8° CONGRES SAMEV

ALGER

29 – 30 Juin 2018

EVALUATION des STENOSES CAROTIDIENNES

Dr A. VIARD

- Les sténoses carotidiennes sont responsables de **20%** des AVC ischémiques.

- **La stratégie thérapeutique dépend du degré de sténose.**

- L'Echo-doppler est actuellement l'***examen de première intention***.

- L'Echo-doppler permet une ***évaluation morphologique et fonctionnelle.***

PSV, PDV
Degré de dispersion spectrale

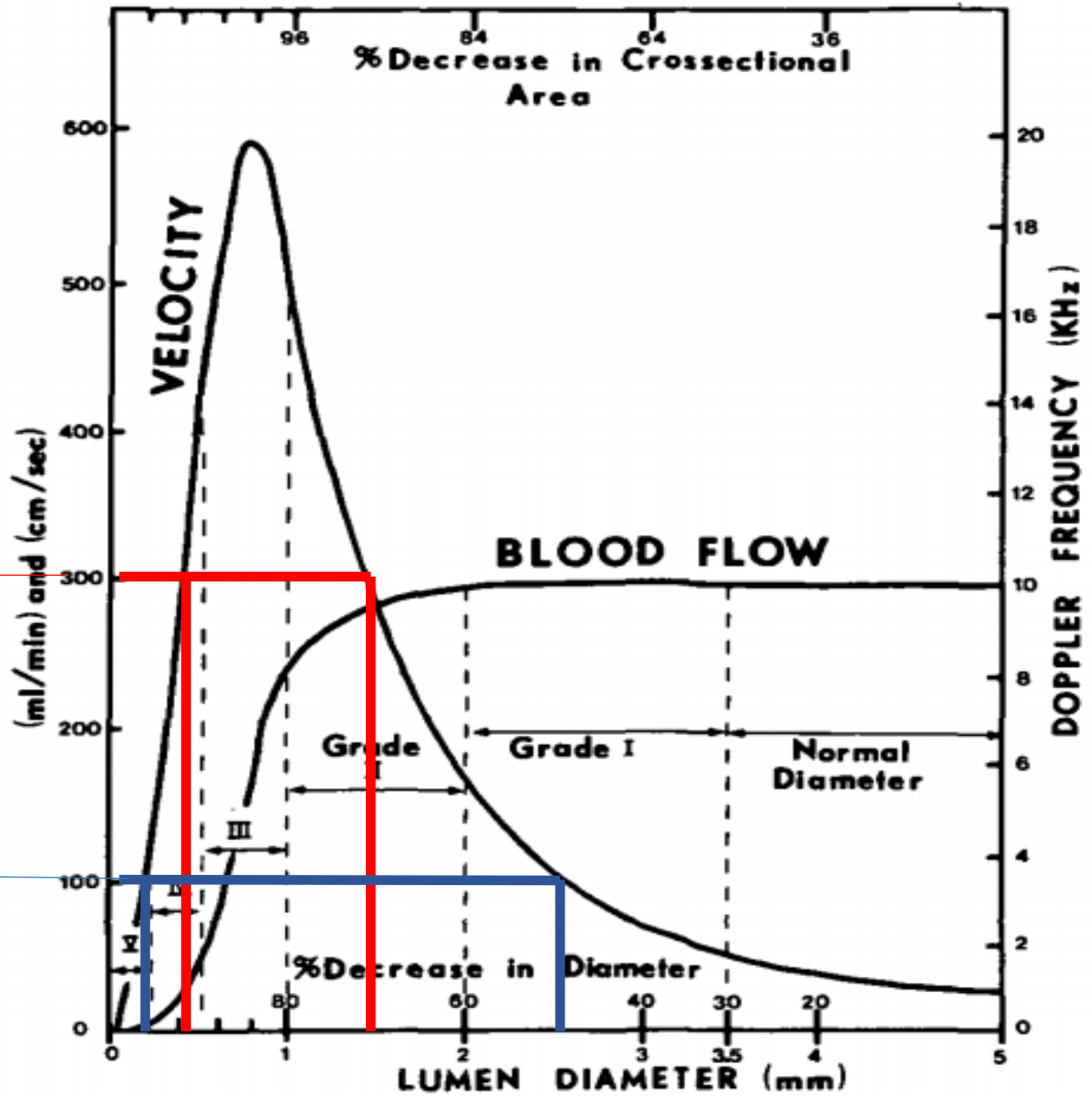
Six catégories(En réduction de diamètre):
Pas de sténose
1%-15%
16%-49%
50%-79%
80%-99%
Occlusion complète

Dr D.E STRANDNESS

Spencer M, Reid JM.
Quantitation of carotid stenosis with continuous wave Doppler ultrasound.
Stroke 1979; 10:326-330

70 ou 90 ?

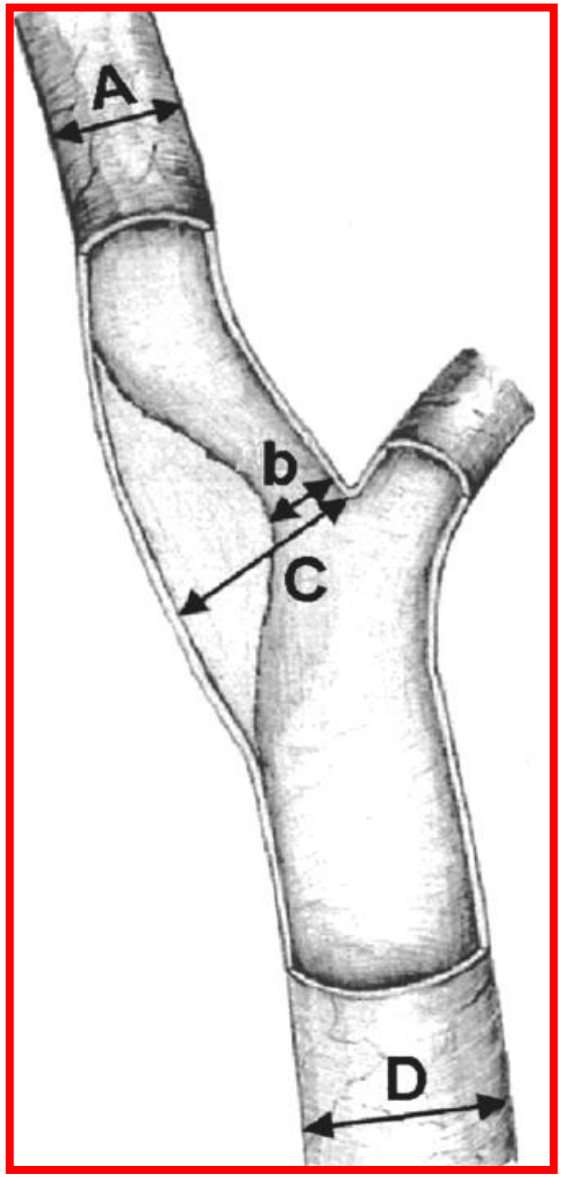
50 ou > 90 ?



NASCET, N Engl J Med 1991
ECST, Lancet 1991
ACAS, JAMA 1995
Naylor AR, Eur J Vasc Endovasc Surg 2003
ACST Lancet 2004

NASCET	ECST
30 %	65 %
40 %	70 %
50 %	75 %
60 %	80 %
70 %	85 %
80 %	91 %
90 %	97 %

Correspondances usuelles entre évaluations nord-américaine (NASCET-ACAS) et européenne (ECST) du mode de calcul d'une sténose carotidienne.



NASCET = b et A

ECST = b et C

2003

Critères de la SRU (2003)

TABLE 3
Consensus Panel Gray-Scale and Doppler US Criteria for Diagnosis of ICA Stenosis

	Primary Parameters		Additional Parameters	
Degree of Stenosis (%)	ICA PSV (cm/sec)	Plaque Estimate (%)*	ICA/CCA PSV Ratio	ICA EDV (cm/sec)
Normal	<125	None	<2.0	<40
<50	<125	<50	<2.0	<40
50–69	125–230	≥50	2.0–4.0	40–100
≥70 but less than near occlusion	>230	≥50	>4.0	>100
Near occlusion	High, low, or undetectable	Visible	Variable	Variable
Total occlusion	Undetectable	Visible, no detectable lumen	Not applicable	Not applicable

* Plaque estimate (diameter reduction) with gray-scale and color Doppler US.

Society of Radiologists in Ultrasound Consensus Conference
Radiology 2003; 229:340-346

2010

DEGUM

Deutsche Gesellschaft für
Ultraschall in der Medizin e.V.

The Neurosonology Research Group
of the World Federation of Neurology

2012

Stroke. 2012 Mar;43(3):916-21. doi: 10.1161/STROKEAHA.111.636084. Epub 2012 Feb 16.

Grading carotid stenosis using ultrasonic methods.

von Reutern GM[1], Goertler MW, Bornstein NM, Del Sette M, Evans DH, Hetzel A, Kaps M, Perren F, Razumovky A, von Reutern M, Shiogai T, Titianova E, Traubner P, Venketasubramanian N, Wong LK, Yasaka M; Neurosonology Research Group of the World Federation of Neurology.

Table 5C.1 Main and additional criteria for grading ICA stenosis

Degree of stenosis as defined by NASCET (%)	Grading of internal carotid stenosis						
	10–40	50	60	70	80	90	Occlusion
Main criteria							
1. B-mode image, diameter	Applicable	Possibly applicable					Imaging of occluded artery
2. Color Doppler image	Plaque delineation	Flow	Flow	Flow	Flow	Flow	Absence of flow
3. PSV threshold (cm/s)		125		230		NA	NA
4a. PSV average (cm/s)	≤160	210	240	330	370	Variable	NA
4b. PSV poststenotic (cm/s)				≥50	<50	<30	NA
5. Collateral flow (periorbital arteries or circle of Willis)				Possible	Present	Present	Present
Additional criteria							
6. Prestenotic flow (diastole) (CCA)				Possibly reduced	Reduced	Reduced	Reduced
7. Poststenotic flow disturbances (severity and length)		Moderate	Pronounced	Pronounced	Pronounced	Variable	NA
8. End-diastolic flow velocity in the stenosis (cm/s)			<100	>100		Variable	NA
9. Carotid radio ICA/CCA	<2	≥2	≥2	>4	>4	Variable	NA

CCA, common carotid artery; ICA, internal carotid artery; NA, not applicable; PSV, peak systolic velocity.

Source: reference [9]

von Reutern GM, Goertler MW, Bornstein NM, et al. Grading carotid stenosis using ultrasonic methods. Stroke. 2012; 43: 916–921

Table 1 The comparison of the main characteristics of the previous criteria for grading the internal carotid artery stenosis

Main characteristics	The consensus of the society of radiologists in ultrasound (2003)	The degum revision (2010)	The Neurosonology Research Group criteria (2012)
Easy to interpret and immediate	+++	+	+
Multi-parametric approach	+	++	+++
NASCET + ECST method	Only NASCET	+++	Only NASCET
% Detailed ICA degree of stenosis (grading in multiple steps)	+	+++	+++
Congruence of PSV values with angiogram curves and clinical menagement	+	+++	+++
Post-stenotic PSV evaluation	–	+++	+++
Clear concept of "near occlusion"	+++	–	–
Concept of "PSV average"	–	+	++
Insonation angle (very precise indications about)	–	–	–

DEGUM Deutsche Gesellschaft für Ultraschall in der Medizin, *NASCET* North American Symptomatic Carotid Endoarterectomy Study, *ECST* European Carotid Surgery Trial, *ICA* internal carotid artery, *PSV* peak systolic velocity; + only in part considered and explained; ++: considered and explained; +++: considered and explained with particular attention; –: not mentioned nor substantially considered

J Ultrasound. 2016 Feb 1;19(2):83-90. doi: 10.1007/s40477-016-0193-6. eCollection 2016.

Searching the perfect ultrasonic classification in assessing carotid artery stenosis: comparison and remarks upon the existing ultrasound criteria.

Mozzini C[1], Roscia G[2], Casadei A[3], Cominacini L[1].

Table 2 The Doppler criteria for grading the internal carotid stenosis according to the Authors' proposal

Degree of stenosis (NASCET) (%)	10	20–40	50	60	70	80	90	Occlusion
Degree of stenosis (ECST) (%)	40	50–60	70	75	80	90	95	Occlusion
Intra-stenotic PSV threshold (cm/s)		115–160	200	250	300	350–400	100–500	
Intra-stenotic end diastolic flow velocity (cm/s)				100	100	>100	>100	
Post-stenotic PSV (cm/s)					>50	<50	<30	
Carotid ratio (ICA/CCA)				≥2	≥2	≥4	≥4	
Pre-stenotic diastolic flow (cm/s)					Possibly reduced	Reduced	Reduced	Reduced

NASCET North American Symptomatic Carotid Endoarterectomy Study, *ECST* European Carotid Surgery Trial, *PSV* peak systolic velocity, *ICA* internal carotid artery, *CCA* common carotid artery

Critères additionnels

- 1. L'emplacement de la plaque;
- 2. L'extension de plaque et la plaque diamètre maximal (mm), transversal et-ou section longitudinale;
- 3. Les détails de surface de plaque (lisse, irréguliere, très irréguliere);
- 4. Classification GRAY WEALE :
  - type 1: uniformément anéchogène ou hypoechogène
  - type 2: principalement ([50 %) hypoechogène
  - type 3: principalement ([50 %) hyperechogène
  - type 4: uniformément hyperechogène
  - type 5: uniformément echogene avec cône d'ombre postérieur

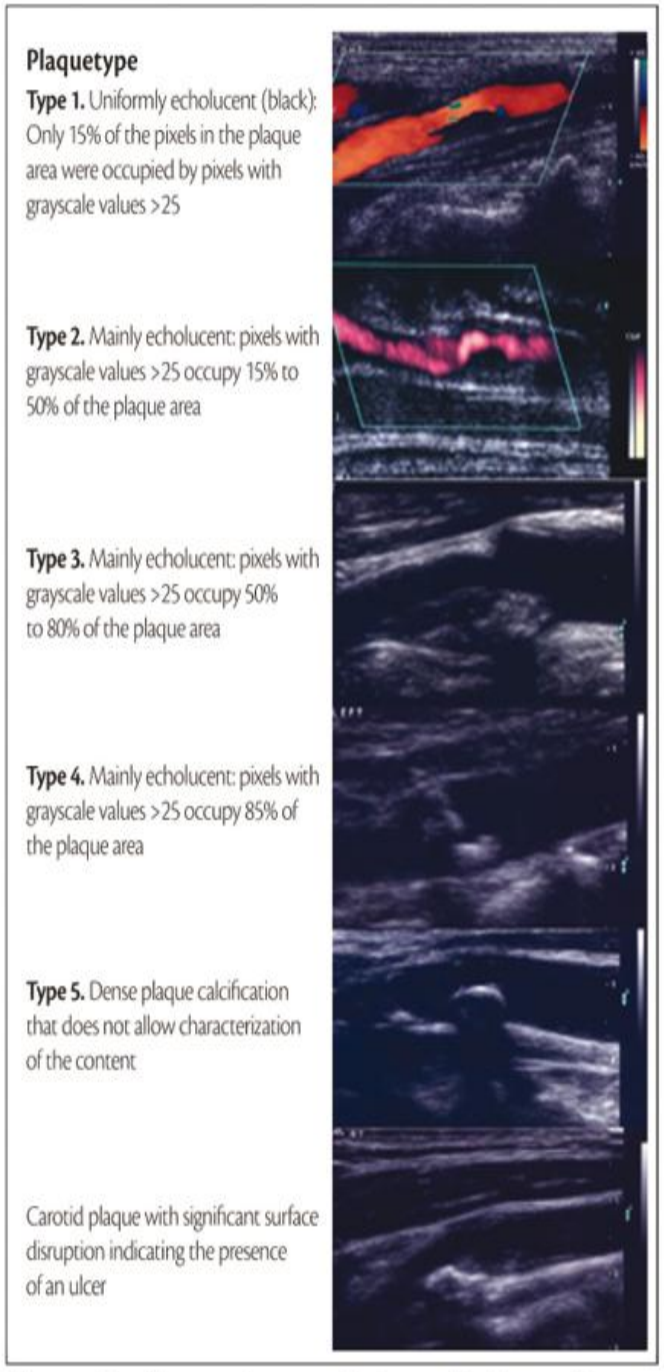


Figure 1. Carotid artery plaque morphology and its characteristics.

Critères additionnels

- 5. Le rapport de réduction de surface ou la réduction de diamètre (tant selon la méthode NASCET que l'ECST) avec la déclaration claire du % de sténose selon la méthode NASCET et, entre parenthèses, à l'ECST;

- 6. PSV intra sténotique et le flux diastolique (cm/s), PSV pré et post-sténotique (cm/s)
- 7. Le ratio carotidien PSV ICA/ACC;
- 8. L'évaluation des flux collatéraux
- 9.L’angle d’insonation Doppler;
- 10. EDTC évaluation polygone Willis, AComA, stenose tandem, sens ACR.

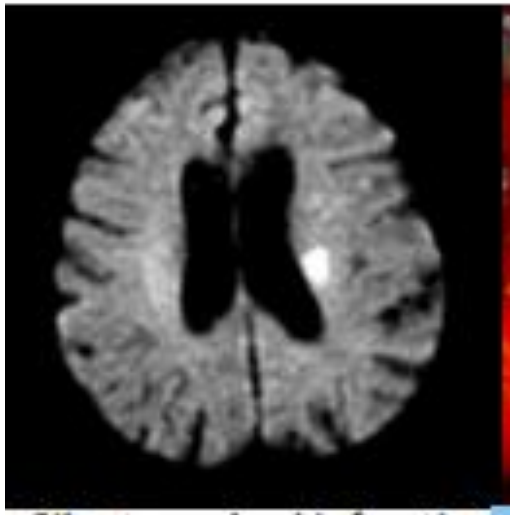
Some clinical and imaging features associated with an increased risk of stroke in patients with asymptomatic carotid stenosis treated medically

Clinical	• Contralateral TIA/stroke
Cerebral imaging	• Ipsilateral silent brain infarction
Ultrasound imaging	• Stenosis progression (> 20%) • Spontaneous embolization on transcranial Doppler (HITS) • Impaired cerebral vascular reserve • Large plaques • Echolucent plaques • Increased juxta-luminal black (hypoechogenic) area
MRA	• Intraplaque haemorrhage • Lipid-rich necrotic core

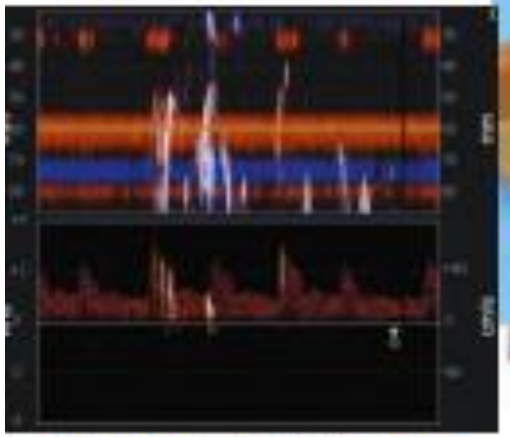
Which patients with asymptomatic carotid stenosis benefit from revascularization?

A. Ross Naylor

Features associated with increased risk of stroke in patients with asymptomatic carotid stenosis treated medically

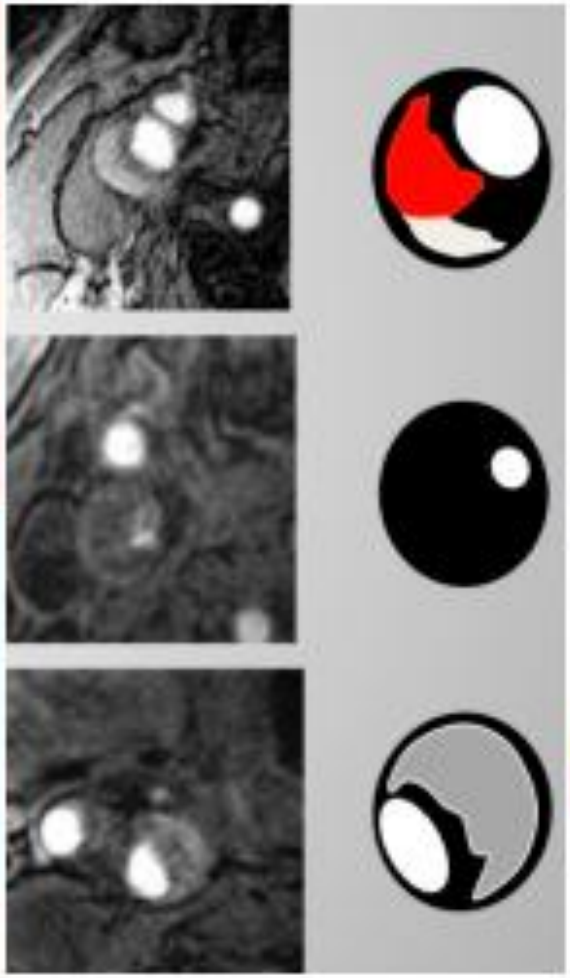


Silent cerebral infarction

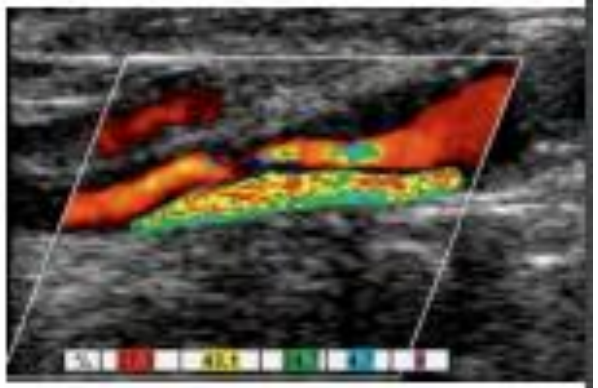


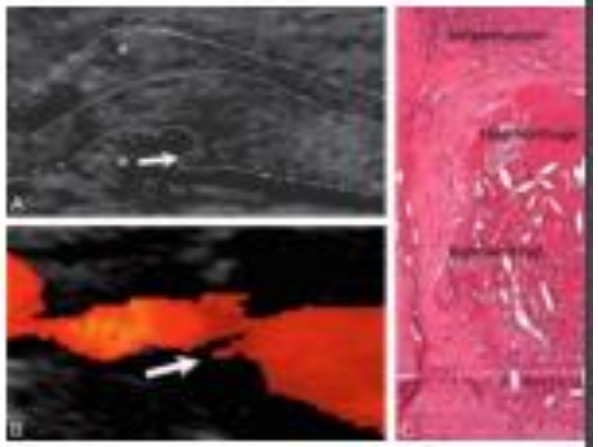
TCD-microembolic signal

intraplaque haemorrhage



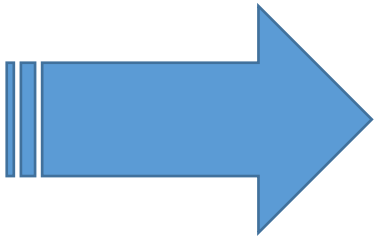
MRI: different types of plaque





DU: hypoechogenic and ulcerated plaques

- **34%** d'Evénements ischémiques pour les sténoses **<60%**
  - – Nicolaides ACSRS eur j vasc endovasc surg 2005



- **Identifier ces plaques vulnérables**

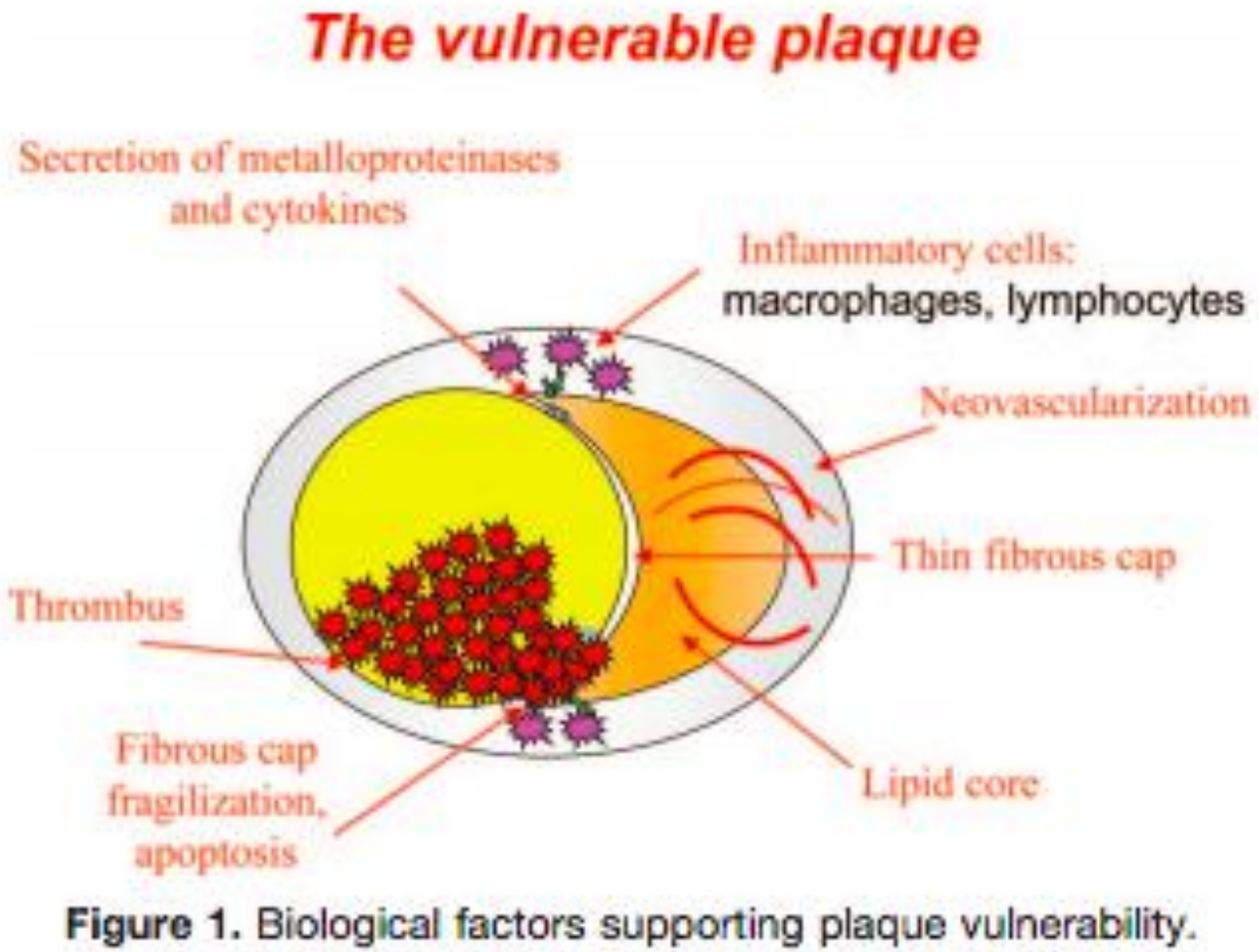


Figure 1. Biological factors supporting plaque vulnerability.

Plaque instable/stable

- **plaque « stable »**
  - chape fibreuse Epaisse et petit coeur lipidique
- **plaque « instable »**
  - chape fibreuse fine et coeur lipidique important

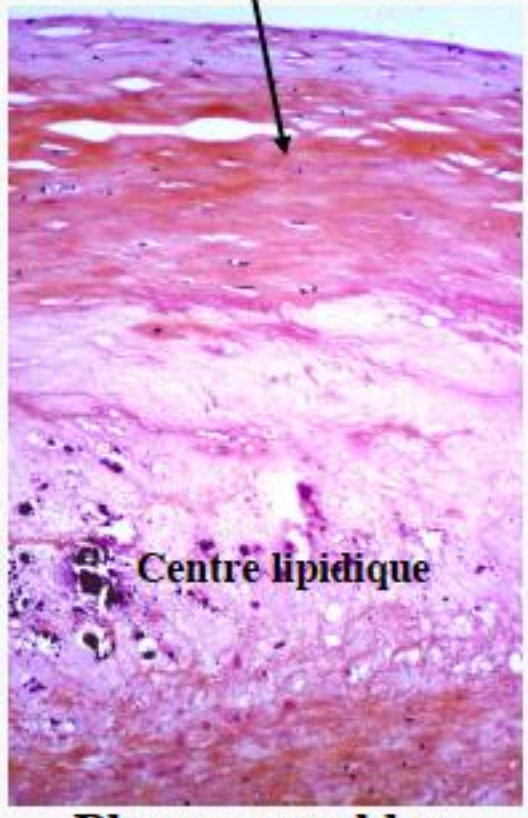
• Plaque vulnérable

• plaque à haut risque d'AVC par embole cruorique ou Athéromateux >> Histologie

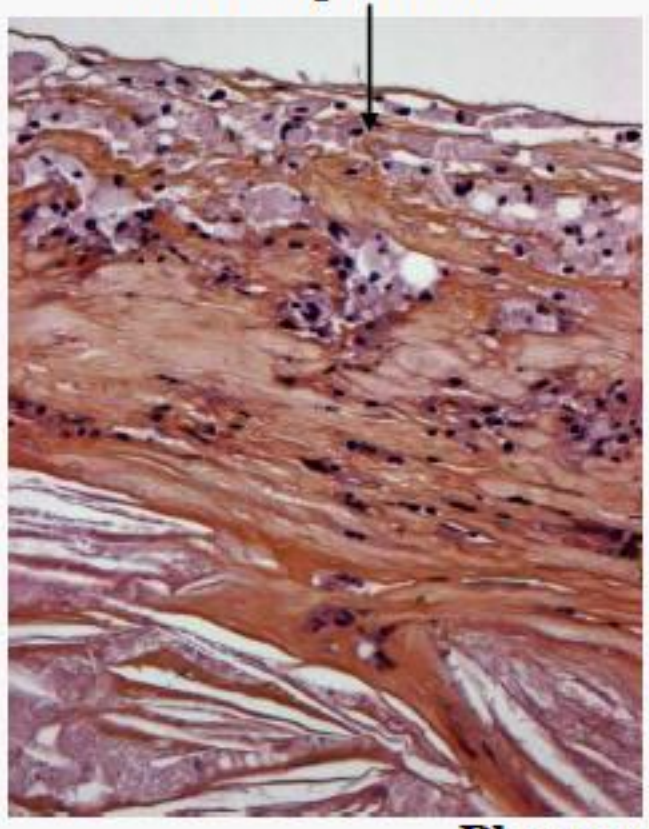
The Vulnerable Carotid Artery Plaque Current Imaging Methods and New Perspectives
Norbert Nighoghossian, MD; Laurent Derex, MD; Philippe Douek, MD
(Stroke. 2005;36:2764-2772.)

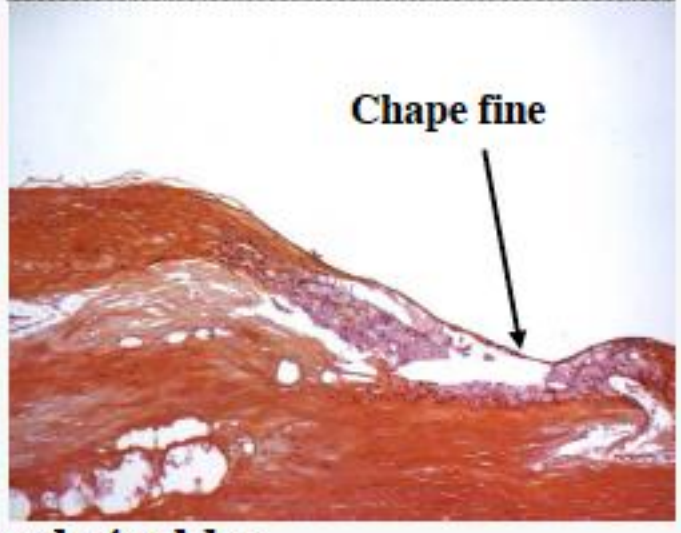
Plaque vulnérable/ histologie

- Plaque vulnérable sur le plan histologique
  - Riche corps lipidique
    - (> 25% de la plaque)
  - Chape fibreuse
    - fine moins de 7 microm
    - ou ulcérée
  - Infiltrat inflammatoire
  - Néo-vascularisation
  - Hémorragie intra-plaque



Plaque « stable »





Plaques vulnérables

Shear rate is a better marker of symptomatic ischemic cerebrovascular events than velocity or diameter in severe carotid artery stenosis

Nizar Hariri, MD,[a] Todd Russell, MD,[a] Gregory Kasper, MD,[a] *and* Fedor Lurie, MD, PhD,[a,b] *Toledo, Ohio; and Ann Arbor, Mich*

Presented as a plenary presentation at the 2018 Vascular Annual Meeting of the Society for Vascular Surgery, Boston, Mass, June 20-23, 2018

https://doi.org/10.1016/j.jvs.2018.04.036

Shear Rate Predicts Symptoms of High Grade Carotid Stenosis

Case-control study | 308 patients | 99 (32%) symptomatic

$$WSR = 32Q / \pi D^3$$

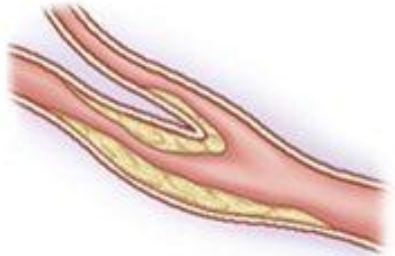
Shear Rate: Ratio of highest carotid PSV & smallest diameter

12x More likely to have symptoms if shear rates **≥ 8000 s^{-1}**

Mean Shear Rates

Symptoms: **9338 s^{-1}**

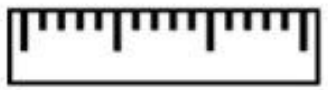
No Symptoms: **7930 s^{-1}**



Shear rate 8000 s^{-1}

better predictor of symptoms in patients with carotid stenosis than:

velocity



diameter

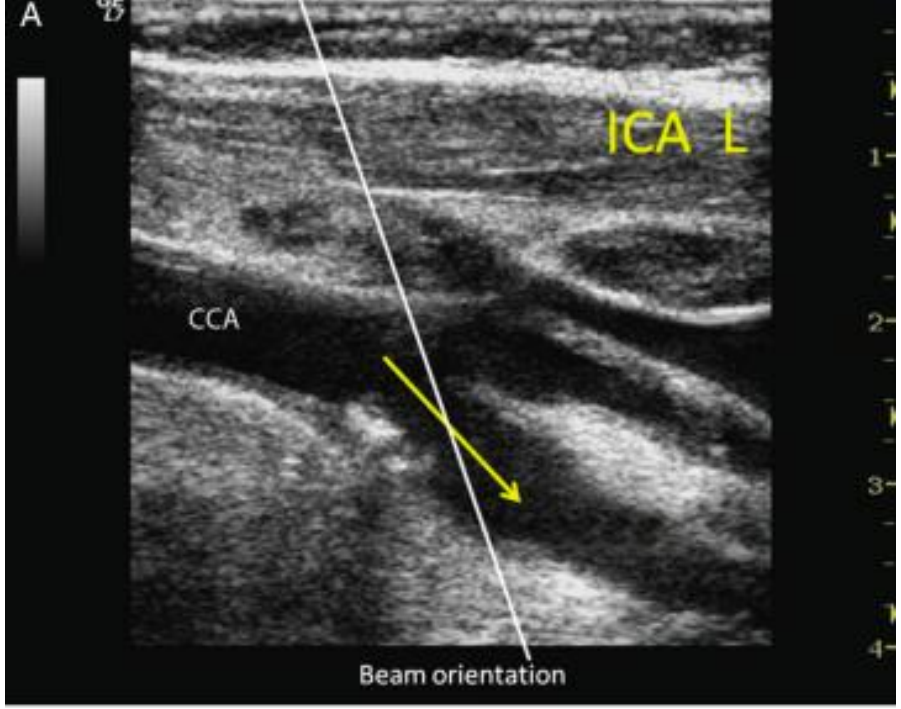
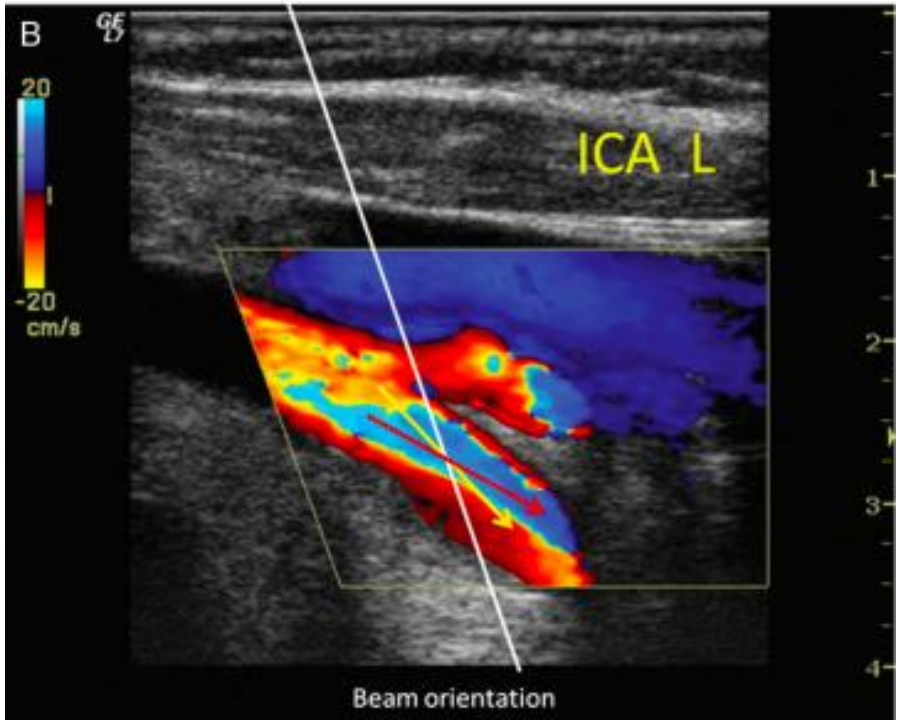
(Receiver operating characteristic curve analysis)

JVS Journal of Vascular Surgery
Official Publication of the Society for Vascular Surgery

Hariri et. al. *J Vasc Surg*

Copyright © 2018 by the Society for Vascular Surgery®

@JVascSurg
@TheJVascSurg

SYNTHESE

- Examen EXIGEANT et **exigeant** une ***méthodologie rigoureuse applicable à tous, utilisée par tous.***
- Examen ***symétrique*** de tous les axes
- **Maitrise des paramètres techniques Doppler**
- **Angle d'insonation doppler +++++**
- **Déclarer le mode de calcul utilisé : NASCET ou ESCET**
- **PSV seul ne suffit pas : au moins 4 paramètres (+ critères additionnels)**
- **Concordance entre les différents paramètres.**