Centre Neurovasculaire Genève

Hôpitaux Universitaires Genève

Sténoses carotidiennes

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Service de Neurologie

HUG

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Centre Neurovasculaire Genève

Hôpitaux Universitaires Genève

Plan

- Etiologies
- Quantification du degré de sténose
- Prise en charge
  - Sténoses symptomatiques
  - Sténoses asymptomatiques
- Screening

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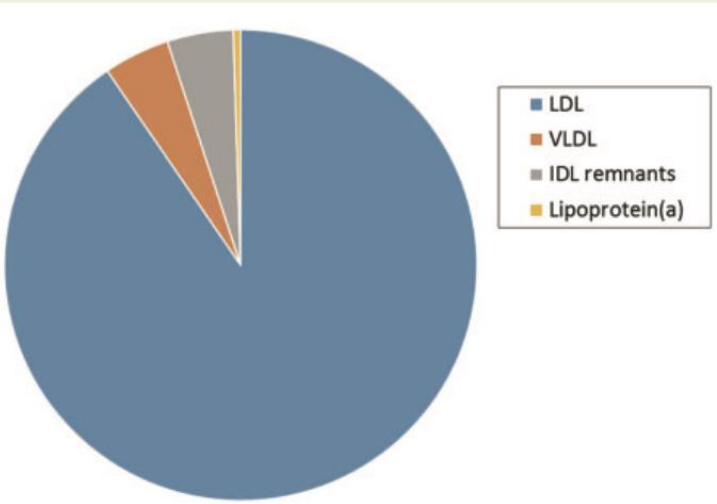
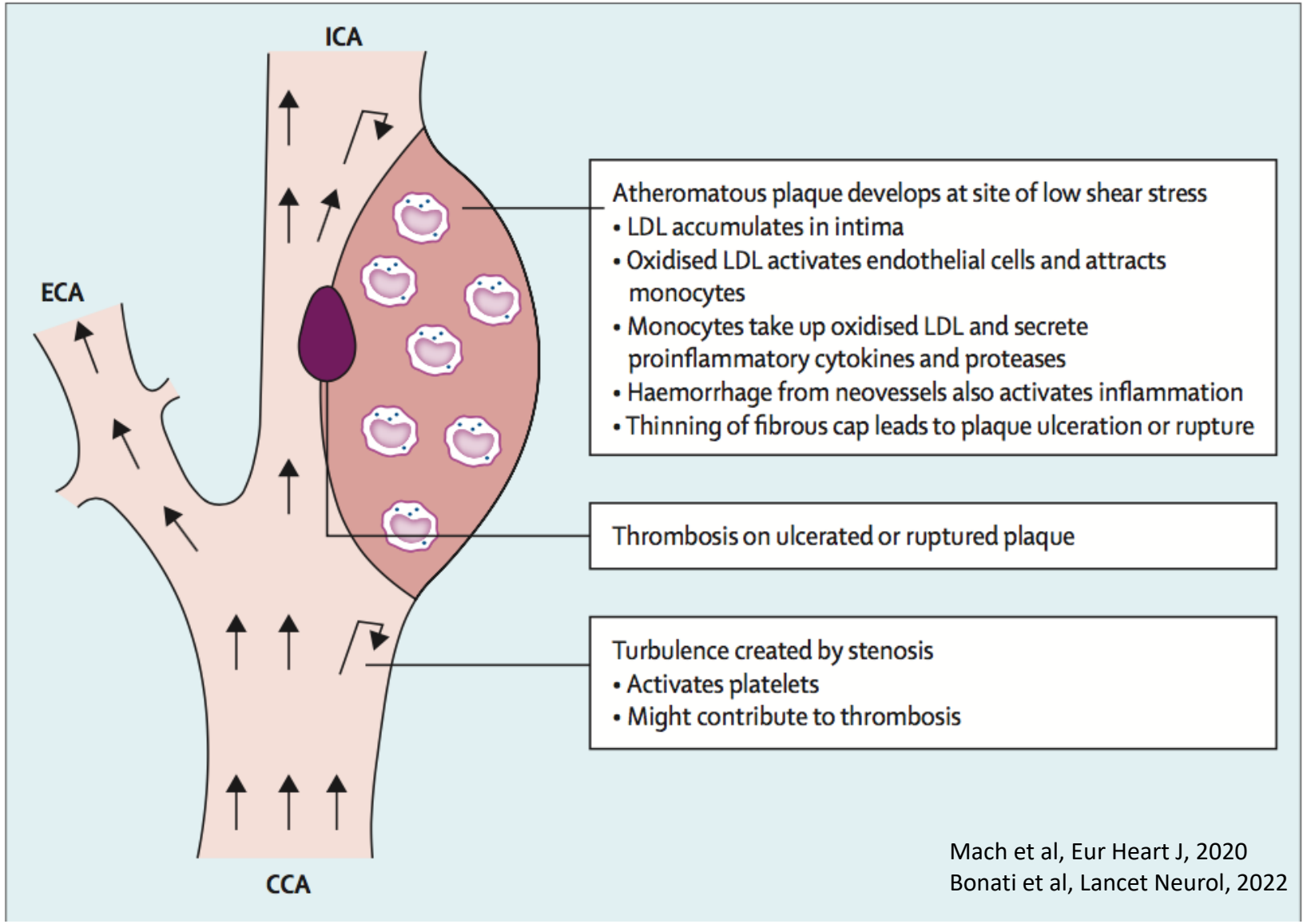
Etiologies des sténoses carotidiennes

Athérosclérose



	Density (g/mL)	Diameter (nm)
Chylomicrons	<0.95	80–100
VLDL	0.95–1.006	30–80
IDL	1.006–1.019	25–30
LDL	1.019–1.063	20–25
HDL	1.063–1.210	8–13
Lp(a)	1.006–1.125	25–30

Apo = apolipoprotein; HDL = high-density lipoprotein;



Mach et al, Eur Heart J, 2020
Bonati et al, Lancet Neurol, 2022

Athérosclérose

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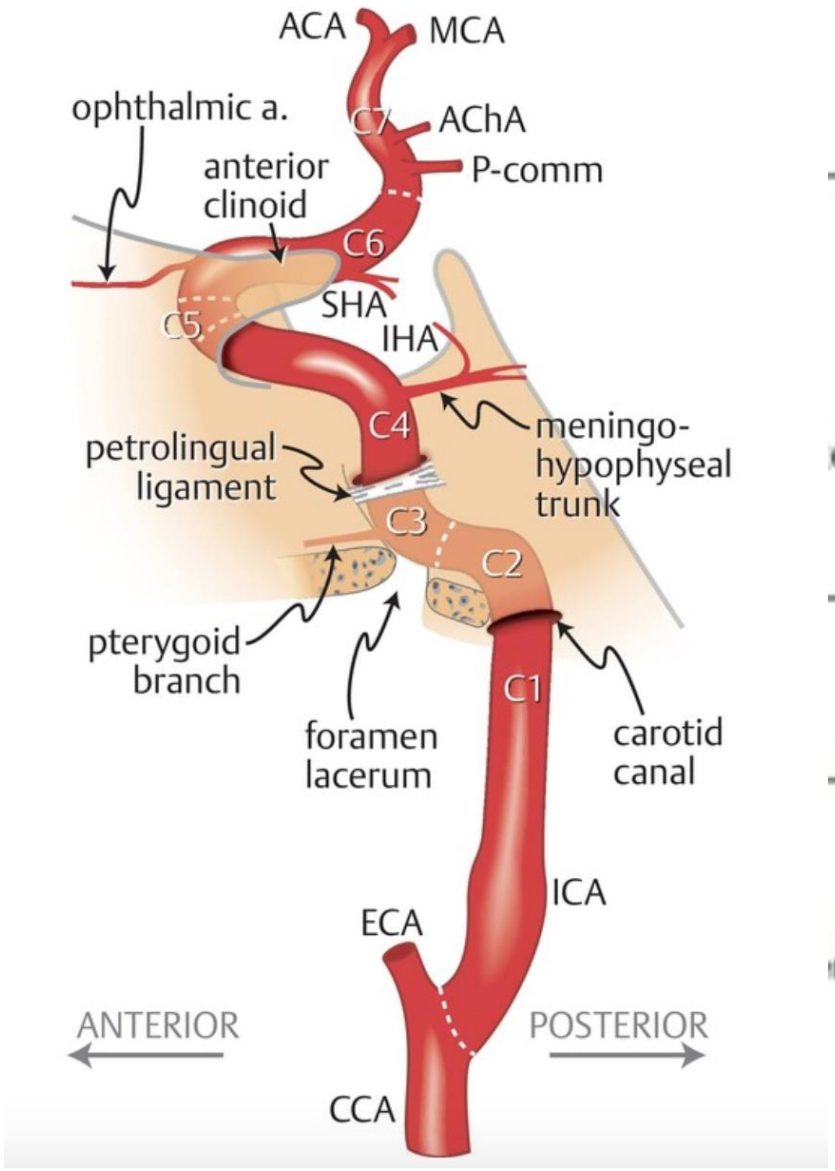

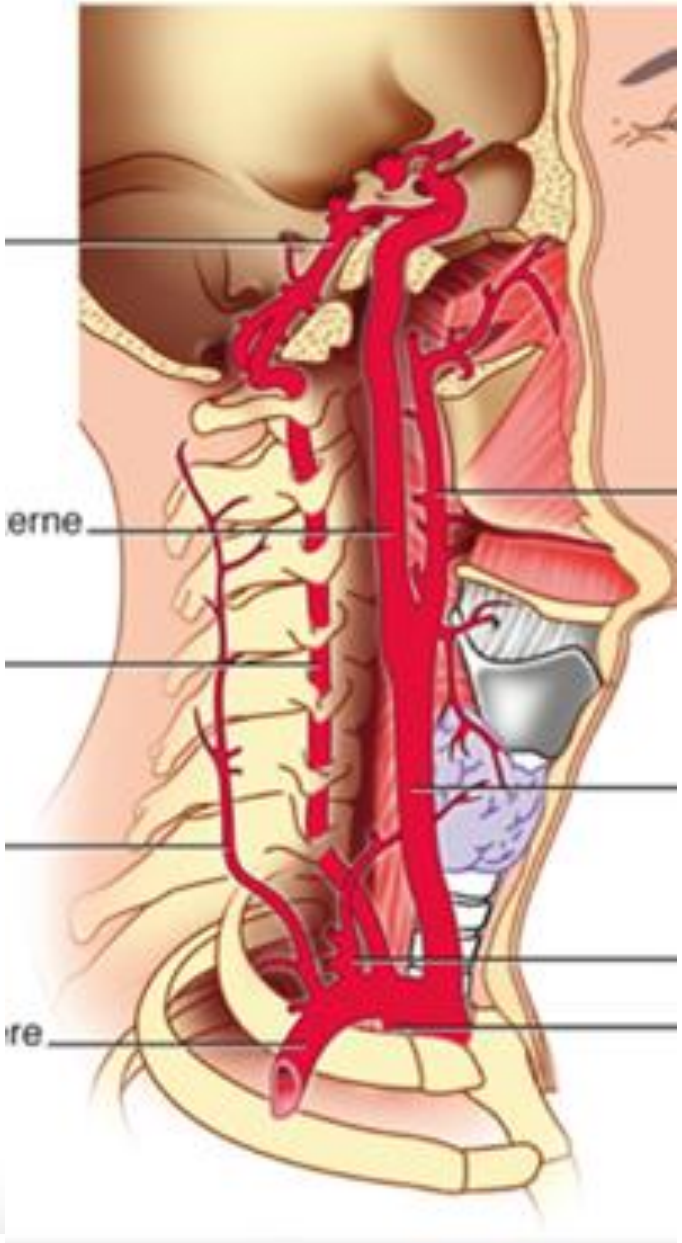

Illustrations: Anaïck Péron; Greenberg, Handbook of Neurosurgery, New York: Thieme, 2019

Athérosclérose – AVC (15-20%)

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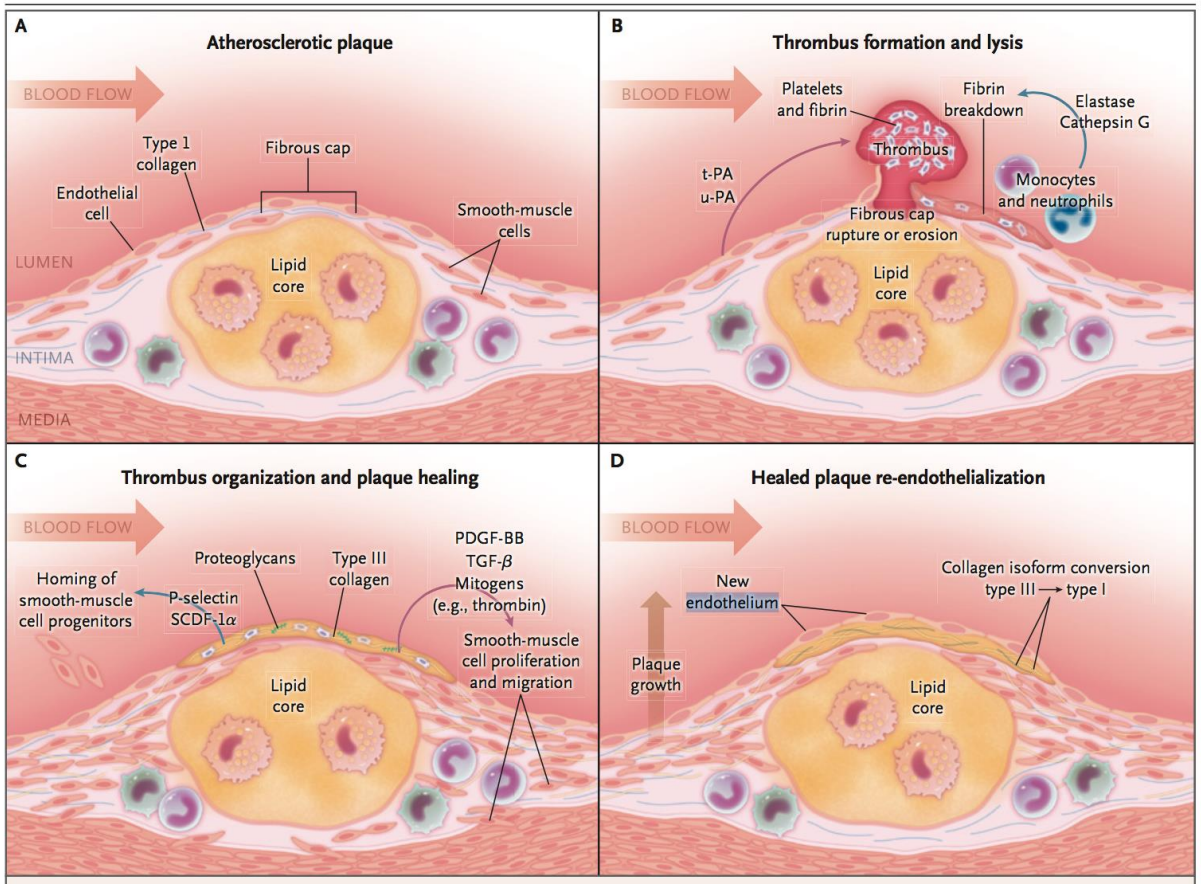
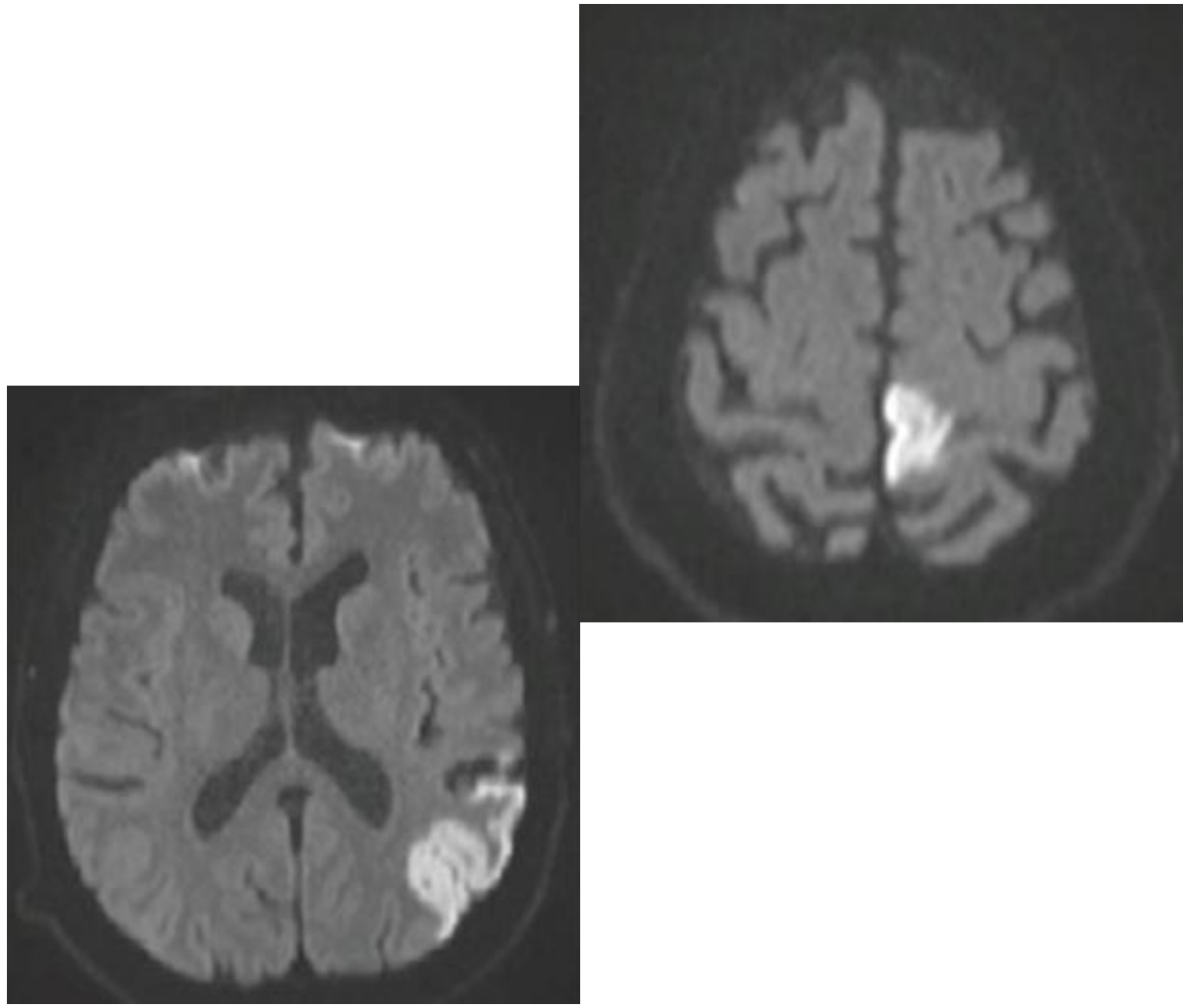
1) Embolisation





Dalager et al, Stroke 2007

Athérosclérose - AVC

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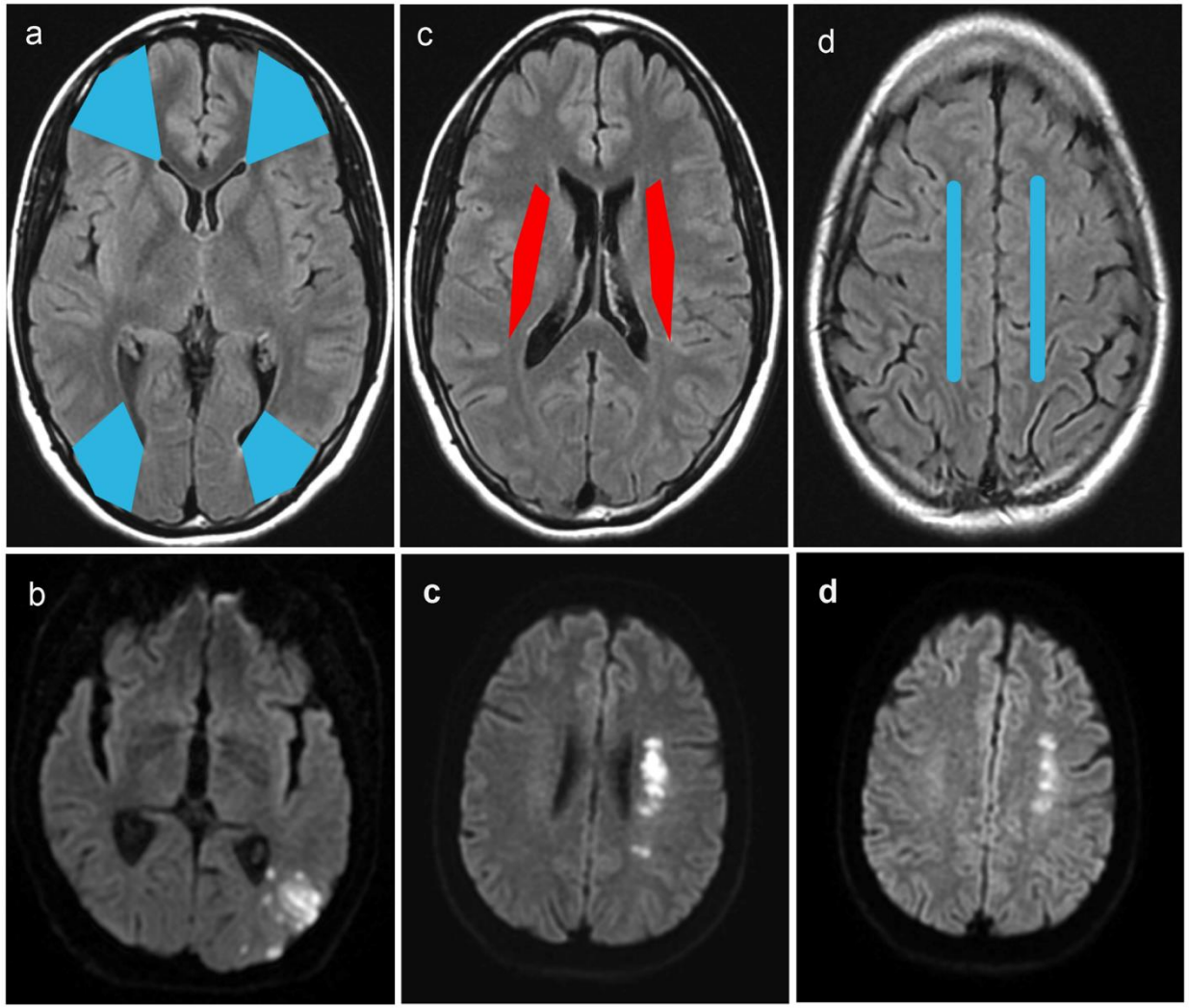
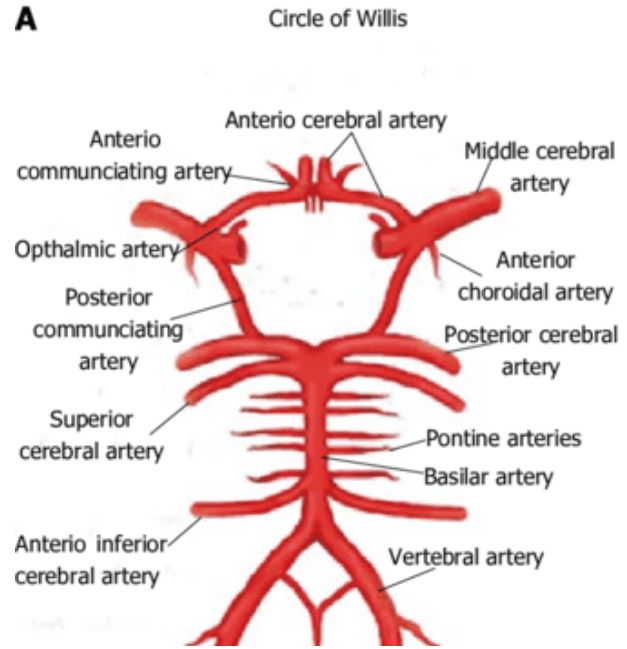
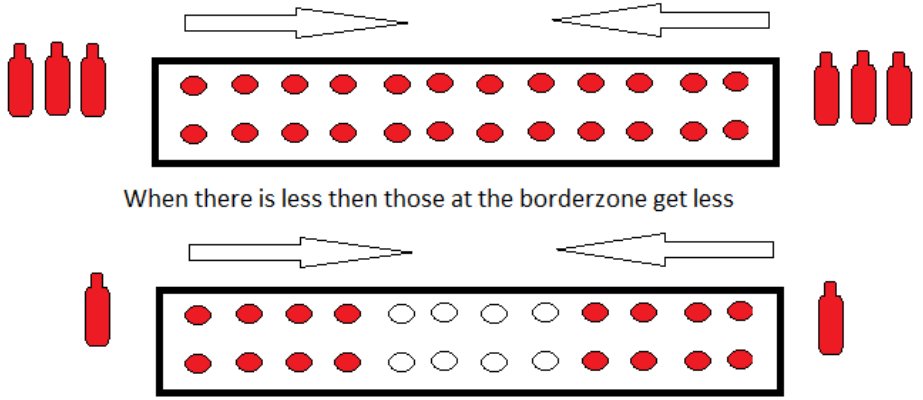
2) Bas débit





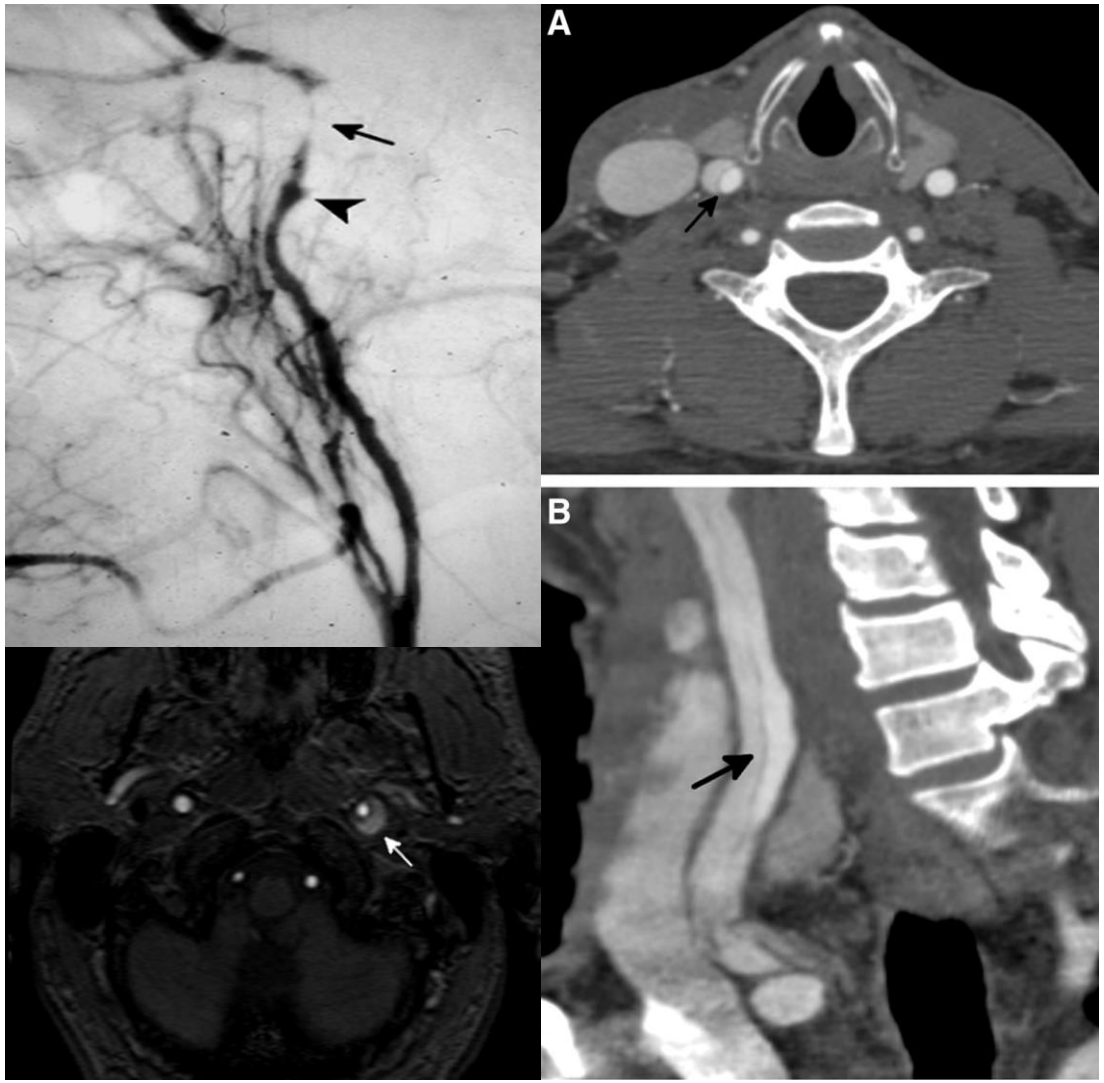
Principles of watershed infarcts - when there is plenty all get supplied



When there is less then those at the borderzone get less

Isabel et al, PLOS,2014
https://neurovascularmedicine.com/

Dissection: hématome de paroi



- Déchirement de l'intima spontannée ou traumatique
- Incidence: 2.6-5/100'000
- Âge moyen 40-50 ans

Facteurs de risque (si absence de traumatisme sévère):

- Anomalies artérielles: dysplasie fibromusculaire, maladies du collagène (Ehler-Danlos, Syndrome de Marfan, Osteogenesis imperfecta, maladie polykystique des reins autosomique dominante)
- Traumatismes mineurs
- Infections respiratoires

Patel et al, Cardiology in Review, 2012; Robertson et al, JEMJ, 2016

Dissection: hématome de paroi

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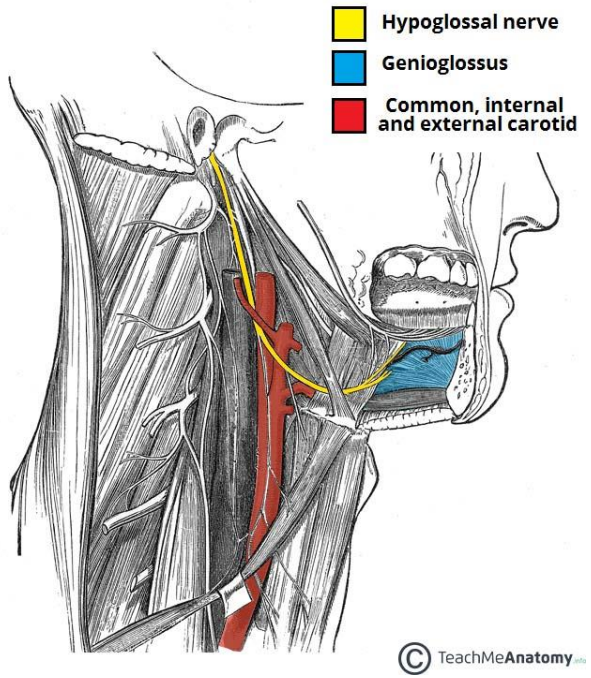
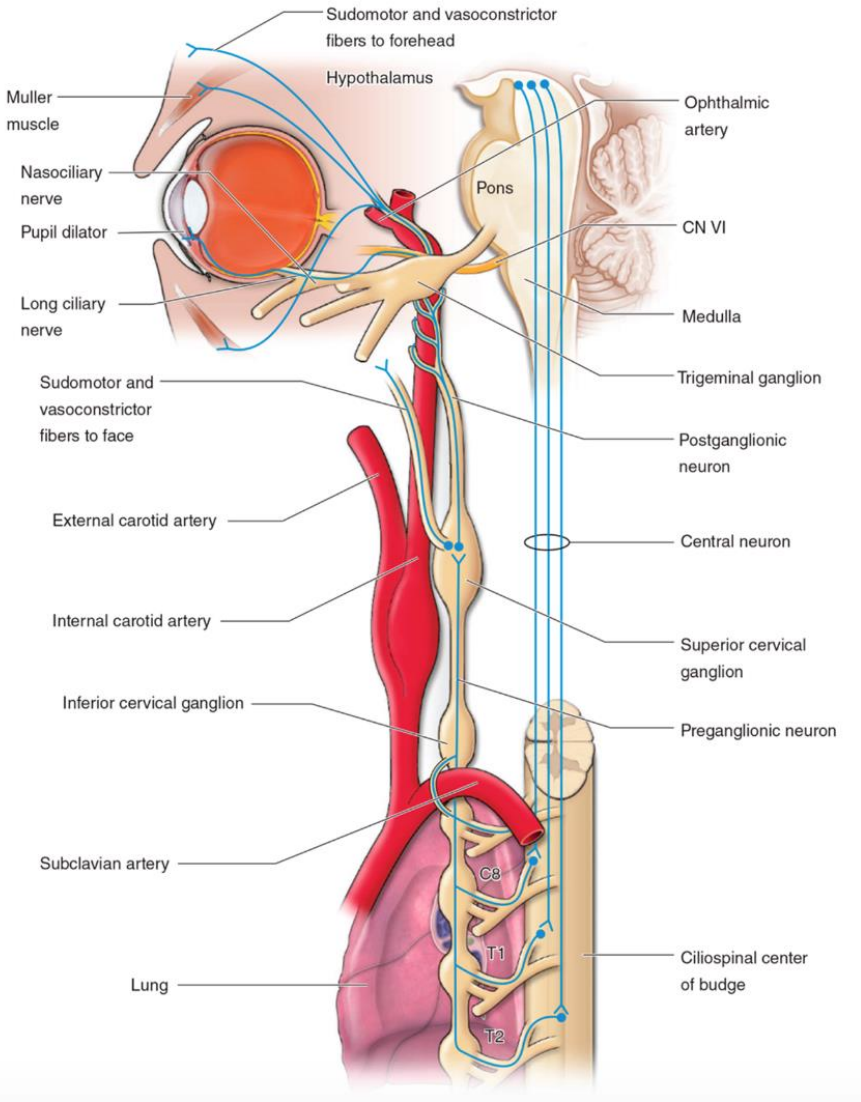
Cliniquement:

- **Douleurs**
- **Syndrome de Claude Bernard Horner** (miosis, ptosis, PAS d'anhidrose)
- **Atteinte du NC XII**
- **AVC**: thrombus (alteration du flux, lésion intimale → facteurs thrombogéniques); bas debit → 1-2 % des AVC, 20-25% des AVC chez les jeunes





Thanvi et al, PMJ, 2005
Martin, ACS Chem Neurosci, 2018

Maladie carotidienne non-athérosclérotique

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- **Inflammatoire**: artérite de Takayasu, Horton

- **Dysplasie fibromusculaire**: vasculopathie non-inflammatoire caractérisée par une dysplasie des petits et moyens vaisseaux. Alternance de rétrécissement et dilatation artérielles, principalement dans la circulation rénale et cérébrale.

- **Syndrome de Moya-Moya**: vasculopathie non-inflammatoire caractérisée par l'apparition progressive de sténoses de l'artère carotide interne distale et des portions proximales des artères cérébrales moyennes.

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Quantification (Sténoses athéromateuses)

Mesure d'une sténose

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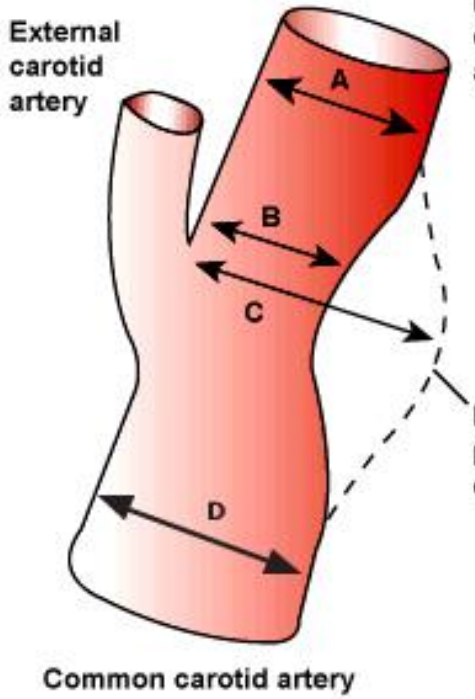
Morphologie:

- **NASCET** (HUG: *CT, IRM*)
  North American Symptomatic Carotid Endarterectomy Trial
- **ECST** (HUG: *doppler*)
  Europeant Carotid Surgery Trial



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

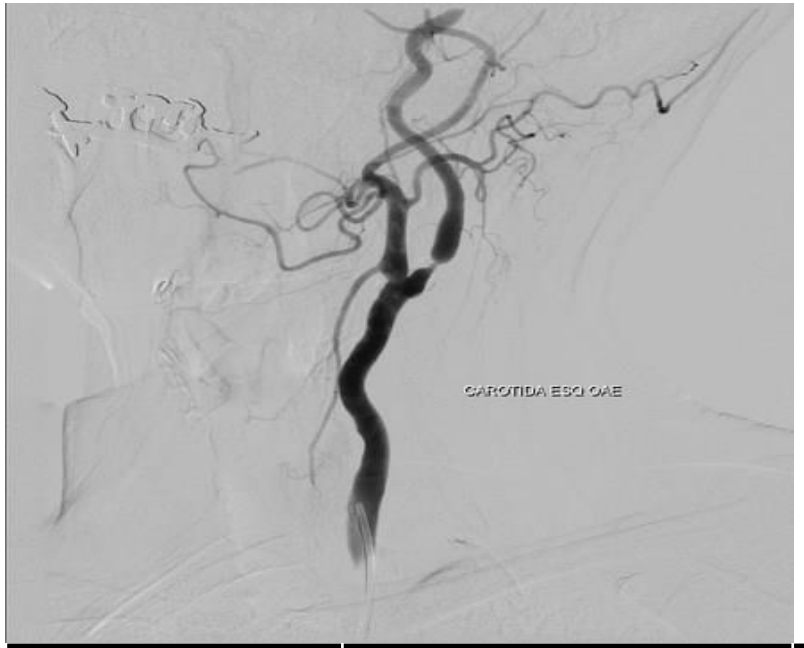
Approximate equivalent degrees of internal carotid artery stenosis used in NASCET and ESCT according to recent direct comparison

NASCET $\frac{A-B}{A}$ ECST $\frac{C-B}{C}$ CC $\frac{D-B}{D}$

Sténose significative dès ECST > 50%

Donnan et al, Lancet, 1998

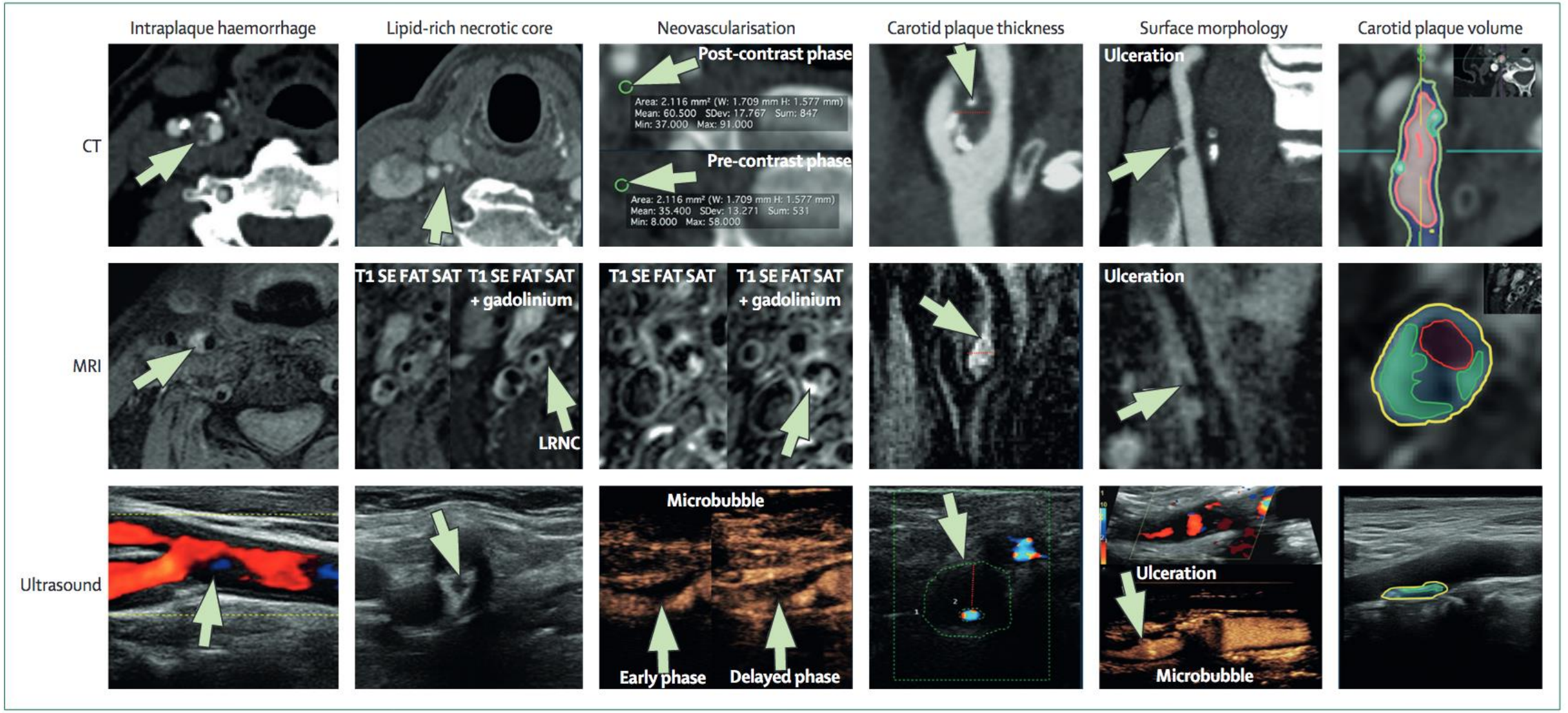
Imagerie



	Artériographie	Doppler	Angio-CT	Angio-IRM
Sens/Spéc. (%)	GOLD STANDARD	89/84	77/95	91/88
Analyses		Morphologie Hémodynamique	TSA complet Anatomie vasculaire	AVC silencieux Hémorragie intraplaque
Limitations	AVC (0.3-3%; centres expérimentés <0.5%)	Calcifications Variabilité	Calcifications Allergies Irradiation	Majore degré sténose Artefact flux

Furie, Uptodate; Radiopaedia.org; AHA/ASA Guidelines, Stroke, 2021

Critères de vulnérabilité



Saba et al, Lancet Neurol, 2019

Angio-CT

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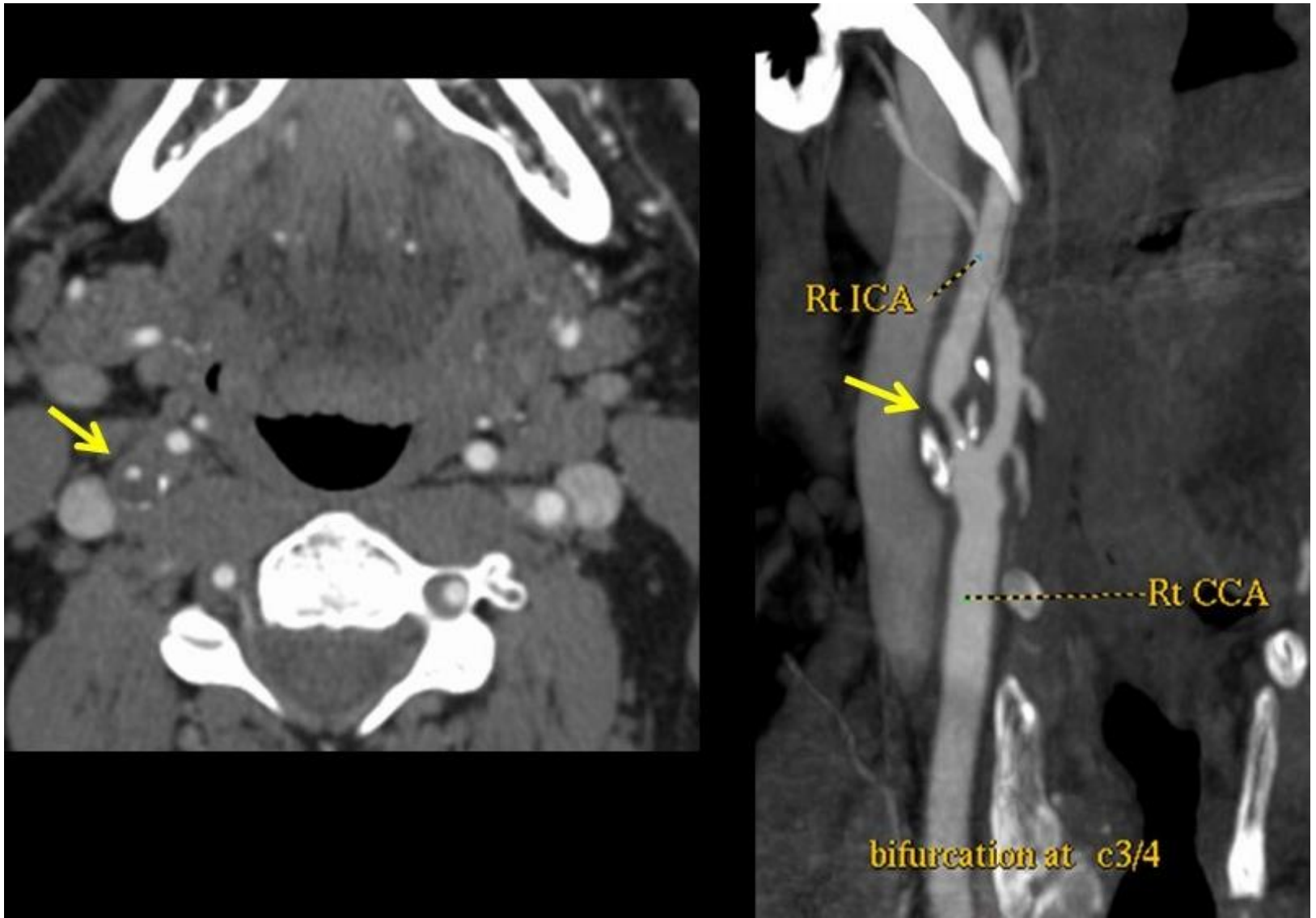
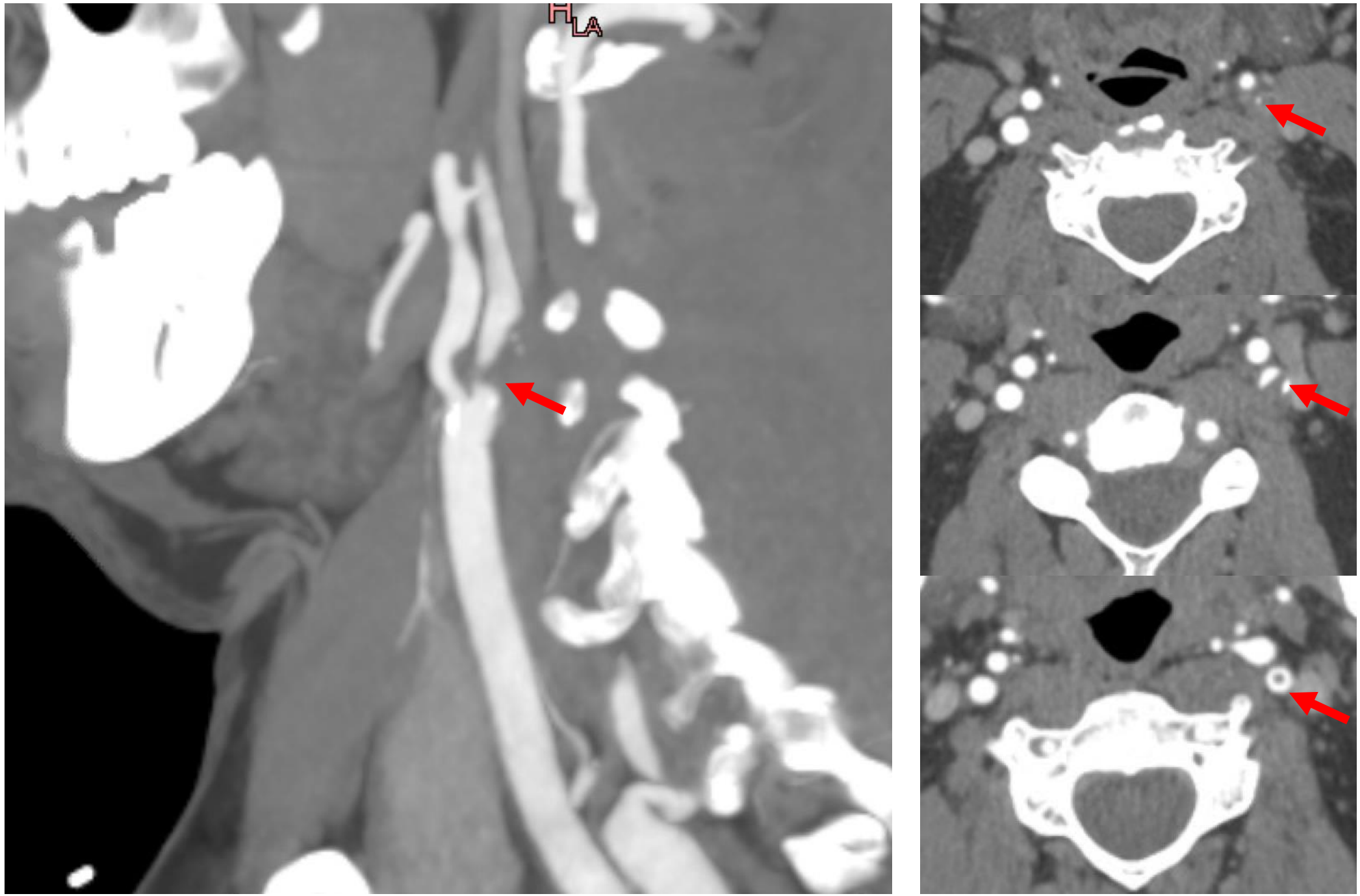


- Degré de sténose morphologique
- Caractérisation de la plaque (irrégularité, composante molle vs calcifiée, présence d'un thrombus flottant,…)

Dpt of Radiology, University Wisconsin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LA

Angio-IRM

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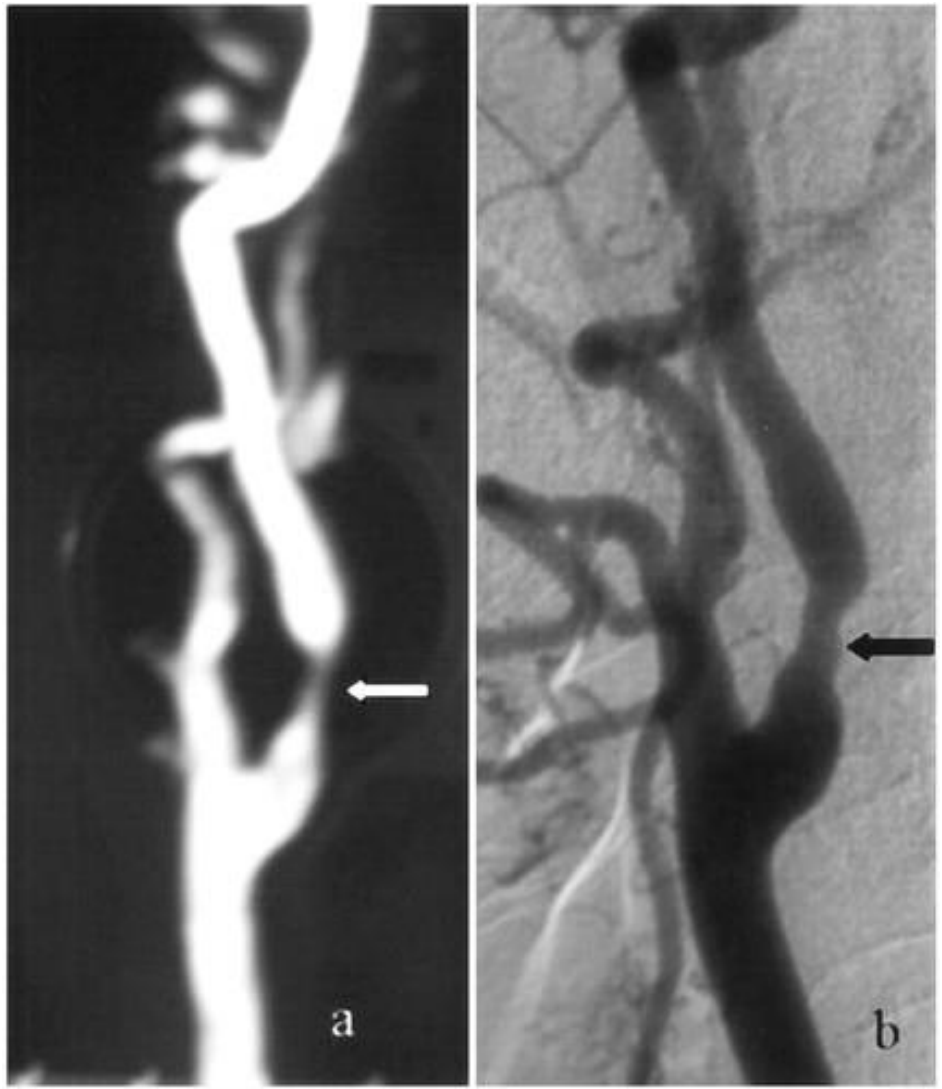
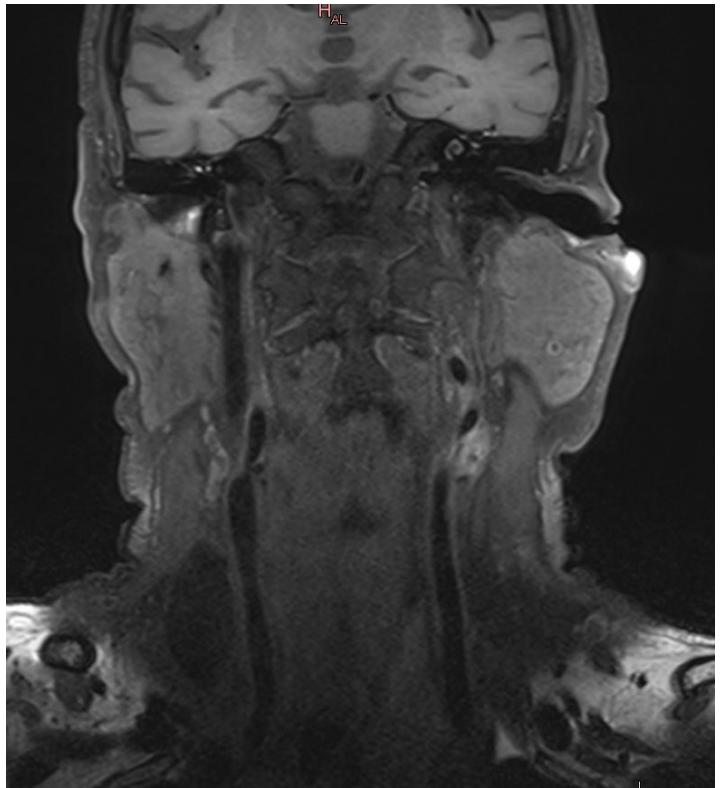


- Degré de sténose morphologique
- Caractérisation de la plaque (irrégularité, hémorragie intraplaque)
- Recherche de lésions ischémiques silencieuses
- CAVE surestimation du degré de sténose



Cosottini et al, 2003

DCV/DTC

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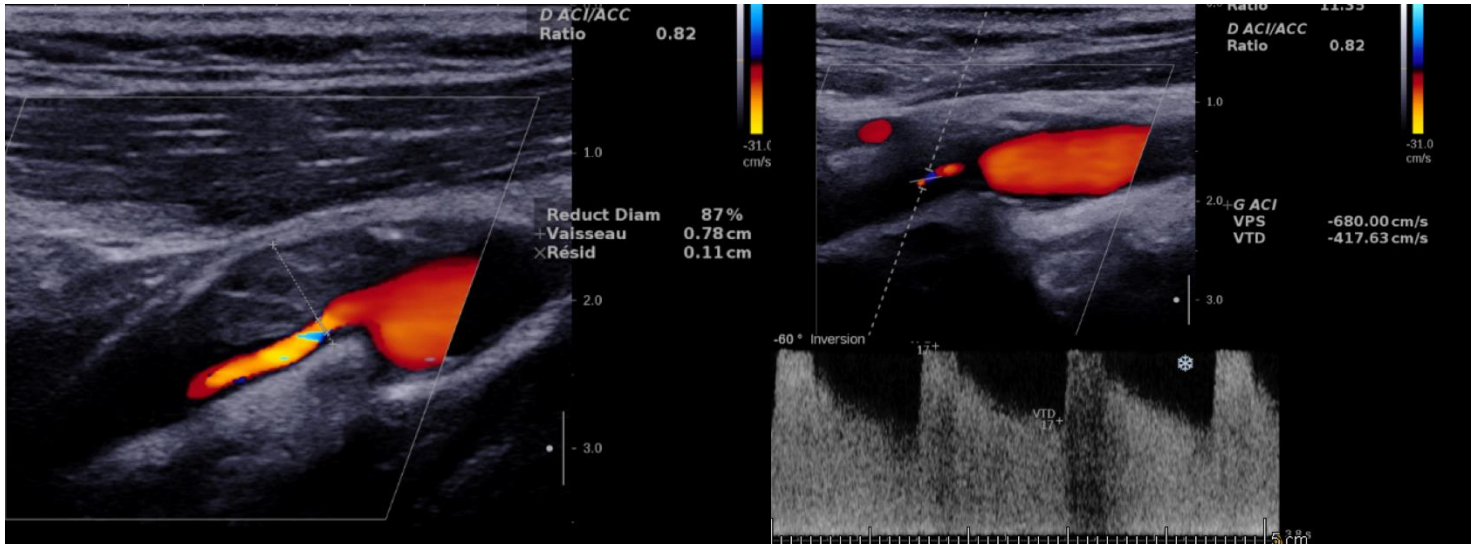
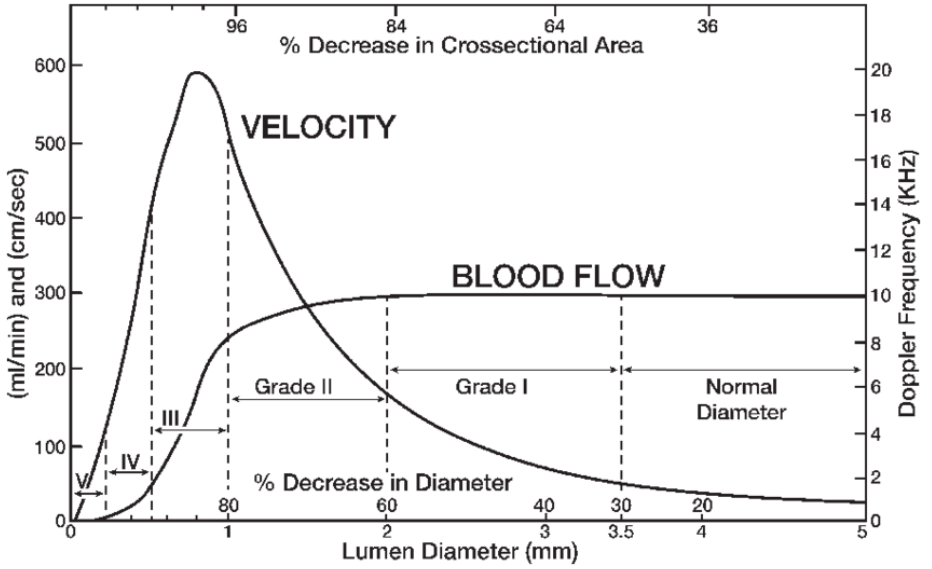
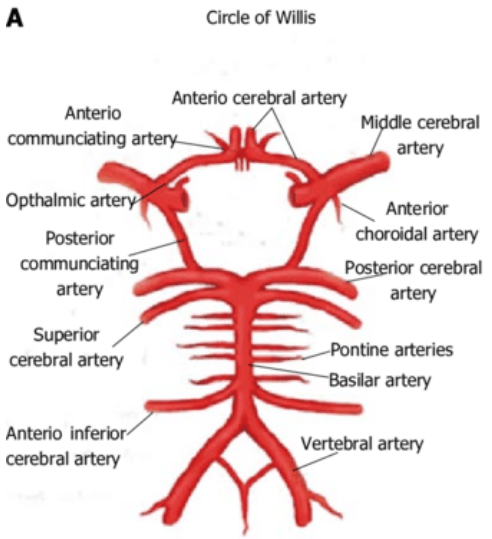
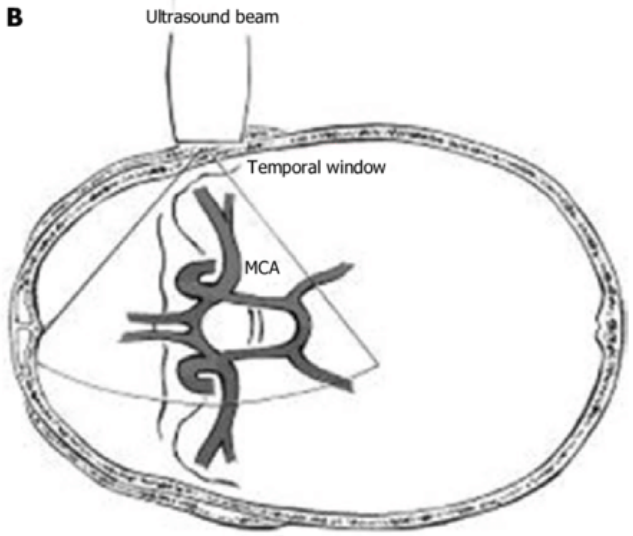
- Degré de sténose morphologique (calcifications)
- Caractérisation de la plaque (morphologie, échogénicité, néovascularisation)
- Flux au niveau et en aval de la sténose
- Répercussion hémodynamique intracérébrales
- Détection d'emboles

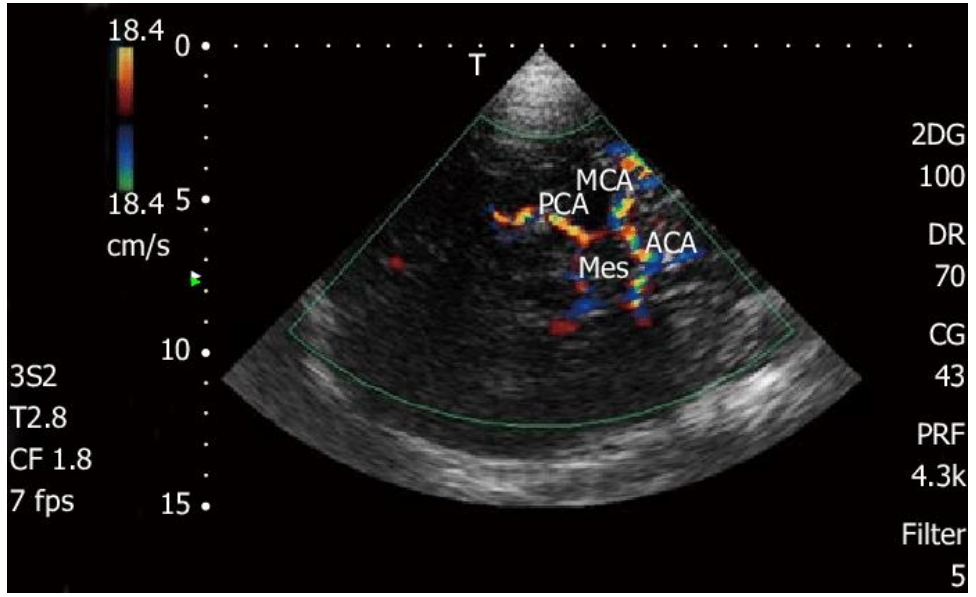




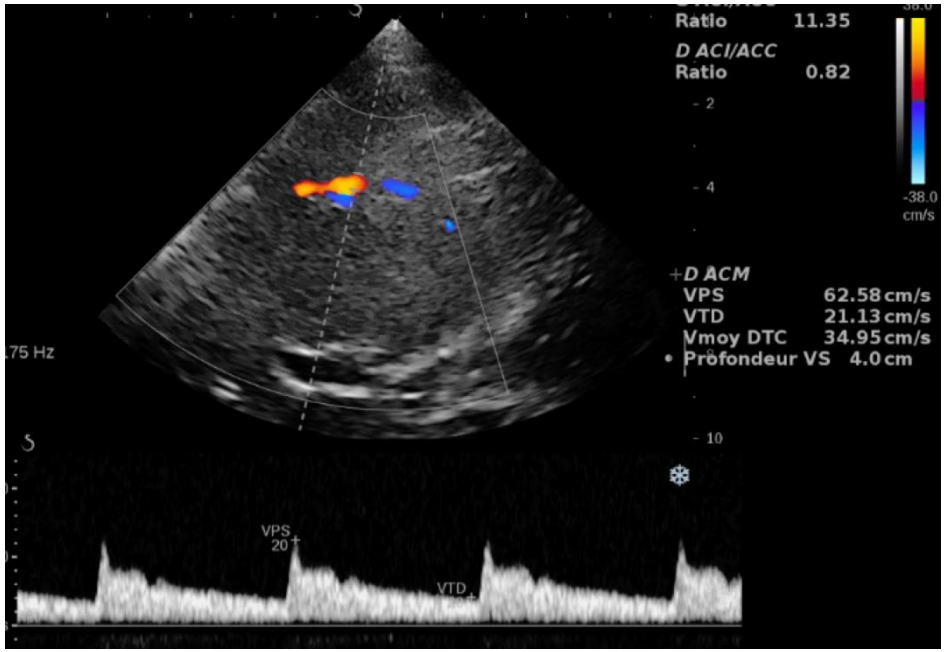
Spencer and Reid, 1979



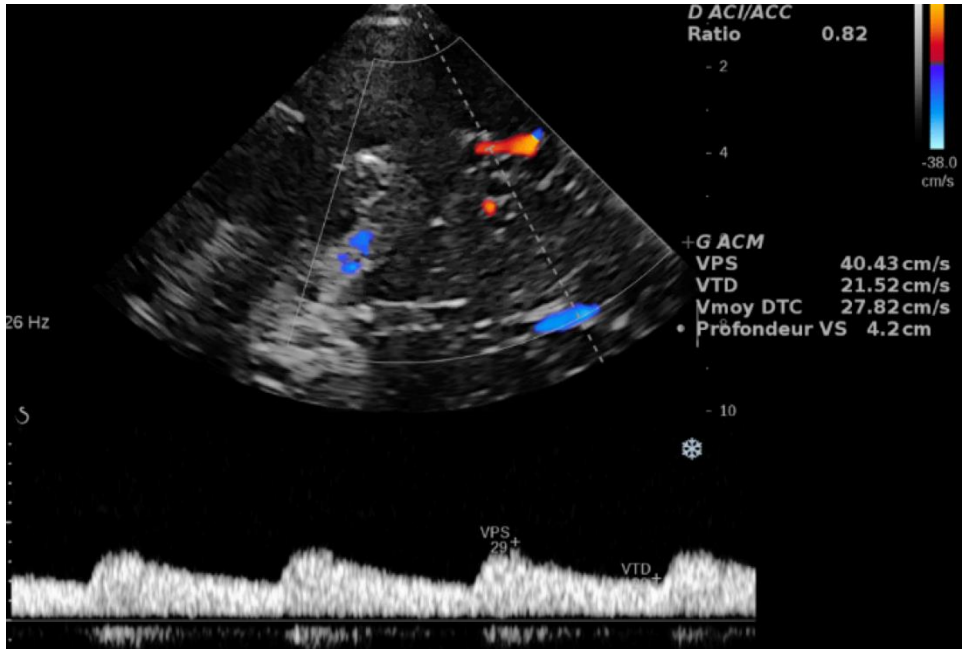




Flux normal



Flux amorti



D'Andrea et al, 2016

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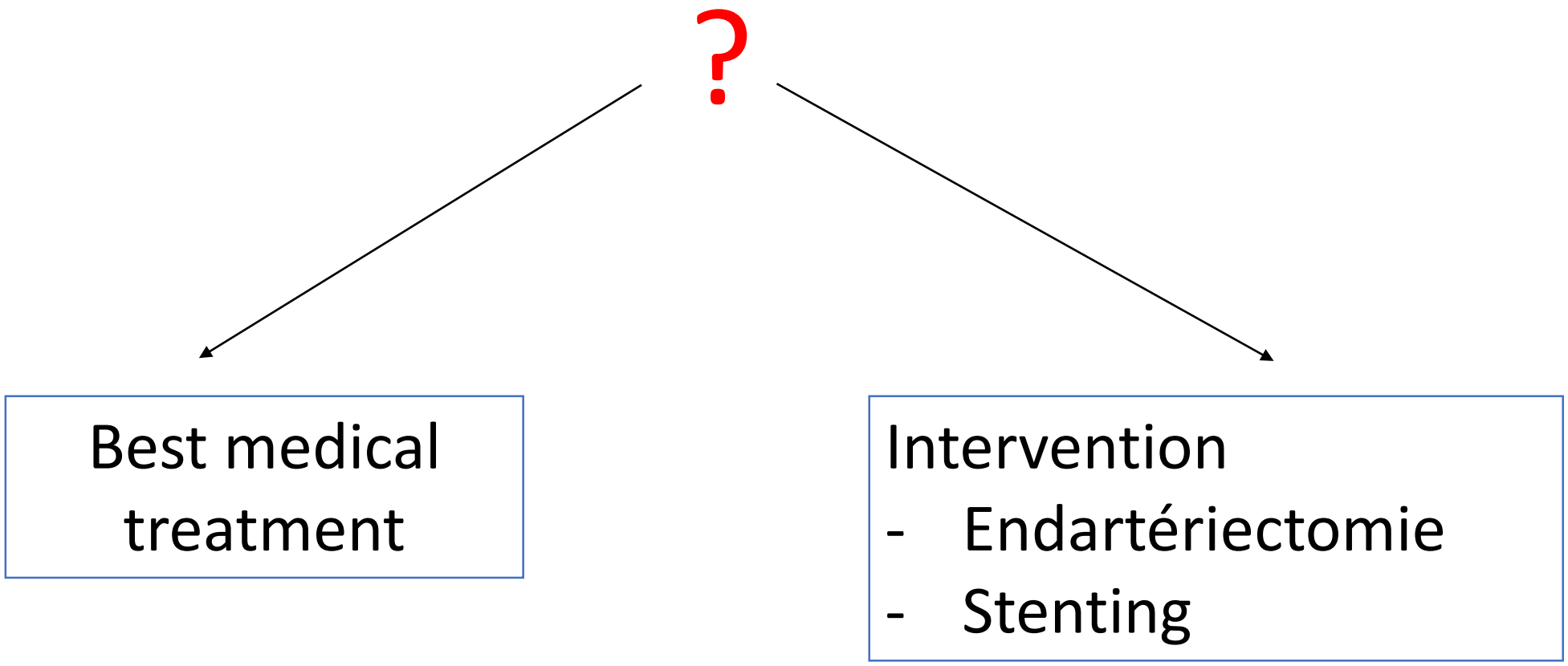
Prise en charge

Options thérapeutiques



Best medical treatment

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- **Anti-agrégation**
- **Statines** (Ezetimibe, anti-PCSK-9)
- **Contrôle optimal des facteurs de risque** (HTA, diabète)
- **Hygiène de vie** (stop tabac, perte de poids, alimentation équilibrée, exercice régulier)

Best medical treatment Anti-agrégation

Sténose symptomatique

Moins de microemboles sous double anti-agrégation

- **CARESS trial** (Clopidogrel and Aspirine for Reduction of Emboli in Symptomatic Carotid stenosis)
- **CLAIR-Study** (Clopidogrel + Aspirine vs Aspirine alone for reducing embolization in patients with acute symptomatic cerebral or carotid artery stenosis)

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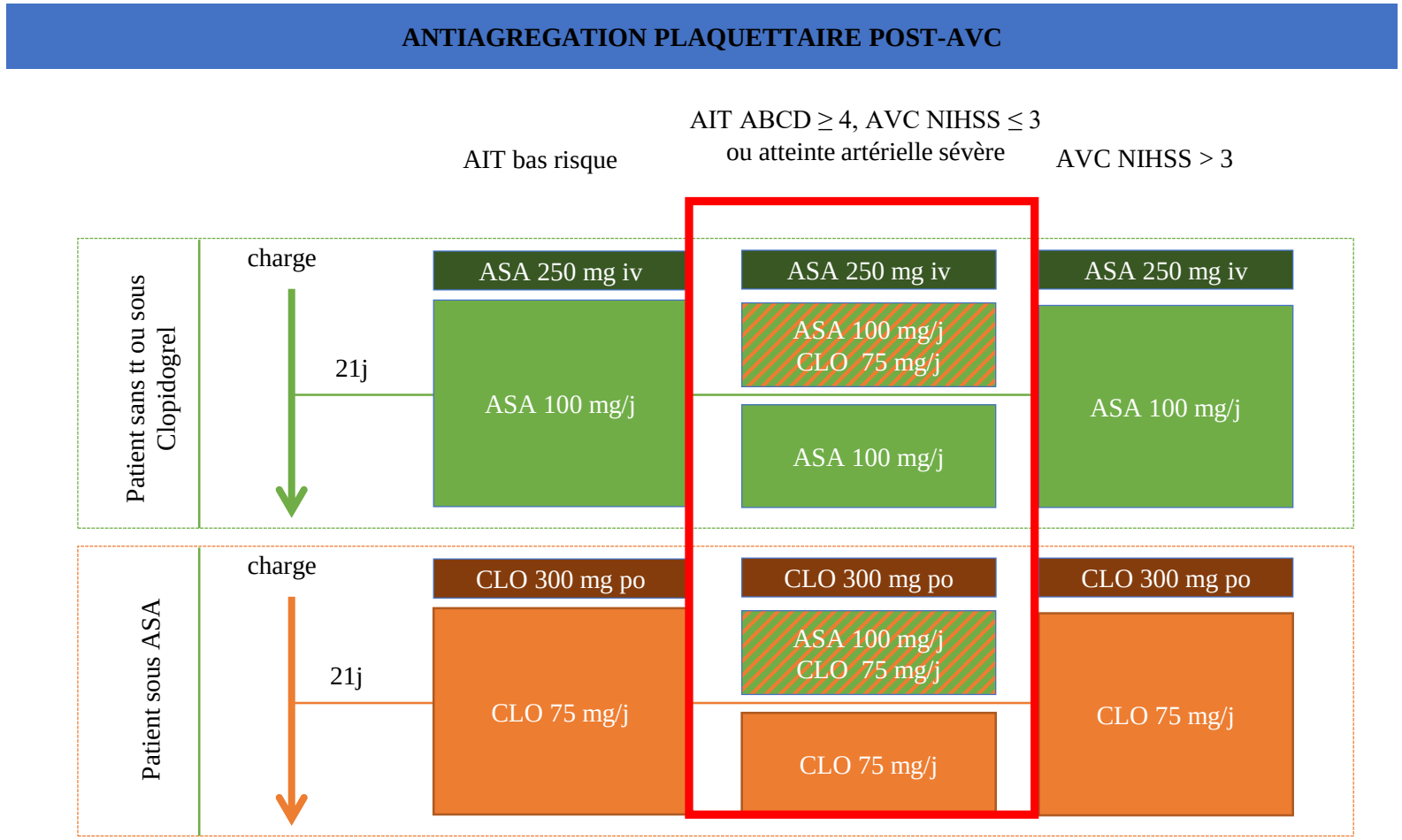

Markus et al, Stroke, 2005; Wong et al, Lancet Neurology, 2010

Best medical treatment Anti-agrégation

Sténose asymptomatique

- Pas d'étude randomisée
- Sténoses de >70% (*étude ACES Asymptomatic Carotid Emboli Study*):
  Anti-agrégation simple
  →prédicteur indépendant d'un risque plus faible d'AVC/AIT ipsilatéral (p=0.001)
  →Prédicteur indépendant d'un risque plus faible d'AVC ou décès d'origine cardiovasculaire (p<0.001)
- ESC (ESVS) guidelines 2017: anti-agrégation simple en prévention du risque d'AVC (et autres maladies cardiovasculaires)

King et al, Stroke, 2017
Aboyans et al, Eur Heart J, 2018
Messas et al, Eur Heart J, 2020

Best medical treatment Dyslipidémie

	Total CV risk (SCORE) %	Untreated LDL-C levels					
		<1.4 mmol/L (55 mg/dL)	1.4 to <1.8 mmol/L (55 to <70 mg/dL)	1.8 to <2.6 mmol/L (70 to <100 mg/dL)	2.6 to <3.0 mmol/L (100 to <116 mg/dL)	3.0 to <4.9 mmol/L (116 to <190 mg/dL)	≥4.9 mmol/L (≥190 mg/dL)
Primary prevention	<1, low-risk	Lifestyle advice	Lifestyle advice	Lifestyle advice	Lifestyle advice	Lifestyle intervention, consider adding drug if uncontrolled	Lifestyle intervention and concomitant drug intervention
	Class[a]/Level[b]	I/C	I/C	I/C	I/C	IIa/A	IIa/A
	≥1 to <5, or moderate risk (see *Table 4*)	Lifestyle advice	Lifestyle advice	Lifestyle advice	Lifestyle intervention, consider adding drug if uncontrolled	Lifestyle intervention, consider adding drug if uncontrolled	Lifestyle intervention and concomitant drug intervention
	Class[a]/Level[b]	I/C	I/C	IIa/A	IIa/A	IIa/A	IIa/A
	≥5 to <10, or high-risk (see *Table 4*)	Lifestyle advice	Lifestyle advice	Lifestyle intervention, consider adding drug if uncontrolled	Lifestyle intervention and concomitant drug intervention	Lifestyle intervention and concomitant drug intervention	Lifestyle intervention and concomitant drug intervention
	Class[a]/Level[b]	IIa/A	IIa/A	IIa/A	I/A	I/A	I/A
	≥10, or at very-high risk due to a risk condition (see *Table 4*)	Lifestyle advice	Lifestyle intervention, consider adding drug if uncontrolled	Lifestyle intervention and concomitant drug intervention	Lifestyle intervention and concomitant drug intervention	Lifestyle intervention and concomitant drug intervention	Lifestyle intervention and concomitant drug intervention
	Class[a]/Level[b]	IIa/B	IIa/A	I/A	I/A	I/A	I/A
Secondary prevention	Very-high-risk	Lifestyle intervention, consider adding drug if uncontrolled	Lifestyle intervention and concomitant drug intervention	Lifestyle intervention and concomitant drug intervention	Lifestyle intervention and concomitant drug intervention	Lifestyle intervention and concomitant drug intervention	Lifestyle intervention and concomitant drug intervention
	Class[a]/Level[b]	IIa/A	I/A	I/A	I/A	I/A	I/A

AVC ischémique aigu: bilan lipidique de base

↓

Atorvastatine 80mg: effets pleiotropiques

↓

Bilan lipidique à 3 mois

↓

Adaptation du traitement hypolipémiant pour une visée LDL selon risque cardiovasculaire (SCORE)

Mach et al, Eur Heart J, 2020
SPARCL, NEJM, 2006
Flint et al; Stroke, 2012

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Revascularisation
Sténose symptomatique

Sténose symptomatique

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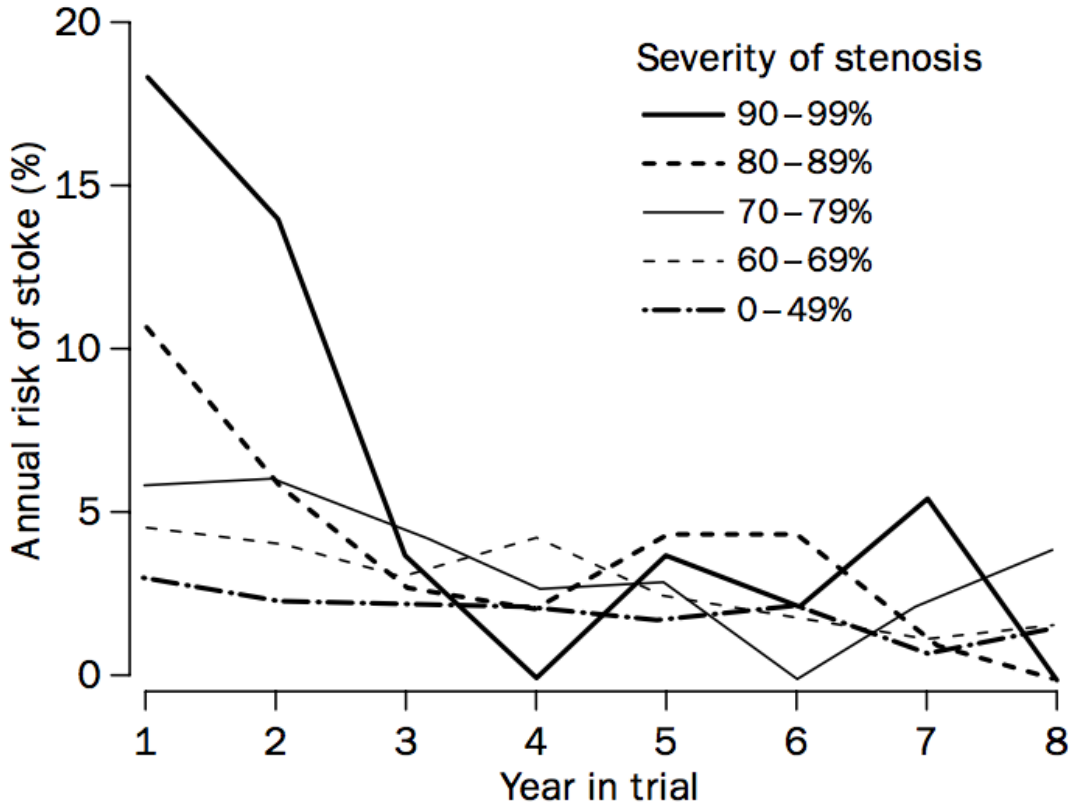
Sténose symptomatique
→ *AVC/AIT/amaurose fugace* ***dans les 6 mois***

Le risque de récidive d'AVC/AIT augmente avec:

- Le degré de sténose
- Les caractéristiques de la plaque: calcifiée vs molle, ulcérée, hémorragique, évolutive



ECST, Lancet, 1998

Sténose symptomatique

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Rôle de l'endartériectomie comme traitement des sténoses symptomatiques, 3 RCTs:

NASCET: mid-1980, AIT ou AVC peu/pas handicapants: 659 patients avec sténoses 70-99%; 858 x sténose modérée (50-69%); 1368 x sténose légère (<50%) → Endartériectomie vs Aspirine.

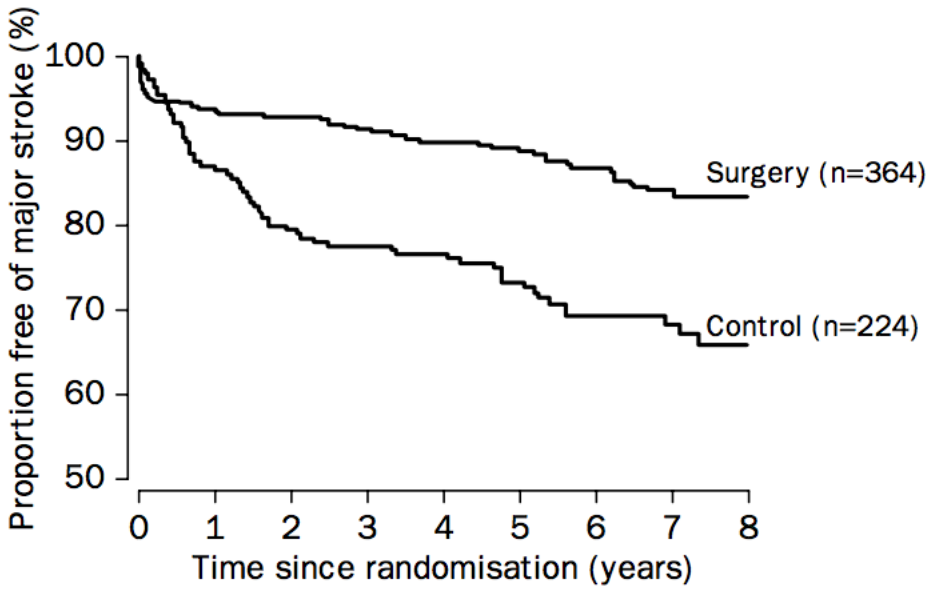
ECST: mid-1980, 3024 patients, AIT ou AVC peu/pas handicapants avec sténoses ipsilatérales (<30%; 30-69%; >70%). Endartériectomie vs Aspirine.

VA: mid-1980, 189 patients avec AVC/AIT/amaurose fugace et sténoses >50%.

CAVE: BMT: antiagrégation (pas statines hautes doses, traitement moins agressifs des FRCV)

Barnett et al, NEJM, 1991 (NASCET); ECST, Lancet, 1998

ECST



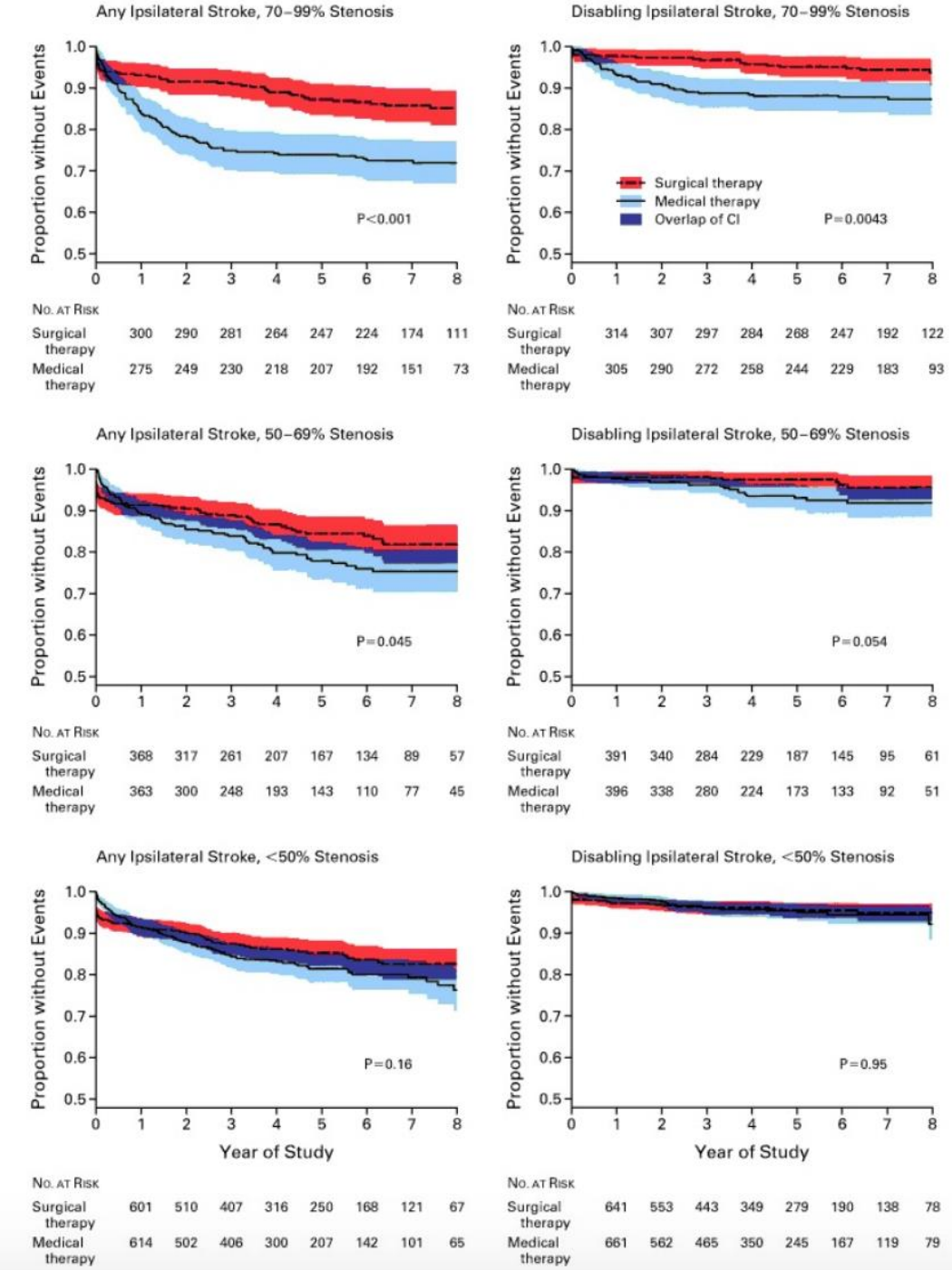
Number at risk

Surgery	364	335	326	306	286	249	195	143	100
Control	224	189	172	165	158	128	92	63	43

Figure 4: **Kaplan-Meier survival curves to show survival free of major stroke (with non-stroke deaths occurring more than 30 days after surgery censored) in surgery and control patients with 80–99% stenosis of symptomatic carotid artery**

Barnett et al, NEJM, 1998; European Carotid Surgery Trialists'Collaborative Group, Lancet, 1998

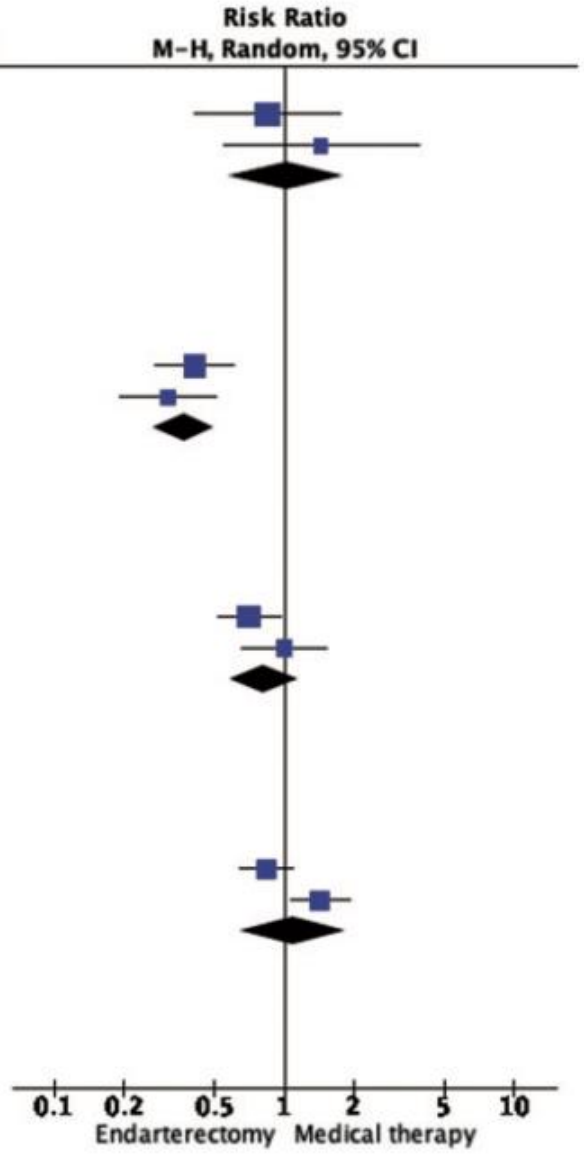
NASCET



Degré de sténose

Study or Subgroup	Endarterectomy Events	Endarterectomy Total	Medical therapy Events	Medical therapy Total	Weight	Risk Ratio M-H, Random, 95% CI	Year
4.1.1 Near occlusion							
NASCET 1991	12	79	12	67	64.2%	0.85 [0.41, 1.76]	1991
ECST 1998	12	78	5	47	35.8%	1.45 [0.54, 3.85]	1998
Subtotal (95% CI)		157		114	100.0%	1.03 [0.57, 1.84]	
Total events	24		17				
Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 0.74$, df = 1 (P = 0.39); $I^2 = 0\%$							
Test for overall effect: Z = 0.09 (P = 0.93)							
4.1.2 Severe (70-99%) stenosis							
NASCET 1991	29	261	72	264	59.6%	0.41 [0.27, 0.61]	1991
ECST 1998	21	257	45	172	40.4%	0.31 [0.19, 0.51]	1998
Subtotal (95% CI)		518		436	100.0%	0.37 [0.27, 0.50]	
Total events	50		117				
Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 0.70$, df = 1 (P = 0.40); $I^2 = 0\%$							
Test for overall effect: Z = 6.45 (P < 0.00001)							
4.1.3 Moderate (50-69%) stenosis							
NASCET 1991	55	428	78	428	58.0%	0.71 [0.51, 0.97]	1991
ECST 1998	46	380	32	266	42.0%	1.01 [0.66, 1.54]	1998
Subtotal (95% CI)		808		694	100.0%	0.82 [0.58, 1.15]	
Total events	101		110				
Heterogeneity: $Tau^2 = 0.03$; $Chi^2 = 1.73$, df = 1 (P = 0.19); $I^2 = 42\%$							
Test for overall effect: Z = 1.14 (P = 0.25)							
4.1.4 Mild (<50%) stenosis							
NASCET 1991	87	677	106	690	50.8%	0.84 [0.64, 1.09]	1991
ECST 1998	125	1085	58	723	49.2%	1.44 [1.07, 1.93]	1998
Subtotal (95% CI)		1762		1413	100.0%	1.09 [0.64, 1.85]	
Total events	212		164				
Heterogeneity: $Tau^2 = 0.13$; $Chi^2 = 7.15$, df = 1 (P = 0.007); $I^2 = 86\%$							
Test for overall effect: Z = 0.32 (P = 0.75)							

Test for subgroup differences: $Chi^2 = 21.16$, df = 3 (P < 0.0001), $I^2 = 85.8\%$



Near occlusion

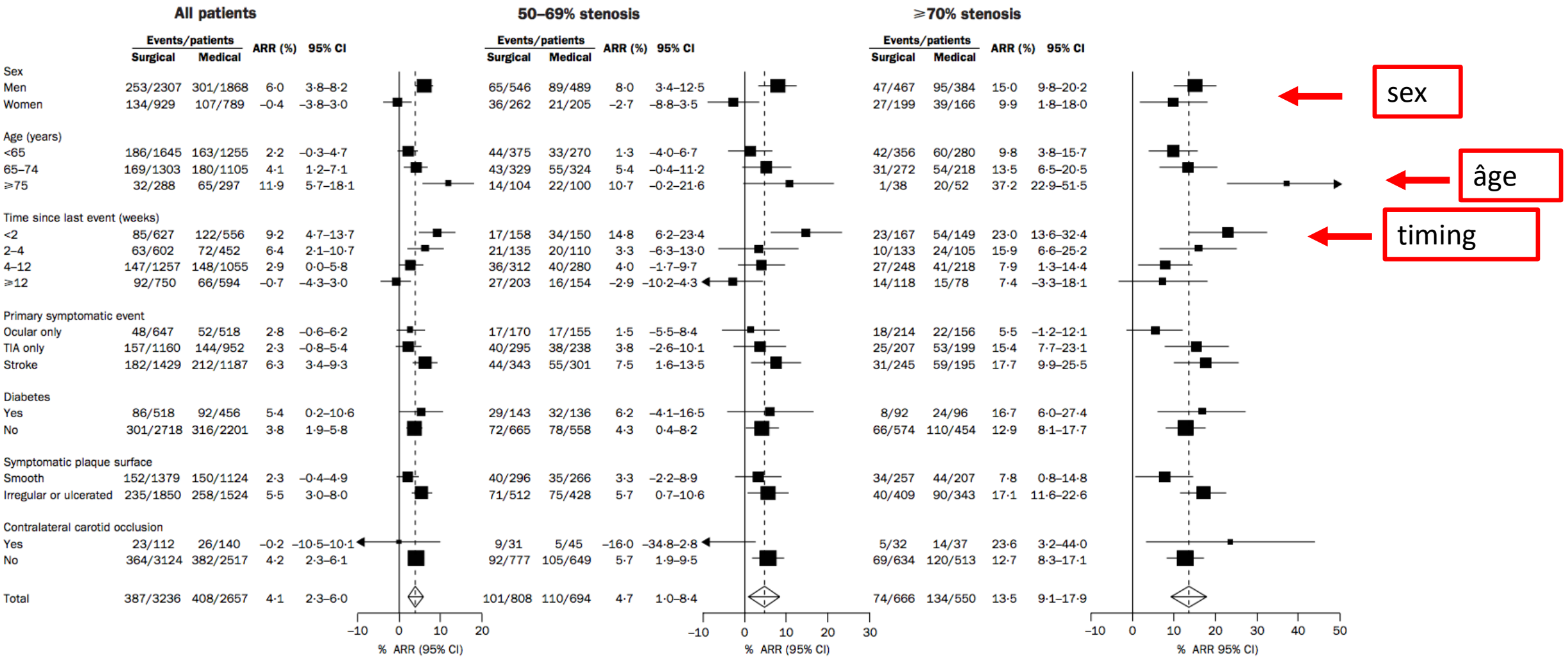
70—99%

50-69%

<50%

Bonati et al, ESO guideline, European Stroke Journal, 2021

Sous-groupes cliniques et timing



Homme (CAVE No), >75 ans, <2 semaines

Rothwell 2004, Lancet, 2004

Sténose symptomatique - QUI

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Procédure de revascularisation:

- Espérance de vie > 3ans
- Risque opératoire <3%
- Sténoses ≥70%
- “Zone grise” : sténoses 50-69%

Critères de vulnérabilité de la plaque:

- degré de sténose
- caractéristiques de la plaque: régularité, structure, hémorragie, HITS

Rothwell et al, Lancet, 2004; Bonati et al, Eur Stroke J, 2021

Sténose symptomatique - QUAND

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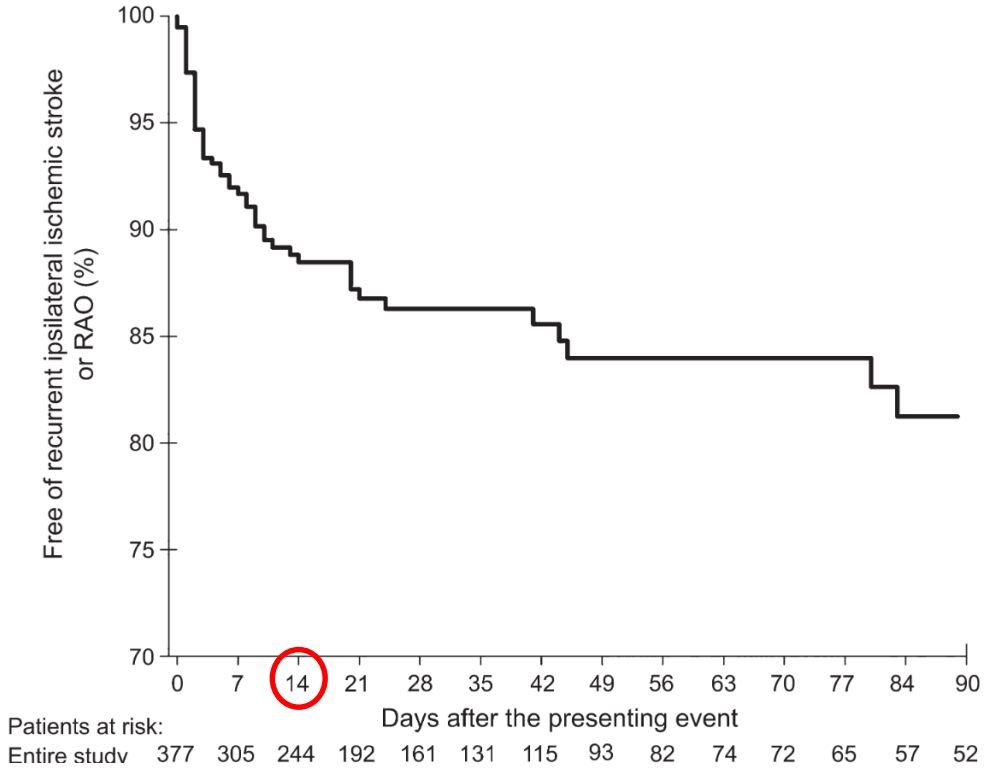
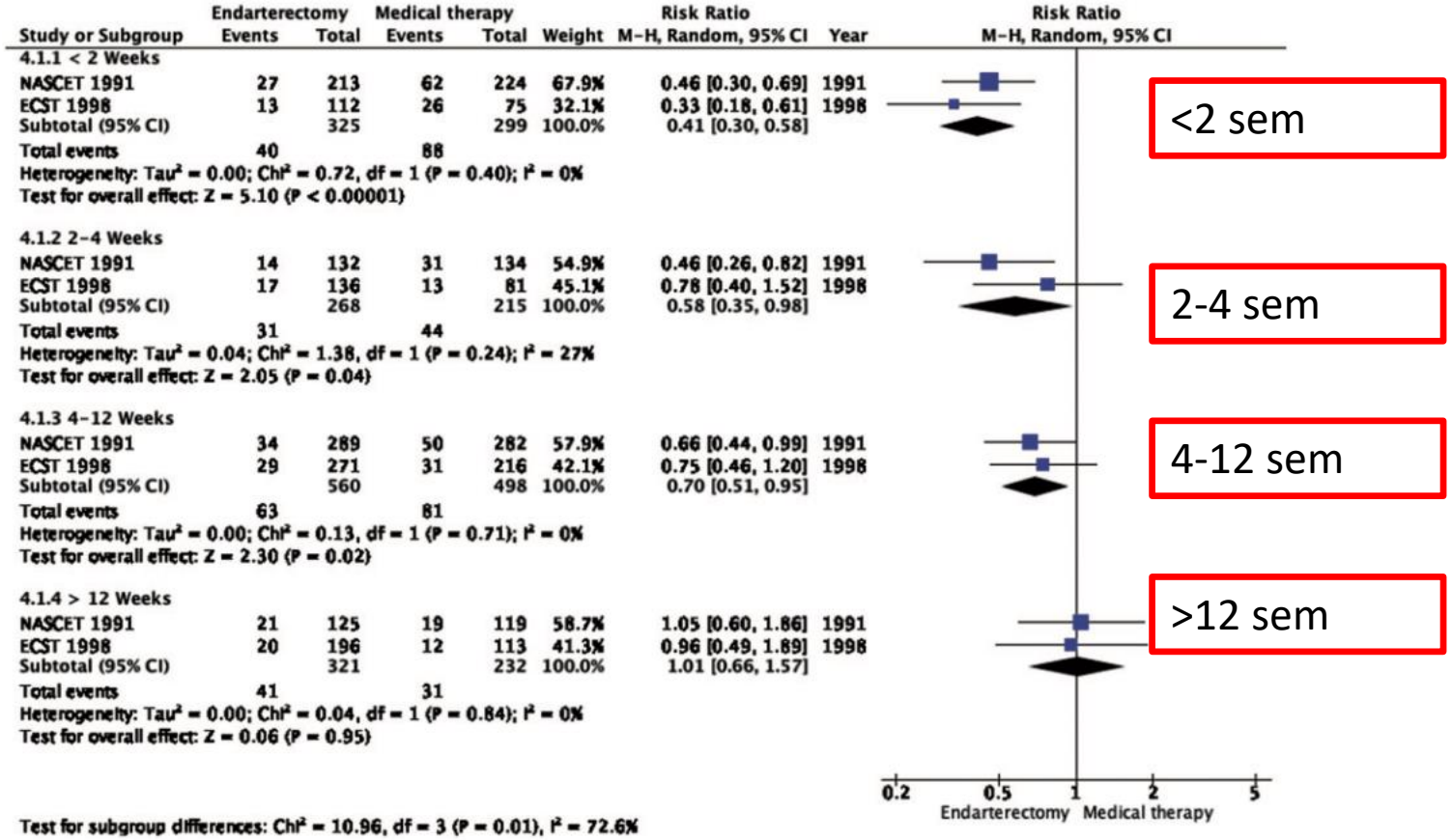
Risque de récidive d'AVC → Augmenté dans les 14 jours





Johansson et al, Neurology, 2016
ECST, Lancet, 1998
Bonati et al, Eur Stroke J, 2021

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Primary and secondary outcomes	< 48 h ($n = 75$)	48 h–14 d ($n = 343$)	p[a]	OR (95% CI) very urgent CEA[b]
Stroke and/or death	6 (8)	10 (3)	.049	2.90 (1.02–8.23)
Stroke	6 (8)	9 (3)	.035	3.23 (1.11–9.36)
Ipsilateral stroke	6 (8)	7 (2)	.016	4.17 (1.36–12.80)
Ipsilateral ischaemic stroke	6 (8)	5 (2)	.006	5.88 (1.75–19.81)

Risque d'AVC péri-procédural: 8% dans les 48h versus <3% dans les 48h—14j

AVC: 48h –14 jours post AVC

AIT: 0 – 14 jours post AIT

De Rango et al, Stroke, 2015

Nordanstig, Eur J Vasc Endovasc Surg, 2017

Sténose symptomatique

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Sténose <50% : BMT

Sténose 50-70%: BMT +/- revascularisation

Sténose 70-99%: BMT + revascularisation

Sténose subocclusive/occlusive: BMT

Sténose symptomatique

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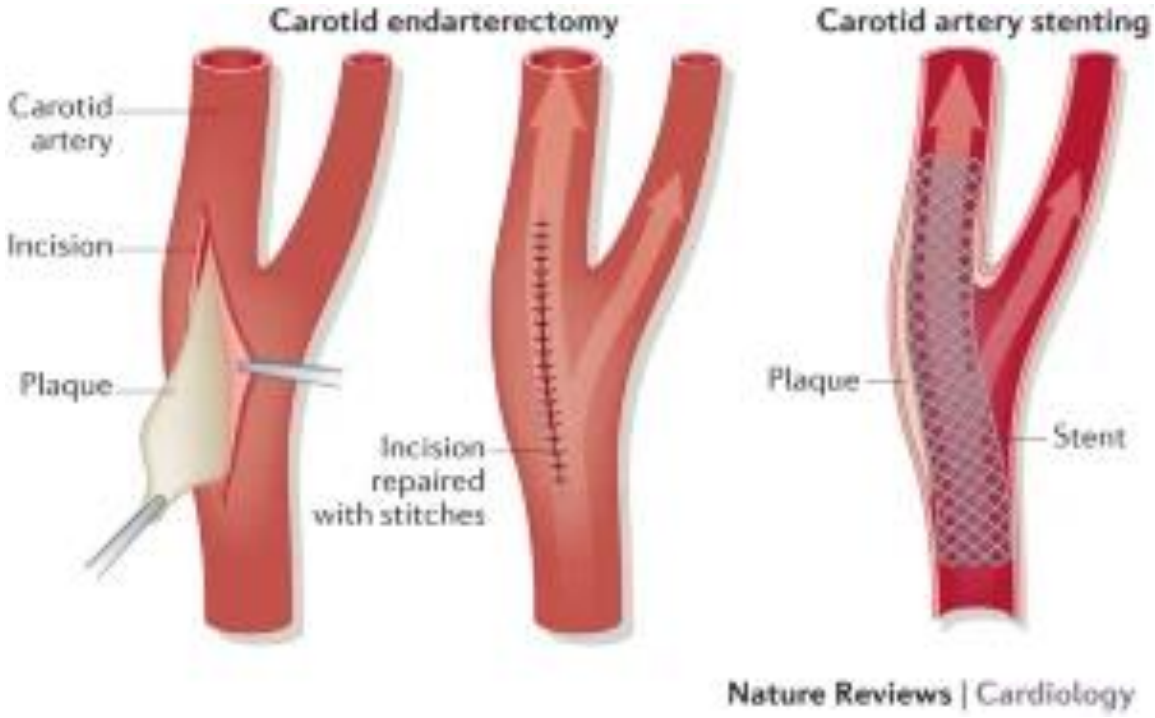
Stent (CAS) ou endartériectomie (CEA)?



Multi-Center RCTs:

- ***EVA-3S*** (2000-2005): 527 patients; sténoses symptomatiques ≥60%
- ***SPACE*** (2001-2006): 1214 patients; sténoses symptomatiques ≥50%
- ***ICSS*** (2001-2008): 1713 patients; sténoses symptomatiques ≥50%
- ***CREST*** (2000-2008): 1321 patients; sténoses symptomatiques ≥50%
- Others: CAVATAS, SAPPHIRE

***Carotid Stenosis Trialists Collaboration (CSTC)*:** Pooled analyses of data from *EVA-3S, SPACE, ICSS* and *CREST* studies

Fernandèz-Ruiz, Nat Rev Card, 2016
Bonati et al, Eur Stroke J, 2021

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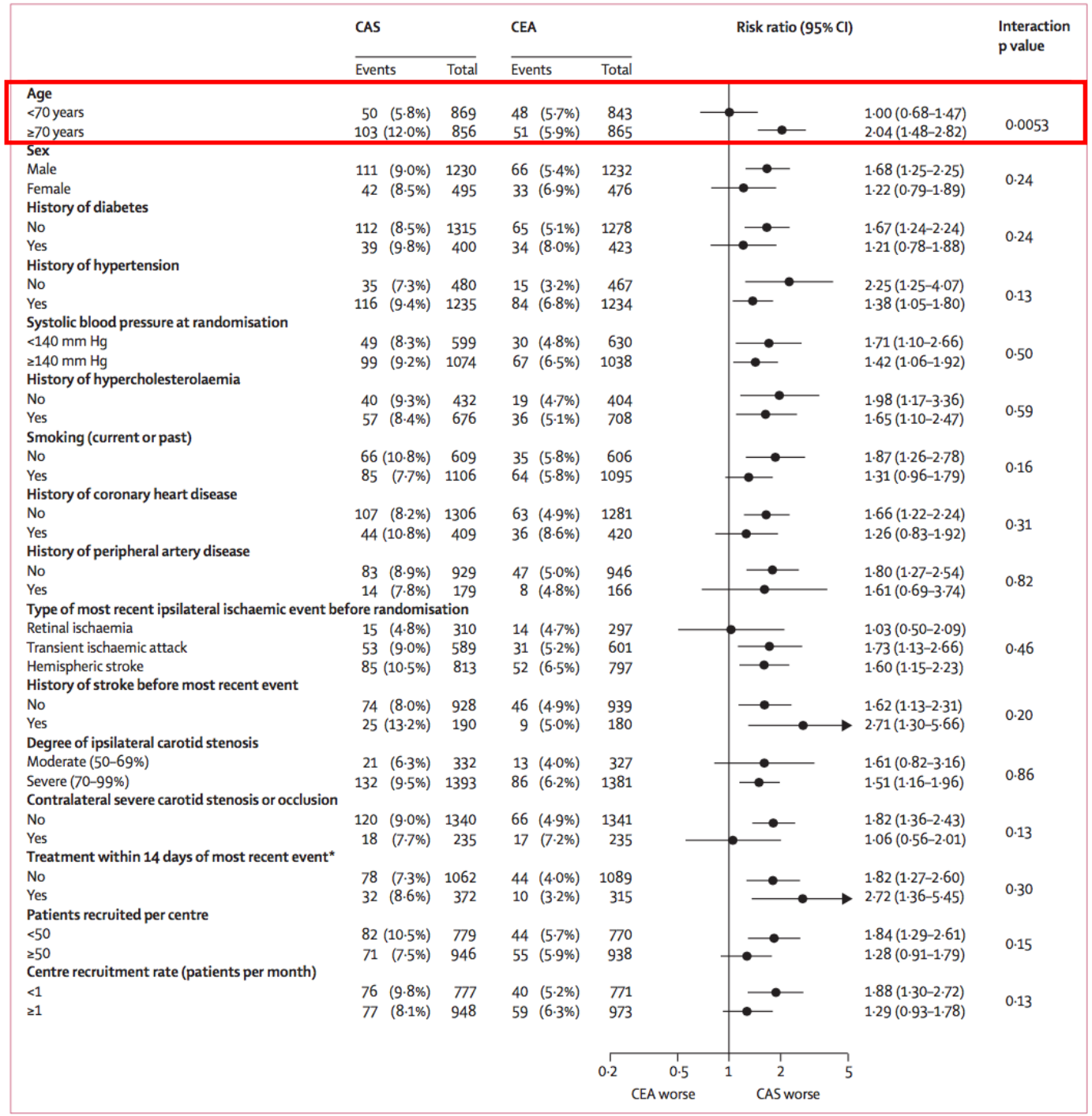
Short term outcome (<120 jours)

	CAS (n=1725)	CEA (n=1708)	Risk ratio* (95% CI)	p value†	Risk difference* (95% CI)
Any stroke or death	153 (8·9%)	99 (5·8%)	1·53 (1·20 to 1·95)	0·0006	3·2 (1·4 to 4·9)
Disabling stroke or death	82 (4·8%)	64 (3·7%)	1·27 (0·92 to 1·74)	0·15	0·9 (–0·4 to 2·3)
All-cause death	32 (1·9%)	22 (1·3%)	1·44 (0·84 to 2·47)	0·18	0·7 (–0·2 to 1·5)
Any stroke	141 (8·2%)	84 (4·9%)	1·66 (1·28 to 2·15)	0·0001	3·3 (1·7 to 5·0)
Stroke severity‡					
Fatal	13 (0·8%)	6 (0·4%)	2·15 (0·82 to 5·65)	0·11	0·4 (–0·1 to 0·9)
Disabling	56 (3·2%)	43 (2·5%)	1·29 (0·87 to 1·90)	0·21	0·5 (–0·5 to 1·6)
Non-disabling	72 (4·2%)	36 (2·1%)	1·99 (1·34 to 2·95)	0·0004	2·0 (0·8 to 3·2)
Stroke type§					
Ischaemic	135 (7·8%)	71 (4·2%)	1·88 (1·42 to 2·48)	<0·0001	3·8 (2·2 to 5·4)
Haemorrhagic	6 (0·3%)	11 (0·6%)	0·54 (0·20 to 1·46)	0·21	–0·3 (–0·8 to 0·1)
Unknown	0	2 (0·1%)	..	..	..
Stroke region§					
Ipsilateral carotid	126 (7·3%)	75 (4·4%)	1·66 (1·26 to 2·19)	0·0003	3·0 (1·4 to 4·5)
Contralateral carotid or vertebrobasilar	13 (0·8%)	9 (0·5%)	1·43 (0·61 to 3·34)	0·40	0·2 (–0·3 to 0·8)
Unknown	2 (0·1%)	0	..	..	..

Data are number (%), unless otherwise indicated. Percentages are number of events divided by number of patients. ..=Adjusted risk ratio or risk difference and 95% CI were not estimated because model did not converge. CAS=carotid stenting. CEA=carotid endarterectomy. *Adjusted for source trial. †Derived by use of binomial regression likelihood ratio test, adjusted for source trial. ‡One patient in the endarterectomy group had two stroke events within 120 days after randomisation. §Refers to first event.

Table 2: **Outcome events occurring within 120 days of randomisation (intention-to-treat analysis)**

Bonati et al, Lancet, 2010
Bonati et al, Cochrane, 2012
Müller et al, Stroke, 2021



Short term outcome (<120 jours):
→ Risque AVC CAS > CEA pour les >70 ans (pas de différence significative pour les <70 ans)

Bonati et al, Lancet, 2010
Bonati et al, Cochrane, 2012
Müller et al, Stroke, 2021

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Certainty assessment							№ of patients		Effect			
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Stenting	Endarterectomy	Relative (95% CI)	Absolute (95% CI)	Certainty	Importance
PICO 3.9: Risk of peri-procedural major stroke or death												
5	Randomised trials	Not serious	Not serious	Not serious	Serious[a]	None	8/1776 (0.5%)	3/1033 (0.3%)	RR 1.54 (0.39–6.07)	**2 more per 1000** (from 2 fewer to 15 more)	⊕⊕⊕◯ MODERATE	CRITICAL
PICO 3.10: Risk of peri-procedural myocardial infarction												
7	Randomised trials	Not serious	Not serious	Serious[c]	Serious[a]	None	12/2041 (0.6%)	16/1304 (1.2%)	RR 0.53 (0.25–1.15)	**6 fewer per 1000** (from 9 fewer to 2 more)	⊕⊕◯◯ LOW	IMPORTANT
PICO 3.11: Risk of peri-procedural cranial nerve injury												
5	Randomised trials	Not serious	Not serious	Not serious	Not serious	Very strong association[d]	2/1823 (0.1%)	36/1092 (3.3%)	RR 0.09 (0.03–0.28)	**30 fewer per 1000** (from 32 fewer to 24 fewer)	⊕⊕⊕⊕ HIGH	IMPORTANT

CAS vs CEA

- MOINS d'infarctus du myocarde (OR, 0.47 [95% CI, 0.24-0.94]; P=0.03)
- MOINS de paralysie de nerfs crâniens (OR, 0.09 [95% CI, 0.06-0.16]; P<0.00001)
- MOINS d'hématomes au site d'accès (OR, 0.32 [95% CI, 0.15-0.68]; P=0.003)

Bonati et al, Lancet, 2010
Müller et al, Stroke, 2021
Bonati et al, Eur Stroke J, 2021

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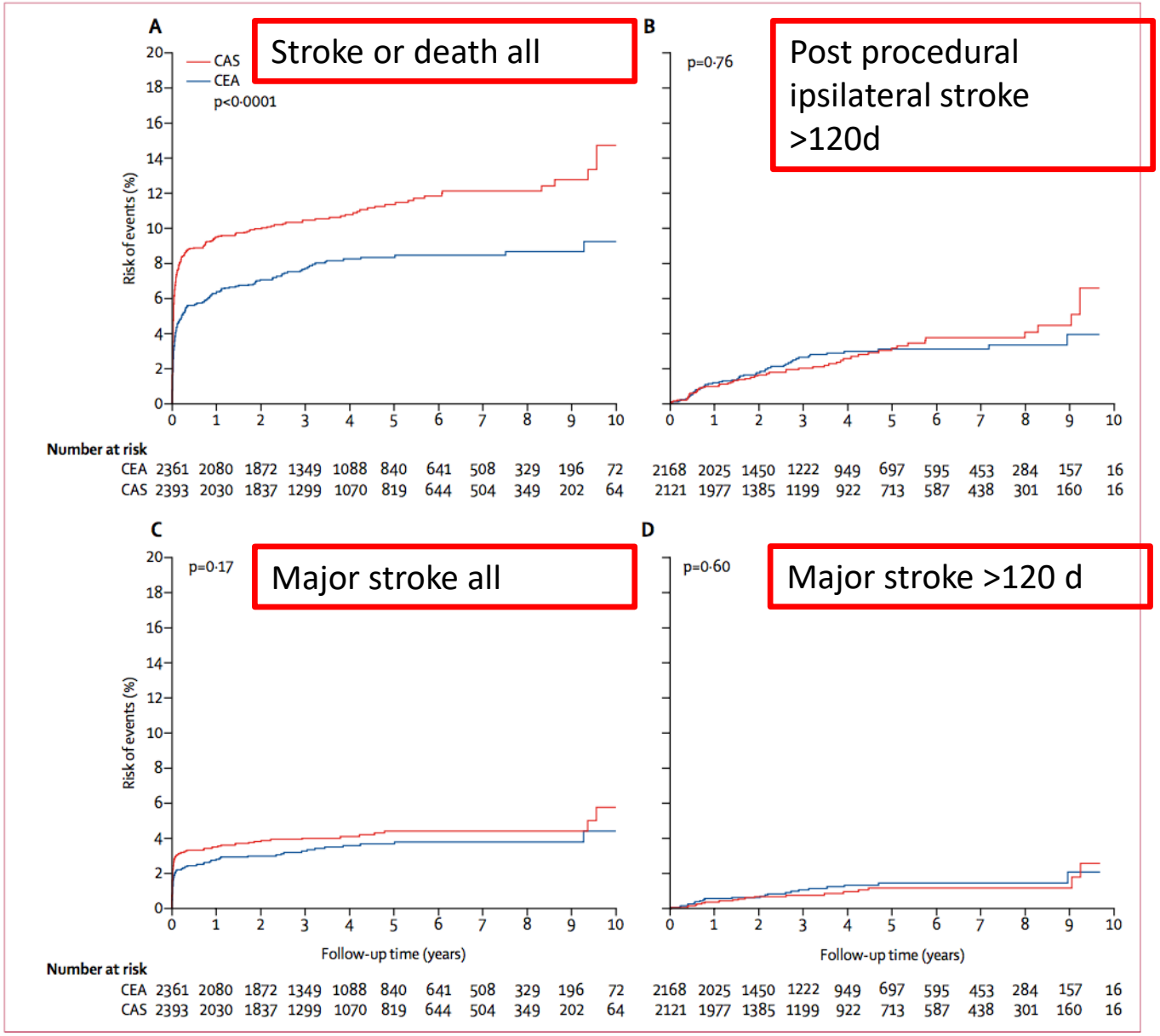
Long term outcome (>120jours)



Brott et al, Lancet, 2019

Sténose symptomatique

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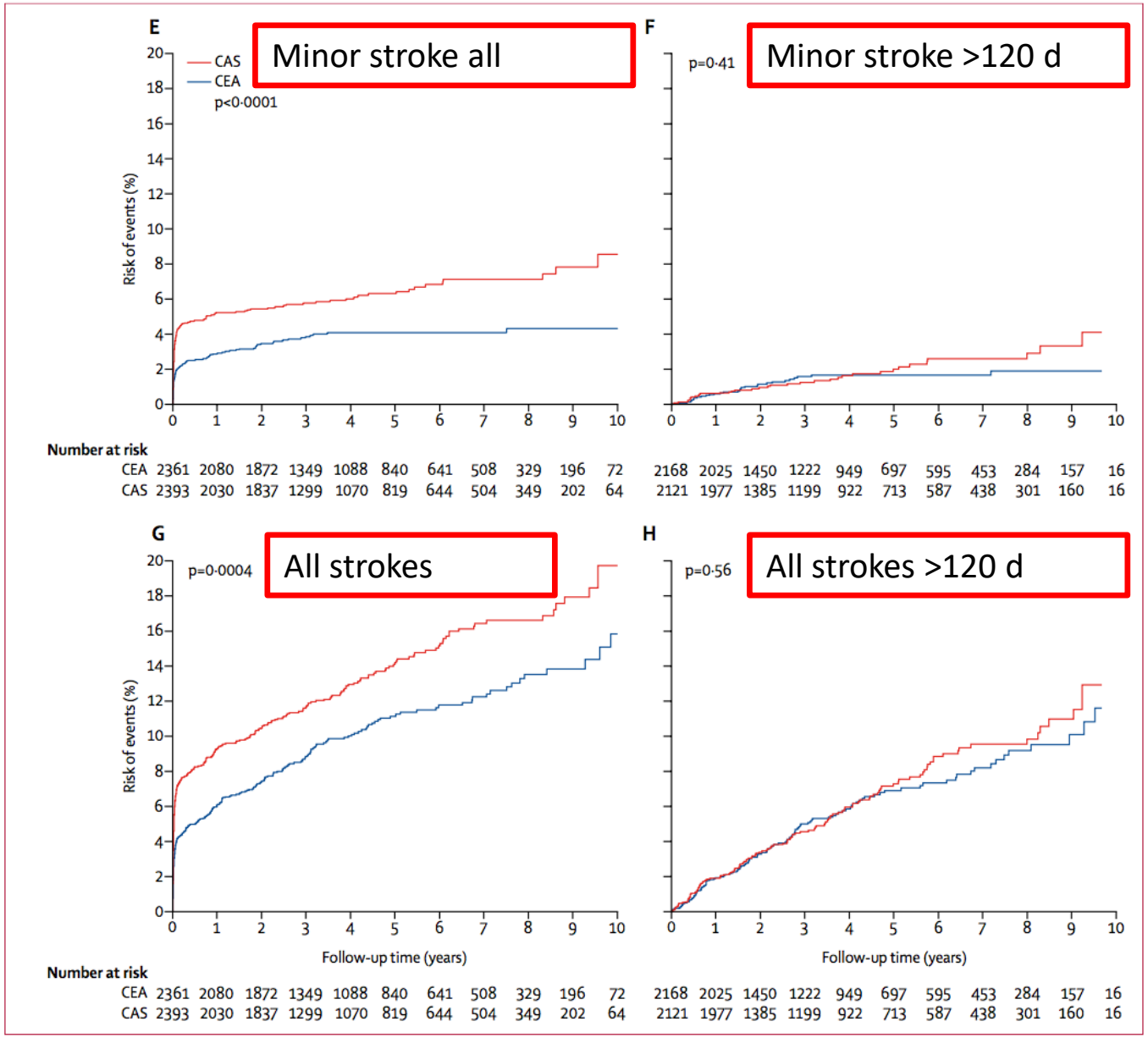
Long term outcome (>120jours)

Outcome global: drivé par la période péri-procedure

→ Pas de différence au-delà de 120 jours entre CEA et CAS



Brott et al, Lancet, 2019

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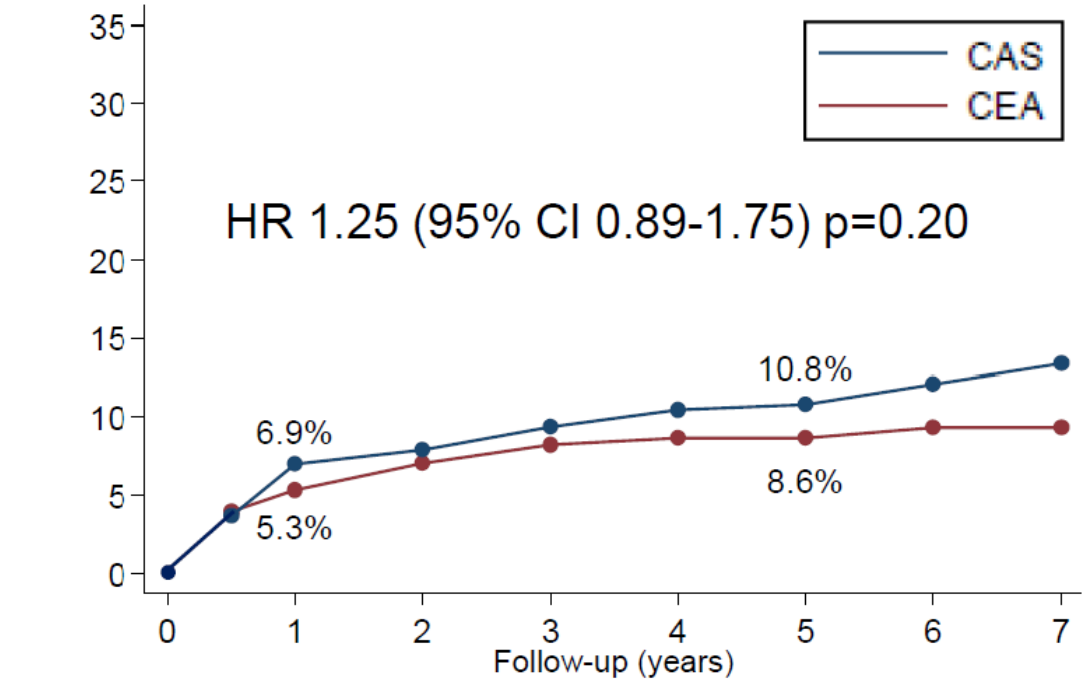
Pas de difference sur le risque de resténose à 10 ans



Number at risk:

CAS	737	638	547	455	347	190	91	44
CEA	793	681	611	483	330	187	89	45

Bonati et al, Lancet, 2015

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- CAS: Plus d'AVC dans les 120 jours post gestes (mais AVC généralement peu/pas handicapants), chez les >70 ans
- CEA: plus d'IM, plus de parésie de NC, plus d'hématome local

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Revascularisation
Sténose asymptomatique

Sténoses asymptomatiques

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Rôle de l'endartériectomie comme traitement de sténoses asymptomatiques:
VA (1983-1987): 444 hommes, sténoses 50-99%, aspirine vs aspirine + CEA → **absolute risk reduction: 1% sur 4 ans.**

ACAS (1987-1995): 1662 adultes, sténoses 60-99%, aspirine vs aspirine + CEA → **ARR: 3% sur 2.7 ans.**

ACST-1 (1993-2004): 3120 adultes, sténoses >60%, immediate CEA vs deferred CEA → **ARR: 3.1% sur 3.4 ans.**

SPACE-2 (2009-2013): 203 adultes CEA, 197 adultes CAS, 113 adultes BMT, sténoses 50-99%, medical therapy vs medical therapy + CEA. Underpowered pour montrer un bénéfice de l'endartériectomie vs BMT à 1 an.

Hobson et al, NEJM, 1993; ACAS, JAMA, 1995; Halliday et al, Lancet, 2004; Reiff et al, Int J Stroke, 2019; Fairman, Uptodate, 2021.

Sténoses asymptomatiques

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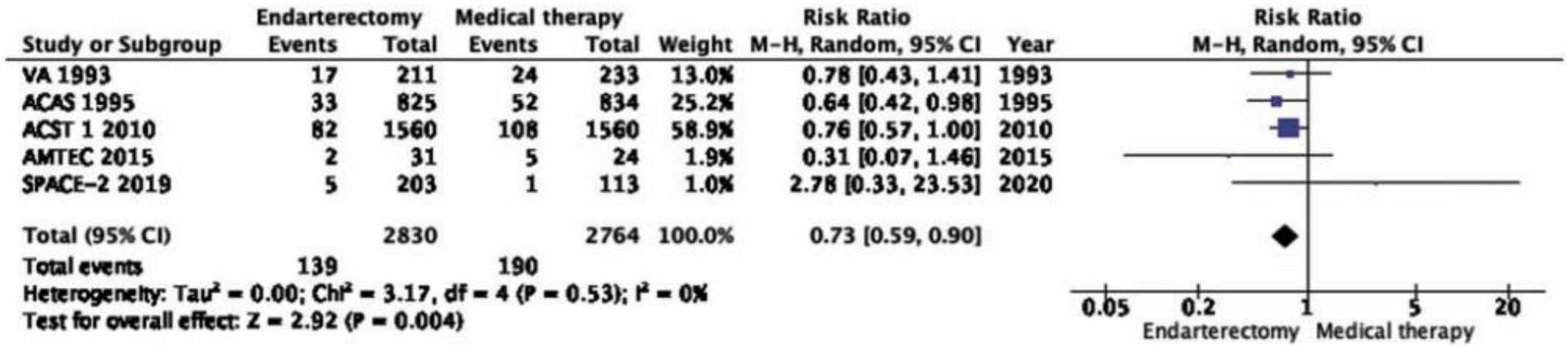
CEA vs BMT

Certainty assessment							№ of patients		Effect			
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Endarterectomy	Medical therapy	Relative (95% CI)	Absolute (95% CI)	Certainty	Importance
PICO 1.1: Long-term risk of ipsilateral stroke, including peri-procedural stroke in any territory or peri-procedural death												
5	Randomised trials	Not serious	Not serious	Serious[a]	Not serious	None	139/2830 (4.9%)	190/2764 (6.9%)	**RR 0.73** (0.59–0.90)	**19 fewer per 1000** (from 28 fewer to 7	⨁⨁⨁◯ MODERATE	CRITICAL



Moins d'AVC post CEA vs BMT

Bonati et al, Eur Stroke J, 2021

Sténoses asymptomatiques

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Rôle du stenting comme traitement de sténoses asymptomatiques:
SPACE-2 (2009-2013): 203 adultes CEA, 197 adultes CAS, 113 adultes BMT, sténoses 50-99%, medical therapy vs medical therapy + CAS → Pas de différence significative

Facteurs de risque:

- Degré de sténose
- Progression/rapidité de la progression
- Embolisation asymptomatique (détection d'embole)
- AVC silencieux à l'imagerie
- Critères de vulnérabilité de la plaque (régularité, structure, hémorragie intraplaque,…)
- Diminution de la réserve vasculaire

Bonati et al, Eur Stroke J, 2021; Gaba et al, 2019; Paraskevas et al, 2018; Bogiatzi et al, 2020; Howard et al, 2021

Sténose asymptomatique

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Sténose <60% : BMT

Sténose 60-99%: BMT +/- revascularisation

Sténose subocclusive/occlusive: BMT

Sténoses asymptomatiques

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Stent ou endartériectomie?

Stenting vs endartériectomie:

CREST (2000-2008): 1181 patients, sténoses asymptomatiques ≥60%, CAS vs CEA

ACT-1 (2005-2013): 1453 patients, sténoses asymptomatiques ≥70%, CAS vs CEA

SPACE-2 (2009-2013): 203 adultes CEA, 197 adultes CAS, 113 adultes BMT, sténoses 50-99%

ACST-2 : 3638 patients, sténoses asymptomatiques, ≥60%, CAS vs CEA

Hobson et al, NEJM, 1993; Executive Committee for the Asymptomatic Carotid Atherosclerosis Study, JAMA, 1995; Halliday et al, Lancet, 2004; Fairman, Uptodate, 2021; Halliday et al, Lancet, 2021.

Sténoses asymptomatiques

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CAS vs CEA: ACST-2

Inclusion:

- Sténose carotidienne (uni ou bilatérale) “sévère”: généralement ≥60%
- Pas de symptôme neurologique dans les 6 mois
- Indication médicale retenue pour une intervention
- Pas de contre-indication à l’une ou l’autre des intervention

Exclusion:

- ATCD de revascularisation carotidienne
- Contre-indication CAS (calcifications, tortuosités,…)
- Contre-indication CEA
- Risque opératoire élevé (IM recent)

Main outcomes: morbidité et mortalité procédurales (AVC, IM, décès dans les 30 jours); AVC non procéduraux (30j-5ans).

Halliday et al, Lancet, 2021 (ACST-2)

<30j

	Allocated CAS (n=1811)	Allocated CEA (n=1814)	p value	Had CAS first	Had CEA first
Had no carotid procedure	106	78	..	..	..
Had a carotid procedure†	1705	1736	..	1653	1788
Worst procedural stroke, mRS score					
6 (fatal)	7	5	0·77	6	6
3–5 (disabling)	6	7	1·00	8	5
2	9	9	1·00	9	9
1	23	15	0·25	21	17
0	16	5	0·03	15	6
0–2 (non-disabling)	48 (2·7%)	29 (1·6%)	0·03	45 (2·7%)	32 (1·8%)
Subtotal: any stroke	61 (3·6%)	41 (2·4%)	0·06	59 (3·6%)	43 (2·4%)
MI					
Fatal	0	4	0·13	0	4
Non-fatal	5	8	0·58	4	9
Subtotal: any MI	5 (0·3%)	12 (0·7%)	0·15	4 (0·2%)	13 (0·7%)
Other death‡	2	2	1·00	3	1
Death, MI, or any stroke	67 (3·9%)	55 (3·2%)	0·26	65 (3·9%)	57 (3·2%)
Death or any stroke	63 (3·7%)	47 (2·7%)	0·12	62 (3·8%)	48 (2·7%)
Death or disabling stroke	15 (0·9%)	18 (1·0%)	0·77	17 (1·0%)	16 (0·9%)

- CAS: plus d'AVC non handicapants perprocéduraux
- CEA: trend vers plus d'IM
- Décès ou AVC handicapant perprocéduraux: risque equivalent (CAS 1%, CEA 0.9%)

30j – 5 ans

	Allocated CAS (n=1811)	Allocated CEA (n=1814)
Procedural stroke or death	63	47
No procedural stroke or death*	1748	1767
Worst non-procedural stroke, by mRS score†		
6 (fatal)	16 (0·9%)	20 (1·1%)
3–5 (disabling)	28 (1·6%)	25 (1·4%)
2	9	5
1	23	17
0	15	12
0–2 (non-disabling)	47 (2·7%)	34 (1·9%)
Total: any non-procedural stroke	91 (5·2%)	79 (4·5%)

- Risque d'AVC: pas de différence significative entre 30j-5ans

Halliday et al, Lancet, 2021 (ACST-2)

Sténoses asymptomatiques

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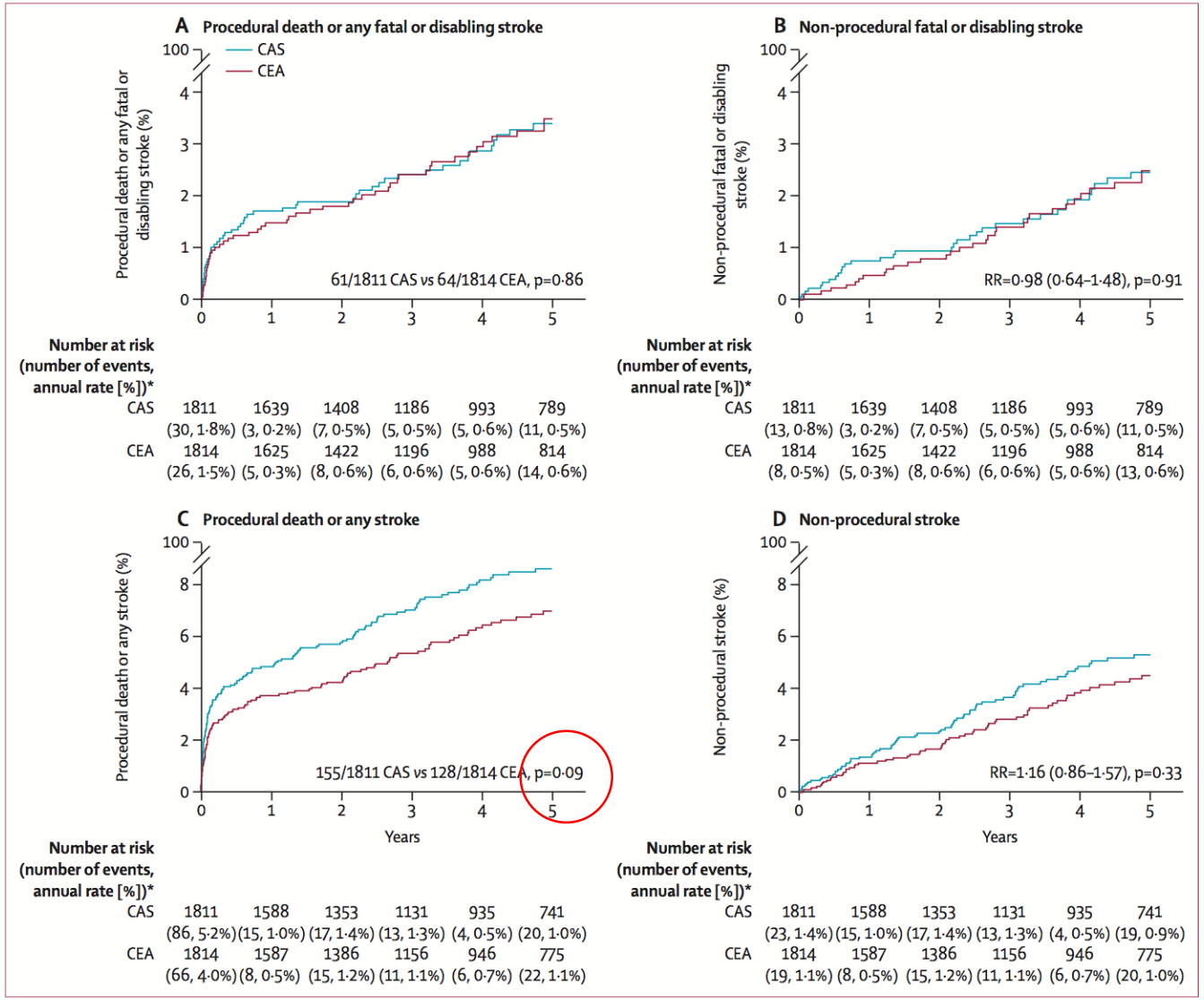

Figure 2: **Kaplan-Meier estimates of 5-year outcomes among asymptomatic patients randomly allocated to CAS versus CEA**
CAS=carotid artery stenting. CEA=carotid endarterectomy. *Last rate is after year 5 (and all three procedural strokes due to a second carotid procedure were after year 5).

Halliday et al, Lancet, 2021 (ACST-2)

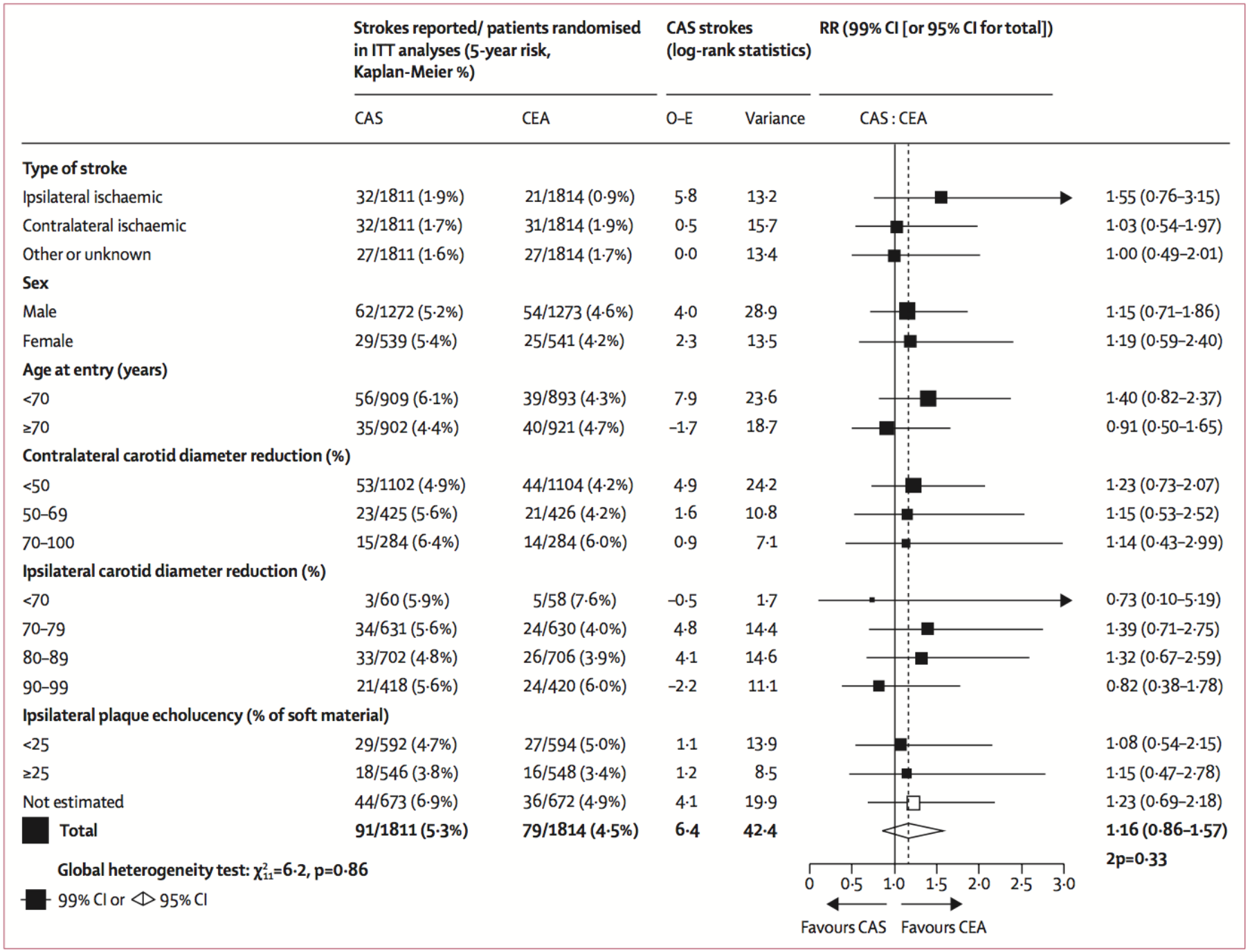

Figure 3: **Subgroup analyses of long-term non-procedural stroke rates, by random allocation to CAS or to CEA**

Pas de différence significative dans l'analyse de sous-groupes (âge, sex, degré de sténose,…)

Halliday et al, Lancet, 2021 (ACST-2)

Sténoses asymptomatiques

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	Ipsilateral ischaemic + other strokes (excluding days 0–30)/patients (%)		CAS: all strokes		RR (99% CI [or 95% CI for total])
	CAS	CEA	O–E	Variance	CAS : CEA
No symptoms in past 6 months					
ACST-2 (5 years)	32 + 59/1811 (5·3)	21 + 58/1814 (4·5)	6·4	42·4	1·16 (0·78–1·73)
CREST (6 years)	21 + 26/594 (7·9)	20 + 23/587 (7·3)	1·7	20·8	1·09 (0·62–1·91)
SPACE-2 (1 year)	1 + 2/197 (1·5)	0 + 3/203 (1·5)	0·0	1·5	1·03 (0·12–8·57)
ACT-1 (1 year)*	[6 + 0/1029] × 2/3 (0·6)	[4 + 0/364] × 2 (1·1)	−1·8	3·1	0·55 (0·13–2·41)
Subtotal: asymptomatic	58 + 87/3116 (4·7)	49 + 84/3150 (4·3)	6·3	67·7	1·10 (0·87–1·39)
Symptoms in past 6 months					
ICSS (4 years)	35 + 30/842 (7·7)	31 + 16/853 (5·5)	9·4	26·2	1·43 (0·86–2·36)
CREST (6 years)	21 + 34/661 (8·3)	21 + 31/651 (8·0)	1·1	24·6	1·05 (0·62–1·76)
SPACE (2 years)	11 + 9/601 (3·3)	10 + 1 /584 (3·4)	−0·3	9·7	0·97 (0·42–2·22)
EVA-3S (7 years)	6 + 13/263 (7·2)	8 + 14/259 (8·5)	−1·7	9·5	0·84 (0·36–1·94)
Subtotal: symptomatic	73 + 86/2367 (6·7)	70 + 71/2347 (6·0)	8·5	69·9	1·13 (0·89–1·43)
Total	**131 + 173/5483 (5·6%)**	**119 + 155/5497 (5·0%)**	**14·8**	**137·7**	**1·11 (0·91–1·32) 2p=0·21**

99% CI or 95% CI

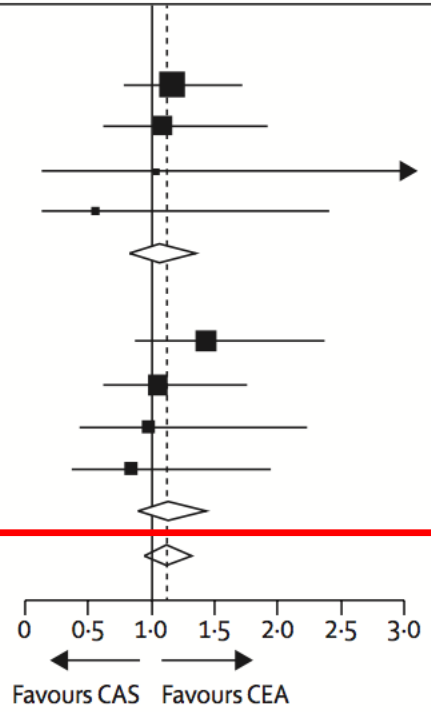

Figure 4: **Trials of CAS versus CEA for asymptomatic or symptomatic carotid stenosis—ITT analyses of non-procedural strokes (ipsilateral ischaemic stroke plus other strokes)**

Sténoses asymptomatiques + symptomatiques: effet protecteur post-procédural similaire pour CAS et CAE

Halliday et al, Lancet, 2021 (ACST-2)

Sténose carotidiennes

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Choix de la procédure: évaluation individuelle

Colloque interdisciplinaire des sténoses carotidiennes (radiologues interventionnels, cardiologues, chirurgiens cardiovasculaires, neurologues)

Mardis 17h, Etage P, salle de colloque n°4

- Limitations anatomiques: bifurcation haute, angle aorto-carotidien, calcifications
- Antécédents/co-morbidités: sténoses actiniques, sténoses post-endartériectomie, cardiopathie instable, IAMI
- Traitements concomitants (anticoagulation,…)
- Choix du patient

Screening

Recommandations US preventive services task force

Table. Summary of USPSTF Rationale: Screening for Asymptomatic Carotid Artery Stenosis

Rationale	General adult population
Detection	• Adequate evidence that duplex ultrasonography has reasonable sensitivity and specificity for detecting clinically relevant carotid artery stenosis. However, duplex ultrasonography yields many false-positive results when screening the general population. • Adequate evidence that auscultating the neck for carotid bruits has poor accuracy for detecting clinically relevant carotid artery stenosis.
Benefits of early detection, intervention and treatment	• Inadequate direct evidence that screening for asymptomatic carotid artery stenosis reduces adverse health outcomes such as stroke or mortality. • Adequate evidence that treating asymptomatic patients with carotid artery stenosis using CEA or CAS provides no to small benefit in reducing adverse health outcomes, including stroke, myocardial infarction, or mortality, compared with current medical therapy.
Harms of early detection and intervention and treatment	• Inadequate direct evidence that screening for asymptomatic carotid artery stenosis can cause harms. However, there are known harms associated with confirmatory testing and interventions. • Adequate direct evidence that treating asymptomatic patients with carotid artery stenosis using CEA or CAS can cause harms, including stroke or death. • The overall magnitude of harms of screening for and treatment of asymptomatic carotid artery stenosis is small to moderate.
USPSTF assessment	Using a reaffirmation process, the USPSTF concludes with moderate certainty that screening for asymptomatic carotid artery stenosis in the general population has no benefit and may be harmful.

Abbreviations: CAS, carotid artery angioplasty and stenting; CEA, carotid endarterectomy; USPSTF, US Preventive Services Task Force.

US Preventive Task Force, JAMA, 2021

Recommandations

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- **PAS** de screening chez patient asymptomatique sans FRCV ni maladie athérosclérotique
  - Prévalence faible (0 à 3%)
  - Risque faible (<1%/an)

- Screening envisageable (par DCV):
  - **Souffle carotidien** (53% sensibilité, 83% spécificité pour détecter une sténose de >70%)→ prédicteur du risque d'AIT (2.6%/an vs 0.9%/an), AVC (1.6%/an vs 1.3%/an), d'IM (3.7%/an vs 1.9%/an), décès de cause cardiovasculaire (2.85%/an vs 1.11%/an) - Cardiopathie ischémique, IAMI
  - **≥2 facteurs de risque cardio-vasculaire, maladie cardiovasculaire**

USPSTF, JAMA, 2021; Brott et al, Stroke, 2011; Ricotta et al, J Vasc Surg, 2011; Picket et al, Lancet, 2008; Picket et al, Stroke, 2010; Mccolgan et al, QJM, 2012

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Merci de votre attention

Sténose symptomatique

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Degré de sténose

Certainty assessment							№ of patients		Effect			
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Endarterectomy	Medical therapy	Relative (95% CI)	Absolute (95% CI)	Certainty	Importance
PICO 4.1.4a: Long-term risk of ipsilateral stroke, including peri-procedural stroke in any territory or peri-procedural death: Near occlusion												
2	Randomised trials	Not serious	Not serious	Serious[b]	Very serious[d]	None	24/157 (15.3%)	17/114 (14.9%)	RR 1.03 (0.57–1.84)	**4 more per 1000** (from 64 fewer to 125 more)	⨁◯◯◯ VERY LOW	CRITICAL
PICO 4.1.4b: Long-term risk of ipsilateral stroke, including peri-procedural stroke in any territory or peri-procedural death: Severe (70–99%) stenosis												
2	Randomised trials	Not serious	Not serious	Serious[b]	Not serious	Strong association[d]	50/518 (9.7%)	117/436 (26.8%)	RR 0.37 (0.27–0.50)	**169 fewer per 1000** (from 196 fewer to 134 fewer)	⨁⨁⨁⨁ HIGH	CRITICAL
PICO 4.1.4c: Long-term risk of ipsilateral stroke, including peri-procedural stroke in any territory or peri-procedural death: Moderate (50–69%) stenosis												
2	Randomised trials	Not serious	Not serious	Serious[b]	Serious[c]	None	101/808 (12.5%)	110/694 (15.9%)	RR 0.82 (0.58–1.15)	**29 fewer per 1000** (from 67 fewer to 24 more)	⨁⨁◯◯ LOW	CRITICAL
PICO 4.1.4d: Long-term risk of ipsilateral stroke, including peri-procedural stroke in any territory or peri-procedural death: Mild (<50%) stenosis												
2	Randomised trials	Not serious	Serious[a]	Serious[b]	Serious[c]	None	212/1762 (12.0%)	164/1413 (11.6%)	RR 1.09 (0.64–1.85)	**10 more per 1000** (from 42 fewer to 99 more)	⨁◯◯◯ VERY LOW	CRITICAL

Bonati et al, ESO guideline, European Stroke Journal, 2021

Sténose symptomatique

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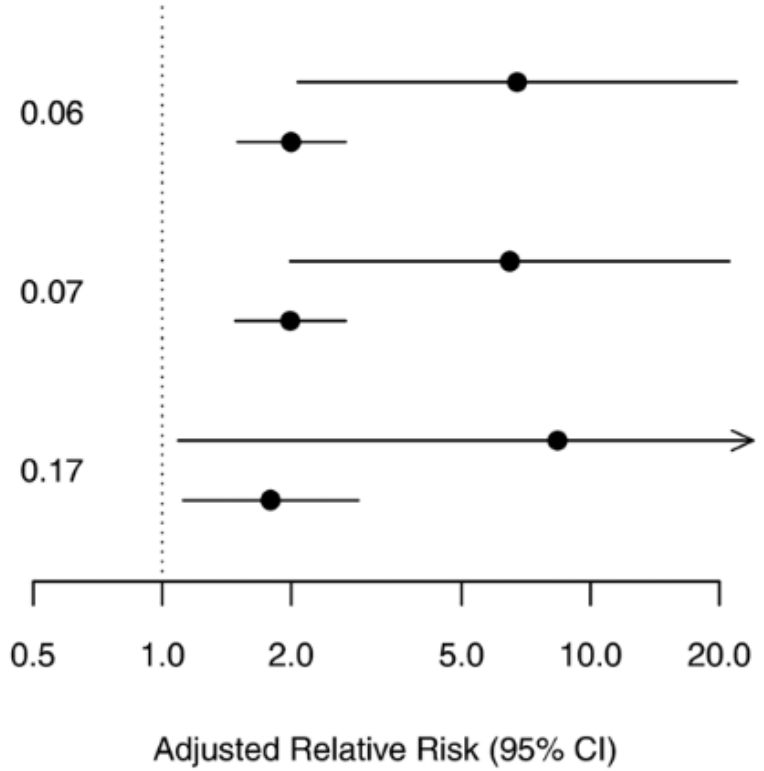
Short term outcome (<30 jours)

	CEA n event/total (%)	CAS n event/total (%)	Adjusted RR (95% CI)	*P Value*	Interaction *P Value*
Any stroke or death					
0–7 days	3/226 (1.3)	24/287 (8.4)	6.74 (2.07–21.92)	0.002	0.06
>7 days	65/1819 (3.6)	129/1806 (7.1)	2.00 (1.50–2.68)	<0.0001	
Any stroke					
0–7 days	3/226 (1.3)	23/287 (8.0)	6.48 (1.99–21.10)	0.002	0.07
>7 days	62/1819 (3.4)	122/1806 (6.8)	1.99 (1.48–2.68)	<0.0001	
Fatal or disabling stroke					
0–7 days	1/226 (0.4)	9/287 (3.1)	8.38 (1.09–64.76)	0.04	0.17
>7 days	26/1819 (1.4)	46/1806 (2.5)	1.79 (1.12–2.87)	0.02	



Rantner et al, Stroke, 2017

Sténoses asymptomatiques

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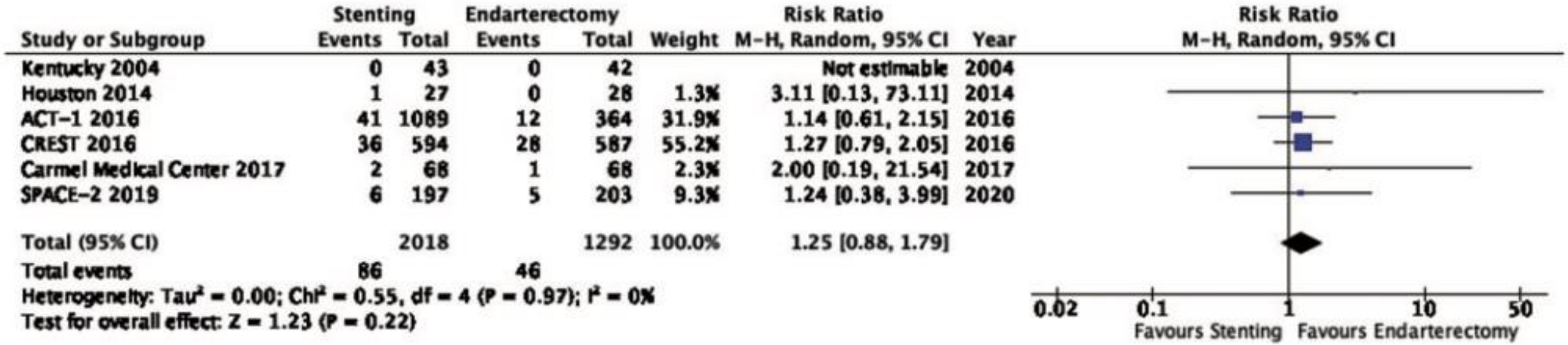
CAS vs CEA

Certainty assessment							№ of patients		Effect			
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Stenting	Endarterectomy	Relative (95% CI)	Absolute (95% CI)	Certainty	Importance
PICO 3.1: Long-term risk of ipsilateral stroke, including peri-procedural stroke in any territory or peri-procedural death												
6	Randomised trials	Not serious	Not serious	Not serious	Serious[a]	None	86/2018 (4.3%)	46/1292 (3.6%)	RR 1.25 (0.88–1.79)	**9 more per 1000** (from 4 fewer to	⨁⨁⨁◯ MODERATE	CRITICAL



Bonati et al, Eur Stroke J, 2021

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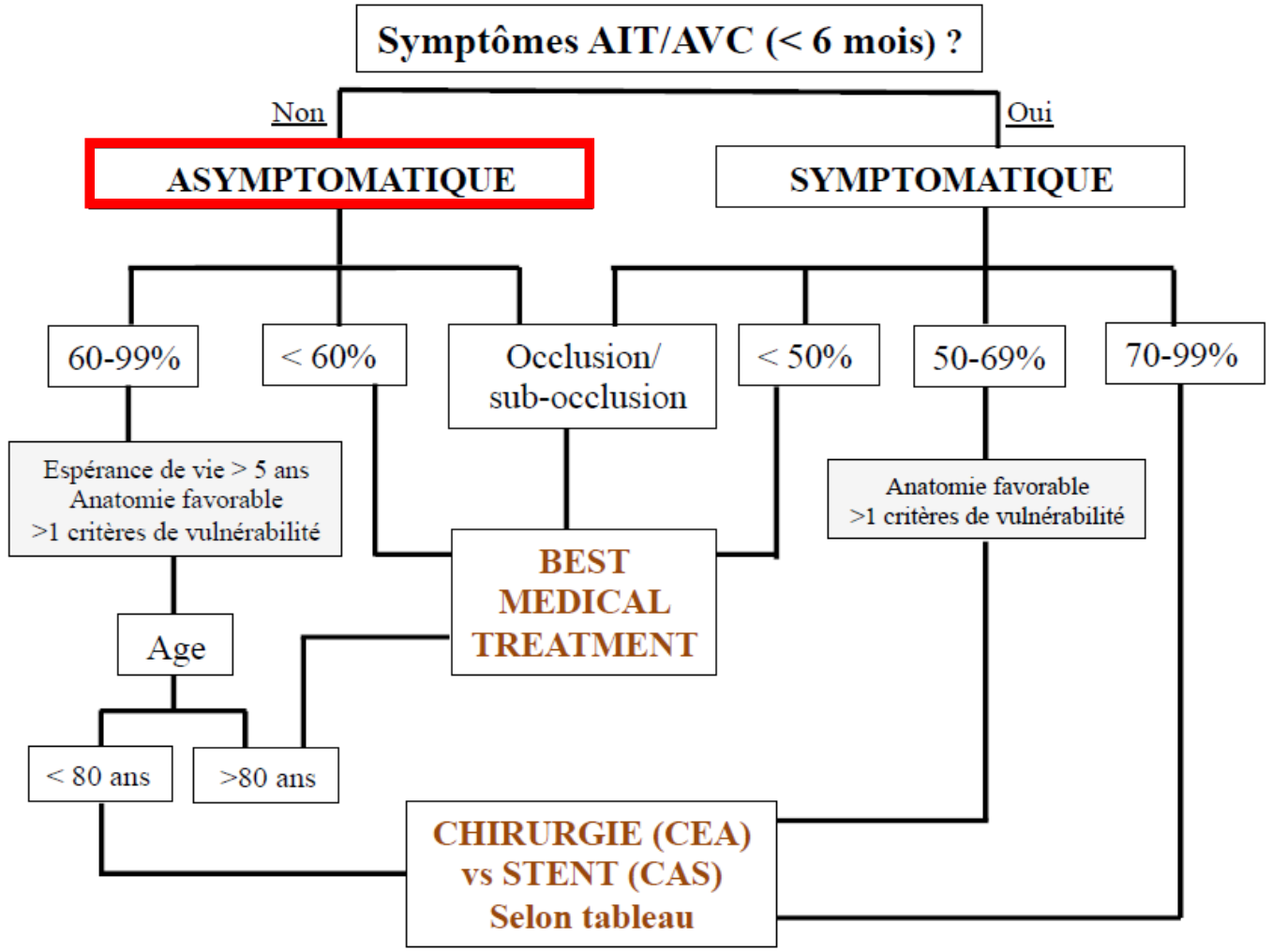

Critères de Vulnérabilité

Morphologie de la plaque
- Hypoechogène
- Irrégulière
- Hémorragique

Aggravation rapide

AVC silencieux IRM ou CT

HITS +

v.1.0 09/2018. Dre Fisch

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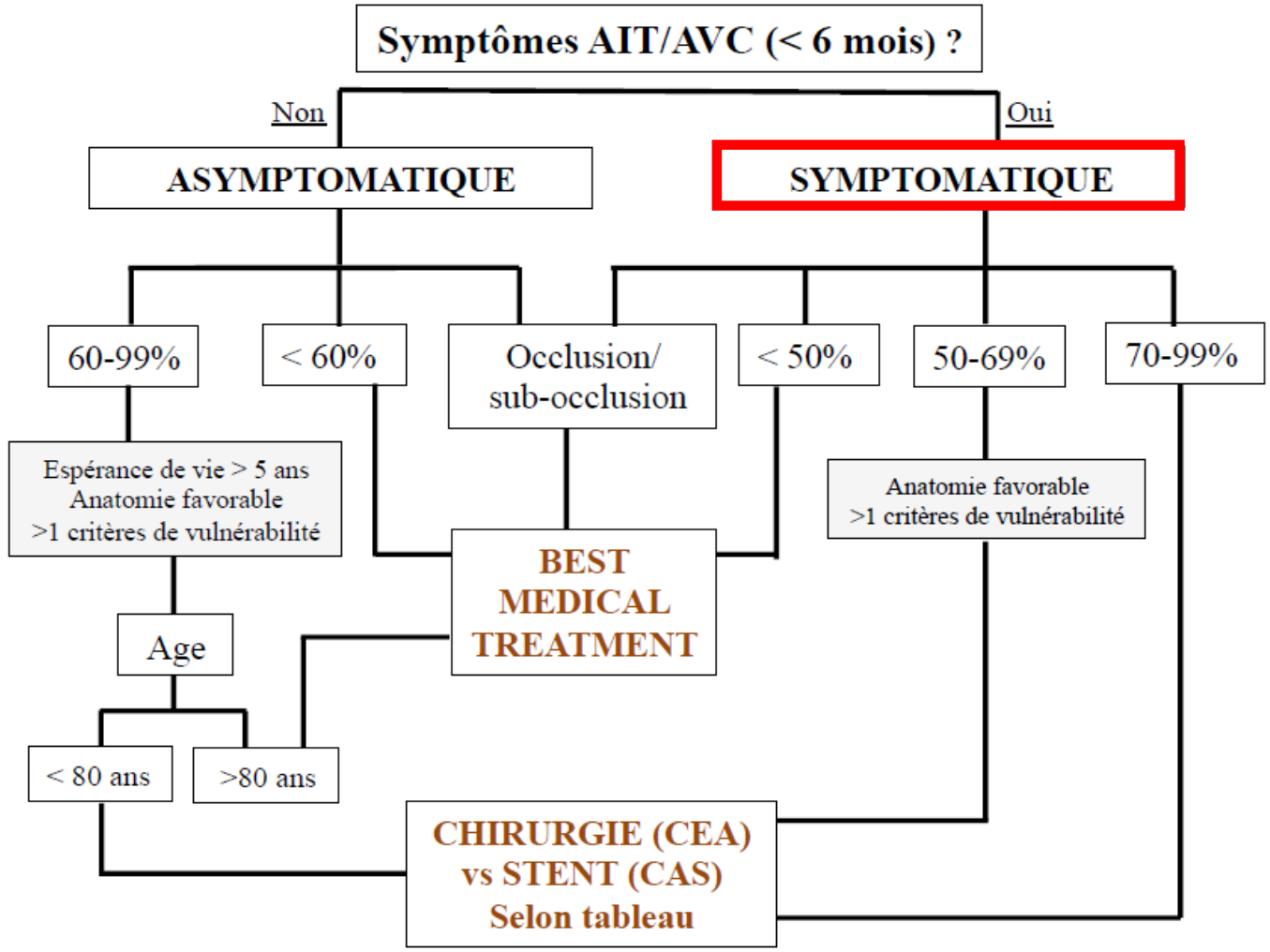
STENOSE CAROTIDIENNE



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Sténoses asymptomatiques

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En cours…

ECST-2: revascularisation carotidienne (CAS ou CEA) vs BMT pour des sténoses asymptmatiques ou symptomatiques a risque faible ou modéré d'AVC (selon un modèle de risque pré-établi) → 469 patients recrutés pour la phase test (avec imagerie).

CREST-2: 2 études parallèles: stenting vs BMT et endartériectomie vs BMT pour des sténoses asymptomatiques de ≥70%.

ACTRIS: endartériectomie vs BMT pour des sténoses asymptomatiques avec critères de gravité à l'imagerie.

Bonati et al, Eur Stroke J, 2021