurements,

No specially trained personnel

Widely used for monitoring in cardiac, pediatric, neurosurgery and ICU

SctO2 changes **correlated with changes in EEG, TCD, SP** and postoperative neurologic deficits.

possible prediction of intra-operative cerebral ischaemia
and shunt indication
cerebral hyperperfusion syndrome

Near-infrared Spectroscopy to Indicate Selective Shunt Use During Carotid Endarterectomy

C.W.A. Pennekamp [a], R.V. Immink [b], H.M. den Ruijter [c], L.J. Kappelle [d], M.L. Bots [c], W.F. Buhre [b], F.L. Moll [a], G.J. de Borst [a,*]

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Cas Medical Systems, Inc, Branford, Connecticut, USA)

Eur J Vasc Endovasc Surg (2017) 53, 783–791

Near Infrared Spectroscopy as a Predictor for Shunt Requirement During Carotid Endarterectomy

M. Jonsson [a,*], D. Lindström [b], A. Wanhainen [c], K. Djavani Gidlund [d], P. Gillgren [a]

[a] Department of Clinical Science and Education, Karolinska Institutet, Södersjukhuset and Department of Surgery, Section of Vascular Surgery, Södersjukhuset, Stockholm, Sweden
[b] Department of Molecular Medicine and Surgery, Karolinska Institutet, Stockholm, Sweden
[c] Department of Surgical Sciences, Section of Vascular Surgery, Uppsala University, Uppsala, Sweden
[d] Department of Surgical Sciences, Uppsala University, Gävle Hospital, Sweden

frontiers in PHYSIOLOGY

REVIEW ARTICLE

published: 17 March 2014

Systematic review of near-infrared spectroscopy determined cerebral oxygenation during non-cardiac surgery

Henning B. Nielsen *

Department of Anesthesia, Rigshospitalet, University of Copenhagen, Copenhagen, Denmark

Original Article

The Efficacy of Near-Infrared Spectroscopy Monitoring in Carotid Endarterectomy: A Prospective, Single-Center, Observational Study

Cell Transplantation 2019, Vol. 28(3) 370–375 © The Author(s) 2018

SAGE

Yu Wang[1], Li Li[2], Tianlong Wang[1], Lei Zhao[1], Hua Feng[1], Qian Wang[1], Long Fan[1], Xuexin Feng[1], Wei Xiao[1], and Kunpeng Feng[1]

Clinical Study

Is Near-Infrared Spectroscopy a Reliable Method to Evaluate Clamping Ischemia during Carotid Surgery?

Luciano Pedrini, Filippo Magnoni, Luigi Sensi, Emilio Pisano, Maria Sandra Ballestrazzi, Maria Rosaria Cirelli, and Alessandro Pilato

The INVOS™ Cerebral/Somatic Oximeter

NIRS monitoring

Cas Medical Systems, Inc, Branford, Connecticut, USA)

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forehead monitoring of a limited region

(frontal lobe)

poor monitoring of other brain areas

(parietal lobe)

signal contamination by the scalp

(minimized by a new algorithm)

Different devices, procedures, parameters

(not comparable)

No consensus on the cut-off SctO2 value

for predicting cerebral ischemia

(e.g. 11.7%-25% from baseline)

Mason PF. **The assessment of cerebral oxygenation during carotid endarterectomy utilising near infrared spectroscopy.** *Eur J Vasc Surg*. 1994 Sep;8(5):590-4.

INVOS

DCS flow-oximeter

Critikon

NIRO500

OM-100 (Shimadzu Co.)

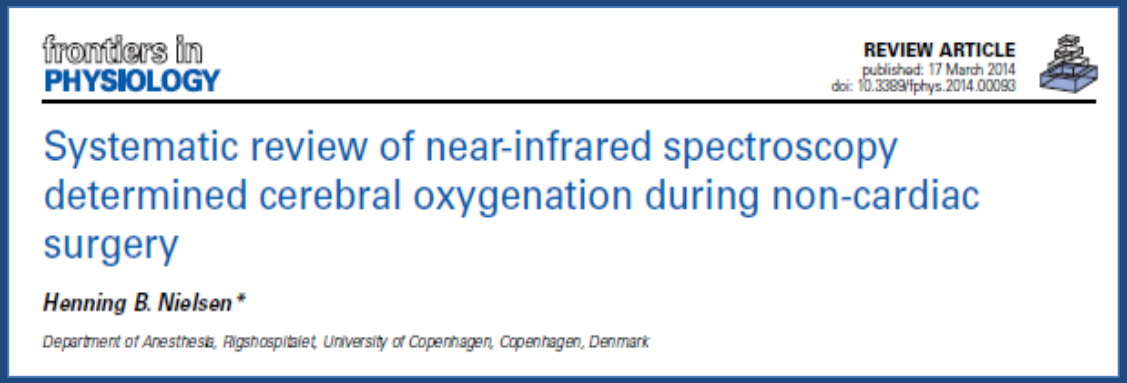
Selfconstruct

NIRS

OM100/110

FORE-SIGHT

TOS96


frontiers in PHYSIOLOGY

REVIEW ARTICLE
published: 17 March 2014
doi: 10.3389/fphys.2014.00093

Systematic review of near-infrared spectroscopy determined cerebral oxygenation during non-cardiac surgery

*Henning B. Nielsen**

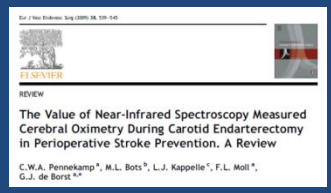
Department of Anesthesia, Rigshospitalet, University of Copenhagen, Copenhagen, Denmark

CAROTID SURGERY

Frontal lobe

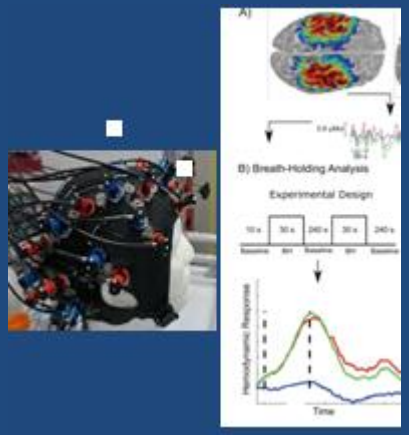
➢50 papers
3000 subjects

NIRS
promising for cerebral monitoring in CEA
but not yet considered a **standard** technique
.


REVIEW

The Value of Near-Infrared Spectroscopy Measured Cerebral Oximetry During Carotid Endarterectomy in Perioperative Stroke Prevention. A Review

Possible applications of NIRS



fNIRS

hemodynamic patterns
collateral circulation
Before surgery?
Stratification of patients?

Edwin J. Forero[1,*]
Sergio L. Novi[1,*]

Medical Research Archives, Vol. 5, Issue 6, June 2017
Use of near-infrared spectroscopy to probe occlusion severity in patients diagnosed with carotid atherosclerotic disease

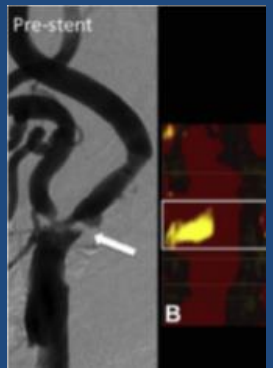
Use of near-infrared spectroscopy to probe occlusion severity in patients diagnosed with carotid atherosclerotic disease

Rickson C. Mesquita[1,2]

Intravascular applications

NIRS+ IVUS

Anatomy and composition of an atherosclerotic plaque



198 Review Article

Intravascular Near-Infrared Spectroscopy: A Possible Tool for Optimizing the Management of Carotid Artery Disease

Martin Horváth, MD[1] Petr Hájek, MD, PhD[1] Cyril Štěchovský, MD[1] Jakub Honěk, MD[1] Josef Veselka, MD, PhD[1]

[1] Department of Cardiology, Charles University in Prague, 2nd Faculty of Medicine and Motol University Hospital, Prague, Czech Republic

Address for correspondence Josef Veselka, MD, PhD, Depart... Cardiology, Motol University Hospital, V Úvalu 84, 150 06, P... Czech Republic (e-mail: veselka.josef@seznam.cz).

Int J Angiol 2015;24:198–204.

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ISSN 1936-8798/$36.00
http://dx.doi.org/10.1016/j.jcin.2013.04.012

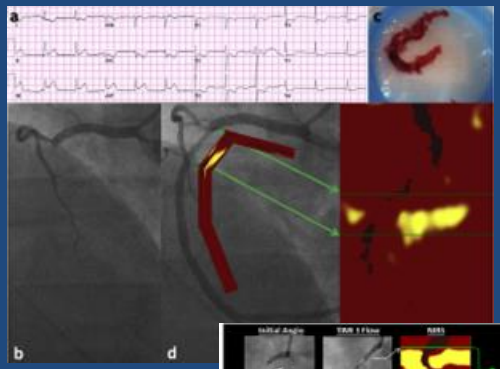
Detection by Near-Infrared Spectroscopy of Large Lipid Core Plaques at Culprit Sites in Patients With Acute ST-Segment Elevation Myocardial Infarction

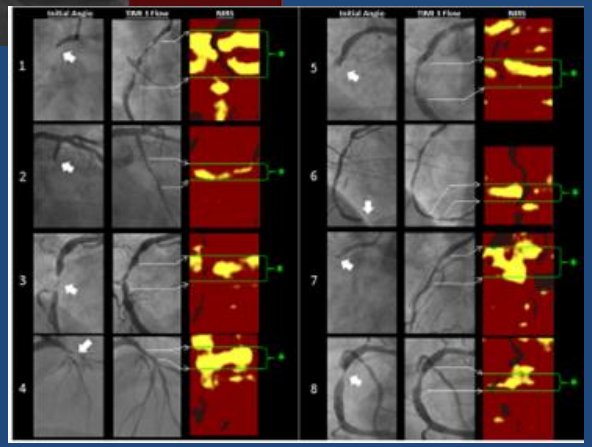
Ryan D. Madder, MD,* James A. Goldstein, MD,† Sean P. Madden, PhD,‡
Rishi Puri, MBBS,§ Kathy Wolski, MPH,§ Michael Hendricks, BS,‡ Stephen T. Sum, PhD,‡
Annapoorna Kini, MD,‖ Samin Sharma, MD,‖ David Rizik, MD,¶
Emmanouil S. Brilakis, MD, PhD,# Kendrick A. Shunk, MD, PhD,** John Petersen, MD,††
Giora Weisz, MD,‡‡ Renu Virmani, MD,§§ Stephen J. Nicholls, MBBS, PhD,‖‖
Akiko Maehara, MD,‡‡ Gary S. Mintz, MD,‡‡ Gregg W. Stone, MD,‡‡
James E. Muller, MD‡

Intravascular NIRS in Cardiology

Cleared by the FDA

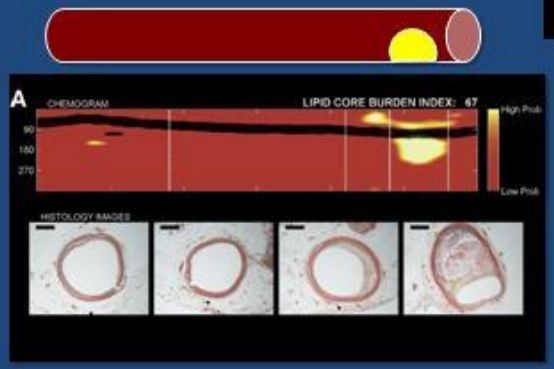
detection in the coronary arteries of lipid-core plaques LCP at higher risk
(spontaneous events, distal embolization and stent failure)





NIRS-IVUS imaging (TVC Imaging System, InfraReDx, Burlington, Massachusetts

The Lipid-core burden index



Chemogram Color	Indication
Red	Low probability of LCP
Yellow	High probability of LCP
Black overlay	Indeterminate

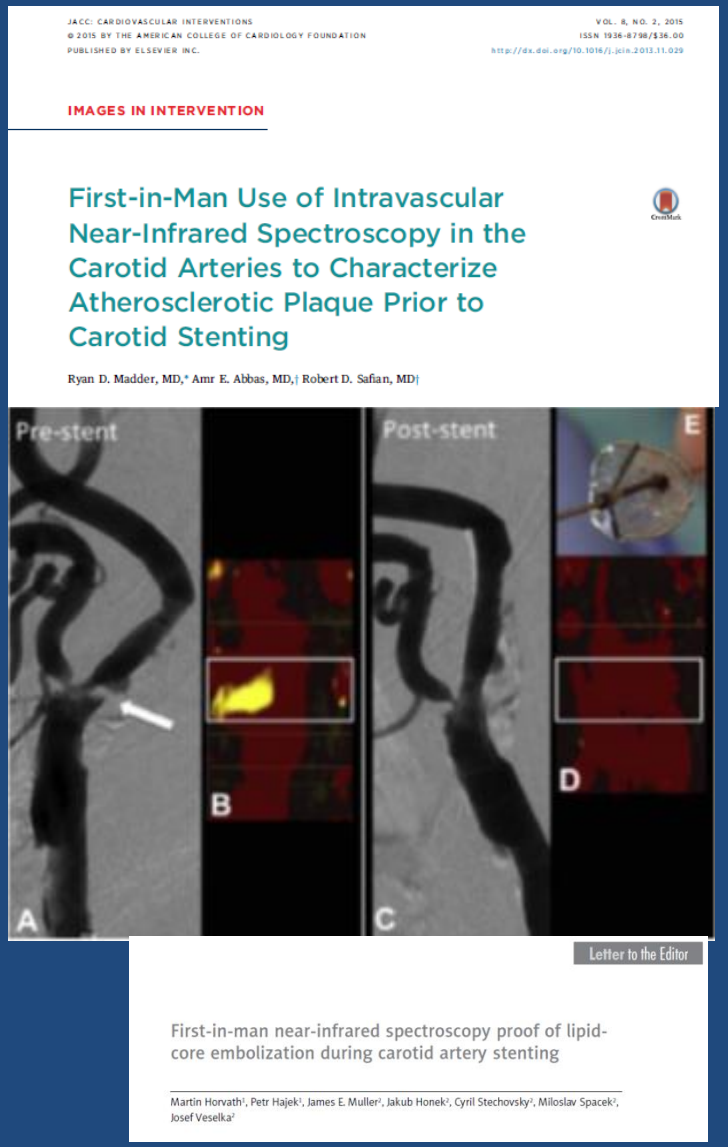
Possible causes:
- Guide wire
- Thrombus
- Flow disturbance

Hypothesis
Detection by NIRS
of **lipid-core plaques** LCP
in the carotid arteries predisposing to stroke

NIRS

not validated or approved by the FDA
for use in carotid arteries

No evidence of utility is currently available



A multimodality catheter (TVC System, Infraredx, Inc, Burlington, MA) that contains intravascular ultrasound (IVUS) and NIRS was used in this carotid case.

In collaboration with

dr Nicola Lamberti, PhD

the Department of Rehabilitation Medicine
University Hospital Ferrara
(Director Prof . N. Basaglia)

the Vascular Diseases Center UNIFE
(Director Prof . P. Zamboni)